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Giacomo Anastasia, Tito Boeri, Oleksandr Zholud

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RFBerlin
ROCKWOOL Foundation Berlin –
Institute for the Economy
and the Future of Work

Gormannstrasse 22, 10119 Berlin
Tel: +49 (0) 151 143 444 67
E-mail: info@rfberlin.com
Web: www.rfberlin.com

A Wartime Labor Market: The Case of Ukraine*

Giacomo M. Anastasia† Columbia University

Tito Boeri‡ Bocconi University

Oleksandr Zholud§ National Bank of Ukraine

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Abstract

Wars disrupt labor markets, yet systematic evidence on how markets for labor services operate during conflicts is almost entirely absent. Ukraine is a rare exception: despite the full-scale Russian invasion, timely data on workers and vacancies, in both stocks and flows, remain available. We use these data to document one of the largest labor supply and reallocation shocks in recent history and to estimate the impact on job matching, showing how labor markets adapt under extreme stress. The labor force shrank by about one fourth, yet vacancy filling rates and matching efficiency declined modestly. Only along the frontline and in occupied regions there is evidence of labor market shutdowns. Wage flexibility, adaptability of recruitment policies of firms, and remote working help explain the resiliency of labor outcomes. Recovering longer-term human capital losses suffered by Ukraine will require a mix of tools going well beyond labor policies and should be a priority for the reconstruction phase.

Keywords: labor supply shock, reallocation, vacancy filling rate, wartime economy, wartime labor market, Russian invasion, Ukraine.

JEL: J22, J23, J24.

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†giacomo.anastasia@columbia.edu

‡tito.boeri@unibocconi.it

§oleksandr.zholud@bank.gov.ua

1 Introduction

How does a labor market perform under the strain of a long war? To what extent do wartime labor markets differ from peacetime markets for labor services? Ukraine provides a unique setting to address these questions. Understanding such dynamics is essential for designing effective post-war reconstruction policies and offers valuable insights for economies facing mounting labor supply shortages and major reallocation. In this paper, we show that labor markets can continue to function under extreme stress through wage flexibility, expanded participation, and organizational adaptation, but geographic and skill mismatches persist, creating simultaneous unemployment and labor shortages.

The full-scale Russian invasion of Ukraine in February 2022 has generated one of the largest combined labor supply and reallocation shocks in recent history, affecting the entire national economy and labor market. Indeed, while war-related events are concentrated along the eastern and southern frontline, military operations and attacks have been documented across all Ukrainian regions. Figure 1 illustrates the geographic scope of the conflict.

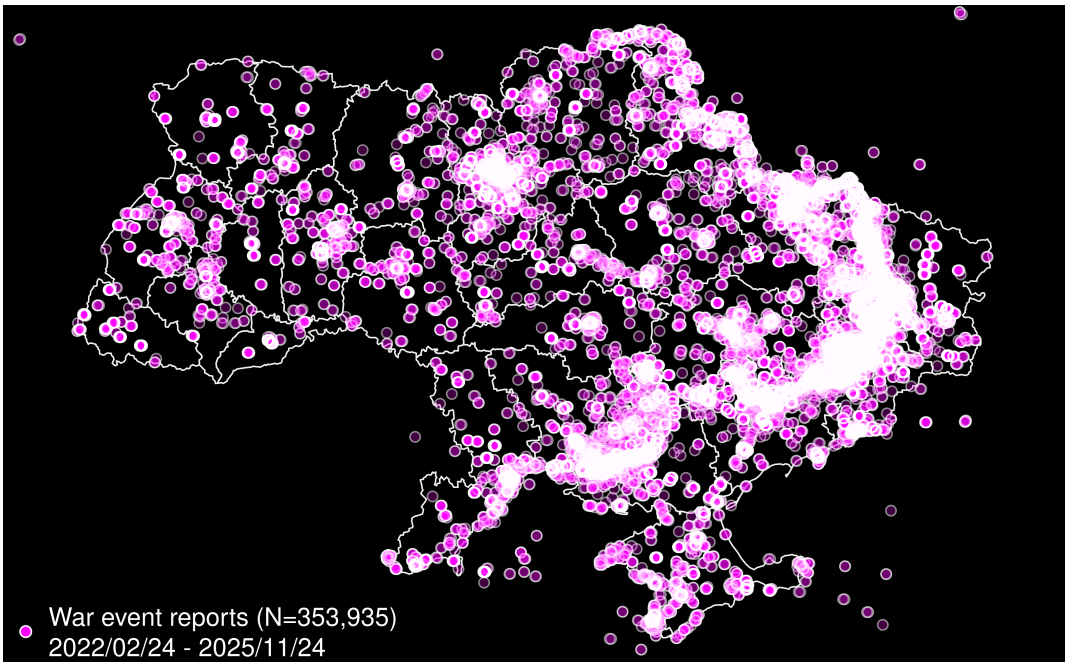


Figure 1: Geographic distribution of war-related events in Ukraine

Notes. Each point represents a geolocated report of military operations, attacks, or conflict-related incidents. The map shows conflict intensity is highest along eastern and southern frontlines but extends across all Ukrainian regions. Data cover the period from February 24, 2022 to November 24, 2025. Source: VIINA (Violent Incident Information from News Articles), available at `https://github.com/zhukovyuri/VIINA`.

As a consequence, out of an estimated population of 41 million people in 2021, almost 5.9 million left the country as refugees according to the latest estimates from the UNHCR, and another 1.2 million are reported to be in a refugee-like situation in Russia.[1] About 70% of

[1]The figure on refugees from Ukraine recorded globally is updated to December 2025. The figure on

the refugees are potential labor force participants. Out-migration alone implied an estimated reduction of about 2.8 workers. At least 700,000 citizens were mobilized into the army. By late 2025, after almost four years of war, around 70,000 Ukrainians had been killed in combat and 400,000 wounded, most of them working-age men. Civilian casualties amount to 50,000 people, between killed and injured. Millions of citizens remain under Russian occupation. Taken together, this amounts to a contraction of about one fourth of the initial labor force in areas still under government control—a negative labor supply shock of unprecedented scale.

The negative labor demand shock was also severe, though having arguably less persistent effects. At the outset of the invasion, more than 10% of firms halted operations and a further quarter downsized by more than half. New online vacancies posting decreased by half during the first year after the full-scale invasion. Firms faced abrupt contractions in demand, severe input shortages, and disruptions of infrastructure. By 2025, however, more than half of the surviving firms had resumed production at 75–100% of pre-February 2022 levels. Firms began to report labor shortages soon after the invasion. The main initial business obstacles were rising input prices, blackouts caused by attacks on energy infrastructure, and transport bottlenecks. By late 2024, however, labor shortages had become the most pressing constraint identified by employers.

Shortages were amplified by the massive and multidimensional reallocation taking place as a result of the war. Employment patterns shifted sharply by sectors and regions, reshaping trends in structural change.[2] Entire local labor markets near the frontline collapsed, with no vacancies or workers left. By any historical precedent, one would have expected a prolonged surge in unemployment in more exposed areas, soaring mismatches, and a collapse in matching efficiency. Yet, aggregate outcomes suggest an ability to reallocate labor with surprising speed under conditions of extreme stress. The unemployment rate surged briefly to over 26% in 2022, but later stabilized near 13%, not too far from its pre-invasion level of around 9%. As we document in this paper, the decline in matching efficiency was modest in less exposed regions given the type of frictions that one should expect in a wartime labor market, while the sharpest deterioration was concentrated in frontline areas.

A variety of explanations can be offered for this resilience of the matching process. On the demand side, firms adjusted recruitment practices and work organization, making broader use of remote work and opening traditionally male-dominated occupations to women, supported by temporary changes in labor regulations. Employers also relied more extensively on older workers and persons with disabilities. On the supply side, some refugees and internally displaced persons continued to provide services remotely, maintaining attachment to Ukrainian firms despite physical dislocation. Wage-setting practices also contributed: with the statutory minimum wage frozen in 2022–2023 and thus becoming less binding in real terms, nominal and real wages adjusted downward in the immediate aftermath of the invasion. Wage dispersion widened, but the gap between posted and asked wages narrowed again after an initial increase, easing reallocation. These combined adjustments mitigated

Ukrainian persons in Russia has not been updated since June 2023. Source: `https://data.unhcr.org/en/situations/ukraine`.

[2]Ukraine's territory is divided in 24 oblasts, one autonomous republic (Crimea) and two cities with special status (Kyiv and Sevastopol). We use the terms regions and oblasts interchangeably.

the unemployment costs of both the negative demand shock and the large-scale reallocation process.

Understanding how labor markets work during wars requires going beyond aggregate outcomes. While the economics of war is a growing area of research, the literature has primarily focused on the macroeconomic consequences of conflict, documenting large and persistent negative effects of wars on output and growth. Recent examples include Benmelech and Monteiro (2025); Chupilkin and Koczan (2022); Federle et al. (2024). Specific to the purpose of this paper, research on labor markets has focused on *post-conflict* reconstruction and reintegration. In related work, Anastasia et al. (2022) review the evidence on the aftermaths of conflicts in Eastern Europe from the late 20th century onward and draw lessons for Ukraine's reconstruction. Three points emerge. First, displacement worsens labor market outcomes, with internally displaced persons and returnees experiencing persistent employment and wage penalties (Kondylis, 2010; Torosyan et al., 2018). Second, wars generate large losses of human capital, particularly through the interruption of education and the destruction of training capacity (Eder, 2014; Swee, 2015). Third, conflict has long-lasting effects on both physical and mental health, with trauma, stress, and deteriorating well-being reducing labor supply and productivity even among non-combatants (Bratti et al., 2015). Beyond individual outcomes, conflict also affects labor markets through its longer-term impact on firm performance, informality, and local economic development (Petracco and Schweiger, 2012).

Much less is known about the granular functioning of large economies *during* wars, especially interstate wars with sustained attacks on civilian infrastructure. From a labor market point of view, it is a setting fundamentally distinct from economies engaged in extra-territorial conflicts without domestic disruption, geographically limited conflicts, or civil wars.[3] Arguably, the main reason why we know remarkably little about how labor markets function in wartime is the scarcity and unreliability of data. Past major wars either occurred in historical periods (e.g., World Wars) or institutional settings (e.g., Iraq War) where robust data collection on workers and firms was not yet available.

The Ukrainian case is rather exceptional: it represents the first modern, large-scale, and protracted war in which timely labor market data on stocks and flows remain available. This reflects the country's digital infrastructure, including online platforms for job postings and public administrative data systems, which have partially continued to operate despite the conflict. While not immune to war-related data challenges, such unique data availability opens an opportunity to study how a labor market functions under active conflict.

This paper offers the first comprehensive analysis of how a labor market functions during a major war fought on its own territory, examining matching efficiency, reallocation across sectors and regions, and firm adjustment mechanisms. We begin by documenting the key

[3]This is also a key difference with the Russian economy. Russia wages war extra-territorially, with combat occurring outside its borders. Russian cities, infrastructure, and civilian populations remain unaffected by direct military operations, allowing labor markets to function without the displacement, destruction, and ongoing threats that characterize Ukraine's experience. Moreover, Russia's much larger population means that mobilization represents a smaller proportional shock to its civilian labor force. Recent reports indicate that Russia's labor market is characterized by record-low unemployment (around 2.4% as of late 2024) and widespread labor shortages reported by firms.

wartime shocks, quantifying the magnitude of labor supply and demand losses. We then examine geographical and sectoral reallocation and aggregate labor market dynamics. Next, we estimate an aggregate matching function, tracing how efficiency evolved before and after the invasion across regions experiencing different intensities of conflict exposure. To our knowledge, no prior study evaluates the matching of job seekers and vacancies in a wartime economy. Then, we turn to firm-level adjustment mechanisms that helped sustain matching efficiency, focusing on recruitment practices, remote work, and wage-setting. Finally, we turn to normative analysis discussing how well the labor market is adjusting to wartime needs and how to best prepare for the peacetime, and mitigate the massive human capital losses caused by the war. Beyond informing Ukraine's reconstruction, our findings offer insights for understanding how large labor markets adapt to extreme shocks more generally, whether from conflicts, natural disasters, or pandemics.

Our analysis draws on a variety of data sources, as well as publications from government agencies and private research institutions monitoring labor market developments since the full-scale invasion in February 2022. Studying such a complex environment requires making several assumptions, which we describe throughout the text. Before proceeding, we clarify three important points about our approach. First, when referring to the labor market, we mean the *civilian* labor market. For security reasons, access to data on the military sector and personnel is restricted, thus our analysis excludes employment in the armed forces. We treat military mobilization as a contraction of the civilian labor supply. Second, we mainly consider the *formal* labor market, as no data on the informal sector are available after 2022.[4] Third, to maintain a stable sample with reliable data, we focus on Ukraine's government-controlled territory, thus excluding Crimea (occupied by Russia since 2014). In the matching analysis, we further exclude the partially occupied regions of Donetsk, Luhansk, Kherson, and Zaporizhzhia.

A final note. Analyzing labor markets through the fog of war presents inherent challenges: territories get conquered and liberated, populations are displaced, infrastructure is destroyed, defense production surges while consumer sectors contract, and regulatory frameworks adapt in real time. Data are incomplete, measurement is imperfect, and overlapping endogenous moving parts often make clean causal identification unfeasible. Our contribution is therefore primarily descriptive—documenting how markets functioned, what patterns emerged, and which mechanisms operated under extreme conditions. In a context where systematic evidence has been entirely absent, careful documentation of facts represents a crucial first step toward understanding wartime labor market dynamics.

The plan of the paper is as follows. Section 2 describes wartime data. Section 3 quantifies supply and demand shocks. Section 4 analyzes the reallocation dynamics. Section 5 estimates the matching function. Section 6 presents evidence on firm-level adjustments. In Section 7, we draw policy implications. Lastly, Section 8 concludes.

[4]When using online job platform data, we may capture some informal employment, though this likely represents a limited share of total informal activity.

2 Wartime Data

This section describes our multiple data sources and discusses their limitations.

2.1 Before and after the full-scale invasion

Prior to the full-scale invasion of Ukraine by Russia in February 2022, the main source of data on labor market conditions was the quarterly Labor Force Survey (LFS) carried out by the State Statistics Service of Ukraine (SSSU). The LFS, based on a representative stratified random sample of around 16,000 households per month, provided systematic information on economic activity across demographic and regional groups. The survey generated harmonized indicators on labor force participation, employment (formal and informal), unemployment, and economic inactivity, with breakdowns by age, gender, education, and region. These data represented the core input for labor market monitoring and policy design in Ukraine, and also enabled cross-national comparisons within Europe and beyond. In addition to household survey data, the SSSU collected enterprise-level statistics. These included average wages by sector on a monthly basis, as well as more detailed quarterly indicators such as wage distributions by gender and economic activity, and enterprise labor costs. Taken together, the household and enterprise surveys constituted the backbone of Ukraine's pre-war labor market statistics, and were widely regarded as reliable and comprehensive. Thus, no alternative data collection with the same scale and scope was in place.

The outbreak of the full-scale war abruptly disrupted Ukraine's statistical system. The SSSU suspended publication of many indicators and, due to the occupation of territories and safety concerns, ceased collecting household survey data - the main source for labor market statistics. As a result, in this paper we are forced to rely on alternative sources of information.

One such source is the quarterly household survey conducted by the research agency Info Sapiens, which has been used by the National Bank of Ukraine (NBU) since 2021. Originally designed to monitor household finances (including transfers from abroad and indebtedness), the survey also collects information on respondents' demographic characteristics (age, gender, location) and labor market status. This has provided a valuable alternative dataset for estimating labor force participation as well as employment and unemployment rates. The Info Sapiens survey interviews around 1,000 individuals aged 16 and older every quarter, using mobile telephone numbers. Sampling is stratified by gender, age, settlement size, and region, according to the pre-war population structure reported by the SSSU. Surveys are not conducted in Crimea, Sevastopol, or other occupied territories where Ukrainian mobile operators do not operate.[5]

We also draw on data from the largest online job-search platform in Ukraine (involving about 125,000 firms and 4.5 million workers). Several such platforms exist in the country,

[5]The reported margin of error does not exceed 3.1%. On employment status, respondents can choose only one option among: employed, self-employed, retired, running a household, temporarily unemployed (and looking or not looking for work), registered private entrepreneur, student/pupil, serving in the Armed Forces (added in October 2022), other, or no answer. Source: `https://www.sapiens.com.ua/en/`.

including both specialized portals (e.g. for IT) and general-purpose sites.[6] In particular, we rely on the weekly aggregate statistics publicly released by Work.ua, which reports: (i) the total stock of resumes and vacancies on the site, (ii) the weekly inflow of new resumes and vacancies, and (iii) monthly expected wages (from resumes) and offered wages (from vacancies). These figures are broken down by 29 categories and by Ukraine's 24 regions, plus Crimea.[7] Similar online vacancy data have been used to study wartime labor demand and wage adjustments in Ukraine and Poland between January 2021 and November 2022 by Pham et al. (2023).

In order to analyze recruitment policies of firms after 2022, we draw on data collected by the State Employment Service (SES) in cooperation with Helvetas Swiss Intercooperation. This cross-sectional survey, conducted in January 2025, covers 55,000 enterprises employing 4.2 million workers as well as 70,000 registered unemployed persons. More details are provided in Appendix G. To assess the extent of sectoral reallocation during the war, we rely on annual data from the State Statistics Service of Ukraine (SSSU) on enterprise sales, investment, employment, and wage bills, which continued to be collected after the invasion.[8] A further source is the quarterly average of monthly wages by economic activity. Before the full-scale invasion, the SSSU published similar statistics on a monthly basis, including employee counts by sector, based on enterprise reports for firms with 10 or more employees. Since 2022, however, direct wage statistics have been discontinued for security reasons. As a result, institutions such as the National Bank of Ukraine (NBU) have produced indirect estimates, relying on budgetary data on personal income tax (PIT) and the Single Social Contribution (SSC). Because the budget distinguishes between revenues and expenditures, SSC payments from the public sector can be separated, while private-sector SSC is computed residually as the difference between total SSC and the public-sector component.

2.2 Data quality

While concerns had occasionally been raised about the pre-2022 SSSU household survey, it was generally regarded as high-quality: the survey followed International Labour Organization (ILO) methodology, relied on face-to-face interviews, and covered a large monthly sample. By contrast, the Info Sapiens survey used by the NBU as a temporary alternative has several limitations: the sample is much smaller (around 1,000 respondents), it is conducted quarterly rather than continuously, and it relies on telephone interviews, excluding potential respondents without mobile phones or in areas with poor connectivity, especially near the frontline. Nevertheless, when we compare labor force participation and unemployment rates for 2021 - the only overlap year - the results from Info Sapiens are broadly consistent with SSSU figures, with differences explained by sample size and timing. Despite its shortcomings, it remains the main regular survey-based source during the war.

[6] Examples of widely used job platforms are Jooble, Work.ua, and Robota.

[7] In this online platform, categories refer to sectors or occupations. For example, one category is *Agriculture*, another is *Top management*.

[8] The definitions and scope of these data follow the EU Regulation on Structural Business Statistics (Regulation (EC) No 295/2008), ensuring comparability across activities and over time.

A broader challenge concerns uncertainty about the size and composition of Ukraine's population itself, which affects the sampling frame for all household surveys. There are only partial estimates of how many people remain under occupation, have migrated abroad or internally, or have died either from the war or from unrelated causes. Revisions of official refugee statistics, discussed in Appendix A, illustrate these difficulties. Info Sapiens applies survey weights based on pre-war population distributions by age, gender, region, and settlement size as of January 1, 2022. This ensures comparability with the pre-invasion structure, though it may not fully capture demographic changes since the war.

By contrast, data from online job platforms are less affected by population uncertainty. The statistics are based on the number of resumes and vacancies submitted through standardized forms requiring the selection of region and sector categories. Although fake entries are theoretically possible, they can be flagged and removed, and there is little incentive to create them either before or after the invasion. We therefore regard these data as sufficiently reliable for our analysis.

3 Quantifying the Aggregate Shocks

The full-scale invasion generated a constellation of simultaneous shocks to the Ukrainian labor market, which interacted with each other in complex ways: firms and workers were often forced to move across regions, sectors, or even out of the country, while the constant threat of attack reshaped investment, hiring decisions, and household labor supply. As a result, the war has not produced a single uniform shock but rather a set of deeply heterogeneous impacts. Understanding the extent and nature of labor market reallocation is thus essential to assess both the immediate and longer-term consequences of the Russian invasion of February 2022.

These dynamics should be interpreted in light of three important considerations. First, Ukraine has faced a sustained decline in the size of its labor force even before the full-scale invasion, driven by demographic aging, migration, and prior conflict. The labor force fell from 21.98 million in 2013 to 19.92 million in 2014 following the Russian annexation of Crimea and initial occupation of parts of Donetsk and Luhansk, and further declined to 18.1 million in 2015. This downward trajectory continued in subsequent years. Second, two prior shocks complicate the analysis of employment trends: the 2014 annexation of Crimea and the 2020 COVID-19 pandemic, which introduced heterogeneous disruptions across sectors and regions. Third, the informal sector in Ukraine is sizable (estimated at about 3 million people in 2021) and its importance might have increased after the full-scale invasion, as firms and workers sought ways to adapt under conditions of uncertainty and displacement. With these caveats in mind, we first document the magnitude of the shocks and their aggregate impacts, and then turn to the geographical and sectoral heterogeneity of their effects.

3.1 The magnitude of labor supply and demand shocks

Table 1 summarizes our estimates of wartime labor market shocks, on both the supply and demand side. The calculations for the supply side, detailed in Appendix A, are restricted to government-controlled areas and measure the cumulative impact of the war from February 2022 through 2025. We report baseline, high, and low scenarios based on alternative assumptions. On the demand side, we use three complementary approaches: counterfactual employment based on firm turnover data holding productivity constant at pre-war levels, firm-reported output levels compared to pre-invasion production, and the collapse in vacancy postings following the invasion. Taken together, the table provides a quantitative benchmark for the magnitude of wartime disruptions in Ukraine's labor market.

