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Economic Implications of Conflict and Disability:

A CASE STUDY OF UKRAINE

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Economic Implications of Conflict and Disability:

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Abstract

This study investigates the economic consequences of the armed conflict in Ukraine via tax revenue channel, with particular emphasis on the effect of disability on regional personal income tax (PIC) revenues. Using a newly assembled panel dataset covering Ukrainian regions and 239 EU regions for the period 2005-2024, the analysis applies a generalized synthetic control (GSC) estimator to construct a credible counterfactual trajectory of PIC in the absence of conflict. The GSC approach is well suited to this setting, as it accommodates the staggered treatment design, characteristic of the Ukrainian context, and accounts for latent confounding factors.

The results reveal substantial and persistent economic losses materialising through the decline in personal income tax contributions attributable to the conflict. By 2024, aggregate regional PIC is estimated to lie more than 60 per cent below its synthetic counterpart, while PIC per capita is more than 40 per cent lower. Disability emerges as an independent and quantitatively meaningful transmission channel: a 10 per cent increase in the regional prevalence of disability reduces aggregate PIC by 1.2 per cent and PIC per capita by 1.75 per cent, controlling for Gross Domestic Product (GDP), population, and conflict intensity.

The findings position disability as a critical yet largely understudied determinant of economic performance in conflict-affected settings. They underscore the need for further research and increased policy attention to disability-inclusive labour market interventions to support economic resilience and post-war recovery.

10% Increase in Regional Disability Prevalence



-1.2%
Aggregate PIC

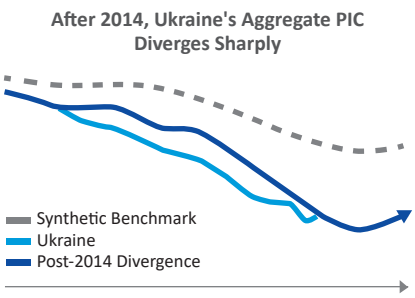


-1.75%
PIC Per Capita

Controlling for GDP, Population & Conflict Intensity

Executive Summary

This report assesses the impact of the war in Ukraine on regional personal income tax (PIC) revenues, with specific attention to the rising share of persons with disabilities (PWD) as a fiscal channel. The analysis uses a generalized synthetic control (GSC) method to construct a counterfactual trajectory of Ukraine's regional PIC based on a donor pool of 239 EU regions, allowing for credible estimation of the effects of conflict intensity, demographic change, and disability prevalence.



Data and Methodology

The study integrates multiple sources of Ukrainian administrative data, including PIC, GDP, population, and disability registrations, with harmonised European regional data from European Commission's Annual Regional Database (ARDECO), Eurostat's EU-SILC (European Union Statistics on Income and Living Conditions), and the European Commission's Taxation Trends database. Given the staggered nature of conflict exposure (2014 in eastern regions; 2022 nationwide) and its time-varying intensity, the GSC estimator provides a robust framework for capturing staggered treatment effects while addressing latent confounding factors.

Main Findings

1. **Large fiscal losses due to conflict.** Aggregate PIC in Ukraine diverges sharply from its synthetic counterpart after 2014, with losses exceeding 60 per cent by 2024. PIC per capita falls by more than 40 per cent, reflecting both economic disruption and population displacement.

2. **Disability as an independent economic channel.** A 10 per cent increase in regional disability prevalence reduces aggregate PIC by 1.2 per cent and PIC per capita by 1.75 per cent. As PIC is one of the sizeable GDP components, disability functions as a direct mechanism through which conflict erodes the tax base, leading to GDP decline.

3. **Robustness of results.** Even after controlling for economic fundamentals and applying a latent-factor structure, the combined effects of conflict and disability remain strong, consistent, and statistically significant.

Policy Implications

The findings underscore the importance of disability-inclusive labour market policies to support both social inclusion and economic recovery. Key interventions include expanding vocational rehabilitation, improving workplace accommodation, and creating targeted employer incentives for hiring PWD. Strengthening rehabilitation systems, digital registries, and inter-agency data coordination would further mitigate long-term revenue losses. Regions most heavily affected by the conflict, where disability prevalence is highest, should be prioritised for economic recovery programmes.

Directions for Future Research

Further research is needed to conduct ex-ante assessments of the fiscal returns to reintegrating PWD into the labour force, especially those whose conditions allow for partial or full employment. The modelling of these potential gains would help governments and development partners design cost-effective, forward-looking strategies to strengthen state capacity and accelerate economic recovery in conflict-affected settings.

Table of Contents

Abstract		3
Executive Summary		4
1.	Introduction	6
2.	Related Literature	8
3.	Institutional Setting	9
4.	Data	10
	4.1 Ukrainian Data Sources	10
	4.2 Data on the European Regions	12
5.	Empirical Strategy	13
	5.1 Generalized Synthetic Controls: An Overview	13
	5.2 Application to the Study of the Impact of Conflict and Disability in Ukraine	14
6.	Results	15
	6.1 Regional Personal Income Tax Contributions	17
	6.2 Personal Income Tax Contributions Per Capita	20
7.	Conclusions, Policy Implications and Directions for Future Research	24
	7.1 Summary of Findings	24
	7.2 Policy Implications	24
	7.3 Directions for Future Research	25
8.	References	26

Table 1. Correlation Matrix 16
Table 2. Summary Statistics 17
Table 3. Effects of Conflict and Disability on Personal Income Tax Contributions 19

Figure 1. Regional Personal Income Tax Contributions, 2025-2026 10
Figure 2. Regional Shares of People with Disabilities in Ukraine, 2005-2024 11
Figure 3. Regional Population in Ukraine, 2005-2024. 12
Figure 4. Sample Composition 15
Figure 5. Regional Personal Income Tax Contributions in Ukraine, 2005-2024 16
Figure 6. GSYNTH Analysis of Log PIC, Ukraine and Synthetic Ukraine 18
Figure 7. Aggregate PIC, Ukraine and Counterfactual Ukraine. 20
Figure 8. GSYNTH Analysis of Log PIC per capita, Ukraine and Synthetic Ukraine 21
Figure 9. PIC per capita, Ukraine and Counterfactual Ukraine 22

1. Introduction

Violent conflict represents one of the most profound shocks an economy can experience. Financial and political crises, trade wars, or severe economic downturns all impose costs, but few events disrupt lives, institutions, and fiscal capacity as profoundly as war. This paper examines the armed conflict in Ukraine, focusing on its fiscal consequences and the role of the sharp rise in disability as a key transmission channel.

The armed conflict was initiated in 2014 with the annexation of Crimea and dramatically escalated with the full-scale war in 2022 has fundamentally reshaped Ukraine's demographic and economic structure. Beyond the destruction of infrastructure, the displacement of millions of people, and the contraction of economic activity, the conflict has generated a substantial rise in disability, both among civilians and war veterans. This development poses unique challenges for Ukraine's fiscal system.

This study examines the impact of military conflict in Ukraine and the associated disability increase on personal income tax contributions, a central pillar of Ukraine's domestic revenues. Personal income tax revenues depend directly on the labour market participation and earnings capacity of the population. A surge in disability reduces both, thereby undermining the government's ability to mobilise resources for public goods, reconstruction efforts, and social protection. This loss of fiscal capacity constitutes a critical social cost of conflict. It operates alongside more visible consequences, such as the destruction of infrastructure, disruption of economic activity, and the loss of human life. Revenue shortfalls constrain the state's ability to deliver essential services such as health care, education, judicial enforcement, and security - functions that are especially vital during wartime. In this way, the fiscal erosion triggered by conflict may result in a vicious circle: reduced revenues weaken institutions just as demands on them intensify, raising the risk of prolonged instability. The study explores this issue using the war in Ukraine as a case in point.

The study begins by constructing a comprehensive regional dataset that combines multiple sources of Ukrainian administrative statistics with harmonised European regional data. Regional PIC data were collected from the Ukrainian Ministry of Finance and reconstructed for earlier years using national budget statements and International Monetary Fund (IMF) Country Reports. Regional GDP, GDP per capita, population, and disability registrations were obtained from the Ukrainian Office of National Statistics. To construct a credible counterfactual, the analysis incorporates data from EU regions drawn from the European Commission's ARDECO database, Eurostat's EU-SILC survey (for disability prevalence), and the EC Taxation Trends database (for regional PIC). The resulting panel dataset spans the period 2005-2024 and includes 239 European regions that together form the pool of potential synthetic control units.