On the labor supply side, migration of Ukrainians abroad was the most significant shock. Before the full-scale invasion, Ukraine's resident population was estimated at 41 million, with a labor force of 17.3 million. According to the latest data from UNHCR, 5.9 million Ukrainians were registered as refugees abroad as of late 2025.[9]

The demographic composition of Ukrainian refugees reveals a clear prevalence of working-age women. According to Eurostat, there were 4.2 million beneficiaries of temporary protection in the EU at the end of May 2025.[10] Of these, 60% were women, a percentage that was even higher right after the full-scale invasion (68% in August 2022).[11] This skew toward women reflects the severe restrictions on the ability of men of mobilization age to leave the country. In terms of age, 69% of beneficiaries were 18 years or older as of May 2025, implying that the majority of the refugee population is of working age. An initial UNHCR survey of refugees, carried out in July 2022 (UNHCR, 2022), found that 80% of respondents had been economically active prior to leaving Ukraine (76% employed and 4% unemployed). This share is markedly higher than in Ukraine as a whole before the full-scale invasion, where the labor force participation rate in the last quarter of 2021 was 54% of the population aged 15 and older.[12] The evidence therefore suggests a strong selection effect: those who left the country were disproportionately drawn from the economically active population.

A second major component is military mobilization. Estimates suggest that more than one million Ukrainians are currently serving in the armed forces and other defense organizations, of whom about three-quarters have been mobilized since 2022, combining voluntary enlistments and military draft. While military personnel remain part of the labor force in a statistical sense, we treat the wartime expansion of the army and other defense formations as a contraction of

[9]Source: `https://data.unhcr.org/en/situations/ukraine`. In addition, the Russian Federation has reported hosting over 1.2 million persons displaced from Ukraine, though these figures have not been updated since June 2023 and are no longer included in UNHCR's official statistics.

[10]The EU's Temporary Protection Directive (2001/55/EC) was activated for the first time in March 2022 in response to the Ukrainian refugee crisis. It grants immediate residence, access to the labor market, housing, health care, and education for displaced persons, without the need to undergo individual asylum procedures and thus allowing refugees to choose their country of destination within the EU. As argued in Anastasia et al. (2022), this has led to a more balanced spread of refugees if compared to previous displacement episodes (such as Syrian refugees in 2015) and likely facilitated their integration in host countries.

[11]Source: `https://ec.europa.eu/eurostat/databrowser/product/page/MIGR_ASYTPSM`.

[12]The higher economic activity of Ukrainian refugees is also supported by a report from the National Bank of Poland (2024). Ukrainians in Poland exhibited higher labor force participation rates than Poles, and this difference persisted even after re-weighting Polish data to match the age distribution of Ukrainian migrants.

Table 1: Labor market shocks

Labor supply shock

	Baseline (mln)	High	Low
Refugees	6.62	6.90	5.40
of which exits from labor force (A)	2.81	2.95	2.27
Increase in military & defense	0.75	0.80	0.70
of which exits from labor force (B)	0.51	0.54	0.48
Military casualties	0.47	0.53	0.41
of which exits from labor force (C)	0.13	0.16	0.11
Civilian casualties	0.06	0.06	0.06
of which exits from labor force (D)	0.02	0.03	0.02
Reduction in LF participation among stayers (E)		0.68	
Total LF change in controlled territory -(A+B+C+D+E)	-3.48	-4.36	-2.87
Labor force drop in government-controlled territory	-22%	-28%	-18%

Labor demand shock

	Total (mln)	% of pre-war
Overmanning assuming constant productivity (adm data)		
Year 2022	-2.95	-17%
Year 2023	-2.46	-14%
Year 2024	-1.83	-10%
Employment in firms with excess capacity (survey of firms)		
Year 2022		-13%
Year 2023		-10%
Year 2024		-10%
Year 2025		-9%
Hiring freeze: drop in the stock of online vacancies		
One month window	-0.03	-37%
One year window	-0.05	-55%

Notes. Labor supply shock calculated for November 2025, excluding 7-11% of pre-war labor force under Russian occupation. Reference: 15-70 age group. Casualties include deaths and wounded; approximately 50% of wounded soldiers returned to active duty and are counted in the military & defense category. Labor demand from turnover in administrative data: Counterfactual private sector employment reduction applying 2021 productivity to post-invasion output. Percentages relative to total 2021 pre-war employment by firms (52% of total employment), assuming demand for self-employment and public sector employment did not change. Labor demand from firm survey: Output decline adjusted for private firm share. Hiring freeze: Drop in online vacancy stock around February 24, 2022. Details in Appendix A.

the civilian labor supply, because mobilization withdraws working-age men from the civilian economy. Also, this increase might be permanent for some time. The decrease in labor force

is not one-to-one because volunteers and draftees were not all labor force participants (e.g. students). Official data on military personnel is not available.

A second major component is military mobilization. Estimates suggest that more than one million Ukrainians are currently serving in the armed forces and other defense organizations, of whom approximately three-quarters have been mobilized since 2022 through voluntary enlistments and military conscription. While military personnel remain part of the labor force in a statistical sense, we treat the wartime expansion of the army and other defense formations as a contraction of the civilian labor supply, because mobilization withdraws working-age men from the civilian economy. This increase is likely to persist for some time even after the conflict ends. The labor force loss is not one-to-one with mobilization, as not all volunteers and conscripts were labor force participants prior to enlistment (e.g., students). Official data on military personnel are classified and unavailable.

Military and civilian casualties represent a third component, though estimates are subject to considerable uncertainty. President Zelensky announced in February 2025 that over 46,000 Ukrainian soldiers had been killed and 380,000 wounded, though approximately 50% of the wounded recovered and returned to active duty.[13] Other sources report somewhat higher figures.[14] For civilian casualties, United Nations monitoring recorded more than 15,000 deaths and approximately 40,000 injuries by late-2025.[15] We estimate labor force losses from casualties by accounting for deaths and the reduced labor force participation of injured individuals who become disabled.[16] Our estimates constitute a lower bound, as comprehensive data on long-term disability among war casualties remain incomplete.

Finally, in the high scenario we also incorporate the decline in participation related to the war among stayers, as measured by the InfoSapiens 2024 survey, and potentially driven by school closures, childcare or injured care burden, and mental stress inhibiting from work.

Overall, migration, mobilization, and casualties reduced the effective labor force in areas controlled by the government by between 18% and 28% of the pre-war levels. The shock occurred to a large extent at the outset of the war and was persistent as four years down the road from the invasion return migration has been very limited in scope, military mobilization has increased and unfortunately also the count of casualties. This is one of the largest labor supply shocks of modern history. It can be compared to the population losses (about 30%) experienced by Serbia during the First World War or to the effects of the Nazi invasion of Russia in 1941 causing a massive population displacement or to the Rwanda genocide, which between April 1994 and July 1994 led to the loss of roughly 30% of its population, either killed or migrated to neighboring countries, with a resulting labor force reduction of 40-50%.

On the labor demand side, firms faced relocation, destruction of physical capital, heightened uncertainty, and abrupt changes in product markets and supply chains. However, quantifying the labor demand shock is particularly challenging due to data limitations. Em-

[13]Source: `https://kyivindependent.com/over-46-000-ukrainian-soldiers-killed-since-start-of-war-zelensky-says/`.

[14]Counts based on public reports suggest a death toll of 75,000 soldiers. Source: `https://ualosses.org/en/`.

[15]Source: `https://ukraine.ohchr.org/en`.

[16]For military casualties, we exclude those who returned to active duty from the labor force loss calculation, as they are already counted in the military & defense category.

ployment levels are equilibrium objects, available data do not allow us to distinguish layoffs from voluntary separations, and firm closures are difficult to measure, as many business units may have relocated or scaled down production without being formally recorded. Nevertheless, several approaches can help bound the magnitude of the demand-side disruption. We construct a first counterfactual using administrative data on enterprise turnover and employment. We calculate what employment would have been if firms maintained their 2021 labor productivity (output per worker) while generating their actual post-invasion turnover. This exercise isolates the mechanical effect of output contraction on labor demand, abstracting from productivity changes and other adjustments. Under this constant-productivity assumption, firms would have required 2.95 million fewer workers in 2022. We scale the private-sector estimates by the private dependent employment share (52% of total employment) to express demand shocks as percentages of total pre-war employment, assuming civilian labor demand in the public sector and self-employment did not change. By 2024, the implied reduction in labor demand had moderated to 1.83 million workers (10% below baseline), reflecting partial recovery.

Another measure of the demand shock can be obtained from the IER monthly enterprise survey, which asks firms to compare their current output to the period before February 2022 (Figure 2). In the first months after the invasion, around 10% of firms reported halting operations entirely, and more than 30% were still active but at half capacity or less. Conditions gradually stabilized over the following years, yet a majority of firms still continued to operate below pre-war capacity in 2025.[17] We again scale by the private firm employment share to express output-based demand losses relative to total pre-war employment. The estimates are similar to those obtained from the administrative data on firms turnover and employees.

A measure of the hiring freeze can be obtained by looking at the number of online vacancies posted on Work.ua. During the first month after the full-scale invasion the stock of open vacancies on the platform declined by about 77%—from roughly 93,000 on 22 February 2022 (two days before the invasion) to 21,000 on 22 March 2022. Comparing average vacancy stocks over one-month windows around the invasion date yields a decline of 37%. When comparing average vacancy stocks over the twelve months before and after the invasion, the decline amounts to about 55%. These reductions compare with falls of 20 to 30% in the number of posted vacancies in the US and the UK at the outset of the Great Financial Crisis of 2008-9, as reported by BLS and ONS respectively. Fluctuations in online vacancies are generally significantly larger (about 50% larger in the US) than at the aggregate level.

Thus, data on vacancy postings and on the degree of capacity utilization point to a major shock occurring also on the demand side, although somewhat comparable to evolutions in OECD countries during the Great Financial Recession, and arguably less persistent than the labor supply shock. Taken together, evolutions on the supply and demand side highlight the scale of wartime disruptions to Ukraine's labor market.

[17] Despite being gradual, the recovery has not been even: in the second half of 2024, a combination of concerns about a repetition of strikes on Ukrainian energy infrastructure and weaker GDP growth caused chiefly by labor shortages (partially due to the more active mobilization processes) led to a temporary increase in the share of enterprises which reported capacity utilization below 25%. This suggests that, although the initial collapse was partially reversed, some wartime disruptions have imposed a persistent drag on productive capacity and labor demand.

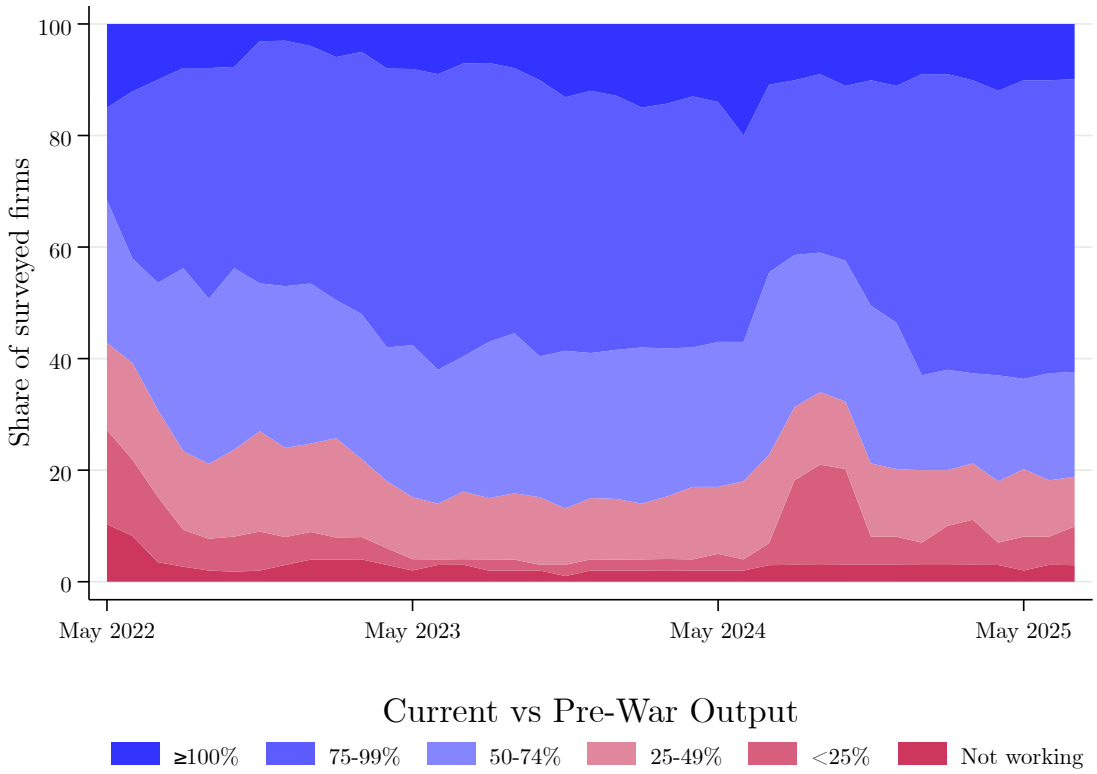


Figure 2: Enterprises output compared to pre-invasion levels

Notes. The survey uses a panel sample that includes around 500 enterprises located in 21 regions of Ukraine (all oblasts excluding Donetsk, Luhansk, Kherson). The survey is conducted monthly, respondents might slightly vary across time. Source: IER enterprises survey.

4 The reallocation shock

In addition to these aggregate shocks, the labor market was characterized by a major reallocation shock taking place across various margins: regions. sectors, occupations, public vs private sector, formal vs. informal sector, small business vs large firms. The Lilien index (Lilien, 1982), in the Ansari et al. (2014) version provides a summary statistics on the extent of labor reallocation. It measures deviations of firm or sector-specific employment growth rates from aggregate employment growth.[18] Formally, the index is defined as:

$$LI_t = \sqrt{\sum_i s_{it} \left[\ln\left(\frac{x_{it}}{x_{it-1}}\right) - \ln\left(\frac{X_t}{X_{t-1}}\right) \right]^2}$$

where x_{it} denotes the measure of interest (total employment, inflows of vacancies and resumes) for unit i (either an economic activity or a region) at time t, X_t is total employment, and

[18]Unfortunately, firm-level data enabling to estimate job turnover and its components (Davis and Haltiwanger, 1992) are not available.

$s_{it} = x_{it}/X_t$ is the employment share of unit i. The index takes value 0 when all units grow at the same rate as the aggregate, and increases with the dispersion of growth rates across units. Higher values of the index point to faster structural change and greater reallocation of employment across units.

Table 2: Average Lilien Index

Source	Indicator	Dimension	Period	
			2017-2019	2022-2024
Administrative data	Total employed (private sector)	Sectors	0.92	1.05
		Regions	0.81	1.11
Online job platform	Inflows of vacancies	Categories	0.34	0.51
		Regions	0.29	0.55
	Inflows of job seekers	Categories	0.30	0.34
		Regions	0.23	0.44

Notes. The table reports block averages of the Lilien index (LI) comparing 2017–2019 and 2022–2024; 2020 is excluded to avoid COVID-related distortions. For administrative data, LI is computed yearly at the NACE 3-digit level. Public-sector activities are excluded. Forestry subsectors 02.1 and 02.2 are aggregated into "forestry and logging." Employment observations that are missing or non-positive are dropped; groups must have at least two years of data. Regional LI uses region-year totals. For the online job platform data, LI is computed monthly across categories and regions, using vacancy and resumes inflows; groups must have at least two months of data. Block averages are the mean of the LI within each period; the first time point within each group is omitted by construction of the index. Sectoral definitions in administrative data and platform categories do not perfectly overlap.

Table 2 displays the Lilien index across sectors, regions and job categories, averaging values over the pre-war and pre-COVID years (2017–2019) and the post-war years (2022–2024). We rely on two complementary sources: yearly administrative data on private-sector employment, and monthly job-platform data on the inflows of resumes (job seekers) and vacancies (job offers). The table suggests that structural change did accelerate after the start of the full-scale invasion. According to administrative employment data, the Lilien index rises from 0.92 to 1.05 across sectors and from 0.81 to 1.11 across regions. The evidence from the online job platform data is consistent: both vacancy postings and job-seeker inflows exhibit higher dispersion in the post-war period, suggesting intensified reallocation. The increase is sizable in both job categories (a combination of sectoral and occupational classifications), and regions.

4.1 Measuring exposure to war

In order to better characterize the nature of this reallocation, notably across regions, we need first to measure the exposure to war disruptions. We do so using air raid alarm data.[19] Air-raid sirens are triggered when missile or drone attacks are detected and remain active for the duration of the event. They therefore provide a high-frequency, time-varying proxy

[19]We use data from this online repository: `https://github.com/Vadimkin/ukrainian-air-raid-sirens-dataset`. We restrict our attention to alerts from official sources.

for the intensity of local wartime exposure since the onset of the full-scale invasion. We construct three alternative exposure metrics at the oblast level: (i) the total duration of alarms measured in hours, (ii) the number of alarm events per 10,000 residents, and (iii) the number of days with at least one active alarm. All three measures yield qualitatively similar results. We provide details on the construction of the metrics and robustness in Appendix C. For expositional purposes, in this section we use the total duration of alarms as our primary metric, which is obtained by summing how long alerts lasted over different air-raid sirens episodes. This measure enables us to partition Ukraine's oblasts into the four categories displayed in Figure 3.

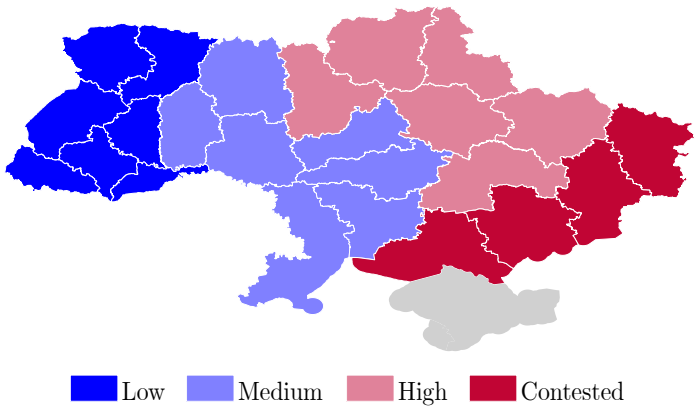


Figure 3: Ukrainian oblasts by exposure (duration of alarms)

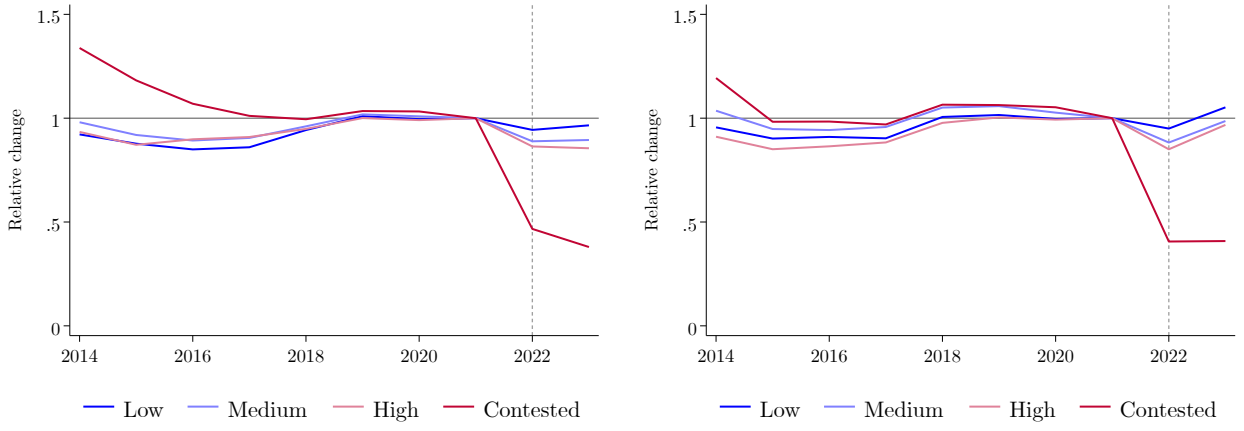
Notes. Exposure categories based on total duration of air raid alarms (in hours) from February 2022 to October 2025. Contested oblasts (Donetsk, Luhansk, Kherson, Zaporizhzhia) are hand-coded due to partial or complete occupation. Remaining oblasts are divided into tertiles. Crimea is excluded from the analysis.

We hand-code as *contested* those oblasts that were partially or entirely under Russian control during our sample period: Donetsk, Luhansk, Kherson, and Zaporizhzhia.[20] Then we divide the remaining oblasts into three groups based on the total duration of alarms: *low exposure* regions, *medium exposure* regions, and *high exposure* regions. Low exposure oblasts, located in Western Ukraine, are geographically distant from active combat zones and experienced fewer attacks. Medium exposure oblasts faced regular air raids but limited ground combat. High exposure oblasts in the East experienced intense and sustained threats, including aerial attacks and proximity to ground operations. Contested territories saw the most severe disruptions, with active combat and prolonged occupation.

[20]While these regions are arguably the most exposed, air raid alarms do not adequately capture the exposure to war in contested territories, as bombings typically do not occur in places that have just been conquered. Thus, we treat partially occupied regions separately. We also exclude Crimea from the analysis. We do not classify Kharkiv oblast as contested, as it was only partially occupied until September 2022 and then liberated. Currently, only a relatively small part of its bordering Luhansk oblast (less than 10% of the territory) remains occupied.

4.2 When local labor markets shut down

Geographical reallocation is largely driven by movements of firms and workers away from the frontline. According to the International Organization for Migration, the number of internally displaced persons (IDPs) reached approximately 3.8 million by 2025 (IOM, 2025), meaning that roughly one quarter of Ukraine's population has been displaced since the onset of the full-scale invasion (counting both international migrants and IDPs). These individuals have lost both physical capital and their social networks, which makes their reintegration into the labor market particularly difficult. Moreover, displacement decisions are often constrained by factors other than labor market considerations: many displaced workers moved to regions based on family ties, housing availability, or perceived safety, rather than employment opportunities, originating spatial mismatches between labor supply and demand. This massive displacement reflects a profound geographical divergence in labor market conditions across Ukraine. Labor markets along the frontline and in contested territories in some cases almost completely shut down, while regions away from the frontline had to simultaneously absorb large inflows of displaced workers and relocating firms.



(a) Total employed

(b) Individual entrepreneurs

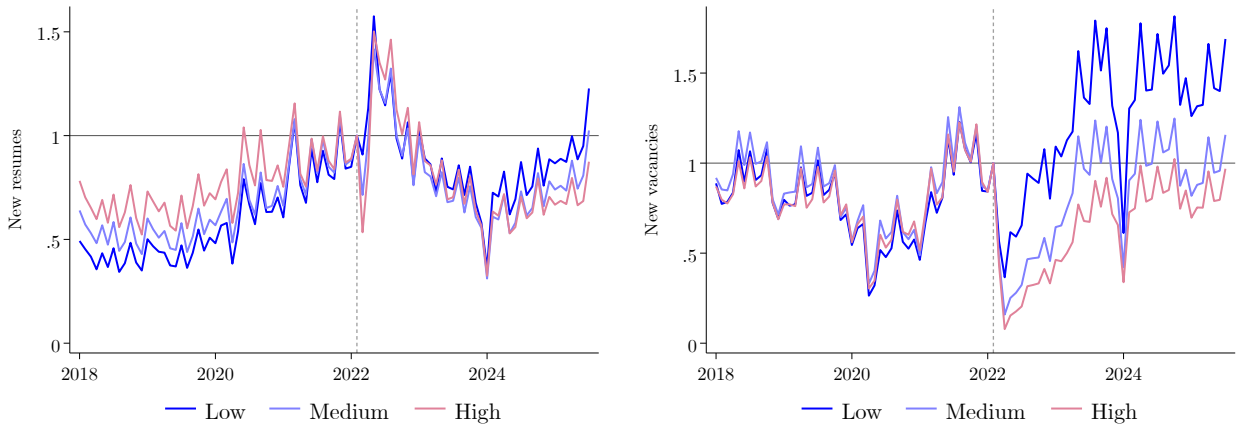
Figure 4: Employment by exposure (duration of alarms), normalized to 2021

Notes. Employment levels in each exposure category are normalized to 2021 values. Low, medium, and high exposure categories are based on tertiles of total alarm duration; contested regions (Donetsk, Luhansk, Kherson, Zaporizhzhia) are hand-coded. The vertical dashed line marks the invasion year. Source: SSSU.

Figure 4 plots the yearly employment levels by exposure category, normalized to 2021, illustrating this stark geographical heterogeneity.[21] In low exposure regions, employment levels reported by enterprises after 2022 are close to pre-war levels. In high exposure regions, employment declined by roughly one-fifth. In contested territories, the number of employed persons fell to less than half of pre-war levels. The picture for individual entrepreneurs is slightly more favorable: in low, medium, and high exposure regions, the number of

[21]The data shown are official reports by enterprises; therefore the total figure is notably lower than the number of employed reported by the quarterly household survey. We assume that the quality of enterprise reports remains unchanged over time, providing reliable estimates of changes.

entrepreneurs in 2023 was close to or above 2021 levels. In contested regions, however, the decline exceeded 50%.



(a) New resumes

(b) New vacancies

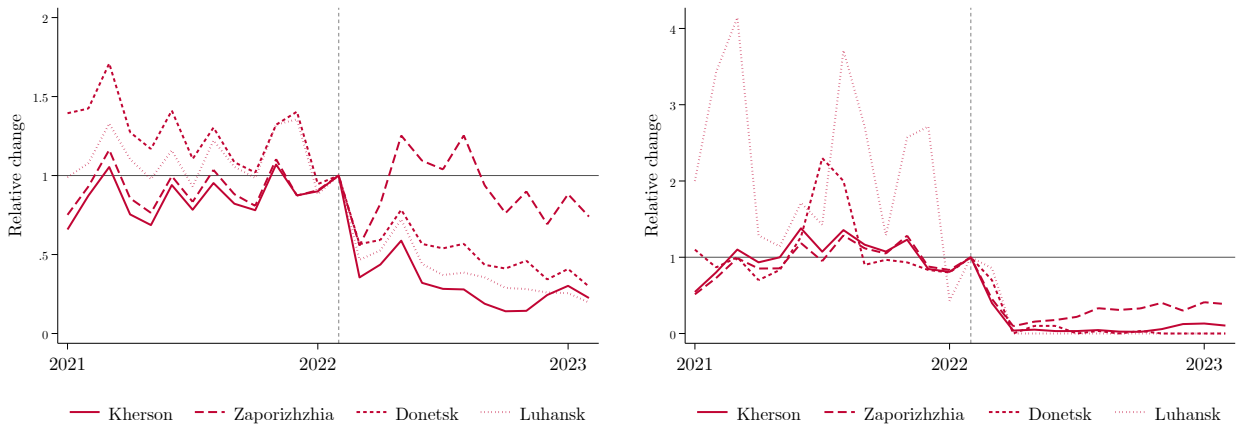
Figure 5: Monthly inflows by exposure (duration of alarms), normalized to invasion month

Notes. Monthly inflows normalized to February 2022. Contested regions excluded due to near-complete collapse in platform activity. The vertical dashed line marks the invasion month. Source: Work.ua.

Online job platform data confirm this geographical heterogeneity. Figure 5 plots monthly inflows of new resumes and vacancies for low, medium, and high exposure regions. In the months following the full-scale invasion, job-seeking activity reallocated away from highly exposed regions (panel a). Vacancy postings also markedly shifted towards safer regions (panel b): after an initial uniform drop across all areas, low exposure regions saw new vacancies rise above pre-war levels, while medium exposure regions returned to pre-war levels. In contrast, vacancy inflows in high exposure regions remained persistently below baseline, consistent with firm exit or substantial contraction in those areas.

Figure 6 focuses on contested territories, where the collapse of labor market activity was most severe.[22] The graph shows how the number of new vacancies posted decreased to virtually zero, and the number of job-seekers declined dramatically. In regions like Kherson, Donetsk and Luhansk, the labor market essentially ceased to exist. The partial exception is Zaporizhzhia, where a substantial portion of the oblast (and more importantly, oblast's largest population center) remained under Ukrainian control throughout the period, sustaining some degree of labor market activity. Thus, while low exposure regions recovered vacancy and resume inflows comparable or even exceeding pre-war levels, high exposure regions experienced

[22]Contested territories (occupied at least at 50%) are far from uniform. Donetsk and Luhansk regions had their main and most populous cities occupied in 2014. The city of Kherson was occupied in March 2022 but liberated in November 2022. The city of Zaporizhzhia has never been occupied. While Kherson is attacked daily by small FPV drones to spread terror (e.g. see `https://kyivindependent.com/russian-drones-target-civilians-dnipro-right-bank/`), Zaporizhzhia is 30 km or more away from the frontline, so the main enemy attacks are the same as in other cities at a similar distance, like Kharkiv or Sumy. They involve Shahed drones and missiles, which are deadly but less constant and omnipresent as FPV drones. The time window of the graph is restricted because the normalized drop would otherwise be difficult to visualize.



(a) New resumes

(b) New vacancies

Figure 6: Monthly inflows in contested regions, normalized to invasion week

Notes. Monthly inflows normalized to February 2022. The oscillations in Luhansk reflect very low baseline levels. The vertical dashed line marks the invasion month. Source: Work.ua.

persistent declines of inflows on both sides of the market. In most contested territories, labor markets shut down with no new vacancies or resumes being posted.

4.3 Other dimensions of reallocation

In addition to regional reallocation, major shifts of jobs and workers occurred across sectors, public and private employment as well as between the formal and informal sectors. War alters relative demand patterns, inducing reallocation across sectors of the economy. In wartime, some activities contract sharply as production and consumption are disrupted, while others expand in response to shifts in government spending, household demand, or strategic priorities.

To document these shifts, Figure 7 plots relative employment growth rates at the level of NACE 3-digit sectors, comparing the pre-war and pre-COVID periods (2016–2019) with the post-war period (2021–2024), drawing on data from the SSSU enterprise survey and removing outliers.[23] Three main facts stand out. First, the correlation between pre-war and post-war employment growth is close to zero. This is consistent with a marked change in the nature of labor reallocation. Second, while most sectors experienced positive relative growth before the war, the distribution shifted markedly downward in the post-war period, in line with aggregate contraction. Third, military-related activities cluster disproportionately among the highest-growing sectors in 2021–2024, reflecting the surge in defense-related demand.[24]

Complementary evidence is provided in Figure 8, which shows the top and bottom ten

[23] In Figures 7 and 8 the NACE 3 sector *Support activities for other mining and quarrying* is not displayed as it is very small (about 5 thousands employees on average) and increased by 311% in the period 2016-2019.

[24] Defense-oriented manufacturing and support industries in the private sector, see Appendix D.

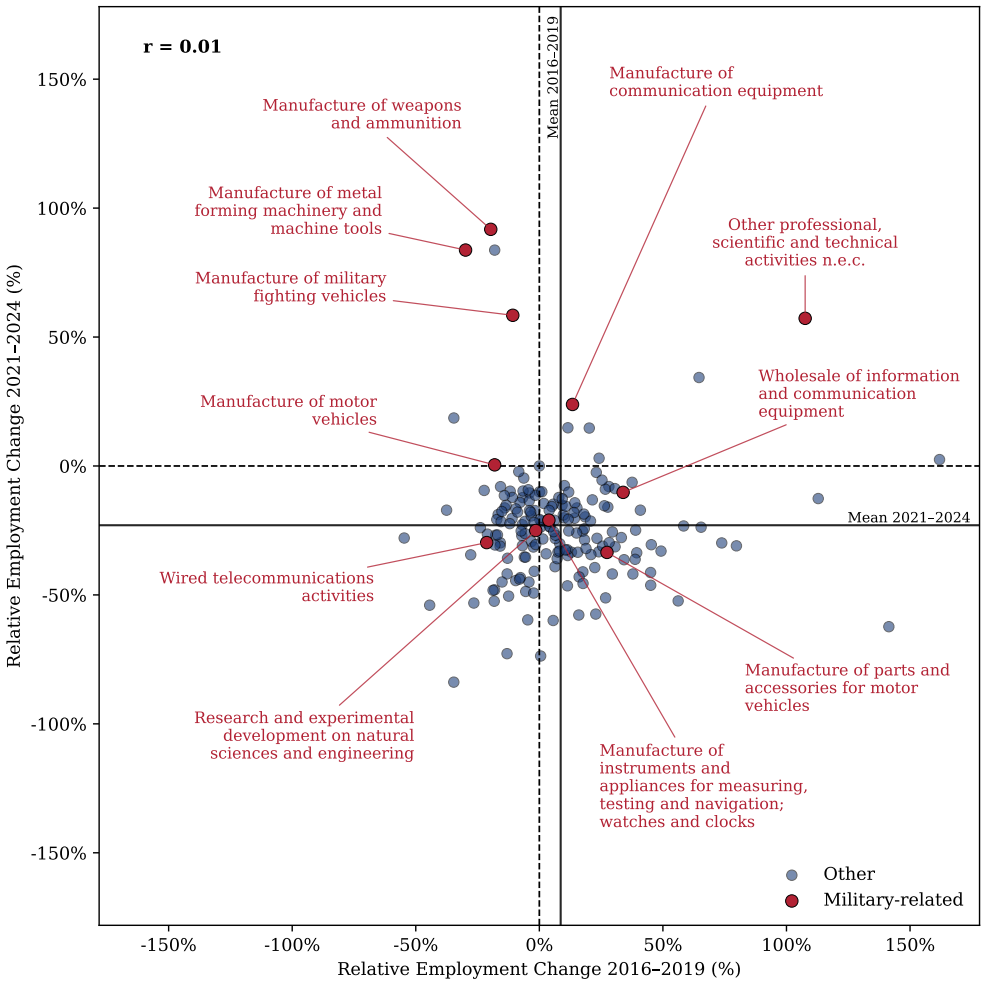


Figure 7: Relative employment change (NACE 3 sectors), 2016-2019 vs 2021-2024.

Notes. Each point represents a NACE three-digit sector, plotting its relative employment change in the pre-period (2016–2019) against its change in the post-period (2021–2024). The year 2020 is excluded to avoid distortions caused by the COVID-19 pandemic. The sample excludes public-sector activities (education, health, and social work) to focus on market-based industries, and drops sectors in the bottom quartile of average employment to remove smaller activities. Values are linearly interpolated for missing years, and sectors with fewer than two valid observations between 2016 and 2024 are excluded. Negative interpolated values are replaced with zero. Forestry subsectors 02.1 and 02.2 are aggregated into a single category ("Forestry and logging") due to a change in categorization. Military-related sectors are highlighted in red, see Appendix D for details. The two solid lines mark mean relative changes across all sectors.

sectors by relative employment growth in each period. Before the war, high-growth activities included support services to energy and mining, professional and scientific services, and construction. By contrast, after 2021 the leading sectors are dominated by defense-related industries, including the manufacture of weapons, ammunition, and military vehicles, as well as some specialized manufacturing branches. At the other end of the spectrum, the largest relative declines are concentrated in mining, transport, and consumer services such as accommodation. Taken together, these patterns underscore a sharp reorientation of the

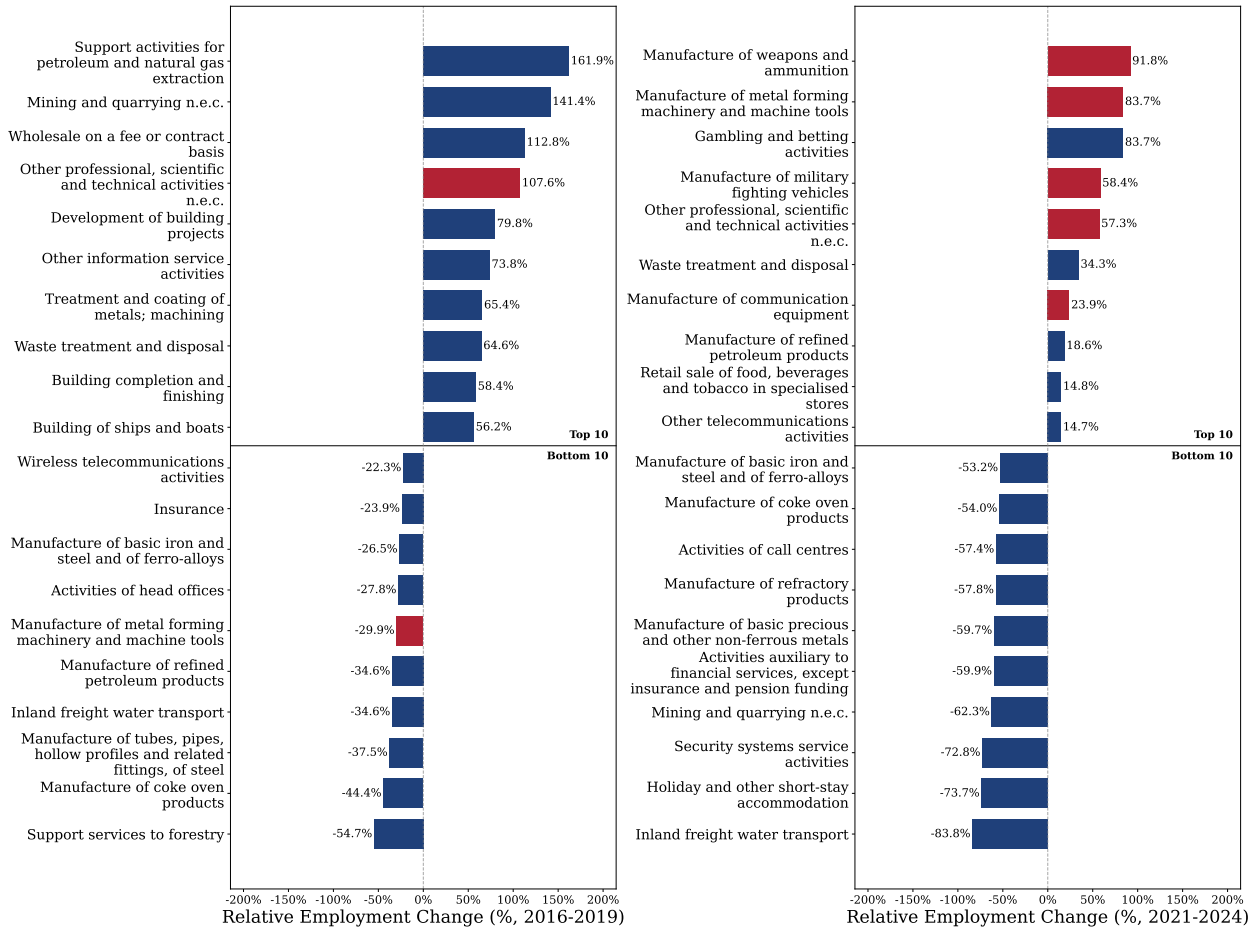
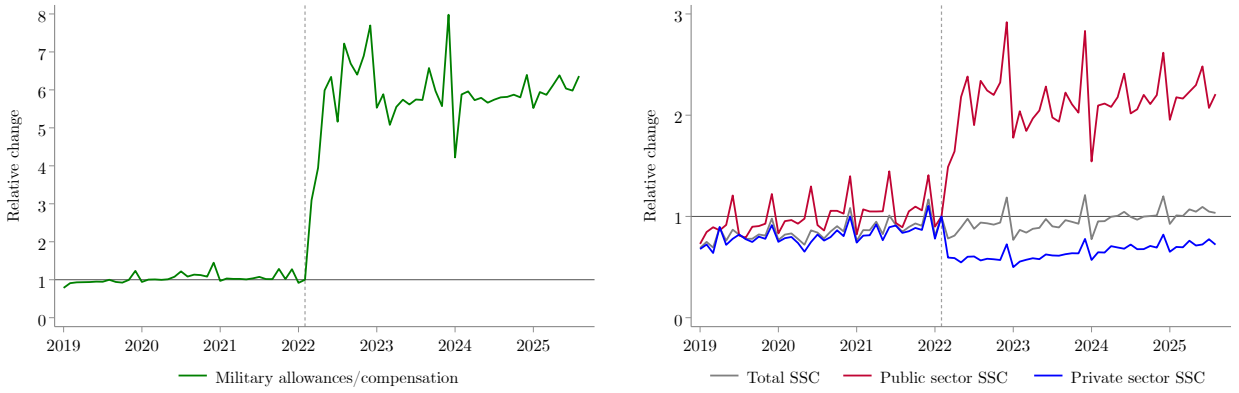


Figure 8: Top & Bottom 10 sectors by relative employment change, 2016-2019 vs 2021-2024

Notes. The figure displays the ten sectors with the largest and smallest relative changes in total employment across the 2016–2019 and 2021–2024 periods. The underlying data and sample construction follow the same criteria as Figure 7.

Ukrainian economy toward military production and away from civilian services and heavy industry, which may reflect both demand and supply factors. On the demand side, increased government spending and procurement directly stimulated defense-related industries, while consumption-oriented services contracted as household purchasing power declined. On the supply side, some of the sharpest declines may partly reflect the mobilization of workers into the army, reducing the available workforce in certain activities.

Indeed, we observe a surge in military compensation in line with a massive reallocation of government resources toward the armed forces (Figure 9, panel a). Other factors, such as disruptions in trade logistics, regional displacement of firms, and the destruction of physical capital, may also have contributed to the observed reallocation patterns. There was also a major reallocation across the public/private sector divide, even excluding the armed forces. Social security contributions (SSC) data suggest that the private sector experienced the sharpest contraction after the invasion, with SSC declining by nearly 40%, before gradually recovering as economic activity stabilized. Assuming downward wage stickiness, the decline in



(a) Military wage bill

(b) Social security contributions

Figure 9: Evolution of military compensation and civilian social security contributions

Notes. Monthly data from the government budget deflated using the CPI, normalized to February 2022. Total SSC represents aggregate social security contributions reported to the budget. Military compensation refers to allowances and wage payments to armed forces personnel. Social security contributions provide a proxy for changes in civilian compensation and employment. Source: Treasury Service of Ukraine, NBU.

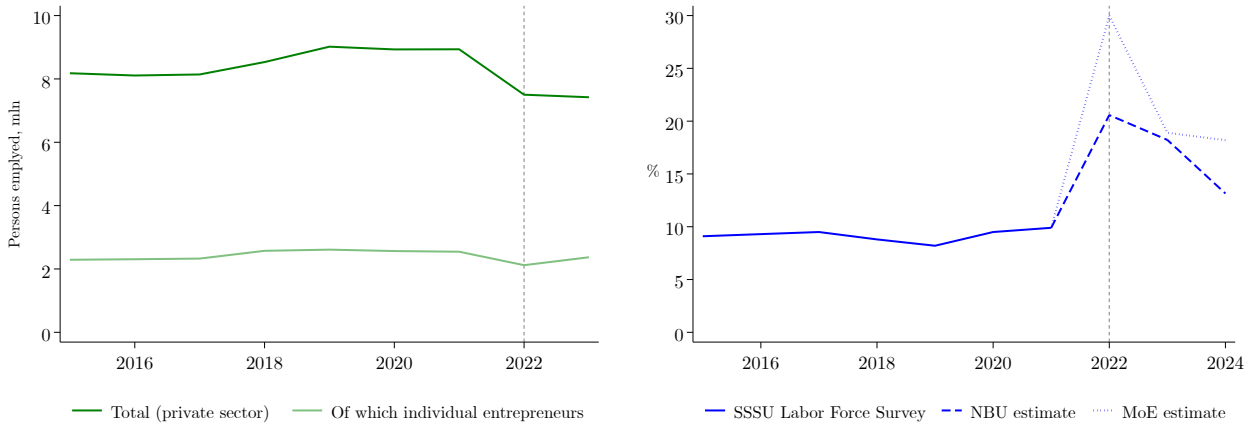
contributions largely reflects employment losses rather than wage cuts. Interestingly enough, reallocation occurred from the private to the public sector going opposite to what observed during the transition to a market economy.

Reallocation of jobs and workers likely occurred between formal and informal employment sectors. Before the war, informality already accounted for a substantial share of Ukrainian employment (about 19% in 2021). Informal work involves more men (22%) than women (16%) and is larger among the rural population (33% vs 12% in cities). Two opposing forces have likely shaped its trajectory since 2022. On the one hand, informality may have expanded as firms and workers sought to substitute for disrupted formal activity. On the other hand, reduced household incomes and mass migration curbed demand for many services where informal work is concentrated, such as retail and personal services. Available data do not allow to establish which of these two opposing factors prevailed. For sure wartime reallocation cannot be fully captured by formal employment statistics alone.

4.4 Aggregate labor market dynamics

In light of the huge reallocation taking place, of the changes in the composition of the labor force and of the wartime labor market frictions, one would have expected unemployment, notably mismatch unemployment, to rise in the aftermath of the full-scale invasion.