A key empirical challenge is that conflict exposure, disability incidence, and tax revenues may be jointly influenced by unobserved regional shocks. To address this concern, the report employs a generalized synthetic control (GSC) method (Powell, 2022). This approach extends the classic synthetic control techniques to settings with staggered and continuous treatments - an essential feature of the Ukrainian context, where regions were exposed to conflict at different times and intensities. The GSC method constructs a "synthetic Ukraine" from EU regions that closely replicates Ukraine's pre-conflict economic and demographic trajectory, thereby allowing for credible causal inference on how conflict and rising disability levels have altered tax revenues.

The findings show that military conflict and its associated rise in disability have had a significant, persistent, and quantifiable impact on Ukraine's fiscal and, consequently, economic capacity. Both aggregate and per-capita regional PIC diverge

sharply from their synthetic counterfactuals after 2014, with losses intensifying after 2022. By 2024, aggregate PIC is estimated to be more than 60 per cent below its counterfactual level, while per-capita PIC is more than 40 per cent lower. Importantly, disability emerges as an independent fiscal channel: a 10 per cent increase in the regional share of PWD reduces PIC revenues by 1.2 and PIC per-capita by 1.75 per cent, even after accounting for GDP, population dynamics, and conflict intensity. These results highlight that disability is not only a social outcome of war, but also a key determinant of fiscal performance during conflict, with important long-term implications for economic recovery.

By incorporating disability into the framework of fiscal analysis, this study contributes to the emerging evidence on the broader economic costs of conflict and provides policy-relevant insights for governments and development partners seeking to strengthen fiscal resilience and state capacity in conflict-affected countries, while supporting inclusive post-war reconstruction.



2. Related Literature

Research on the economic impact of conflict spans several dimensions, including output, fiscal performance, and state capacity. Early cross-country studies established broad correlations between conflict and diminished economic outcomes. Collier (1999) estimates the impact of conflict on the level and composition of output; Knight, Loayza, and Villanueva (1996) estimate "higher capacity output" from reduced military spending, while Gupta et al. (2007) calculate losses to growth and tax revenues due to conflict. However, most cross-country studies suffer from significant identification challenges. Countries differ not only in conflict intensity and duration but also in structural features such as institutions, economic diversification, demographics, and geography, making causal inference difficult (Blattman and Miguel (2010)).

For these and related reasons, more recent research has increasingly focused on outcomes at partly or fully subnational levels. This shift has allowed researchers to exploit within-country contrasts and to apply methods that credibly address omitted variable bias. For example, Besley and Mueller (2012) and Mueller (2016) use subnational panel data to estimate the economic cost of conflict in Northern Ireland and African regions, respectively. Brodeur (2018) uses randomness in the success of terrorist attacks in the United States during 1970–2013 to identify their causal impact on local economic activity. Abadie and Gardeazabal (2003) examine the economic impact of conflict in the Basque Country. This study pioneered the synthetic control method to demonstrate how conflict can depress economic activity relative to a counterfactual constructed from unaffected regions of Spain. Abadie et al. (2010) subsequently extended this framework to broader set of comparative case studies, while Powell (2022) generalised it to accommodate dynamic and continuous treatments. Together, these contributions have become central tools for analysing the localised economic consequences of conflict.

Another common theme across this literature is the use of fiscal outcomes as a proxy for state capacity. Tax revenues, in particular, reflect both the strength of economic activity and the state's ability to mobilise it. Within-country studies of conflict frequently emphasise this channel, demonstrating how violence can weaken the fiscal contract between citizens and the state. Ch et al. (2018) and Cárdenas, Eslava, and Ramírez (2016) document a negative relationship between conflict and various measures of state capacity, including municipal tax revenues. Finally, Barrett (2022) uses provincial-level data to estimate government revenue losses due to conflict in Afghanistan since 2005.

While numerous studies have explored the link between conflict and various measures of state capacity, including tax revenues, far less attention has been devoted to the fiscal consequences of conflict-induced demographic shocks, such as mass disability. Disability affects labour market participation, productivity, and ultimately narrows the base of personal income taxation. Although disability economics has long established the earnings penalties faced by individuals with disabilities (see for example Priebe, Rink, and Stemmler (2024); Takasaki (2024)), its intersection with conflict economics remains underexplored. In the case of Ukraine, where the war has generated a rapid and substantial increase in disability, this gap is particularly salient. By explicitly linking disability to personal income tax outcomes, this study adds a novel dimension to the literature on the fiscal costs of conflict.

3. Institutional Setting

Ukraine has experienced profound institutional and economic disruptions since the outbreak of armed hostilities in 2014. The annexation of Crimea and the onset of fighting in the Donbas marked the beginning of a protracted confrontation, while the full-scale armed conflict launched in February 2022 transformed the conflict into one of the largest wars in Europe since World War II. The scale of violence, destruction, and displacement has been extraordinary. Millions have fled abroad or been internally displaced, economic activity has contracted sharply in affected regions, and the state has been forced to mobilise resources on an unprecedented scale.

The fiscal system has faced simultaneous pressures. On the one hand, government expenditures have expanded dramatically to finance defence, humanitarian support, and reconstruction. On the other, the revenue base has weakened. Destruction of productive capacity, emigration, and the redirection of labour to military service have all undermined tax collection. A further challenge stems from the sharp rise in disability among both civilians and veterans. Beyond its direct social and human costs, this demographic shift reduces labour market participation and erodes the personal income tax base, a key component of Ukraine's domestic revenue.

Despite these shocks, Ukraine has maintained core fiscal institutions. The State Tax Service continues to administer major revenue sources, and international assistance has partly offset fiscal gaps. However, the long-term sustainability of public finances depends critically on domestic tax capacity. Hence, understanding how conflict-related disability erodes personal income tax revenues is essential to assessing both the short-term fiscal strain and the longer-term challenges of post-war recovery.



4. Data

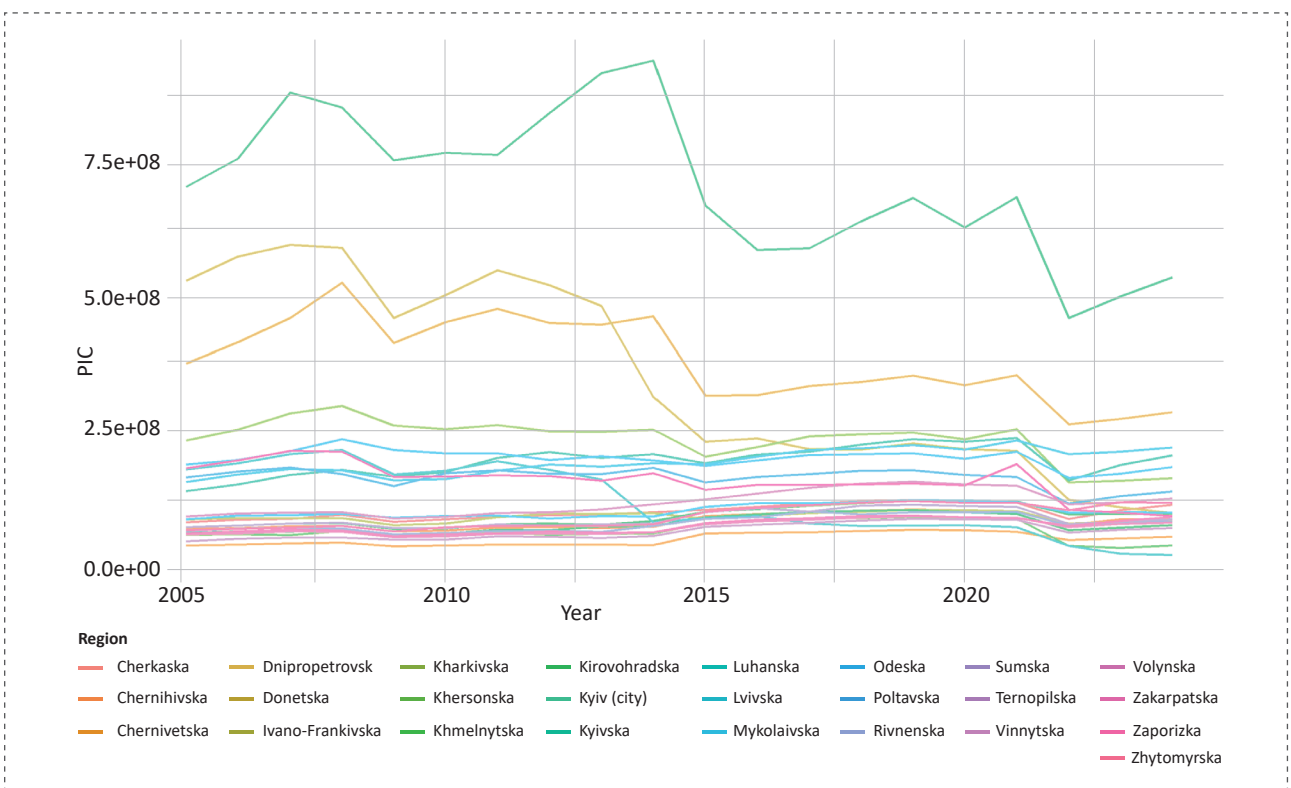
This section provides an overview of the data used in this study.

4.1 Ukrainian Data Sources

The dependent variable in this study is regional personal income tax contributions (PIC). The final dataset was compiled from two sources. Regional PIC data for 2015-2024 were obtained directly from the Ukrainian Ministry of Finance. Because regional PIC data were not available prior to 2015, national PIC totals were extracted from annual consolidated budget statements and cross-validated against IMF Country Reports. These national figures were then regionalised using average regional PIC shares from 2015-2022, thereby excluding the wartime years in which conflict-related distortions could bias regional shares. The resulting series is presented in Figure 1.

Overall, the data show a clear downward trend, which becomes more pronounced after 2014 for the regions affected by the first wave of armed conflict, and after 2022 - the year marking the onset of the full-scale armed conflict - for the rest of Ukraine.

***Figure 1**. Regional Personal Income Tax Contributions, 2005-2024*

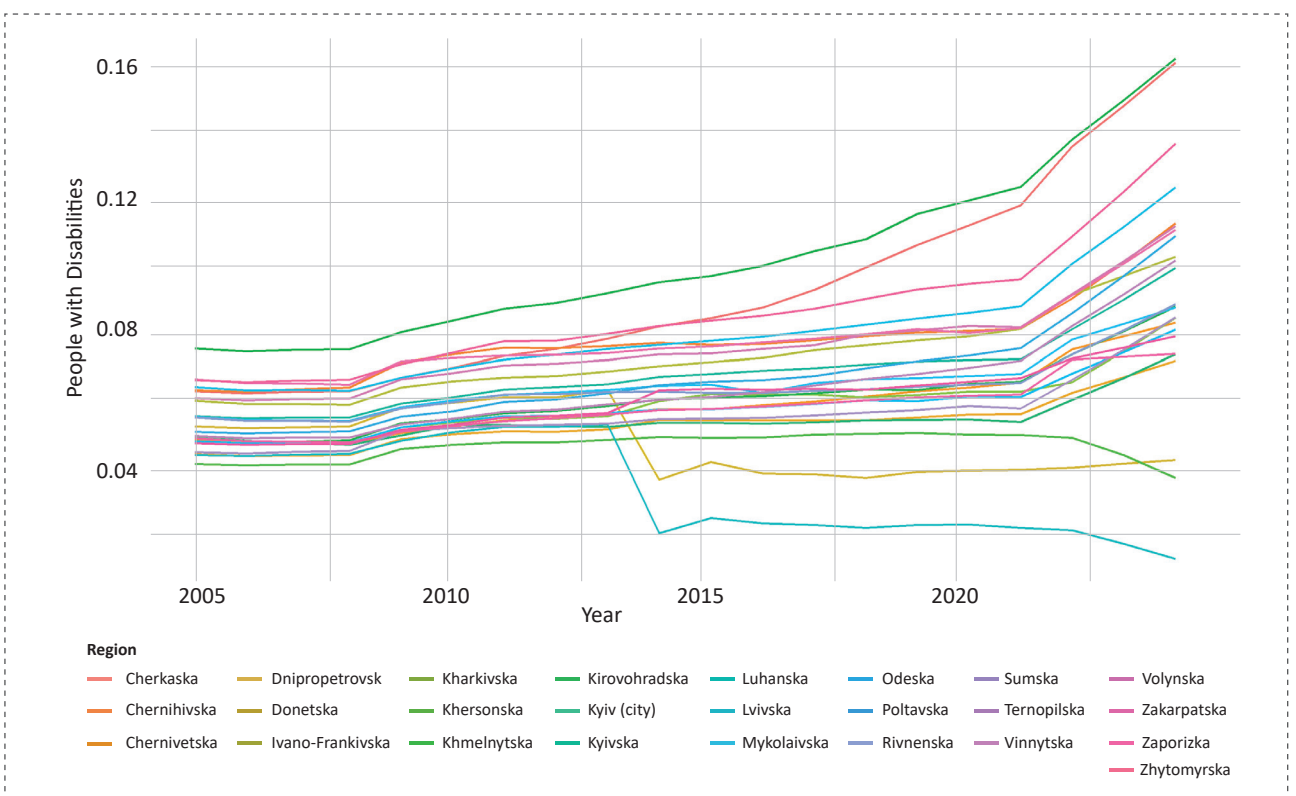


Note: The source of data is Ministry of Finance Ukraine, Euro constant 2015 prices.

The nominal regional GDP and nominal regional GDP per capita were obtained from the Ukrainian Office of National Statistics. To account for inflation, these data were deflated to a 2015 base year using official GDP deflators from the National Bank of Ukraine, supplemented with GDP growth forecasts from IMF Country Reports for 2022-2024. This procedure enabled the construction of real GDP and GDP per capita series expressed in constant 2015 UAH (Ukrainian hryvnia) prices. These values were then converted into euros using the official 2015 UAH/EUR exchange rate published by the National Bank of Ukraine.

We also collected official regional data on the number of PWD, both in total and disaggregated by disability group, from the Ukrainian Office of National Statistics. Under Ukrainian legislation, adults are classified into three disability groups: (1) severe impairments that preclude employment, (2) moderate impairments, and (3) less severe impairments that still limit functional capacity. As shown in Figure 2, the series displays a general upward trend that accelerates markedly following the start of the full-scale armed conflict in Ukraine in 2022. The data also show a sharp decline in the number of registered PWD in the two regions affected by the first wave of armed conflict in 2013-2014, Luhansk and Donetsk, which can be attributed to large-scale outmigration from these areas.