Figure 10 indicates that the unemployment rate increased from an average of about 9% in the 2018–2021 period to 21% in 2022, according to estimates of the National Bank of Ukraine. However, by 2025, unemployment had declined to around 11.5%, only 2–3 base points above the pre-invasion level. This relatively low level of unemployment at the aggregate level should not conceal large differences in its distribution across socio-economic groups. According



(a) Total employed (private sector)

(b) Unemployment rate

Figure 10: Employment levels and unemployment rate

Notes. Administrative data on employment levels are from official reports of firms. The estimate for the unemployment rate by the NBU is published in the *NBU Inflation Report*. The Ministry of the Economy reports somewhat higher figures, published irregularly on their website. Source: SSSU, NBU, Ukranian MoE.

to the International Organization for Migration, the unemployment rate among internally displaced workers is around 15%.[25] We estimate the unemployment rate among disabled persons at about 16% (see Appendix B for details on our methodology). Unsurprisingly, the labor supply shock strongly reduced employment levels. The total number of people officially in private sector employment in 2022 decreased by about 1.4 million from 2021, a drop of approximately 16%, stabilizing at these levels in the following years. The decrease was not confined to dependent employment: the number of individual entrepreneurs (a measure of self-employment) declined by 330 thousands units, showing a partial rebound in 2023.

In Ukraine wages are typically set as a result of negotiations carried out at the individual level as collective bargaining is almost inexistent.[26] This has been particularly the case during the war. After an initial decline in the quarters immediately following the full-scale invasion, *nominal* wages had already returned to pre-war levels by late 2022 and grew in nominal terms by nearly 50% between 2022 and 2025 (Figure 11, panel a). Yet much of this nominal growth was offset by high inflation, which substantially eroded purchasing power. As a result, real wages remained about 20% below their 2021 level in 2022 and only gradually recovered in 2023, reaching and eventually surpassing pre-war levels by 2024. One may interpret the initial drop in wages as driven by the demand shock. However, the labor supply shock was not evenly distributed along the skill range as refugees had higher human capital than stayers. Hence, it is plausible that compositional changes contribute to explain the initial wage decline.

Labor productivity, measured as real turnover per employee, exhibits substantial regional heterogeneity correlated with war exposure (Figure 11, panel b). High-exposure regions

[25]Source: `https://ukraine.iom.int/news/displaced-ukrainians-face-disproportionate-unemployment-rates-iom-report-reveals`.

[26]See Appendix H for a discussion of wage dynamics and wage-setting institutions prior to 2022.

experienced the sharpest productivity declines post-invasion, falling to approximately 50% of 2021 levels by 2022 before partially recovering. Medium-exposure regions showed more moderate declines, while low-exposure regions increased turnover per worker in the years after the full-scale invasion. This pattern reflects the severe operational disruptions in frontline areas, including infrastructure destruction, supply chain breakdowns, and workforce displacement.

(a) Average wages

(b) Labor productivity by war exposure

Figure 11: Wages and productivity

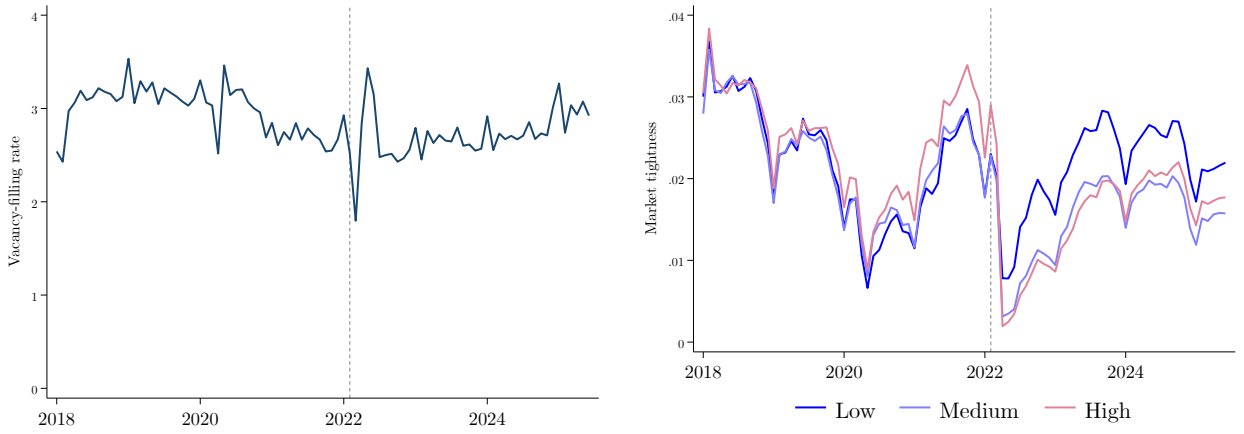
Notes. Panel (a) shows average wages normalized to the last quarter of 2021. Panel (b) displays labor productivity (real turnover per employee) by region, normalized to 2021 baseline. Each line represents the average for regions in a given war exposure tertile (Low, Medium, High). Productivity measured using administrative data on turnover and employment. Contested regions (Donetsk, Luhansk, Kherson, Zaporizhzhia) and Crimea excluded. The vertical dashed line marks the full-scale invasion (February 2022). Sources: Panel (a) NBU; Panel (b) SSSU, authors' calculations.

5 Matching Job-Seekers and Vacancies During a War

As shown above, Ukraine experienced huge labor supply and reallocation shocks. Some local labor markets virtually shut down, but, on aggregate, after a sharp initial increase, unemployment was largely reabsorbed and labor productivity returned to pre-war levels. In order to understand this remarkable resilience of the Ukrainian labor market, we look at the core of the functioning of a labor market: the matching of jobseekers and vacancies.

Given the huge negative labor supply shock and the less pronounced fall in vacancy rates documented earlier, one would have expected vacancy filling rates to drop significantly in the aftermath of the full-scale invasion, as a result of negative trading externalities. As Figure 12 suggests, this was not the case: vacancy filling, after an initial drop, recovered to pre-war levels. Wartime frictions and the massive reallocation of workers and jobs across regions, and sectors documented in the previous section could also have largely reduced the efficiency of the matching process.

In order to assess how the matching of vacancy to jobseekers evolved during the war we estimated an aggregate matching function using high-frequency data from the online job platform Work.ua. A detailed description of the data preparation is provided in Appendix E.



(a) Vacancy-filling rate (aggregate)

(b) Market tightness by war exposure

Figure 12: Vacancy-filling rate and market tightness

Notes. Panel (a) shows the monthly vacancy-filling rate (ratio of matches to vacancy stock) aggregated across all regions and categories, $q_t^V := M_t^V/V_t$, where M_t^V denotes the number of matches in period t constructed using the vacancy flow identity, and V_t the aggregate stock of vacancies. Panel (b) displays market tightness ($\theta = V/U$) by war exposure tertile, based on total alarm duration (contested regions of Crimea, Donetsk, Luhansk, Kherson, Zaporizhzhia excluded). The vertical dashed line indicates February 2022. Source: Work.ua.

5.1 Empirical Framework

Let r index regions, c categories (the combination of sectors and occupation in which the data from the platform can be broken down), and t months. Denote by U_{rct} and V_{rct} the stocks of resumes and vacancies, respectively, observed on the first day of each month t in region r and category c. Let inflow^U_{rct} and inflow^V_{rct} represent the number of new resumes and vacancies posted during month t. Assuming that vacancies are either filled or keep on been posted on the platform, we recover the number of matches from the stock-flow identity for vacancies.[27] It is given by:

$$M^V_{rct} = V_{rct} + \text{inflow}^V_{rct} - V_{rc,t+1} \tag{1}$$

We estimate a Cobb-Douglas matching function without imposing constant returns to scale at the region-category-month level. The basic functional form is:

$$M_{rct} = A_{rct} \cdot U^{\alpha}_{rct} \cdot V^{\beta}_{rct} \tag{2}$$

where α and β are the elasticities with respect to resumes and vacancies, and A_{rct} captures matching efficiency (shifting the Beveridge curve). Taking logs yields our baseline estimating equation:

$$\log M_{rct} = \log A_{rct} + \alpha \log U_{rct} + \beta \log V_{rct} \tag{3}$$

We allow matching efficiency to vary after the invasion estimating A as a constant term plus a post-invasion indicator. We also include region fixed effects, and category fixed effects:

$$\log A_{rct} = \kappa + \gamma \cdot \text{Post}_t + \delta_r + \theta_c \tag{4}$$

where κ is a constant, Post_t is a dummy equal to one from March 2022 onward, δ_r are region fixed effects, and θ_c are category fixed effects. Substituting equation (4) into equation (3), our first estimating equation becomes:

$$\log M_{rct} = \kappa + \alpha \log U_{rct} + \beta \log V_{rct} + \gamma \cdot \text{Post}_t + \delta_r + \theta_c + \varepsilon_{rct} \tag{5}$$

where ε_{rct} is an idiosyncratic error term capturing unobserved determinants of matching efficiency at the region-category-month level. Thus, we allow for matching efficiencies specific to each region and category, with a common shift post-invasion captured by γ. Standard errors are two-way clustered at the region and category levels to account for serial correlation within regions and common shocks within categories.

[27] Symmetrically, matches can be computed from the stock-flow identity for resumes. In principle, the two measures should coincide; in practice, discrepancies arise due to reporting delays, data quality, and the fact that not all postings result in matches. We rely on matches derived from vacancies, since maintaining open vacancies entails costs for firms, whereas resume postings are for free and applicants may be more prone to over-reporting or slower updating. Indeed, firms using the platform pay a subscription fee based on the number of vacancies they plan to post per month. The fee is proportional to the inflow. Leaving a vacancy on when unfilled is costless for firms. Fees are also related to the degree of access to the set of resumes.

Table 3: Matching Estimation - Aggregate War Effect

	(1)	(2)	(3)	(4)
Elasticity wrt resumes ($\log U$)	0.032	0.058*	0.117***	0.071**
	(0.028)	(0.030)	(0.015)	(0.027)
Elasticity wrt vacancies ($\log V$)	0.979***	0.960***	0.907***	0.897***
	(0.021)	(0.022)	(0.013)	(0.013)
Post-invasion ($\geq$ Feb 2022)		-0.147***	-0.168***	-0.145***
		(0.016)	(0.016)	(0.023)
Constant	0.807***	0.739***	0.483***	0.870***
	(0.176)	(0.183)	(0.078)	(0.204)
Observations	49950	49950	49950	49950
R^2	0.965	0.967	0.977	0.977
Category FE	No	No	Yes	Yes
Region FE	No	No	No	Yes
CRS test p-value	0.554	0.347	0.008	0.214

Notes. The dependent variable is log matches at the region-category-month level ($\log M_{rct}$). CRS test reports the p-value for the null hypothesis $\alpha + \beta = 1$. Two-way clustered standard errors (region $\times$ category) in parentheses. Sample: January 2018 to June 2025, excluding the contested oblasts of Donetsk, Luhansk, Kherson, Zaporizhzhia, and Crimea. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

5.2 Results

Table 3 reports the results from estimating equation (5) using monthly region-category-level data from January 2018 to June 2025. We exclude from the sample the four contested oblasts (Donetsk, Luhansk, Kherson, Zaporizhzhia) and Crimea.

In our preferred specification (with both region and category fixed effects, see column 4) we cannot reject constant returns to scale, and, in any event, the sum of the two elasticities ranges from 0.97 to 1.02 across specifications. Thus, the size of the labor market does not seem to affect the matching of vacancies to jobseekers. The post-invasion coefficient in columns (2)-(4) is negative and significant, indicating a decline in matching efficiency of approximately 13.5-15.5% following the full-scale invasion, controlling for changes in the stocks of vacancies and resumes and for regional or sectoral composition.[28] This decline is roughly half of the size of the reductions in matching efficiency estimated during the Great Financial Crisis in the US (Ahn and Crane, 2020; Barnichon and Figura, 2015).

5.3 Regional Heterogeneity

As seen in the previous section, the impact of the war has been highly heterogeneous across regions. This heterogeneity can be better characterized by allowing for post $\times$ region interactions. Figure 13 shows the total efficiency decline by region, obtained by adding the

[28]Percentage changes are calculated as $(e^{\hat{\gamma}} - 1) \times 100$, where $\hat{\gamma}$ is the estimated coefficient.

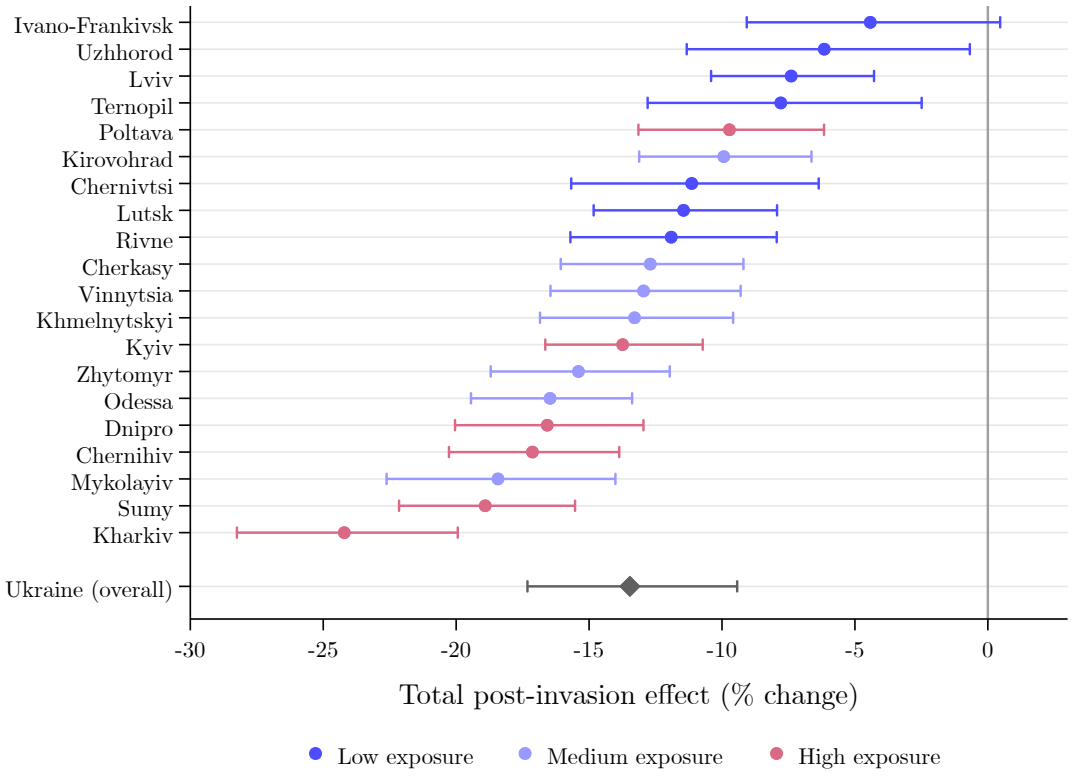


Figure 13: Regional Heterogeneity in War Impact on Matching Efficiency

Notes. Figure shows total post-invasion effects on matching efficiency (percentage change) for each region. Regional coefficients are the sum of the post-invasion coefficient and region-specific interaction terms from a specification with category FE and post × region interactions (baseline: Lviv). "Ukraine (overall)" shows the pooled post-invasion effect from a specification with category and region FE but no regional interactions. Exposure groups based on terciles of total alarm duration. Two-way clustered standard errors (region × category) shown as 95% confidence intervals. Sample: January 2018 to June 2025, excluding contested oblasts.

baseline post-invasion coefficient to each region-specific interaction term. We plot coefficients with different colors by exposure category, based on terciles of total alarm duration. The "Ukraine (overall)" coefficient represents the pooled estimate from the specification in Table 3, column (4), which imposes a common post-invasion effect across all regions while controlling for region and category fixed effects. This aggregate effect lies near the center of the regional distribution, masking substantial variation ranging from minimal 4-8% declines in western regions to severe 18-24% disruptions in eastern and southern areas most exposed to active conflict. In turn, this results into increases in vacancy duration. For example, in the Lviv oblast, the estimated efficiency drop implies an increase of 9% in time it takes to fill a vacancy (corresponding to 1 more day on average). In the Kyiv oblast, 16% more time (+1.6 days on average), and in Kharkiv oblast 35% (+3.4 days).[29]

[29]See Appendix F for details.

5.4 Sectoral Heterogeneity

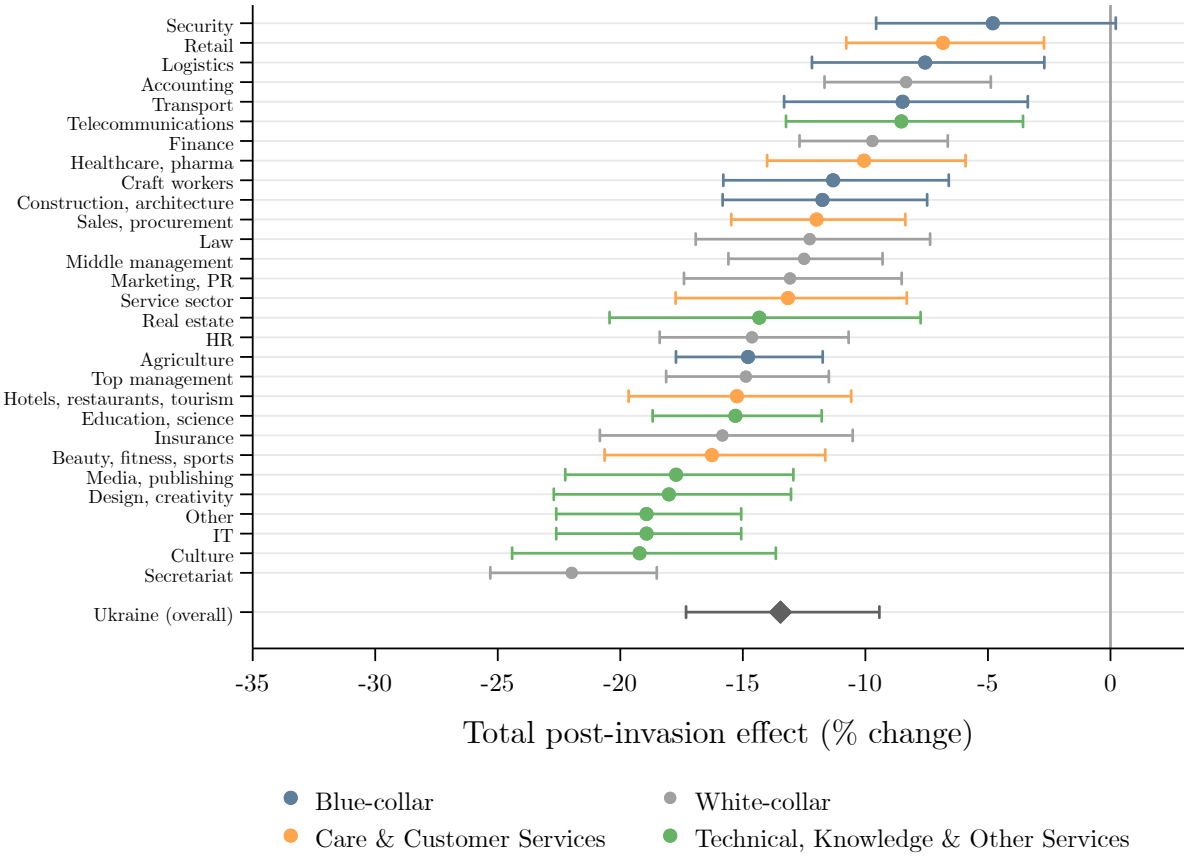


Figure 14: Sectoral Heterogeneity in War Impact on Matching Efficiency

Notes. Figure shows total post-invasion effects on matching efficiency (percentage change). We divide job categories in four groups. Category coefficients are the sum of the post-invasion coefficient and category-specific interaction terms from a specification with region FE and post × category interactions (baseline: IT). "Ukraine (overall)" shows the pooled post-invasion effect from a specification with category and region FE but no category interactions. Two-way clustered standard errors (region × category) shown as 95% confidence intervals. Sample: January 2018 to June 2025, excluding contested oblasts.

The war's impact on matching efficiency also varied substantially across occupational categories. Figure 14 presents total post-invasion effects by sector, estimated from a specification with region fixed effects and post × category interactions (baseline: IT). Efficiency declines range from approximately 5% in Security to 22% in Secretariat positions.

Blue-collar sectors experienced smaller efficiency losses, while some white-collar and services positions faced larger matching frictions. This heterogeneity may reflect differences in skills mismatch, the importance of local networks, the effectiveness of job search, and firm hiring standards.

5.5 The Impact of Exposure to War

In order to assess whether this substantial regional heterogeneity in post-invasion effects is explained by variation in war exposure intensity, we extend our baseline specification by allowing matching efficiency to vary with the intensity of conflict at the region-month level. We use air raid alarm data to measure regional war exposure. Specifically, we decompose matching efficiency as follows:

$$\log A_{rct} = \kappa + \phi \cdot \text{Exposure}_{rt} + \delta_r + \theta_c + \lambda_t \tag{6}$$

where λ_t are month fixed effects and Exposure_{rt} captures war exposure in region r during month t. Substituting equation (6) into equation (3) yields our estimating equation:

$$\log M_{rct} = \kappa + \alpha \log U_{rct} + \beta \log V_{rct} + \phi \cdot \text{Exposure}_{rt} + \delta_r + \theta_c + \lambda_t + \varepsilon_{rct} \tag{7}$$

where ε_{rct} is an idiosyncratic error term capturing unobserved determinants of matching efficiency at the region-category-month level.

This specification allows us to estimate the effect of war intensity on matching efficiency at the region-month level. The month fixed effects (λ_t) control for common time trends affecting all regions, such as national economic conditions, seasonal patterns, and the overall trajectory of the war. The identifying variation comes from differential exposure to air raids across regions within the same month. The identifying assumption is that, conditional on region, category, and time fixed effects, the timing and intensity of air raids in a given region are unrelated to contemporaneous region-specific labor market shocks. This assumption is plausible since Russian targeting decisions are driven primarily by military and strategic considerations rather than Ukrainian labor market conditions.[30]

We interpret our estimates as measuring the reduced-form impact of war exposure on matching efficiency. The coefficient ϕ should capture both the direct disruption from alarms (workers seeking shelter, fear, uncertainty), associated infrastructure damage (power outages, internet disruptions), and other conflict-related factors correlated with alarm intensity (rather than isolating the mechanical effect of alarms alone). As such, air raid alarms data serve as a proxy for the broader intensity of conflict exposure. We consider the three alternative metrics introduced in Section 4: (i) the number of air raid alarms per 10,000 residents, (ii) the number of days with at least one active alarm, and (iii) the total duration of air raid alarms measured in hours. All exposure measures equal zero before March 2022. We use the metric in levels, thus the coefficient ϕ represents a semi-elasticity (percentage change in matches per unit change in exposure). Since we do not have a strong prior on which metric best captures war exposure, we estimate the specification for all three measures.