Figure 2. *Regional Shares of People with Disabilities in Ukraine, 2005-2024*

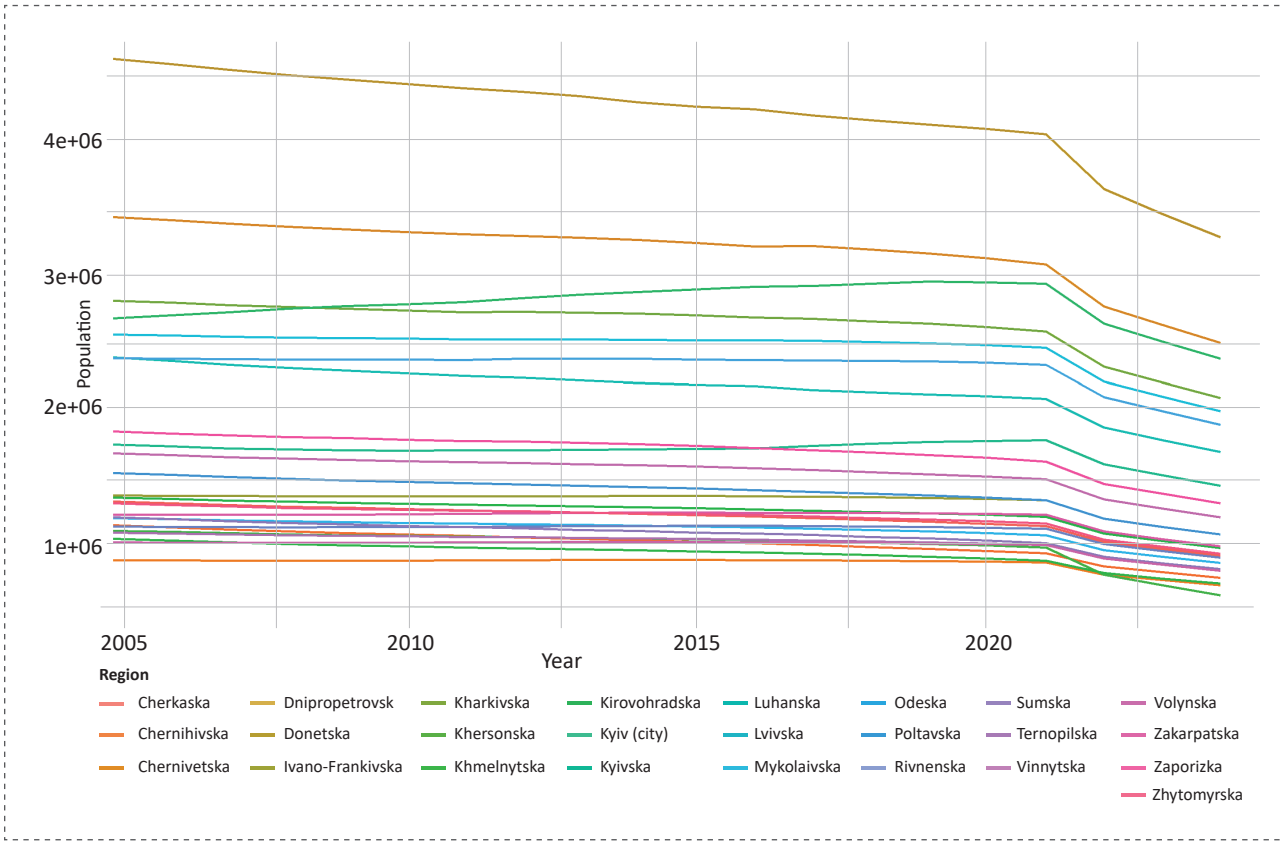


Note: The source of data is National Office of Statistics (Derzhkomstat).

Finally, we have obtained data on regional population for the period 2005-2022. These data were jointly used to construct regional disability shares for the period of 2005-2021. Due to the unavailability of data beyond 2021 (mostly due to the ongoing war in Ukraine) we extended the existing data to 2024 based on several assumptions. Most of the official sources (see for example: UNRIC (2023)) report a decline in Ukrainian population of around 10 million people during the period 2022-2024. Furthermore, more exposed regions are reported to suffer heavier losses due to ongoing military actions as well as emigration. At the same time, less exposed central and western regions experience lighter losses of population, partially compensated by the arrivals of internally displaced persons (IDPs).

Given the above, we assume that the overall decline of 10 million occurred in the following manner: 60 per cent decline in 2022, 30 per cent decline in 2023, and a 10 per cent decline in 2024. Additionally, we assume larger population declines in eastern and southern regions, including Donetsk, Luhansk, Kherson, Zaporizhzhia, Mykolaiv; a moderate decline in Chernihiv, Sumy, Kharkiv, and Odesa regions; and a lower decline in western regions. Finally, we assume a lower decline in heavily affected, but large IDP-hosting regions, such as Kyiv city and region, Lviv, Dnipro and Poltava.

Figure 3. *Regional Population in Ukraine, 2005-2024*



Note: The source of data is National Office of Statistics (Derzhkomstat).

4.2 Data on the European Regions

This section describes the data on EU regions used for constructing the synthetic control group. Although the initial premise suggested that the most suitable control units would be regions in Eastern European countries, particularly former members of the Soviet bloc, the study ultimately opted to include all EU regions in order to build a broader and more flexible donor pool.

We began by extracting regional GDP and GDP per capita at current prices from ARDECO. We then obtained country-level PIC data from the European Commission's Taxation Trends database. Because some countries lack reported PIC values for 2023-2024, missing observations were imputed using linear projections. These national PIC totals were subsequently regionalised based on annual regional GDP shares. To correct for inflation, all monetary values were converted to constant 2015 euro prices using the GDP chain-type price index.

In the next step, we constructed regional disability measures for EU regions using data from the EU-SILC, which underpin Eurostat's disability indicators. EU-SILC measures disability primarily through the Global Activity Limitation Indicator (GALI) and longstanding health conditions, enabling cross-country comparisons in income, living standards, labour market participation, and social inclusion. While EU-SILC is designed to be nationally representative, its regional representativeness varies across Member States. To approximate regional disability prevalence, we first calculated country-level disability rates from EU-SILC and then allocated these rates across regions using regional population data from ARDECO. As some regions' latest EU-SILC values fall in 2023, we interpolated missing 2024 observations based on trends in prior years.

5. Empirical Strategy

The empirical analysis employed in this report is based on a generalized synthetic control estimation (GSC) approach. This method, proposed by Powell (2022), builds on Abadie and Gardeazabal (2003) and produces estimates which are robust to a broad class of unknown omitted variables bias under relatively weak identifying assumptions.

5.1 Generalized Synthetic Controls: An Overview

In their influential contribution, Abadie and Gardeazabal (2003) examined how terrorist violence by ETA (Euskadi Ta Askatasuna) affected economic performance in the Basque Country. A central challenge in their analysis was constructing a credible counterfactual, as the rest of Spain, taken as a whole, was quite a poor fit due to its differences from the Basque Country along several structural dimensions unrelated to terrorism.

To address this issue, Abadie and Gardeazabal (2003) introduced the synthetic control method. The approach constructs a "synthetic" Basque Country by forming a weighted combination of unaffected regions that best replicates the Basque Country's pre-conflict characteristics. When this synthetic unit closely matches the treated region during the pre-treatment period, it provides a credible representation of what the Basque economy would have looked like in the absence of terrorism, thereby enabling meaningful post-treatment comparisons.

More formally, let y_0 and y_1 be vectors of the outcome of interest in N units in periods 0 and 1, respectively. Suppose that only unit 1 is treated in period 1. Abadie and Gardeazabal (2003) construct a length-N vector of weights $W=(w_1,w_2,\ldots,w_N)$ under the conditions that: (i) all weights are non-negative, (ii) they sum to one, and (iii) $w_1=0$.

The synthetic control weights $\hat{W}$ minimise the squared difference between the pre-treatment true and synthetic outcomes:

$$y_{i,0} - W''Y_0 \qquad (1)$$

The estimated treatment effect is the same difference, calculated on a post-treatment data:

$$\hat{\beta} = y_{1,1} - \hat{W}'y_1 \qquad (2)$$

A key drawback of the classic synthetic control method is that it only works in cases of a one-time, discrete treatment applied to the single unit. It is not well-suited for situations where the treatment varies in intensity across units over time, as is the case with the military conflict in Ukraine that began less intensively in 2014 and escalated into a full-scale armed conflict in 2022.

To address this limitation, Powell (2022) extended the synthetic control method to settings with continuous, time-varying treatments. In this GSC setting, there are N units and T periods, and the outcome $y_{i,t}$ is affected by a continuous treatment $x_{i,t}$. Let β denote the true marginal effect of $x_{i,t}$ on $y_{i,t}$.

Because treatment can occur in every period, matching solely on pre-treatment outcomes is inappropriate. Instead, the method adjusts the observed outcome by removing the candidate treatment effect:

$$y_{i,t} - \tilde{\beta} x_{i,t} \quad (3)$$

If V_i is the weight vector for unit i, the treatment-adjusted error compares the adjusted observed value with its synthetic equivalent:

$$u_{i,t}(\tilde{\beta}, V_i) = (y_{i,t} - \tilde{\beta} x_{i,t}) - V_i' (y_t - \tilde{\beta} x_t) \quad (4)$$

The GSC estimator jointly minimises the sum of treatment-adjusted errors over both the treatment effect $\tilde{\beta}$ and the unit-specific weight matrix $V = (V_1, \ldots, V_N)$.

The simultaneous minimisation in two stages makes clearer the analogy with classic synthetic controls. For a given value of $\tilde{\beta}$, we first choose V_i to minimise the treatment-adjusted error for each unit i conditional on $\tilde{\beta}$, yielding $\hat{V}_i(\tilde{\beta})$. This is analogous to the standard synthetic control procedure, but it applies to treatment-adjusted outcomes rather than to pre-treatment values only.

In the second stage, the estimator selects the value of $\tilde{\beta}$ that minimises the total error conditional on $V_i = \hat{V}_i(\tilde{\beta})$. Taken together, these two steps yield the estimated treatment effect $\tilde{\beta}$ and the estimated weight matrix $\hat{V}$. This approach works well, as the estimation over each unit i is independent.

In the current case, the matching of synthetic and real units occurs conditional on (the best guess of) what personal income tax contributions would look like if the affected regions in Ukraine had zero conflict.

The main theoretical result of Powell (2022) is that the generalized synthetic control estimator is consistent even when the true data-generating process is a latent factor model of the form:

$$y_{i,t} = \beta x_{i,t} + \mu_i' \lambda_t + u_{i,t} \quad (5)$$

where λ_t is a vector of time-varying latent factors and μ_i is a vector of unit-specific factor loadings.

If $\mu_i' \lambda_t$ is correlated with $x_{i,t}$, then a standard fixed-effects regression that includes only unit and time fixed effects will suffer from omitted variable bias. The GSC overcomes this by allowing synthetic weights to approximate the latent factor structure.

The identifying assumption is that there exist weights v_{ij} satisfying:

$$E[\mu_i' \lambda_t + u_{i,t} \mid x_{i,t}] = \sum_{j \neq i} u_{ij} (\mu_j' \lambda_t + u_{j,t}) \quad (6)$$

which rules out latent factors that affect only a single unit. Logically, this should just rule out the possibility that one latent factor could affect a single unit, as in such a case there would be no information about this latent factor in the other units and so no good synthetic approximation for it would exist.

5.2 Application to the Study of the Impact of Conflict and Disability in Ukraine

The GSC method is particularly well suited to the context of the current study for several reasons. First, the treatment happens over several periods of time. Some Ukrainian regions were subject to treatment in earlier periods (i.e. military conflict in Lugansk and Donetsk oblast in 2014), while the rest of the regions were treated at a later stage (i.e. the beginning of the full-scale armed conflict in 2022). Hence, in this case, a classic synthetic control method, which is designed for a single treated unit and a one-time intervention, would not yield reliable results.

Second, data limitations and the inability to control for all the confounding factors in the model mean that a classic fixed-effects regression might be problematic. A range of time-varying, region-specific characteristics cannot be adequately captured by the data at hand due to the difficulties related to the collection of reliable regional and local statistics during post-treatment periods. Hence, an omitted variable bias would be an obvious concern with the classic fixed-effects regression approach.

The GSC framework offers a robust solution to these challenges, as it is well-suited to omitted variables that follow latent-factor structures. Violations would require a factor that uniquely affects only one region, which is highly unlikely in our case. And even in such a case, such bias would be small and would not invalidate the counterfactual credibility of the estimator.

Hence, we employ GLS method to estimate the following model

$$y_{i,t} = \beta x_{i,t} + \mu_i' \lambda_t + u_{i,t} \quad (7)$$

Where $y_{i,t}$ is regional PIC (or PIC per-capita), $x_{i,t}$ vector of regional characteristics including regional GDP, population and disability share, λ_t is a vector of time-varying latent factors and μ_i is a vector of unit-specific factor loadings, $u_{i,t}$ idiosyncratic error term.

6. Results

This section presents the main empirical findings of the study. In what follows we report the estimates of the impact of military conflict in Ukraine taking into account the impact of regional share of PWD on regional personal income tax contributions. A preliminary inspection of the data confirms the availability of a rich and appropriate donor pool, consisting of EU regions used to construct the synthetic control group. (Figure 4)

Turning to the Ukrainian data, the weighted average of Ukraine's regional personal income tax contributions exhibits a negative trend since 2014 (Figure 5). This pattern is consistent with the timing of two major exogenous shocks: (i) military conflict in the east of Ukraine in 2014; (ii) the full-scale armed conflict in 2022. Both events resulted in substantial declines in regional population and economic activity, affecting not only the directly exposed regions but also the country as a whole.

Figure 4. *Sample Composition*

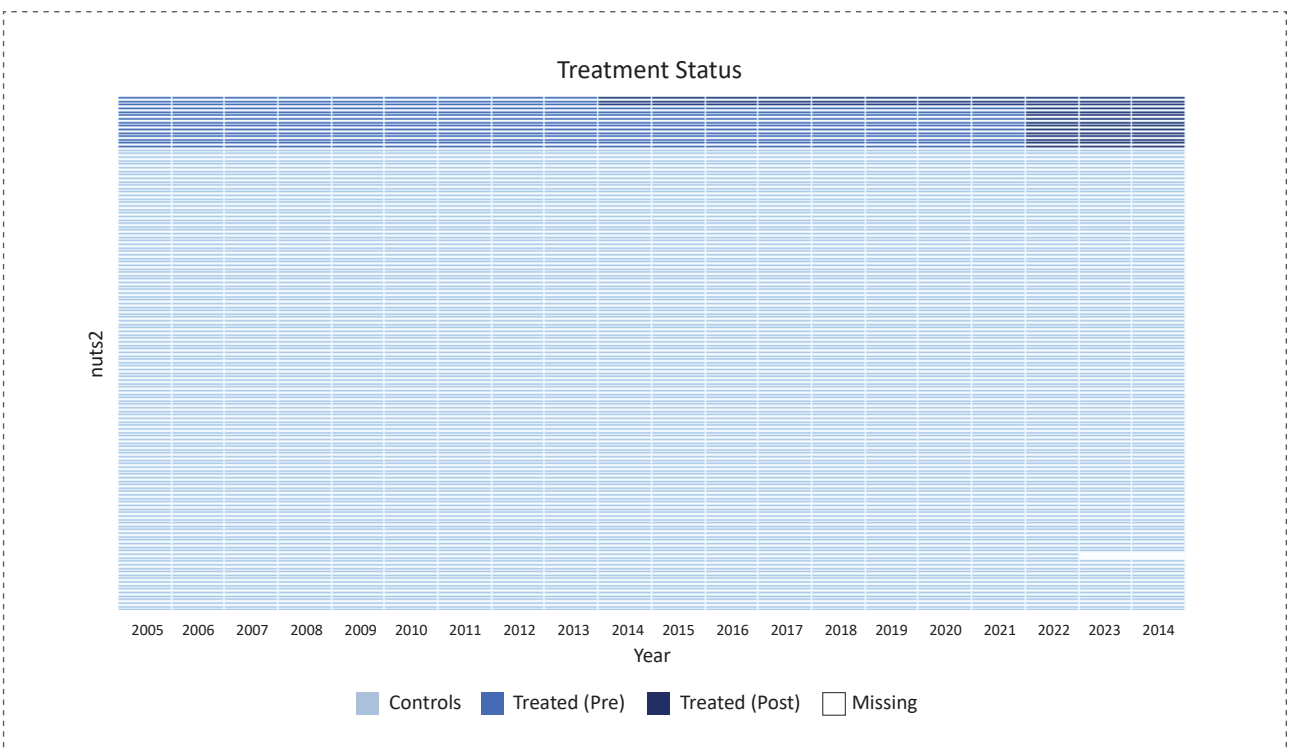
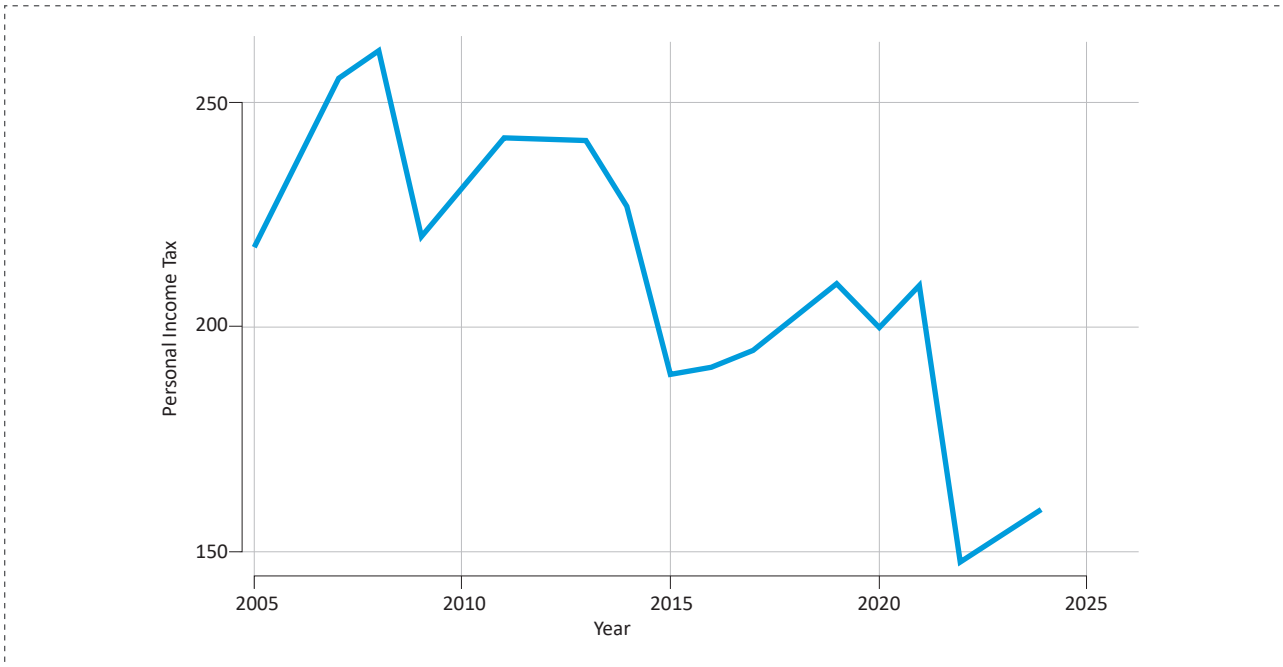