Table 4 reports the results. Elasticities remain stable across specifications: vacancy elasticities range from 0.89 to 0.97 and resume elasticities from 0.04 to 0.15.[31] All three

[30]This assumption could be violated if Russian forces systematically targeted regions experiencing positive labor market shocks, or if Ukrainian authorities allocated resources (e.g., air defense systems) based on regional labor market conditions. However, available evidence suggests that targeting follows military logic - proximity to front lines, strategic infrastructure, etc. - rather than economic performance indicators.

[31]The sum $\alpha + \beta$ ranges from 1.01 to 1.04. CRS test p-values in our preferred specifications (columns 2, 4,

Table 4: Matching Estimation - War Exposure

	Alarms per Capita		Days with Alarms		Total Duration	
	(1)	(2)	(3)	(4)	(5)	(6)
Elasticity wrt resumes ($\log U$)	0.047	0.146***	0.062*	0.144***	0.042	0.144***
	(0.030)	(0.027)	(0.031)	(0.027)	(0.030)	(0.027)
Elasticity wrt vacancies ($\log V$)	0.965***	0.895***	0.956***	0.893***	0.972***	0.896***
	(0.023)	(0.016)	(0.023)	(0.015)	(0.022)	(0.016)
Exposure (alarms per 10k)	-0.110***	-0.031**				
	(0.028)	(0.014)				
Exposure (days with alarms)			-0.006***	-0.003**		
			(0.001)	(0.001)		
Exposure (duration, 100 hours)					-0.032**	-0.013**
					(0.012)	(0.005)
Constant	0.759***	0.220	0.709***	0.273	0.764***	0.234
	(0.182)	(0.196)	(0.188)	(0.203)	(0.187)	(0.198)
Observations	49950	49950	49950	49950	49950	49950
R^2	0.966	0.983	0.967	0.983	0.966	0.983
Category FE	No	Yes	No	Yes	No	Yes
Region FE	No	Yes	No	Yes	No	Yes
Month FE	No	Yes	No	Yes	No	Yes
CRS p-value	0.500	0.079	0.347	0.126	0.453	0.090

Notes. Dependent variable: log matches ($\log M_{rct}$). All specifications use OLS. Exposure measured as: alarms per 10,000 residents (columns 1-2), days with alarms (columns 3-4), or alarm duration in 100-hour units, winsorized at the 95th percentile of the post-invasion distribution (columns 5-6). All exposure variables equal zero before March 2022. CRS p-value tests the null hypothesis $H_0 : \beta_U + \beta_V = 1$ (constant returns to scale). Standard errors clustered at the region level in parentheses. Sample: January 2018 to June 2025, excluding the contested oblasts of Donetsk, Luhansk, Kherson, Zaporizhzhia, and Crimea.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

exposure measures yield consistently negative effects on matching efficiency.

For alarms per capita (columns 1-2), each additional alarm per 10,000 residents reduces efficiency by 3.1% in our saturated specification (column 2, $p < 0.05$). At the median post-invasion exposure of 0.27 alarms per 10k, this implies a 0.8% decline; at the 90th percentile (1.04 alarms), a 3.2% decline. The interquartile range spans 0.15 to 0.64 alarms per 10k, corresponding to efficiency declines of 0.5% to 2.0%.

The days-with-alarms measure (columns 3-4) yields larger estimated effects. In column 4, each additional day with active alarms reduces efficiency by 0.3% ($p < 0.01$). The median region-month experienced 22 days with alarms post-invasion, implying a 6.6% decline, while the 90th percentile (31 days) corresponds to a 9.3% decline. The interquartile range (15 to 29 days) corresponds to efficiency declines of 4.5% to 8.7%. This 9.3% effect accounts for a substantial portion of the aggregate post-invasion decline of around 15% documented in Table 3.

For total alarm duration (columns 5-6), the coefficient is -0.013 ($p < 0.05$), indicating

6) range from 0.079 to 0.126, indicating we cannot reject constant returns to scale at conventional levels, with elasticity sums very close to unity.

that 100 additional hours of alarms reduce efficiency by 1.3%.[32] The median exposure of 45 hours implies a 0.6% decline, while the 90th percentile of 271 hours corresponds to a 3.5% decline. The interquartile range (23 to 100 hours) corresponds to efficiency declines of 0.3% to 1.3%. Duration effects are smaller in magnitude than days with alarms but comparable to alarms per capita, suggesting differences in how each measure captures war exposure.

5.6 Comments

Five takeaways emerge from this analysis. First, Ukraine's labor market experienced approximately a 15% decline in matching efficiency following the full-scale invasion in February 2022. This decline appears substantial yet not catastrophic, consistent with evidence that Ukrainian economic activity remained resilient despite active conflict and major reallocation of workers and jobs.

Second, the aggregate decline masks substantial heterogeneity. Western regions (Ivano-Frankivsk, Uzhhorod, Lviv, Ternopil) experienced relatively modest declines of 4-8%, while eastern and southern frontline areas (Kharkiv, Sumy, Mykolayiv, Chernihiv, Dnipro) suffered severe disruptions, declining by 17-24%. This variation aligns closely with war exposure intensity. Heterogeneity is present also along the job category dimension.

Third, higher war exposure significantly reduces matching efficiency across all three metrics examined. Each additional alarm per 10,000 residents reduces efficiency by 3.1%, each additional day with alarms by 0.3%, and each 100 additional hours of alarm duration by 1.3%. These negative effects persist across specifications with region, category, and month fixed effects, indicating robust disruption of labor market functioning from conflict exposure.[33] Our preferred specifications with month fixed effects isolate regional variation by comparing areas experiencing different bombing intensities within the same month, providing more credible causal estimates. The identifying variation comes from differential timing and intensity of air raids across regions, which plausibly reflects military and strategic considerations rather than local labor market conditions.

Fourth, days with alarms yields the largest estimated efficiency drop among our exposure metrics. At the 90th percentile of exposure, days with alarms implies a 9.3% efficiency decline, compared to 3.2% for alarms per capita and 3.5% for duration. This finding might suggest that persistent, repeated disruptions impose greater coordination costs than either discrete attack events or cumulative exposure time. A region experiencing frequent brief alarms could face more severe matching frictions than one with similar total duration concentrated in fewer, longer periods, consistent with adaptation mechanisms operating more effectively during sustained threats than during repeated interruptions.[34]

[32]The duration measure is winsorized at the 95th percentile (456 hours) of the post-invasion distribution to address extreme outliers.

[33]Specifications without month fixed effects conflate differential regional exposure with common nationwide trends and consequently overstate impacts.

[34]Alarms per capita and total duration may also be noisier measures, e.g. in cases of multiple reports for the same air raid event. If so, differences in coefficients might partially be due to extrapolation.

Finally, while the estimated effects in our preferred specifications appear moderate in magnitude, they represent the marginal impact of differential exposure conditional on region-specific baseline matching efficiency, occupation-specific matching rates, and common monthly trends. The unconditional estimates are 2 to 3.5 times larger, indicating that controlling for fixed effects substantially attenuates coefficients by isolating within-region, within-category, within-month variation in exposure. Days with alarms shows the smallest proportional reduction when adding fixed effects, suggesting it primarily captures cross-sectional persistence in regional exposure rather than common time trends in bombing intensity or baseline differences across regions and occupations. The robustness of negative, significant effects across three conceptually distinct measures is consistent with a causal impact of war exposure on matching efficiency, though our observational design cannot rule out alternative explanations.

5.7 Limitations

Several caveats warrant discussion. First, our analysis relies on Work.ua, Ukraine's largest online job platform, which captures digitally-connected employment rather than the full labor market. However, this limitation is less severe than might initially appear. Before the full-scale invasion, internet penetration in Ukraine reached 68% of the total population (including children and elderly), with mobile internet coverage extending to 92% of the country's territory. In 2021, 69% of the labor force lived in urban areas where digital job search is standard practice. Even rural workers frequently access online platforms.[35] While the war damaged infrastructure including internet and power networks, mobile connectivity remained operational even in heavily shelled regions. Thus, our data capture a substantial segment of Ukraine's labor force, though coverage may be lower among the least digitally-literate workers and in the most conflict-exposed areas.

Second, we infer successful matches from vacancies that disappear from the platform between periods. One concern is that vacancies might be withdrawn from the platform for reasons unrelated to the filling of jobs. Neglecting factors such as the relocation or shut down of firms involving the removal of vacancies from the platform would induce an overstating of the actual number of matches. However, there is reason to think that such cancellations from the platform occur rarely. First firms pay fees to work.ua based on vacancy inflows while they incur no cost in maintaining posted vacancies on the platform, giving them little incentive to close unfilled vacancies.[36] More importantly, if war-related disruptions systematically increased cancellations unrelated to the actual filling of vacancies, this measurement error

[35] During COVID-19 quarantines, rural unemployment rose sharply because many rural residents commuted to urban jobs, indicating integration into formal labor markets accessible via online recruitment. Data from DataReporter (`https://datareportal.com/reports/digital-2021-ukraine`). Another source, ITU (`https://www.itu.int/en/ITU-D/Statistics/Documents/DDD/ddd_UKR.pdf`), reports 83% of households have internet access at home, including 73% in rural areas in 2021.

[36] Firms receive one free vacancy posting per month; each additional vacancy costs approximately 1/20 of the average monthly wage. Fees are charged at posting, maintaining an open vacancy thereafter is free, unless a firm decides to pay to boost vacancy visibility in search results.

should be most severe in highly-exposed regions, artificially inflating their apparent matching efficiency. We observe the opposite: matching efficiency declined most in regions experiencing the greatest disruption (18-24% in contested areas versus 4-8% in western regions). This pattern is inconsistent with measurement error from non-match closures driving our results.

Third, the platform allows multi-region and multi-category posting, meaning our cells are not mutually exclusive. This primarily affects level interpretations. To the extent that multi-posting behavior remained stable during the conflict, it introduces classical measurement error that would not systematically bias our war exposure coefficients. We found no evidence that firms or workers altered multi-posting patterns in response to conflict.[37]

Fourth, our data may suffer composition bias from two sources: sectoral selection and firm survival. While our estimates include fixed effects for broad sectors and occupations, we have no information on entry and exit of firms. Digitally-connected firms and workers in Work.ua may be more adaptable to wartime conditions. In addition, only firms that continued operating through the initial shock remain in our sample, mechanically selecting for organizations with greater adaptive capacity. Data from the State Employment Service (SES), which focuses on different occupational segments, shows persistently weak job placement rates during the war. However, SES data suffer from severe selection problems of their own: registered unemployment represents only 21% of total unemployment even in peacetime, men increasingly avoid SES registration during wartime due to mobilization fears, and the composition of workers and firms relying on SES likely shifted after the invasion (e.g., toward workers with disabilities who are harder to match). No administrative data source is immune from composition bias in this context, and no other dataset would allow us to estimate the matching function at this level of granularity.

These limitations warrant careful interpretation but do not fundamentally undermine our findings. Our contribution lies in documenting how conflict intensity affects matching efficiency within the formal, digitally-connected segment—a substantial portion of Ukraine's labor market. The negative war exposure effects we identify are plausibly causal and robust across multiple specifications. Our results suggest that the matching process in Ukraine's labor market proved rather resilient during wartime, at least for the substantial segment we observe; whether resilience was greater or lower in informal or non-digitally-connected segments remains an open question.

5.8 What Matching Efficiency Captures, and What It Does Not

Matching efficiency in our framework measures how effectively job seekers and vacancies are brought together. Changes in matching efficiency reflect variation in search frictions, geographic and occupational mismatch, information flows between workers and firms, and the effectiveness of institutions that facilitate matching. In other words, we are dealing with shifts of the Beveridge Curve altering the number of matches per any given level of U and V.

Matching efficiency is one dimension of labor market performance. We lack systematic

[37]We verified that the frequency of multiple postings across regions and categories did not change significantly after the full-scale invasion.

data on hours worked, workplace safety compliance, or other job amenities during the conflict, and thus cannot directly assess such margins. It is plausible that working conditions and non-wage amenities deteriorated during the war, and that enforcement of employment protection legislation was relaxed. However, we found no evidence that wartime labor policies could have systematically worsened labor market conditions; any such deterioration likely reflects the direct effects of the war rather than deliberate policy choices under Martial law.

Our focus on matching efficiency addresses a first-order question for sustaining economic activity during conflict: in a wartime economy experiencing massive displacement and reallocation, can workers and firms still find each other? Our analysis documents that this coordination function proved surprisingly resilient despite unprecedented disruption.

6 Evidence on Firm-level Adjustment to Shocks

In a wartime labor market, subject to major labor supply and reallocation shocks, skill mismatches, fear and uncertainty among workers, heightened informational frictions, business volatility, and the relocation of internally displaced people who lost local networks are all factors that naturally reduce the matching of workers and jobs. The observed decline in the efficiency of job matching, especially in western regions, was instead mild. In this section, we focus on the mechanisms that compensated these emerging frictions allowing matching efficiency not to lose much ground with respect to the conditions prevailing before the full scale invasion.

6.1 Mobilization of underrepresented groups

Wars often narrow gender employment gaps, as large-scale mobilization of men for the army generates both labor shortages and opportunities for women to enter previously male-dominated occupations (Acemoglu et al., 2004; Aneja et al., 2025; Ferrara, 2023; Klugman and Mukhtarova, 2020). The SES - Helvetas survey of firms, conducted in early 2025, indicates that 32% of enterprises reported being willing to employ women in positions traditionally held by men. Although this is a one-time survey, the share is remarkably high and suggests that substitution of male labor with female workers has been a widespread response to wartime shortages. Anecdotal evidence corroborates this view: women have increasingly taken jobs as miners, truck and public bus drivers, etc. (Méheut, 2024; The Economist, 2023). These shifts were supported by both public initiatives and joint public–private training programs aimed at preparing women for work in heavy industries (Shevchenko, 2025). Legislative changes also played a role: under martial law, restrictions that previously barred women from working in hazardous and underground occupations were temporarily lifted, allowing women to voluntarily take such positions.[38]

[38]Article 9 of the Law of Ukraine No. 2136-IX *"On the organization of labor relations under martial law"* states that during the period of martial law, the employment of women (except for pregnant women

Similarly, war may have induced higher participation of elderly and disabled people. As of October 2024, approximately 2.8 million out of 10.3 million pensioners were still employed, with the share rising from around 19% in 2017 to 26% in 2024.[39] The SES - Helvetas survey indicates that, on average, 13% of firms' employees are aged more than 60.[40]

The share of disabled people and people with special needs among employees was in October 2024 more than 10%, a relatively large number by international comparisons. Moreover, about 21% of firms stated that they were planning to hire workers with disabilities.

Some of these developments can be a part of long-term process of inclusion of under-represented groups in the labor force. In order to isolate the role played by wartime factors in the recruitment of these groups, we used the SES survey to elicit recruitment plans of firms. In particular, we estimate a linear probability model of planned recruitment policies of firms:

$$y_{irs} = \kappa + \sum_{k \in \{\text{Med,High}\}} \alpha_k \mathbf{1}\{\text{Exposure}_r = k\} + \beta_s + \gamma X_i \tag{8}$$

where y denotes our outcome of interest (recruitment of internally displaced persons, of workers aged 60+ or of persons with disabilities, allowing for remote work) in firm i active in region r and operating in sector s, *Exposure* is a categorical variable that corresponds to terciles of total alarm duration (*low* is the omitted category), β_s are sector-specific fixed effects, while X_i controls for the log of firm size.[41]

The first four columns of Table 5 suggest that hiring of IDPs or of workers aged 60 or more significantly increases with exposure to air-raid alarms whatever metric we use. Results concerning planned hiring of disabled persons are less clearcut. They increase in regions at medium exposure and decrease in regions most exposed depending on the metric. According to other questions in the survey, hiring of disabled persons in highly exposed regions is more constrained than elsewhere by accessibility issues.

6.2 Remote work in wartime

The next two columns of Table 5 suggest that remote working was also used more intensively in more exposed regions. While the adoption of remote work had already accelerated during the COVID-19 pandemic, the war would seem therefore to have reinforced this trend and

and women with children under the age of one year) with their consent is allowed to perform heavy work and work in harmful or dangerous working conditions, as well as underground work. Link: `https://zakon.rada.gov.ua/go/2136-20`. Evidence so far points to modest but tangible changes. For instance, one coal mine reported an increase in the share of women among underground miners from 0% to 3% between 2022 and 2024 (Економічна правда, 2024). Similarly, according to the State Employment Service, 1,200 women were placed in the construction sector in 2023 - 38% of all placements in that sector - compared to 20% in 2021 (правда, 2024).

[39]Source: `https://niss.gov.ua/en/doslidzhennya/socialna-politika/outlook-elderly-people-labour-market-ukraine`.

[40]In Ukraine in 2024 retirement age for both sexes was 60 years, but for some professions it is lower.

[41]The results are robust to the inclusion of controls. In the appendix, we allow for a richer set: size and composition of the firm, regional production and demographic characteristics, vacancies at the firm, training at the firm, and dummies for cooperation with employment services.

Table 5: Firm-level adjustments to exposure: Hiring and remote work

	Hiring IDPs		Hiring people aged 60+		Hiring people with disabilities		Remote work allowed	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Days with Alarms: Medium	0.096***		0.064***		0.033**		0.028*	
	(0.023)		(0.015)		(0.012)		(0.015)	
Days with Alarms: High	0.075***		0.035*		-0.026**		0.066***	
	(0.018)		(0.017)		(0.010)		(0.023)	
Duration: Medium		0.081***		0.070***		0.035**		0.013
		(0.018)		(0.017)		(0.015)		(0.016)
Duration: High		0.092***		0.040**		-0.011		0.059***
		(0.024)		(0.019)		(0.015)		(0.014)
Constant	0.528***	0.529***	0.261***	0.261***	0.444***	0.444***	-0.003	-0.003
	(0.022)	(0.023)	(0.020)	(0.020)	(0.013)	(0.014)	(0.023)	(0.023)
Observations	16,553	16,553	16,552	16,552	16,553	16,553	51,221	51,221
R^2	0.082	0.082	0.084	0.084	0.065	0.064	0.077	0.078
Sector FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes. Dependent variables are dummies for firm policies. All specifications use OLS with sector fixed effects. Exposure measured as days with alarms (odd columns) and alarm duration (even columns). Control variables used: log of firm size in 2025. Standard errors clustered in at the region level in parentheses. Sample: SES survey sample (see Appendix G), excluding the contested oblasts of Donetsk, Luhansk, Kherson, and Zaporizhzhia. Crimea was not sampled by the survey. For outcomes in specifications (1) – (6), sample is restricted to firms planning employee recruitment in 2025.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

provided another mechanism by which labor markets continue to operate even under rather extreme wartime conditions.

Remote work arrangements also made it possible for some internally displaced persons and migrants abroad to remain attached to their employers in Ukraine and continue providing services, despite physical dislocation. A recent IOM survey found that among refugees who declared to be employed, 14% reported working remotely for Ukrainian companies (with that figure reaching as high as 36% in Moldova's subsample).[42] Importantly, return intentions differed sharply by type of employment: only 62% of remote workers reported plans to remain abroad in the short term, compared with 92% among those formally employed in host countries. Hence, remote work can also operate as a potential lever for encouraging higher rates of return migration once conditions allow, by maintaining ties between firms and their displaced employees and thereby helping to mitigate the long-run loss of human capital.

[42]Link: `https://www.migrationpolicy.org/sites/default/files/publications/mpie-iom_ukraine-return-intentions-2024-final.pdf`.
Another survey of refugees finds 9% working remotely `https://www.german-economic-team.com/en/newsletter/a-survey-of-ukrainian-refugees/`.

6.3 Wage flexibility

Wage flexibility may have been an important factor in facilitating reallocation and adjustment to the wartime labor supply shock. In the immediate aftermath of the full-scale invasion, not only real wages but also nominal wages fell. This drop is unseen in the Ukrainian context, where nominal wages had continued to grow even during previous crises – such as the global financial crisis of 2008 and the Russian annexation of Crimea in 2014 – although real wages declined in both episodes. Notably, the statutory minimum wage was kept unchanged in 2022 and 2023. As high inflation reduced its real value, the minimum became less binding, thereby permitting greater downward wage adjustments at the lower end of the distribution.[43] See Appendix H for details.

The wage dispersion widened, both during the initial contraction and in the subsequent recovery. At the outset of the war, the most severely affected sectors were those providing direct consumer services: real wages in entertainment and recreation declined by 32% year-on-year, while trade and transportation fell by 22%. Peacetime construction projects were largely halted, leading to a 36% decline in real wages in the sector. In contrast, wage declines in the public sector were more contained than in private-sector activities. Military compensation increased markedly, especially for personnel deployed at the frontline, reflecting both higher risk premia and the sharp rise in defense-related expenditures.

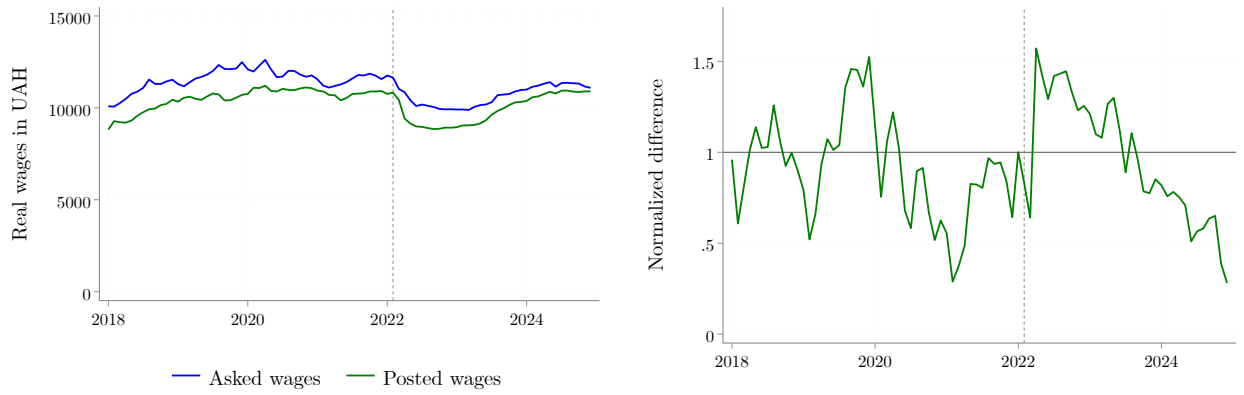
The recovery phase was likewise uneven. By 2024, average wages in sectors dominated by private enterprises had already surpassed pre-invasion levels and continued to grow rapidly. By contrast, sectors where public ownership dominates - such as healthcare and education - remained below the nationwide average. The only exception was public administration and defense, where wages increased nearly in line with the national average, again reflecting both expanded defense spending and higher compensation in military-related activities.