Figure 5. *Regional Personal Income Tax Contributions in Ukraine, 2005-2024*



Note: The figure plots regional population-weighted average regional income tax contribution. Units: EUR constant 2015 prices.

The correlation matrix reported in Table 1 indicates a negative relationship between regional personal income tax contributions and the regional share of PWD. However, several additional factors may influence personal income tax revenues. These include regional population size, regional GDP, and, crucially, exogenous shocks such as military conflict. Because some of these variables are not directly observable due to data limitations, we employ the GSC method outlined in section 5. This approach accounts for the influence of latent factors while simultaneously controlling for observable factors such as population, regional GDP, and exposure to military conflict. The estimator constructs a "synthetic Ukraine" from EU regions with similar characteristics and compares its evolution to that of actual Ukraine, with the synthetic version representing the counterfactual path the country might have followed in the absence of the war.

Table 1. *Correlation matrix*

	Regional GDP	Regional PIC	Regional Population	Regional PWD	Regional share of PWD	Regional PIC pc
Regional GDP	1.00	0.86	0.37	0.12	-0.41	0.64
Regional PIC	0.86	1.00	0.58	-0.33	-0.36	0.68
Regional Population	0.37	0.58	1.00	0.87	0.03	-0.04
Regional PWD	0.12	-0.33	0.87	1.00	0.37	-0.23
Regional share PWD	-0.41	-0.36	0.03	0.37	1.00	-0.50
Regional PIC pc	0.64	0.68	-0.04	-0.23	-0.50	1.00

Note: Monetary units are represented in constant EUR 2015 prices.

Table 4 reports summary statistics for the main variables, presented separately for the control and treated groups. The control regions show lower average regional GDP and PIC than the treated regions, but display greater variability, particularly in GDP and population size. This pattern is expected, as the control group comprises all European regions, which differ widely in their size, and economic and social characteristics.

In contrast, the Ukrainian regions (the treated group) exhibit higher average GDP and PIC levels but include fewer units and observations. The average regional share of PWD is considerably higher in the control group (27 per cent) than in the treated group (7 per cent). This difference primarily reflects the use of the EU-SILC survey to construct disability statistics for EU regions, where disability is self-reported and based on much less stringent criteria than those applied by the Ukrainian Office of National Statistics, which follows the World Health Organization (WHO) convention. To mitigate potential bias arising from differences in the reported shares of PWD between the treated and control regions, the empirical analysis is conducted using changes rather than levels, thereby comparing trends over time rather than absolute values.

PIC per capita is also higher in the treated group, again reflecting the greater heterogeneity within the broad set of regions comprising the control group. Overall, the table highlights substantial differences between treated and control regions in terms of economic size, population, and PWD prevalence. Nevertheless, the breadth of the control group should facilitate the selection of regions most comparable to Ukraine, thereby supporting the credible implementation of the generalized synthetic control estimator.

Table 2. *Summary Statistics*

	Control					
	Units	N obs	Mean	SD	Min	Max
Regional GDP	mln EUR	4665	803.62	1643.81	10.65	23622.46
Regional PIC	mln EUR	4665	59.90	86.37	0.54	935.92
Regional Population	thousands	4665	1810.08	1431.32	23.06	11146.85
Regional PWD	thousands	4665	477.6688	420.9826	3.333527	3919.935
Regional share		4665	0.27	0.09	0.04	0.52
Regional PIC pc	EUR	4665	33.88	32.79	0.43	323.99
			Treated			
Regional GDP	mln EUR	115	2731.57	2610.89	605.87	16195.01
Regional PIC	mln EUR	115	128.18	84.16	21.01	535.01
Regional Population	thousands	115	1625.74	938.82	648.24	4294.47
Regional PWD	thousands	115	103.578	48.7366	22.641	246.841
Regional share		115	0.07	0.03	0.01	0.16
Regional PIC pc	EUR	115	83.90	32.27	12.31	223.23

Note: For the list of sources, please refer to the data section.

6.1 Regional Personal Income Tax Contributions

We now turn to the main findings of the paper, beginning with a visual presentation of the results for regional PIC contributions. Figure 6 displays the estimated dynamic average treatment effect on the treated (ATT) and provides visual evidence in support of the parallel-trends assumption. The results are based on estimating equation (7) using the Gsynth (TW-FE) estimator.

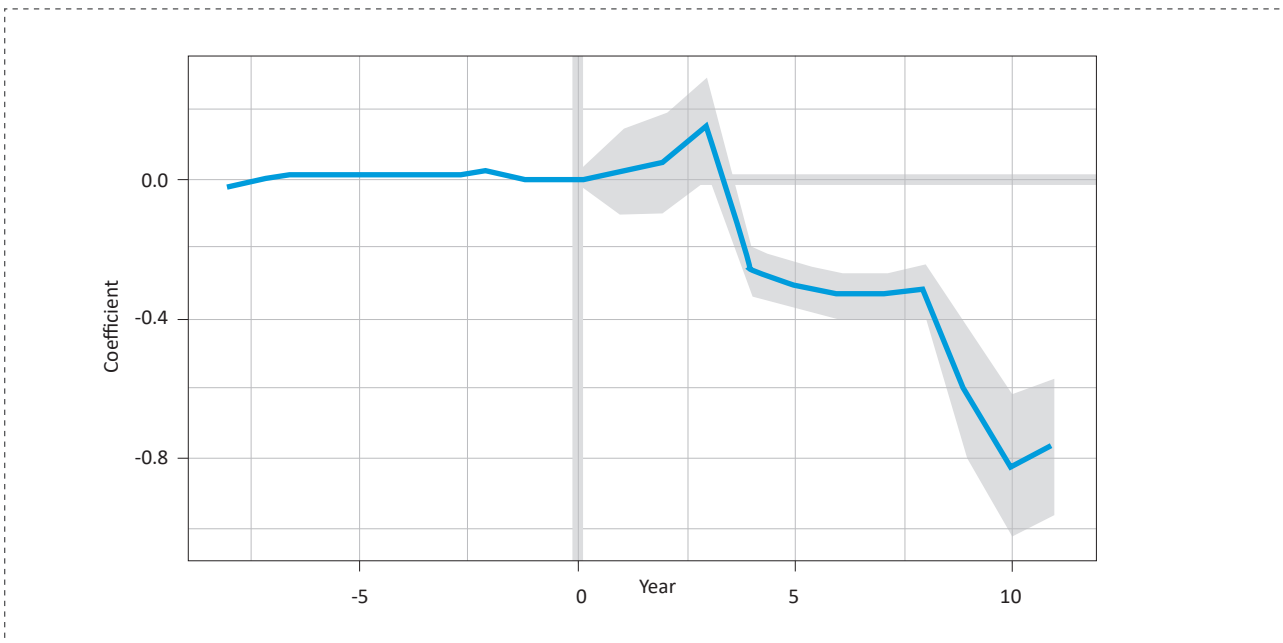
In the figure, the vertical axis reports the percentage change in PIC, while the horizontal axis shows time relative to the treatment. The vertical line at Year = 0 marks the onset of treatment (i.e., the military intervention). Because treatment occurs at different times across regions - 2014 for Luhansk and Donetsk, and 2022 for the rest of Ukraine - the graph is plotted using event time, with all regions aligned relative to the year in which they were treated.