6.4 The gap between posted wages and asked wages

Other factors can influence the matching rate, such as adjustments of reservation wages and search intensity of workers (Petrongolo and Pissarides, 2001).

As Figure 15 suggests, in the months following the full-scale invasion both wages stated in resumes (asked wages) and wages posted in job platforms declined. This may be related to changes in the composition of the workforce as out-migration was largely concentrated at the upper end of the skill distribution. The initial sizable labor demand shock could also have played a major role in this context The fact that the decline in posted wages was sharper than in asked wages (as well as the initial fall in nominal wages) is consistent with this demand-driven interpretation. The gap between asked and posted wages, however, narrowed down rapidly: by mid-2023 it had returned to pre-war levels and ever since it has fallen below

[43]Wage arrears were instead less relevant than in the late 1990s. The latest pre-full scale invasion data from the SSSU indicate that in January 2022 total wage arrears amounted to UAH 3 bn, or 2.9 % of the wage bill for that month. The latest data available data (September 2025) point to wage arrears accounting for a lower fraction (2.4 %) of the wage bill.

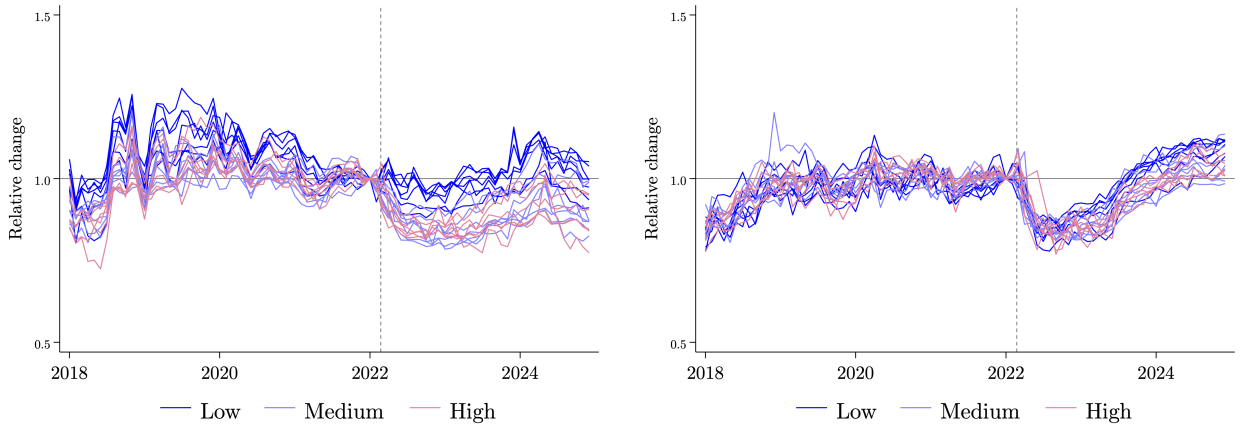


(a) Evolution (b) Difference (normalized to Jan 2022)

Figure 15: Asked vs posted real wages

Notes. Data shown in Panel (a) are averages across the economy. Panel (b) plots their normalized difference. Source: Work.ua.

the lowest levels observed since 2018. This is consistent with the persistence of the labor supply shock.



(a) Average asked wages (from resumes) (b) Average posted wages (from vacancies)

Figure 16: Asked vs offered real wages by region and war exposure

Notes. Average real wages normalized to February 2022 (invasion month) for each region. Each line represents one region, colored by war exposure intensity. Wages deflated using CPI (2018=100). Contested regions (Donetsk, Luhansk, Kherson, Zaporizhzhia) and Crimea excluded. The vertical dashed line marks the full-scale invasion (February 24, 2022). Source: Work.ua.

A natural question is whether wage adjustments compensated workers for regional variation in danger. Standard theory predicts compensating differentials: workers should demand higher wages in high-risk regions, and competitive firms should offer them to attract scarce labor. Figure 16 displays real wages by region, colored by war exposure intensity. The data reveal no such pattern. Both asked wages and posted wages declined sharply after the invasion

across all regions, with high-exposure regions showing no systematically higher growth levels than low-exposure regions. If anything, especially for asked wages, the gap between low and high exposure regions widens relative to the pre-war period. This absence of wage premia likely reflects collapsed productivity in frontline regions combined with limited geographic mobility, preventing the spatial wage adjustments that would be expected in a frictionless labor market.

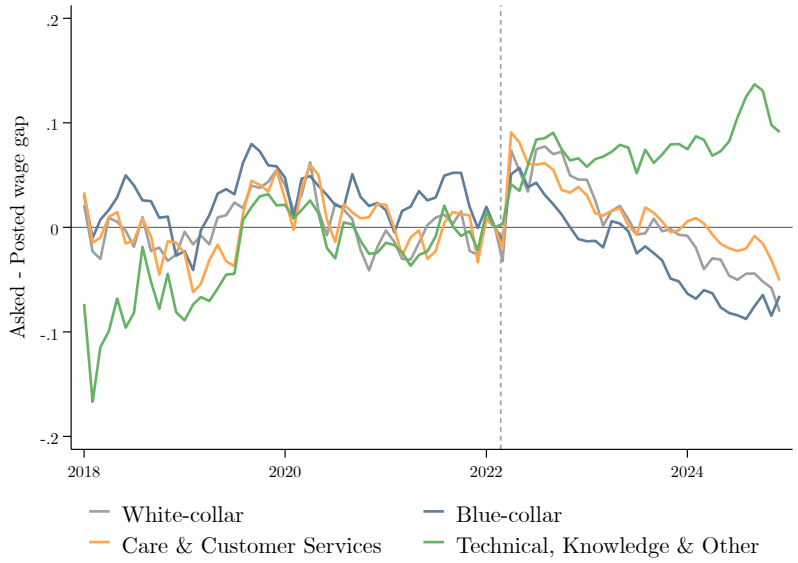


Figure 17: Posted vs asked average wage gap by job category

Notes. Gap between posted and asked wages, where positive values indicate firms offer on average more than workers request. Categories grouped as follows. White-collar: Middle Management, Accounting, Marketing/PR, Secretariat, Insurance, HR, Finance, Top Management, Law. Blue-collar: Logistics, Security, Craft Workers, Construction/Architecture, Transport, Agriculture. Care & Consumer Services: Hotels/Restaurants/Tourism, Beauty/Fitness/Sports, Healthcare/Pharma, Service Sector, Sales/Procurement, Retail. Technical, Knowledge & Other: IT, Design/Creativity, Culture, Real Estate, Education/Science, Media/Publishing, Telecommunications, Other. Wages deflated using CPI (2018=100). Source: Work.ua.

On the job category margin, both posted and asked wages declined sharply across all categories following the invasion (Figure 17). By 2024, the wage gap turned positive in three sectors—white-collar, blue-collar, and care & consumer services—indicating firms offered wages above workers' asked levels in these occupations. Technical and other services, however, maintained negative gaps, with workers' wage expectations exceeding firm offers. Beyond prolonging unemployment spells for some job categories, this mismatch might pose a significant outmigration risk, particularly for knowledge workers and technical professionals whose skills are portable and internationally competitive.

6.5 Other possible explanations

Workers and firms may have also adjusted their search intensity or decreased their choosiness in response to market disruptions. We find limited evidence for this hypothesis. Occupational search breadth increased very modestly post-invasion (workers posted across 0.6% more job categories, firms 0.7% more) while geographic search breadth declined sharply (workers posted in 6% fewer regions, firms in 10% fewer), with differences statistically significant at $p<0.001$. While consistent with workers broadening occupational search amid sectoral disruption while facing binding geographic constraints, these patterns could also partly reflect compositional changes in platform users rather than behavioral adjustments among continuing users.

Several additional factors, harder to document systematically, may have contributed to the resilience. First, the increased reliance on online job platforms may have facilitated faster matching between workers and vacancies, although the lack of comprehensive coverage data prevents us from quantifying this effect. Second, government interventions may have mitigated coordination failures by channeling demand and resources toward critical sectors, thereby stabilizing employment. Third, solidarity networks within communities and firms may have reduced search frictions. Finally, the Ukrainian economy's repeated exposure to crises - including the financial crisis of 2008, the 2014 annexation of Crimea, and the COVID-19 pandemic - may have fostered experience in making rapid adjustments under uncertainty.

7 Policy Implications

7.1 In Wartime

A wartime labor market needs to accommodate a major reallocation of jobs and workers towards military related industries. It should do this while experiencing a major negative labor supply shock due to army mobilization and emigration, and in a context where the matching of vacancies and workers is seriously hampered by the perils of war, and the high uncertainty regarding the survival of the employment relationships. These frictions can be as large as to shut down entire labor markets, as shown by the experience of the partly occupied regions along the frontline. How did the Ukrainian labor market perform in the four years after the Russian full scale invasion?

Our findings indicate that the Ukrainian labor market so far did remarkably well in reconciling defense, reallocation and job matching. The direction of structural change was reversed at the outset of the war, as the priority became producing guns rather than butter. Ukraine lost at the beginning of the war in a few weeks millions of workers who migrated abroad, and who had, on average, higher educational attainments than those who stayed. Between 6 and 7 million people remain abroad as of late-2025. Another several hundred thousands workers were lost because of the army mobilization and casualties of the war. Yet, the efficiency, at least in the digital labor market, was only mildly affected by these quite dramatic evolutions. The industries operating in close connection to the military industry –

such as security and logistics – suffered only marginal reductions in matching efficiency. This was made possible by adjustments in recruitment policies of firms, allowing for a broader use of remote working, involving more women in traditionally male dominated occupations and adapting work organizations to persons with disabilities.

What are challenges ahead in case the war continues?

Shortages of workers are emerging in many sectors of the economy. Recruitment difficulties are peaking notably for skilled workers (Figure 18). Wages for these workers are increasing but not as much as to match their aspirations. A continuation of the war will necessarily require a higher mobilization of persons so far inactive and a greater contribution from those who left the country before the war. Remote working makes it possible to involve the refugees in the generation of value added to support the war effort and possibly prepare their re-entry as soon as the war ends.

Figure 18: Recruitment difficulty by skill level

Notes. The figure shows the net balance of firms reporting recruitment difficulties (share reporting "harder" minus share reporting "easier" to find workers). Data from the monthly IER enterprise survey. Qualified labor refers to skilled workers; unqualified labor refers to unskilled workers.

The army will unavoidably need more persons if the war continues. The adoption of military techniques less labor intensive should be as much as possible encouraged. Yet conscription will remain essential for national defense—and strategic considerations must take precedence. Incorporating labor market evidence into mobilization policy design may help reducing its economic impact. Ukraine already implements a reservation system for employees in critical enterprises, including defense industries, energy, healthcare, and other sectors vital to the war effort. However, labor market evidence points to potential refinements. First, temporary rotation systems for workers in sectors experiencing the most severe shortages could help preserve production capacity while maintaining mobilization levels. Second, approaches accounting for local economic conditions may reduce aggregate disruption: areas where labor

markets function better appear better positioned to absorb mobilization shocks, suggesting that economic performance could inform the geographic sequencing of conscription efforts. Any such refinements require transparent criteria to maintain public trust and must be compatible with military effectiveness.

7.2 Priorities for the Reconstruction

How to prepare for the challenges of the reconstruction?

The war and the pandemic have left lasting scars on human capital. With the words of Clark (1916), "there are effects of war which are more tragic than the economic burden it will place on future generations and there are some that are more morally revolting; but there are none which will last longer or do a greater total amount of harm." Prolonged school closures, displacement, and reliance on distance learning have created significant gaps in educational attainment. Addressing these deficits, alongside retraining workers displaced by reallocation, will be essential for the reconstruction phase (Anastasia and Boeri, 2023; Angrist et al., 2022; Égert and de la Maisonneuve, 2024; Gorodnichenko et al., 2022).

Gender dynamics also raise concerns. While the conflict temporarily narrowed employment gaps by pulling women into male-dominated occupations, composition effects, slower wage growth in public services, and high military compensation have likely widened the gender wage gap. Before 2022, women earned on average 80% of men's wages (Klemparskyi et al., 2022). While female participation has increased during the war, the historical evidence on the persistence of such war-related shifts is mixed (Rose, 2018; Shatnawi and Fishback, 2018). Migration pressures compound these risks. With average wages in early 2025 only 26% of those in Poland and 11% of those in Germany, incentives for out-migration remain high, particularly once borders reopen for men of conscription age. The danger of a renewed exodus of skilled workers is therefore substantial.

Policies should reflect these vulnerabilities. We identify six priorities for the reconstruction phase.

1. *Reintegration of veterans* will be a central challenge: up to one million individuals may eventually return from military service, yet current labor force participation among veterans remains extremely low (around 0.5% of employees across firms according to SES–Helvetas data). Targeted measures such as retraining subsidies, hiring incentives, psychological support can facilitate their transition to civilian employment. Strengthening mental health services will be critical not only for veterans but also for civilians affected by trauma, as the psychological legacies of the war risk becoming a major obstacle to labor market participation.

2. Rebuilding human capital will require decisive *investment in education.* Lessons can be drawn from intensive remedial training initiatives and remote tutoring programs developed during the COVID-19 pandemic (Carlana and La Ferrara, 2025). Programs already implemented in Ukraine during the war that proved to be cost-effective, improving learning and reducing stress among students, should be scaled (Dinarte-Diaz

et al., 2025). Crucially, resources should not be limited to the physical reconstruction of schools but must also target teachers and programs, including those leveraging contributions from refugee professionals abroad. This effort should actually be made immediately, even if the war is prolonged. The evidence about the increasing divergence between asked and posted wages in technical and education services suggests that there may be also a risk of a further brain drain.

3. Sustaining higher female participation rates will depend on *inclusion policies* such as expanding childcare provision, strengthening parental leave, and improving family–work reconciliation. More generally, labor market policies must ensure high employment rates among traditionally underrepresented groups. Particular attention must also be given to workers with physical or psychological war-related impairments, for whom both job opportunities and workplace infrastructure need to be adapted.

4. *Active labor market policies* will be needed to facilitate reallocation across regions and sectors, including mobility assistance, relocation allowances, and apprenticeships. Place-based policies will be necessary to support reconstruction in frontline areas, where labor markets have collapsed and risks of long-term divergence are highest. Addressing informality, which risks expanding under wartime conditions, will also be important to ensure adequate protections and tax revenues.

5. *Migration policies* will play a key role. While encouraging the return of refugees and displaced workers remains important, the evidence suggests that not all will come back. Incentive schemes - such as preferential tax treatment for returnees, modeled on programs in other European countries - can help attract back at least part of the skilled diaspora (Bassetto and Ippedico, 2024).[44] At the same time, fostering connections with those who remain abroad is crucial: remote work, digital platforms, and cross-border professional networks can mitigate the long-term costs of brain drain by channeling knowledge and services back to Ukraine. Ukraine should also look outward, actively encouraging migration from abroad and simplifying its visa system to help offset demographic decline and labor shortages in key sectors. The risk of outmigration should also be taken into account. Our evidence suggests it is acute among technical and knowledge workers, where persistent wage gaps between Ukrainian offers and worker expectations might create powerful incentives to seek opportunities abroad.

6. Finally, demographic aging and the likely inflows of permanently unemployed or disabled workers will add pressure to the pension system, requiring careful adaptation of eligibility rules and benefit design. For older workers with obsolete skills, limited bridging schemes toward retirement could be envisaged, though demographic constraints rule out large-scale early exit.

To rise to these challenges, solid labor market statistics and economic analysis will be indispensable, and reinforcing the capacity of the institutions responsible for producing

[44]The design of such schemes requires particular care, as preferential treatment for returnees could generate perceptions of unfairness among those who remained in Ukraine throughout the war.

them will help improve the quality of policy design and evaluation. Given that government intervention in reconstruction will inevitably be extensive, the scope for industrial policy should be weighed carefully: while it can support recovery, weak postwar institutions risk opening space for capture and inefficiency. One practical tool could be the use of social clauses in public procurement contracts - for instance, requiring firms to employ a share of veterans or workers with disabilities - although rigorous evidence on the effectiveness of such measures is limited.

International support will remain essential. Ukraine's reconstruction will require sustained financial and technical assistance to scale up labor market policies, from retraining programs to veteran reintegration and the inclusion of workers with war-related disabilities. The European Union is be a natural partner, both through direct funding instruments and through its convergence agenda. External assistance should go beyond financing: continuous monitoring and institutional support will be key to ensuring that reconstruction policies are effective.

Reconstruction should also build on the new capacities developed during the war. Ukraine has become a testing ground for technological and organizational innovations, particularly in sectors such as drones, cybersecurity, and logistics. These advancements have clear civilian applications and could position the country as a hub for specific technologies within Europe. Historical experience shows that military-driven innovations can generate powerful spillovers into the civilian economy.[45] At the same time, sustained military spending can crowd out resources for welfare and public investment, underscoring the importance of ensuring that wartime technological advances are redirected toward civilian uses. Turning these innovations into peacetime engines of growth will require policies that facilitate knowledge transfer, support entrepreneurship, and attract investment into emerging industries.

8 Conclusion

Long wars are often won in factories rather than on battlefields. In Ukraine, the 2022 full-scale invasion triggered one of the largest combined labor supply and reallocation shocks in recent history. Millions of workers were displaced abroad or mobilized into the armed forces, while many firms suspended or downsized activity. In spite of that, almost four years later, the labor market has overall proven resilient, adjusting through profound geographical and sectoral reallocation. Several elements help explain why aggregate outcomes were less catastrophic than the severity of the shock might have suggested, even though major challenges remain. On the firm side, employers adapted recruitment procedures and the organization of work - including the scope for remote working - to cope with the new characteristics of labor supply. On the workforce side, women moved into occupations traditionally dominated by men, while persons with disabilities became more integrated into employment. Wage setting at the individual level cushioned productivity shocks without generating mass layoffs, and

[45] For example, Israel's experience with defense-related R&D during decades of conflict, supported by large-scale U.S. transfers and the presence of American companies, later underpinned the emergence of its high-tech industries.

real wages (and productivity) gradually recovered the ground lost.

Compared to previous conflicts, the war in Ukraine did not prevent the systematic collection of labor market data, at least outside the territories occupied by Russian forces. This allowed us to conduct a much richer analysis of wartime labor markets than in earlier episodes. Labor markets in areas shielded from direct combat were able to reabsorb displaced workers and sustain labor demand, with employment and vacancies returning close to pre-war levels. By contrast, in frontline and occupied territories economic activity contracted dramatically, and in some cases labor markets virtually ceased to operate. Sectoral differences were equally pronounced: consumer-facing services such as trade, transportation, and recreation experienced sharp contractions, while activities linked to logistics, information technology, and defense-related production proved more resilient or even expanded. The wartime labor market is therefore best understood as a dual system, with stark contrasts between shielded and exposed regions, and between sectors sustained by wartime demand and those crippled by disruption.

To conclude, the Ukrainian labor market has so far withstood shocks of unprecedented magnitude, but the challenges of reconstruction will be no less formidable than those of the war itself. Scars of war will be pervasive in the economy. The capacity for rapid adjustment shown during the conflict must now be converted into a strategy for sustained recovery. Success will depend on investing in human capital, securing high employment among underrepresented groups, and strengthening the institutions that govern labor markets. What ensured survival in wartime must now secure prosperity in peace.

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A Estimate of labor supply and demand shocks

A.1 Labor supply

We are interested in estimating the supply shock to the labor market as of late 2025, measuring the cumulative impact from February 2022 through 2025. We take as reference the labor supply in government-controlled territory in the 15-70 age group. We exclude the labor force in territories occupied by Russia from our calculation, as it is unclear how labor under occupation should be treated. Unlike migrants abroad, there are no reliable statistics on the population residing in occupied territories. While there are estimates of the share of territory controlled by Russian forces, these need not coincide with the share of the labor force under occupation. We therefore combine multiple sources, including oblast-level population data and statements by Ukrainian authorities, to assess this share. According to our estimates, 2.5 million individuals are in occupied territories. At the 2021 labor force participation rate, this equals 1.6 million labor force participants, 9% of the pre-war labor force. Given the uncertainty around this figure, in the pessimistic scenario we consider a share of 11%, in the optimistic one 7%.[46] The denominator throughout is thus the 2021 Ukranian labor force adjusted for the share currently in government-controlled areas, s_{ctrl}:

$$LF_{\text{ctrl}} = LF_{2021} \cdot s_{\text{ctrl}}$$

To quantify the labor supply shock, we proceed as follows.

Refugees abroad. We take the stock of refugees abroad from UNHCR and consider three scenarios: a baseline (average stock in 2024), a high scenario (maximum reported stock at the beginning of 2025), and a low scenario (average estimates in 2024 excluding Russia). For each scenario we (i) apply the share of working-age individuals, (ii) split by gender, and (iii) multiply by pre-war 2021 gender-specific labor force participation rates:

$$Loss_{\text{ref}} = R_f \cdot r^f_{wa} \cdot p^f_{2021} \;+\; R_m \cdot r^m_{wa} \cdot p^m_{2021}$$

where R_f and R_m denote the female and male refugee stocks, r^f_{wa} and r^m_{wa} are the gender-specific shares of refugees in working age, p^f_{2021} and p^m_{2021} are the pre-war participation rates

[46] This restriction is also sensible given that, at present, it remains uncertain whether Ukraine will be able to regain control over the occupied territories. We assume 25% of the 2021 regional labor force is in government controlled territory in Donetsk and Luhansk, 50% in Zaporizhia and Kherson, 95% in Kharkiv. We exclude Crimea from our calculations. The corresponding estimates are in line with public statements by Ukrainian authorities. In particular, in 2024 the Minister for Reintegration of the Temporarily Occupied Territories, Iryna Vereshchuk, reported that the total population in territories under occupation amounted to around 6 million persons. Subtracting the population of Crimea in 2014 (2 million) and the portions of Donetsk and Luhansk under occupation before 2022 (1.2-1.6 million) yields a residual of approximately 2.6 million persons in territories occupied after the full-scale invasion, consistent with our baseline. Source: `https://unity.gov.ua/en/2024/01/29/the-international-community-should-pay-constant-attention-to-ukrainians-living-in-temporarily-occupied-territories`.

by gender (56.1% for females, 68.1% for males). Multiple surveys of refugees exist, but they differ in methodology, sample design, point in time, and geographical coverage. As a result, figures vary across sources. We therefore use as baseline the age and gender split estimated by UNHCR.[47]

A note on the UNHCR refugee statistics. UNHCR began publishing statistics on displaced Ukrainians in March 2022, initially based on border-crossing data. In June 2023, the methodology was revised to rely instead on counts of individuals granted temporary protection or equivalent status in host countries, which lowered the reported stock from 8.2 to 6.3 million persons, mainly through downward adjustments for Russia and Belarus. A second revision in May 2025 excluded approximately 1.2 million individuals reported by Russia as migrants from Ukraine who did not hold refugee or temporary protection status. Many of these individuals may have been forced to move to Russia. Since Russian authorities had not updated their data since June 2023, UNHCR excluded them, reducing the total stock from 6.9 to 5.6 million. Taken together, these revisions reduced the headline estimate of refugees by nearly 30% relative to the original figures. We adopt the revised numbers only in the low-scenario estimate since, for the purpose of our analysis, these individuals should in any case be treated as a loss to the Ukrainian labor force, regardless of legal classification.