Examining the trends in percentage PIC changes before the onset of the military conflict (i.e., before Year = 0), we observe that the pre-treatment paths are relatively flat. This suggests that the parallel-trends assumption is reasonably satisfied, landing support to the validity of the chosen control group and empirical strategy, particularly given the breadth and heterogeneity of our sample.

The post-treatment period reveals a substantial negative impact of the military intervention and other controls, including the regional share of PWD on regional personal income tax contributions. However, the figure also shows a lag between the start of the conflict and the point at which the negative PIC effects become visible. Several factors may account for this delay. First, national statistical systems may have experienced disruptions and required time to adapt to the new realities of war following the full-scale armed conflict. Second, many individuals who relocated immediately after the war. may have continued working and paying personal income taxes in the regions where they were previously registered.

Despite this delay, the results clearly indicate a significant adverse effect of military conflict on regional PIC contributions. Overall, our findings - summarised in Table 5 - suggest that a 10 per cent increase in conflict intensity is associated with roughly a 1.2 per cent decline in regional personal income tax contributions.

Figure 6. *GSYNTH Analysis of Log PIC, Ukraine and Synthetic Ukraine*



Note: The figure plots the estimates of the average treatment effect on the treated (ATT) for the regional personal income tax contributions during 2005-2024. Vertical axis plots the percentage changes (i.e. the impact of the treatment) of regional personal income tax revenues. Horizontal axis plots time. Due to the staggered treatment design (i.e. treatment occurring at different times for different units) the time on the x-axis is given relative to treatment, with treatment happing at year=0. The estimates presented in the figure are obtained using the generalized synthetic control estimator in R, package gsynth.

Table 5 presents detailed statistics for our main set of results. Column (1) reports the estimates for aggregate regional PIC contributions. In addition to the impact of military conflict discussed above, the table provides estimates for the effects of several key control variables.

First, the regional GDP results confirm the expected positive and significant relationship with PIC: a 10 per cent increase in regional GDP is associated with an approximately 8.5 per cent increase in regional personal income tax contributions. Regional population also emerges as an important determinant of PIC. Our estimates indicate that a 10 per cent increase in regional population leads to roughly a 2.2 per cent increase in PIC.

Finally, we turn to our main parameter of interest, the regional share of PWD. The findings show

that a 10 per cent increase in the share of PWD in a region is associated with a 1.2 per cent decline in aggregate regional personal income tax contributions. Given that the average share of PWD in a Ukrainian region is 7 per cent (Table 2), a 10 per cent increase in a share of PWD would imply that a regional share of PWD would change from 7 per cent to 7.7 per cent, or else, increase by 0.7 per cent of the total regional population. Hence, an increase in PWD by 0.7 per cent of total regional population would lead to a 1.2 per cent decline in aggregate regional personal income tax contributions.

Table 3. *Effects of Conflict and Disability on Personal Income Tax Contributions*

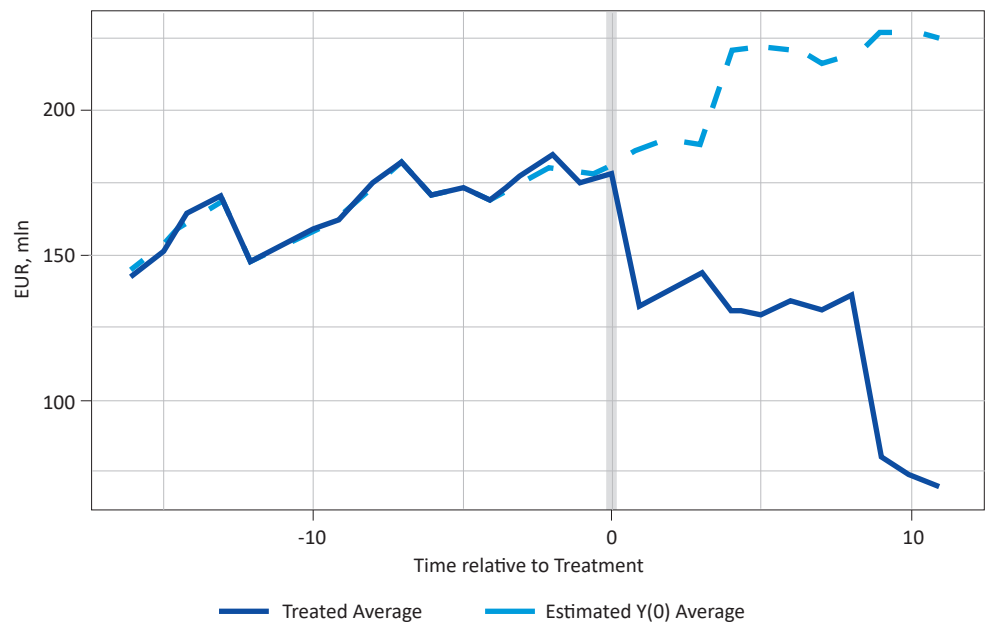
GSYNTH (TW-FE) Estimates		
	(1)	(2)
Dependent variable	Log PIC	Log PIC per capita
$T^{GSYNTH-}$	-0.117**	-0.166**
	(0.063)	(0.079)
Regional GDP	0.852***	0.677***
	(0.001)	(0.185)
Regional Population	0.221**	0.210***
	(0.127)	(0.161)
Regional Disability share	-0.121**	-0.175**
	(0.078)	(0.084)
Time FE	✔	✔
Region FE	✔	✔
Observations	4,780	4,780
No of regions	239	239

Note: The table reports the estimated effects of the military intervention and other factors in regional personal income tax contributions in Ukraine. The table reports the generalized synthetic control estimates using Eq. (5) and employing gsynth package in R. Column (1) reports the results for aggregate regional personal income tax; column (2) reports the results for the regional personal income tax per person. Time FE represent year fixed effects. Region FE represent regional fixed effects. Robust standard errors are clustered at the country level and reported in parentheses.
**** p < 0.01, ** p < 0.05, * p < 0.1.*

Finally, we present a visual comparison of predicted regional PIC revenues for a counterfactual Ukraine, constructed using the GSC method, with the actual observed values. Figure 7 plots the trajectories of average regional PIC for both actual and synthetic Ukraine over the period 2005–2024.

The two series track each other closely until 2014. Following the onset of the first military conflict in 2014, the trajectories begin to diverge. By 2020, actual PIC in Ukraine falls to roughly 45 per cent below that of the synthetic control. After 2022, this gap widens substantially, with the difference in regional PIC reaching more than 60 per cent by the end of the period.

Figure 7. *Aggregate PIC, Ukraine and Counterfactual Ukraine*



Note: The figure plots the actual and synthetic regional personal income tax contributions during 2005-2024. Vertical axis plots annual percentage changes (i.e. growth) of regional personal income tax revenues. Horizontal axis plots time. Due to the staggered treatment design (i.e. treatment occurring at different times for different units) the time on the x-axis is given relative to treatment, with treatment happing at your=0. The estimates presented in the figure are obtained using the generalized synthetic control estimator in R, package gsynth. Unit: Euro at constant 2015 prices, mln.

6.2 Personal Income Tax Contributions Per Capita

We next turn to the estimates using the second version of the dependent variable: per-capita PIC contributions. This measure more directly captures the effects of population movements, which have intensified substantially since the onset of the military conflict. Importantly, regions in Eastern and Central Ukraine, those most exposed to hostilities, have experienced much larger population outflows than less affected Western regions, where departures were more limited and partially offset by the arrival of IDPs. These population dynamics may introduce bias into the estimates based on aggregate PIC, making the per-capita specification a valuable complementary perspective.