Military mobilization. While members of the armed forces are formally part of the labor force, we treat the net increase in the number of individuals serving in the army and other defense and security forces (e.g., National Guard, Territorial Defense) as a labor supply shock to the civilian labor market. This expansion was induced by the war through both military conscription and voluntary enlistment. There are no official public statistics on the exact number of personnel, as these figures are classified for security reasons. Combining available estimates, we assume in the baseline scenario the net increase in military and defense personnel amounts to 750,000 people, ± 50,000 in high/low scenarios.

The labor force loss is not one-to-one with mobilization, as not all volunteers and conscripts were labor force participants prior to enlistment (e.g., students). We compute the associated labor force loss by applying the pre-war male labor force participation rate:

$$Loss_{\text{mil}} = M \cdot p^{m}_{2021}$$

where M is the estimated net increase in military and defense personnel and $p^{m}_{2021} = 0.681$ is the male labor force participation rate in 2021.

Casualties. We account separately for military and civilian casualties, both of which reduce the labor force through deaths and permanent disabilities among injured survivors.

- *Military casualties.* Combining statements from Ukrainian authorities, independent analysis, and public reports of deaths, we assume 70,000 soldiers have been killed (±

[47] As of November 2025, UNHCR reports 26% of refugees are adult males, 44% adult women, and 30% children. In the *high* scenario, we assume 29% are adult males and 41% are adult women. In the *low* scenario, we assume 23% are adult males and 47% are adult women. Source: `https://data.unhcr.org/en/situations/ukraine`.

10,000) and 400,000 injured (± 50,000), for a total of 470,000 casualties (± 60,000).[48]

For deaths, all individuals exit the labor force. For the wounded, approximately 50% recovered and returned to active duty; these individuals are already counted in the military mobilization category above. For the 50% of wounded who did not return to active duty, we assume they become disabled with reduced labor force participation. Based on U.S. disability labor force participation rates (approximately 25%), we assume disabled individuals have a labor force participation rate of 25% in the baseline scenario, 20% in the pessimistic scenario, and 30% in the optimistic scenario. The labor force loss from injured individuals is the difference between their pre-injury and post-injury participation rates.

Military casualties labor force loss is computed as:

$$Loss_{\text{mil\_cas}} = D_m \cdot p^m_{2021} + 0.5 \cdot I_m \cdot (p^m_{2021} - p_{\text{disabled}})$$

where D_m denotes military deaths, I_m military wounded, $p^m_{2021} = 0.681$ is the male labor force participation rate in 2021, and p_{disabled} is the labor force participation rate among disabled individuals (0.25 baseline, 0.20 pessimistic, 0.30 optimistic).

- *Civilian casualties.* United Nations monitoring recorded more than 15,000 civilian deaths and approximately 40,000 injuries by late 2025.[49] We apply the same disability labor force participation assumptions as for military casualties, but using the overall (rather than male-only) pre-war participation rate. Civilian casualties labor force loss is:

  $$Loss_{\text{civ\_cas}} = D_c \cdot p_{2021} + I_c \cdot (p_{2021} - p_{\text{disabled}})$$

  where D_c denotes civilian deaths, I_c civilian injured, $p_{2021} = 0.618$ is the aggregate pre-war labor force participation rate, and p_{disabled} is the labor force participation rate among disabled individuals.

  Total casualties labor force loss is:

  $$Loss_{\text{cas}} = Loss_{\text{mil\_cas}} + Loss_{\text{civ\_cas}}$$

Our estimates are conservative and should be interpreted as lower bounds. Casualty counts may be incomplete as some deaths and injuries in occupied territories or remote areas are not captured in official monitoring. Data on long-term disability among both military and civilian casualties are unavailable.

Decline among stayers. Finally, we allow for an intensive-margin decline in participation among those who remain in government-controlled territory. To approximate this, we apply the difference between the aggregate pre-war labor force participation rate (61.8%) and the

[48] President Zelenskyy announced in February 2025 that over 46,000 Ukrainian soldiers had been killed and 380,000 wounded. Counts based on public reports suggest military deaths may be higher.

[49] Source: `https://ukraine.ohchr.org/en/reports/protection-of-civilians`.

InfoSapiens 2024 estimate (56%) to the labor force in government-controlled areas net of refugees, mobilized, and casualties:

$$Loss_{\Delta p} = \left(p_{2021} - p_{2024}^{\text{survey}}\right) \cdot \left[LF_{\text{ctrl}} - (Loss_{\text{ref}} + Loss_{\text{mil}} + Loss_{\text{cas}})\right]$$

This adjustment is included only in the high scenario. The rationale is that part of the observed participation decline may overlap with other outflow categories, creating a risk of double counting, and that compositional changes in the controlled population may also affect measured participation.

Aggregate shock. The total labor force loss is the sum of all components:

$$Loss_{\text{tot}} = Loss_{\text{ref}} + Loss_{\text{mil}} + Loss_{\text{cas}} + Loss_{\Delta p}$$

and the labor supply shock in the government-controlled territory is given by:

$$\text{Labor supply shock}_{\text{ctrl}} = \frac{Loss_{\text{tot}}}{LF_{\text{ctrl}}}$$

A.2 Labor demand

We estimate the labor demand shock using three complementary approaches: (i) counterfactual employment based on administrative turnover data, (ii) firm-reported output levels from enterprise surveys, and (iii) vacancy stock collapse as a measure of hiring freezes. These measures cover dependent employment in formal private firms.

Turnover-based counterfactual (administrative data). We construct a productivity-based counterfactual to isolate the pure demand shock from productivity changes. Using aggregate administrative data on firms real turnover and employment, we calculate baseline labor productivity in 2021:

$$\text{Productivity}_{2021} = \frac{\text{Real Turnover}_{2021}}{\text{Employment}_{2021}}$$

For each subsequent year, we compute counterfactual employment—the number of workers firms would have needed if productivity had remained at 2021 levels given observed output:

$$\text{Employment}_t^{\text{counterfactual}} = \frac{\text{Real Turnover}_t}{\text{Productivity}_{2021}}$$

The implied labor demand shock in firms in the private sector is then:

$$\text{Demand shock}_t^{\text{private}} = \text{Employment}_t^{\text{counterfactual}} - \text{Employment}_{2021}$$

To express this as a percentage of total pre-war employment (both private firms, self-employment and public sectors), we calculate:

$$\text{Demand shock}_t^{\%} = \frac{\text{Demand shock}_t^{\text{private}}}{\text{Employment}_{2021}^{\text{total}}} \times 100 = \frac{\text{Demand shock}_t^{\text{private}}}{\text{Employment}_{2021}^{\text{private}}/(0.72 * 0.72)} \times 100$$

where 0.72 is both the private sector share of total employment, and the share of firms employment vs self-employment in the private sector in 2021.[50] This approach attributes all output decline to reduced labor demand, holding productivity constant. In reality, productivity also fell due to war disruptions (infrastructure damage, supply chain breakdowns, displaced workers). The gap between counterfactual and actual employment therefore reflects a combination of: (i) actual productivity declines that reduced firms' labor needs, (ii) labor hoarding by firms anticipating future recovery, and (iii) frictions preventing adjustment. Without firm-level data or natural experiments, we cannot cleanly separate these channels. We interpret our estimates as the mechanical effect of output contraction on labor demand, acknowledging they represent an upper bound on the pure demand shock. The administrative data cover only the private sector (2021 baseline: 9.06 million workers, 72% of total employment). We report absolute values as private sector firms employment changes and express percentages relative to total pre-war employment to enable comparison with labor supply shocks. We assume public sector and self-employment labor demand remained unchanged, though in practice government hiring may have increased in defense and security sectors while declining in other areas.

Output-based estimates (firm surveys). We use monthly enterprise surveys that ask firms to report current production levels relative to pre-war (February 2022). Firms select from categories: not working, less than 25%, 25-49%, 50-74%, 75-99%, or 100% or more of pre-war output. We assign midpoint values to each category (0%, 12.5%, 37.5%, 62.5%, 87.5%, 125%) and compute the weighted average relative output for each year:

$$\text{Output}_t^{\text{rel}} = \sum_c w_{c,t} \cdot m_c$$

where $w_{c,t}$ is the share of firms in category c at time t and m_c is the midpoint value for that category. The implied labor demand reduction is:

$$\text{Demand shock}_t^{\%} = (1 - \text{Output}_t^{\text{rel}}) \times (0.72 \times 0.72) \times 100$$

where (0.72×0.72) reflects the private firm employment share (firms are 72% of the private sector, which is 72% of total employment, yielding approximately 52% of total employment), under the assumption that public sector and self-employment demand remained stable. Percentages are expressed relative to total pre-war employment. This approach assumes a one-to-one relationship between output and employment, implicitly holding productivity constant. In practice, firms may have adjusted labor more or less than proportionally to

[50] We exclude the informal sector from the calculation.

output changes. The close alignment between turnover-based and survey-based estimates provides reassurance, despite their different methodologies and data sources.

Hiring freeze (vacancy data). We measure the immediate demand shock through the collapse in online vacancy postings on Ukraine's largest job platform (Work.ua), which accounts for approximately 70% of online job listings. We calculate the percentage drop in vacancy stock comparing: (i) a one-month window (January 2022 vs. March 2022), and (ii) a one-year window (2021 average vs. 2022 average). This metric captures firms' hiring freeze rather than total labor demand. Firms may have frozen hiring while retaining existing workers (labor hoarding) or may have filled positions through informal channels not captured in platform data. We report these figures as complementary evidence of demand contraction severity, recognizing they measure flow (hiring intentions) rather than stock (employment needs).

B Construction of group-specific unemployment rates

We combine the aggregate unemployment rate with composition data from the SES survey to estimate unemployment rates for disabled workers. Let g denote the disabled group and $u = 0.113$ denote the aggregate 2025 unemployment rate (National Bank of Ukraine, 2025). Using SES microdata, we compute:

$$s_U^g = \frac{U_g^{SES}}{U^{SES}} = \text{disabled share among unemployed in SES},$$
$$s_E^g = \frac{E_g^{SES}}{E^{SES}} = \text{disabled share among employed in SES}.$$

The group-specific unemployment rate is then:

$$UR_g = \frac{s_U^g \, u}{s_U^g \, u + s_E^g (1 - u)}. \tag{9}$$

This formula scales the aggregate rate by the relative representation of disabled workers among unemployed versus employed in the SES sample. We assume that the SES sample composition matches national composition for disabled workers. This requires that disabled individuals register with the State Employment Service at similar rates whether employed or unemployed.[51]

[51]We applied this methodology to internally displaced persons (IDPs) but obtained an implausibly high unemployment rate of 53%. This likely reflects selection bias: IDPs who register with the SES are disproportionately unemployed, while part of the employed IDPs work informally and do not appear in the sample. The same issue is likely less severe with disabled population.

C Measuring war exposure with air raid sirens

This section provides detailed documentation of the three alternative exposure metrics used in our analysis and demonstrates the robustness of our findings across measurement approaches. Our first measure is the total duration of alarms, which sums the cumulative hours that air raid alerts remained active in each region. This metric should directly capture the time during which economic activity is disrupted. A potential concern is that the same attack might trigger multiple overlapping alarms, potentially overstating exposure—especially if attacks that trigger multiple sirens tend to be more prolonged. We therefore complement this measure with two additional metrics that attenuate this concern. The second measure is days touched by alarms, which counts the number of calendar days on which at least one alarm was active. This metric captures the chronic and persistent nature of exposure. By construction, it is insensitive to overlapping alarms within the same day, though it loses information about within-day intensity. The third measure is alarms per capita, which normalizes the total count of distinct alarm events by regional population (as of January 1st, 2022.). While this approach adjusts for potential differences in alarm system density across regions (cities may have more comprehensive alert infrastructure), the main drawback is that it treats all alarms equally regardless of their duration or severity.

Below we present the complete set of maps. Reassuringly, the categorizations of oblasts into low, medium, high, and contested groups overlap almost entirely, and all three metrics yield qualitatively similar patterns in the figures used in the paper.[52]

C.1 Total duration of alarms

For each oblast–month pair, we sum the durations of all alarms recorded in that period. Let $\text{dur}(a)$ denote the duration of alarm a in hours. The total duration of alarms in that oblast–month cell is simply

$$\text{total}_{o,m} = \sum_{a \in \mathcal{A}_{o,m}} \text{dur}(a),$$

To get the categories used in Section 4, we aggregate over the full sample period:

$$\text{total}_{o} = \sum_{m \in \mathcal{T}} \sum_{a \in \mathcal{A}_{o,m}} \text{dur}(a),$$

which represents the cumulative number of hours under active alarm in oblast o from February 2022 to October 2025.

[52] The only differences in categorization concern a small number of regions in central Ukraine, but this does not affect our substantive conclusions. Days touched and alarms per capita yield the same exposure categorization.

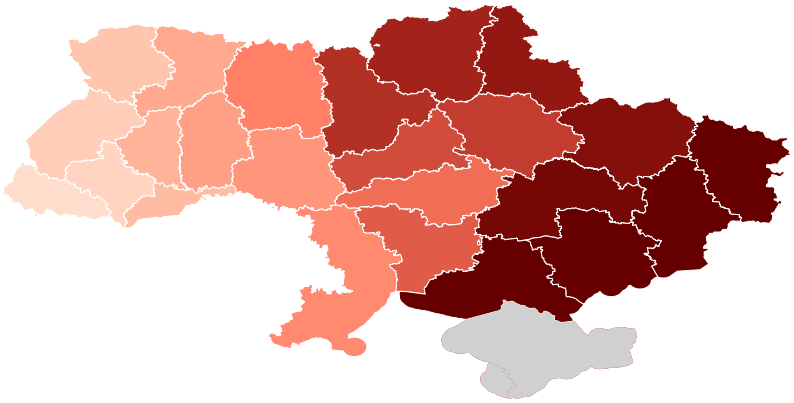


Figure 19: Ukrainian oblasts by exposure (total duration of alarms)

Notes. Regions are ordered from light to dark red based on total duration of air raid alarms (in hours) from February 2022 to October 2025. Color intensity reflects ranking. Contested oblasts (Donetsk, Luhansk, Kherson, Zaporizhzhia) are hand-coded due to partial or complete occupation. Crimea is excluded from the analysis.

C.2 Days touched by alarms

Let $\mathcal{A}_{o,m}$ be the set of alarms in oblast o during month m, and $d(a)$ the set of calendar days spanned by alarm a. At the monthly level,

$$D_{o,m} = \left|\{d \in \text{month}_m : \exists\, a \in \mathcal{A}_{o,m} \text{ such that } d \in d(a)\}\right|.$$

Aggregating over all months,

$$D_o = \sum_{m \in \mathcal{T}} D_{o,m},$$

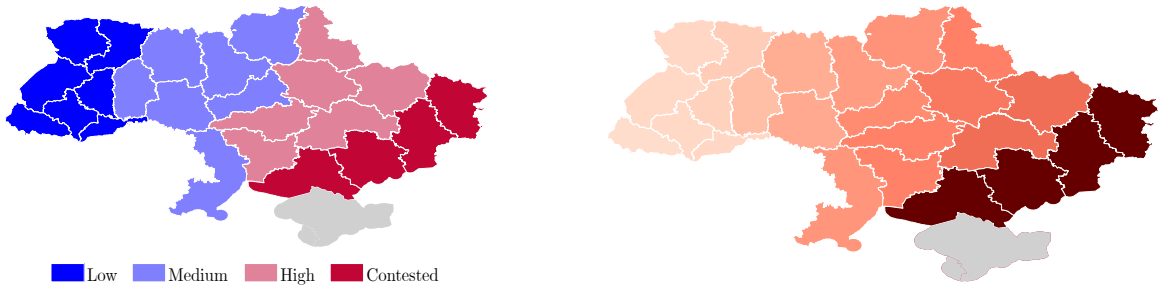
so that each oblast has a single cumulative measure summarizing the number of days with at least one active alarm since February 2022.

C.3 Alarms per capita

Let $A_{o,m}$ denote the number of distinct alarm events recorded in oblast o during month m, and P_o the resident population of oblast o (as of January 2022). For mapping purposes, we sum across all observed months $\mathcal{T}$:

$$A_o = \sum_{m \in \mathcal{T}} A_{o,m}, \qquad \text{alarms}_o = \frac{A_o}{P_o}.$$

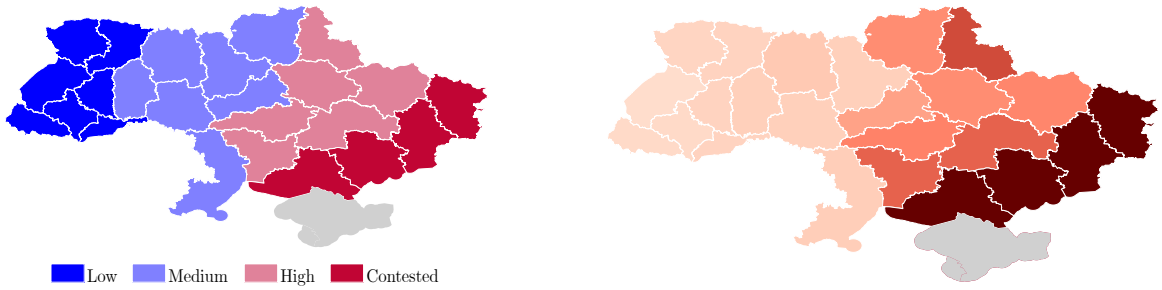
For the monthly panel used in the regression, the same formula applies at the (o, m) level, replacing A_o with $A_{o,m}$, and multiplying for $10,000$ people to ease the interpretation.



(a) Category (b) Continuous

Figure 20: Ukrainian oblasts by exposure (days with alarms)

Notes. In panel (b), intensity reflects the number of days with at least one active alarm from February 2022 to October 2025. Contested oblasts in dark red (Donetsk, Luhansk, Kherson, Zaporizhzhia) are hand-coded due to partial or complete occupation. Crimea is excluded from the analysis.



(a) Category (b) Continuous

Figure 21: Ukrainian oblasts by exposure (alarms per capita)

Notes. In panel (b), intensity reflects the number of alarms per capita from February 2022 to October 2025. Population benchmark is as of of January 1st, 2022. Contested oblasts in dark red (Donetsk, Luhansk, Kherson, Zaporizhzhia) are hand-coded due to partial or complete occupation. Crimea is excluded from the analysis.

D Military-related sectors classification

We classify NACE 3-digit sectors as "military-related" based on their technological proximity to defense production and relevance for military capacity.[53] Ideally, such classification would rely on input-output linkages to identify sectors supplying defense production. However, this approach is not feasible for several reasons. First, input-output tables for Ukraine are available only for the pre-war period and lack the sectoral detail required for NACE 3-digit classification. Second, wartime disruptions likely altered sourcing patterns substantially, rendering pre-war linkages unreliable. Third, military procurement often draws inputs from diverse sectors in ways that are difficult to trace systematically—for instance, drone production involves components from electronics, telecommunications, and precision manufacturing. Finally, information on military procurement and defense-related industrial activity is classified for security reasons. We therefore adopt a classification developed by prompting ChatGPT-4 and Claude Sonnet 4.5 to assess each NACE 3-digit sector's relatedness to military. The sectors classified as military-related can be broadly divided in six categories: (i) sectors producing primarily for defense procurement, (ii) dual-use manufacturing whose outputs serve civilian markets but can be readily adapted for military purposes, (iii) telecommunications and information infrastructure providing command, control, and secure communication capabilities, (iv) repair and maintenance services that can be mobilized to sustain equipment availability, (v) security services, and (vi) R&D and technical activities underpinning weapons development and defense-relevant innovation.[54]

1. Directly military:
    - manufacture of weapons and ammunition
    - manufacture of military fighting vehicles
    - manufacture of air and spacecraft and related machinery
    - manufacture of metal forming machinery and machine tools

2. Dual-use manufacturing:
    - manufacture of motor vehicles
    - manufacture of bodies for motor vehicles; trailers and semi-trailers
    - manufacture of parts and accessories for motor vehicles
    - manufacture of optical instruments and photographic equipment
    - manufacture of instruments and appliances for measuring, testing and navigation; watches and clocks
    - manufacture of communication equipment
    - manufacture of electronic components and boards

[53] For a full list of NACE codes, see `https://ec.europa.eu/competition/mergers/cases/index/nace_all.html`.

[54] Security sectors relating primarily to private security (e.g., "Security systems service activities") are excluded.

- manufacture of consumer electronics
- manufacture of magnetic and optical media

3. Telecommunications and information infrastructure:
   - wired telecommunications activities
   - wholesale of information and communication equipment
   - other telecommunications activities
4. Repair and maintenance capacity: repair of fabricated metal products, machinery and equipment.
5. Security services: security and investigation activities.
6. R&D, scientific, and technical activities:
   - research and experimental development on natural sciences and engineering
   - other professional, scientific and technical activities n.e.c.

E Matching

To estimate a matching function at the monthly frequency, we construct a dataset with the following variables: year, month, economic category, region, monthly stocks and inflows of job seekers (resumes, denoted U) and vacancies (denoted V), and monthly matches. The raw information comes from two separate datasets on stocks and inflows, both recorded weekly at the region-category level.[55] In addition to individual regions and categories, the platform also reports a *Total* group (coded as category 0 or region 0), which reports aggregates of the numbers of unique resumes or vacancies present on the job platform. Selecting *Total* region and *Total* category yields the overall number of resumes or vacancies on the platform; selecting *Total* region and category c yields the total number of resumes or vacancies in Ukraine for that category; and selecting region r and *Total* category yields the total number of resumes or vacancies in that region. Counts at the disaggregated level need not to equal aggregate counts, as people and firms can list multiple regions or categories.

The first dataset contains the total number of resumes and the total number of vacancies, for each region-category pair. Since we are interested in monthly stocks, we can proceed in three ways: we can average stocks withing each year-month-category-region combination; we can keep the first observation per year-month-category-region; or we can interpolate daily values averaging subsequent observations by the days span between them, and recover monthly stock by taking the value on the first day of the month. The second dataset contains the number of new resumes and new vacancies, i.e. the inflows of job seekers and vacancies. To obtain consistent monthly aggregates, we can either sum observations per year-month-region category, or we can again interpolate daily observations and then aggregate monthly.[56] As Figures 22 and 23 show, the different approaches yield almost equal results. In the paper, we use the interpolated data.

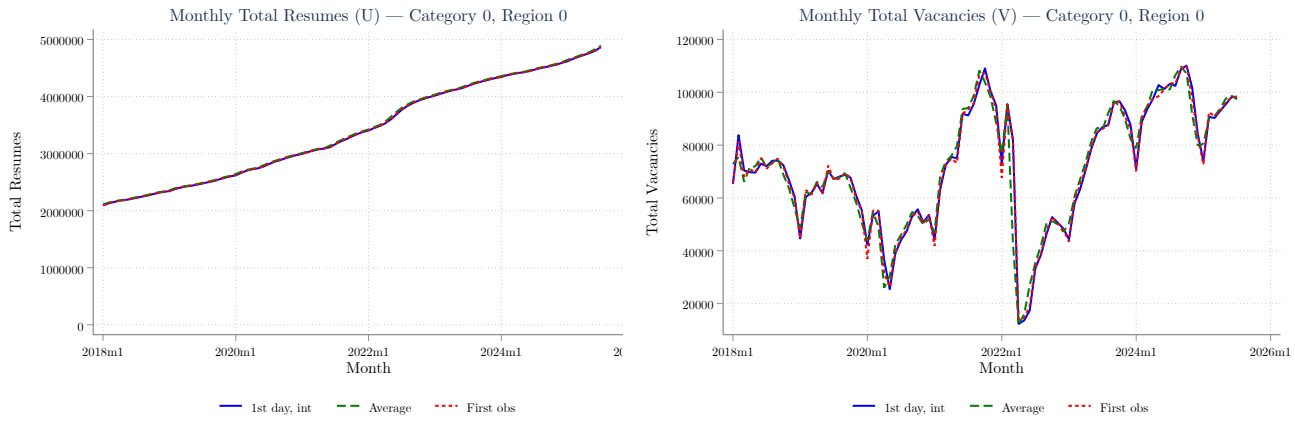


Figure 22: Comparison of monthly stocks of resumes and vacancies

[55]The original datasets had gaps between observations in 2020 and 2021. The platform has supplied us corrections of the data.

[56]We evenly distribute each observation backward across the number of days since the previous recorded value, within each region-category cell.

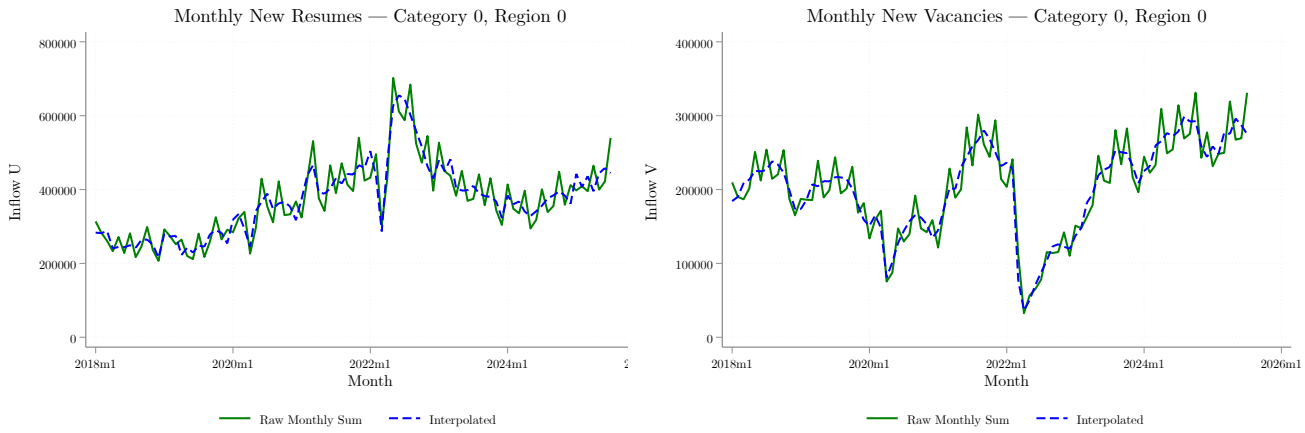


Figure 23: Comparison of monthly inflows of resumes and vacancies

Matches can then be constructed using two accounting identities, one from the job seeker side and one from the vacancy side. Let r index regions, c categories, and t months. Denote by U_{rct} and V_{rct} the stocks of unemployed individuals and vacancies, respectively, observed on the first day of month t in region r and category c. Let inflow^U_{rct} and inflow^V_{rct} represent the total number of new resumes and new vacancies posted during month t. We define the number of matches as residuals from the monthly stock-flow identities:

$$M^U_{rct} = U_{rct} + \text{inflow}^U_{rct} - U_{rc,t+1}$$
$$M^V_{rct} = V_{rct} + \text{inflow}^V_{rct} - V_{rc,t+1}$$

These expressions assume that changes in stocks are solely accounted for by inflows and matches, and that outflows from the stock are entirely due to successful matches. Figure 24 shows the resulting derived matches. For the analysis we focus on vacancy-based matches, which are likely to provide a more accurate signal: keeping a vacancy open entails costs for firms, resumes may remain posted even when job seekers are no longer actively searching.

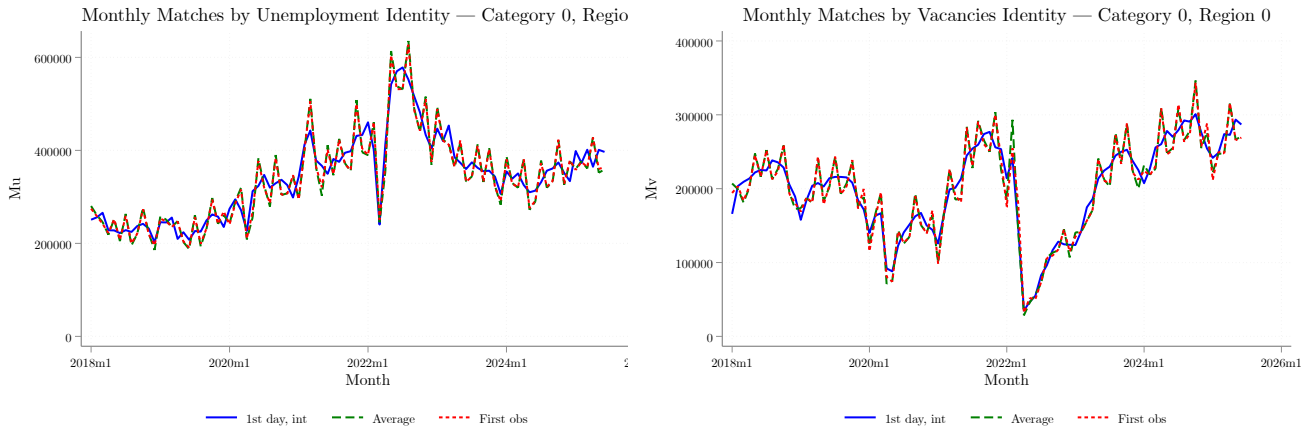


Figure 24: Comparison of monthly matches derived from resumes or vacancies identities

F Vacancy Duration from the Matching Function

To capture regional heterogeneity in war impacts, our estimating equation is:

$$\log M_{rct} = \kappa + \alpha \log U_{rct} + \beta \log V_{rct} + \gamma \cdot \text{Post}_t + \sum_{r \neq r_0} \delta_r + \sum_{r \neq r_0} \phi_r \cdot \text{Post}_t \cdot \mathbf{1}\{Region = r\} + \theta_c + \varepsilon_{rct} \tag{10}$$

Vacancy duration (time-to-fill) is defined by the stock-flow relationship:

$$d_{V,rct} = \frac{V_{rct}}{M_{rct}} \tag{11}$$

Substituting the matching function:

$$d_{V,rct} = \frac{V_{rct}}{A_{rct} \cdot U_{rct}^{\alpha} \cdot V_{rct}^{\beta}} \tag{12}$$

$$= \frac{1}{A_{rct}} \cdot U_{rct}^{-\alpha} \cdot V_{rct}^{1-\beta} \tag{13}$$

Therefore:

$$d_{V,rct} = \frac{V_{rct}^{1-\beta}}{A_{rct} \cdot U_{rct}^{\alpha}} \tag{14}$$

Taking logarithms:

$$\log d_{V,rct} = -\log A_{rct} - \alpha \log U_{rct} + (1-\beta) \log V_{rct} \tag{15}$$

Substituting our specification for matching efficiency:

$$\begin{aligned} \log d_{V,rct} = {} & -\kappa - \alpha \log U_{rct} + (1-\beta) \log V_{rct} - \gamma \cdot \text{Post}_t + \\ & - \sum_{r \neq r_0} \delta_r - \sum_{r \neq r_0} \phi_r \cdot \text{Post}_t \cdot \mathbf{1}\{Region = r\} - \theta_c \end{aligned} \tag{16}$$

From equation (16), we can derive the war's impact on vacancy duration by taking the derivative with respect to the post-invasion indicator:

$$\frac{\partial \log d_{V,rct}}{\partial \text{Post}_t} = -\gamma - \phi_r \cdot \mathbf{1}\{Region = r\} \tag{17}$$

Therefore, the total post-invasion change in log vacancy duration for region r is:

$$\Delta \log d_{V,rct} = \log d_{V,rct}^{\text{post}} - \log d_{V,rct}^{\text{pre}} = -(\gamma + \phi_r) \tag{18}$$

Exponentiating both sides:

$$\frac{d_{V,rct}^{\text{post}}}{d_{V,rct}^{\text{pre}}} = \exp\left(-(\gamma + \phi_r)\right) \tag{19}$$

Rearranging, we get the percentage change in vacancy duration:

$$\frac{d_{V,rct}^{\text{post}} - d_{V,rct}^{\text{pre}}}{d_{V,rct}^{\text{pre}}} = \exp\left(-(\gamma + \phi_r)\right) - 1 \tag{20}$$

The *total efficiency decline* for region r is $(\gamma + \phi_r)$, which corresponds to the coefficients plotted in Figure 12.[57] For example, if region r experienced a total efficiency decline with $\hat{\gamma} + \hat{\phi}_r = -0.20$, then matching efficiency fell by $(e^{-0.20} - 1) \times 100 \approx -18.1\%$, and vacancy duration increased by $(e^{0.20} - 1) \times 100 \approx 22.1\%$. The *differential* effect of region r relative to the baseline is captured by ϕ_r:

$$\Delta \log d_{V,rct} - \Delta \log d_{V,r_0ct} = -\phi_r \tag{21}$$

If $\hat{\phi}_r < 0$ (region r experienced a larger efficiency decline than Lviv), then vacancy duration increased *more* in region r than in Lviv.

[57] For the baseline region r_0 (Lviv), the post-invasion change in log vacancy duration is $\Delta \log d_{V,r_0ct} = -\gamma$.

G The SES - Helvetas survey

In this section, we provide details on the large employers and employees surveys conducted by the State Employment Service of Ukraine (SES) in collaboration with Helvetas Swiss Intercooperation. Results and analysis from those organizations are reported in Helvetas & SESU (2025a) and Helvetas & SESU (2025b).

The employer survey was conducted as part of the project "Resilience: Building a Sustainable and Inclusive Labor Market in Ukraine", implemented under an agreement between the Swedish International Development Cooperation Agency (Sida – Styrelsen för Internationellt Utvecklingssamarbete) and Helvetas Swiss Intercooperation with the support of Sweden. Interviews took place between December 17, 2024, and January 31, 2025. Staff of the SES employer service and recruitment departments at district branches invited employers to participate, distributed links to online questionnaires for self-completion, and/or conducted the survey by phone. The main respondents for large and medium-sized enterprises were managers or human resources specialists, while in small enterprises the respondents were managers or accountants.

In total, 54,677 employers participated in the survey, representing enterprises that together employ about 4.5 million hired workers, roughly half of all officially employed persons in the economy. The selection criteria required enterprises to be economically active businesses with an average headcount of 10 or more employees (based on reports from the Pension Fund of Ukraine as of July 1, 2024). Enterprises affiliated with or related to the defense sector, or located in areas not controlled by the government, were excluded. The survey sample is representative at the regional level. The overall margin of error for surveyed territories is 0.4%, with regional sampling errors ranging from 1.03% to 7.79% and sector-specific sampling errors ranging from 0.91% to 6.18%.[58]

The survey of registered unemployed persons was conducted jointly by the State Employment Service of Ukraine, the Federation of Employers of Ukraine, and Helvetas Swiss Intercooperation. The sample comprised 66,800 registered unemployed individuals, representing about 70% of all persons with this status. The study "Registered Unemployment in Ukraine: Needs, Features, Estimates" was implemented within the project "Support to Economic Development of Internally Displaced Persons and Persons Affected by the War in Ukraine", led by Helvetas Swiss Intercooperation under an agreement with the Ministry of the Interior of the Czech Republic and in cooperation with the Czech Agency for Employment and Social Protection (CzechAid). The goal of the study was to understand the dynamics of human capital in wartime and to inform the adaptation of employment policies to better serve the interests of individuals, businesses, and the state.

[58]The aggregated data can be accessed at `https://www.dcz.gov.ua/stat/statsurvey` (in Ukrainian).

Table 6: Firm-level adjustments to exposure: Hiring and remote work

	Hiring IDPs		Hiring people aged 60+		Hiring people with disabilities		Remote work allowed	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Days with Alarms: Medium	0.112***		0.121***		0.062**		0.017	
	(0.030)		(0.026)		(0.023)		(0.024)	
Days with Alarms: High	0.101***		0.095***		-0.003		0.069**	
	(0.027)		(0.019)		(0.019)		(0.026)	
Duration: Medium		0.108***		0.110***		0.034		0.034
		(0.028)		(0.023)		(0.022)		(0.021)
Duration: High		0.092***		0.070***		-0.031		0.091**
		(0.032)		(0.015)		(0.021)		(0.035)
Constant	0.241	0.284	-0.367**	-0.260**	0.168	0.358***	-0.276	-0.403**
	(0.183)	(0.177)	(0.137)	(0.108)	(0.149)	(0.115)	(0.187)	(0.184)
Observations	16,517	16,517	16,516	16,516	16,517	16,517	51,126	51,126
R^2	0.108	0.108	0.115	0.115	0.080	0.079	0.103	0.102
Sector FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes. Dependent variables are dummies for firm policies. All specifications use OLS with sector fixed effects. Exposure measured as days with alarms (odd columns) and alarm duration (even columns). Control variables used: size and composition of the firm (log of firm size in 2025, share of managers in the workforce, share of professionals, share of office workers, share of skilled workers, share of young workers, share of workers over 60, share of disabled), regional characteristics (region level: share of firms in manufacturing, share of firms in utilities, share of firms in services, population), openings by the firm (ratio of vacancies to firm size, dummy for availability of vacancies), training (dummies for availability of training at firm's training centers and availability of on-the-job training), and dummies for cooperation with employment services (SES and CVTE). Standard errors clustered in at the region level in parentheses. Sample: SES survey sample (see Appendix G), excluding the contested oblasts of Donetsk, Luhansk, Kherson, and Zaporizhzhia. Crimea is not in the sample.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

H Wages and Labor Market Regulation in Ukraine

H.1 Wage Dynamics Before the Full-Scale Invasion (1990-2022)

In the 1990s, Ukraine began its transition from a planned to a market-oriented economy. The process was far from smooth. For most of the decade GDP per capita declined, accompanied by a period of hyperinflation. To bring inflation under control, monetary growth was sharply curtailed, which further deepened the contraction. Only in 2000 did real GDP grow for the first time since independence in 1991. This recovery created space for wages to rise, albeit from a very low base: in 2002, the average monthly wage was UAH 376, or approximately USD 71.

Economic growth during the 2000s and 2010s led to sustained productivity improvements, which in turn boosted wages. This occurred despite considerable political and economic turbulence: two revolutions (2004 and 2013), the global financial crisis (2008), the loss of control over part of Ukraine's territory following the Russian invasion in 2014, and the COVID-19 pandemic. As shown by Kornieieva et al. (2022), labor productivity increased by 147.6% between 2014 and 2021, reflecting both GDP growth in PPP terms (27.4%) and a contraction in the number of employed persons (–13.2%). According to the National Bank of Ukraine (NBU), however, over the longer period 2002–2019 real wage growth outpaced productivity growth, generating inflationary pressure. Even on the eve of the full-scale invasion, both wages in PPP terms and labor productivity remained among the lowest in Europe.

Two methodological issues are important when measuring labor earnings in Ukraine. First, until 2009 only large and medium-sized enterprises (50 or more employees) were required to report wage data to the State Statistics Service of Ukraine (SSSU). From 2010 onwards, the coverage expanded to include small and micro enterprises (10 or more employees). This change did not materially affect either growth rates or volatility of reported wages.

Second, "regular workers" in 2021 comprised 7.1 million out of 15.6 million employed persons, according to the SSSU quarterly household survey based on ILO methodology. Informal employment was substantial: 1.9 million persons were estimated to work in the informal sector (67% in agriculture and 17% in construction), while an additional 1.1 million were informally employed within the formal sector. Another important category was the self-employed. This legal status, introduced in 1999, aimed to reduce informality and support small businesses. Registered self-employed individuals faced significantly lighter reporting obligations and a far lower tax burden than regular employees. Whereas the combined tax wedge for regular workers (personal income tax, PIT, plus the Single Social Contribution, SSC) was around 40%, for the self-employed it was closer to 5%. This asymmetry created strong incentives for firms and workers to shift into self-employment arrangements. For example, during the 2000s most IT companies contracted Ukrainian developers as self-employed contractors, making them eligible for the lower tax regime. While the self-employment regime supported genuine small business activity, it has long been debated whether it primarily functions as a channel for reclassifying regular employment to reduce tax liabilities (IMF).

H.2 Wage Setting and Regulation Before the Full-Scale Invasion

Formally, Ukraine has a significant trade union presence. Unions are expected to participate in tripartite social agreements between employees, employers, and the government. A Presidential Decree in 2005 established the basis for the National Council on Social Dialogue, which was approved in 2006 and granted permanent status in 2011.[59] In practice, however, the Council has not played an important role in wage bargaining. For instance, between 2018 and 2021 it failed to fulfill its mandate due to the absence of its Chair. This institutional dysfunction attracted little public debate, and the Council's lack of activity was not considered a pressing issue in Ukrainian policy discussions at the time.

The minimum wage in Ukraine is set annually in the *Law on the State Budget*, adopted by Parliament on the proposal of the Cabinet of Ministers. Formally, the rate is determined in consultation with social partners—trade unions and employers' associations—within the framework of Ukrainian legislation. In practice, however, the Cabinet of Ministers sets the minimum wage largely on the basis of projected budget revenues and expenditures. For example, after approval of the 2017 budget, the Cabinet unilaterally decided to double the minimum wage compared with the figure initially written into the law (Betliy, 2016), departing from the gradual increases of earlier years. The main rationale appears to have been raising revenues from the Single Social Contribution and Personal Income Tax, particularly to cover the chronic deficit of the State Pension Fund. At the time, roughly one-fifth of employees were officially paid at the minimum wage, but it was widely assumed that many also received additional untaxed "envelope" payments (Gorodnichenko et al., 2016). In 2021, the minimum wage was UAH 6000 from January (49% of the average wage in that month) and UAH 6500 from December (46% of the November average).[60]

Beyond wage setting, labor regulation was governed by an outdated Labor Code originally adopted in 1971 during the Ukrainian Soviet Socialist Republic era. Despite more than 180 amendments between 1973 and 2025, the Code remained overloaded with Soviet-era provisions poorly suited to a market economy.[61] The most significant rigidity concerned dismissal procedures.[62] Terminating employment at the employer's initiative remained extremely difficult, creating substantial adjustment costs for firms.

H.3 Wage Setting and Regulation After the Full-Scale Invasion

The minimum wage was raised only marginally immediately before the full-scale invasion, from UAH 6500 in December 2021 to UAH 6700 in January 2022. It then remained unchanged during the first two years of the war, 2022 and 2023 in spite of high inflation. As conditions

[59] Presidential Decree No. 1871/2005 "On Development of Social Dialogue in Ukraine." `https://zakon.rada.gov.ua/go/1871/2005`

[60] Because December wages are typically inflated by end-of-year bonuses, comparisons with that month can be misleading.

[61] Labor Code, current version: `https://zakon.rada.gov.ua/go/322-08`

[62] For example, during the attempted purge of law enforcement agencies in 2014-2015, courts reinstated approximately half of dismissed officers by 2017, citing Labor Code violations.

stabilized in 2024, the minimum wage was increased twice: in January (to UAH 7100, +6%) and in April (to UAH 8000, +12.5%), where it remains as of December 2025. Because many public-sector wages are linked to the minimum wage, this freeze effectively caused public-sector earnings to stagnate during 2022–2023. By contrast, private-sector nominal wages rose rapidly, driven by labor shortages, widening the gap between minimum and average wages. In the first quarter of 2025, the minimum wage stood at 34% of the average wage.

In parallel with changes in wage setting, labor regulation evolved substantially during the war. As of the end of 2025, regulation operates under a dual system combining the pre-war Labor Code with temporary martial law legislation. Several laws adopted between 2022 and 2025 (starting with Law No. 2136-IX, *"On the organization of labor relations under martial law"*) introduced significant flexibility: women gained access to positions previously prohibited (e.g., underground work in mines); employers received authority to suspend employment contracts; electronic documentation became legally valid; and remote and gig work arrangements were formally enabled.[63] The temporary legislation primarily expanded access and flexibility at a critical juncture when the rigid pre-war Labor Code would have constrained the economy's ability to reallocate labor efficiently. The Ministry of Economy is currently developing a comprehensive Labor Code revision to align Ukrainian labor law with EU standards.

[63]Law No. 2136-IX, current version: `https://zakon.rada.gov.ua/go/2136-20`