As before, we begin with a visual presentation of the estimated dynamic average treatment effect on the treated (ATT). Figure 8 again indicates that the parallel-trends assumption is reasonably satisfied. The results are obtained by estimating equation (5) using the Gsynth (TW-FE) estimator with log regional PIC per capita as the dependent variable.

In the figure, the vertical axis reports the percentage change in PIC per capita, while the horizontal axis depicts time relative to treatment. The vertical line at Year = 0 marks the onset of the military intervention. Because treatment timing differs across regions, 2014 for Luhansk and Donetsk, and 2022 for the rest of Ukraine, the graph is presented in event time, aligning all regions relative to their respective year of treatment.

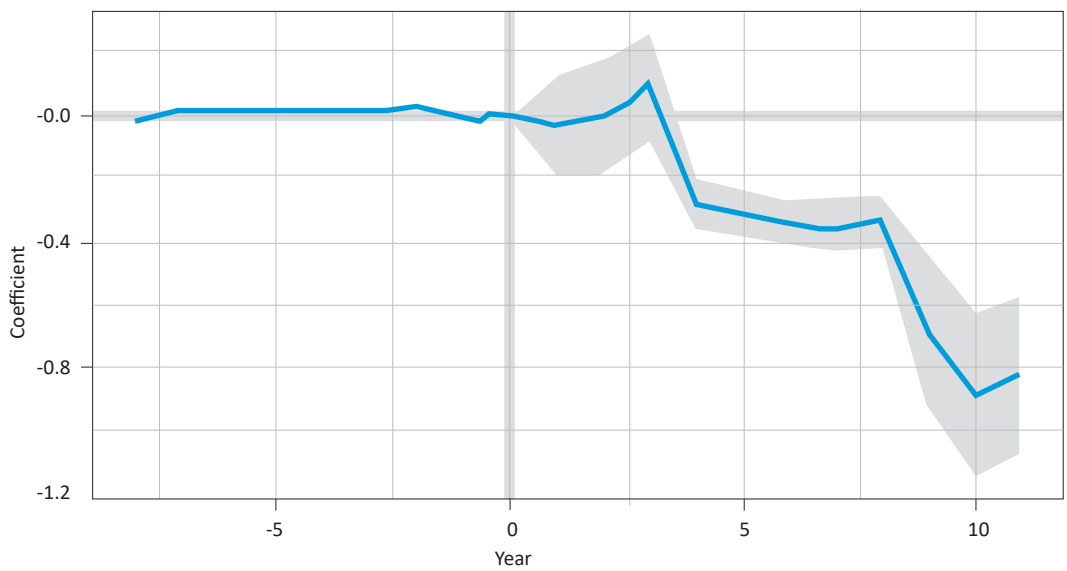
Examining the trends in percentage changes in PIC per capita prior to the onset of the military conflict (i.e., before Year = 0), we observe relatively flat pre-treatment patterns. This pattern supports the parallel-trends assumption and reinforces the adequacy of the control group and empirical design, particularly given the breadth and heterogeneity of the sample.

The post-treatment period reveals a clear and significant negative effect of the military conflict on per-capita regional PIC. As in the aggregate specification, the figure indicates a delay between the start of the conflict and the point at which the negative effects become

evident. One plausible explanation is that many individuals who relocated immediately after the war continued to work and pay personal income taxes in the regions where they remained administratively registered.

Despite this short lag, the estimation results consistently confirm a substantial negative impact of military conflict, alongside other relevant factors, on regional per-capita personal income tax contributions. Overall, the estimates presented in Table 5 suggest that a 10 per cent increase in conflict intensity is associated with an approximately 1.7 per cent decline in regional per capita PIC.

Figure 8. *GSYNTH Analysis of Log PIC per capita, Ukraine and Synthetic Ukraine*

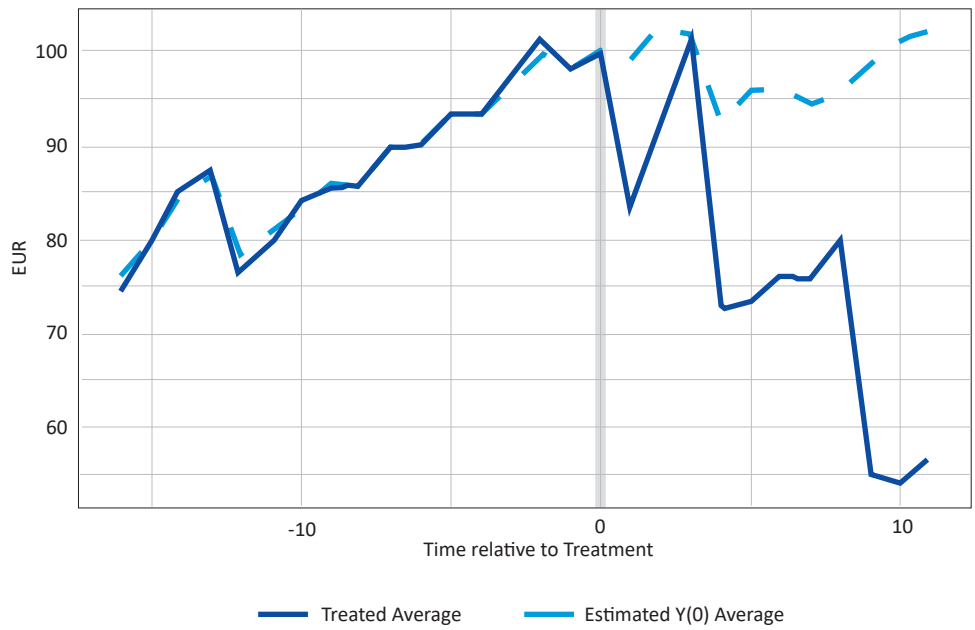


Note: The figure plots the estimates of the average treatment effect on the treated (ATT) for the regional personal income tax contributions per-capita during 2005-2024. Vertical axis plots the percentage changes (i.e. the impact of the treatment) of regional personal income tax revenues. Horizontal axis plots time. Due to the staggered treatment design (i.e. treatment occurring at different times for different units) the time on the x-axis is given relative to treatment, with treatment happing at year=0. The estimates presented in the figure are obtained using the generalized synthetic control estimator in R, package gsynth.

The main set of estimates for the per-capita regional PIC is presented in Table 5, Column (2). As before, we discuss the estimates on the effects of additional factors that we directly control for in the model. First, regional GDP estimates again confirm an expected positive and significant effect of regional GDP on regional per-capita personal income tax contributions, with a 10 per cent increase in regional GDP resulting in around 6.8 per cent increase in regional per-capita personal income tax revenues. Another important factor of PIC is regional population. Consistent with the existing literature, a 10 per cent increase in regional population is associated with an increase of around 2.1 per cent in regional PIC per capita (Prammer, 2019; Yashio & Hachisuka, 2014).

We next turn to the main parameter of interest – the regional share of PWD. Our findings show that a 10 per cent increase in a share of PwD in a region would result in a 1.75 per cent decline in regional per-capita personal income tax contributions. Given that the average share of PWD in a Ukrainian region is 7 per cent (Table 2), a 10 per cent increase in a share of PWD would imply that a regional share of PWD would change from 7 per cent to 7.7 per cent, or else, increase by 0.7 per cent of total regional population. Hence, an increase of PWD by 0.7 per cent of total regional population would lead to a 1.75 per cent decline in aggregate regional personal income tax contributions.

Figure 9. *PIC per capita, Ukraine and Counterfactual Ukraine*



Note: The figure plots the changes in actual and synthetic regional personal income tax contributions during 2005-2024. Vertical axis plots annual percentage changes (i.e. growth) of regional personal income tax revenues. Horizontal axis plots time. Due to the staggered treatment design (i.e. treatment occurring at different times for different units) the time on the x-axis is given relative to treatment, with treatment happing at your=0. The estimates presented in the figure are obtained using the generalized synthetic control estimator in R, package gsynth.

Finally, we visually present the predicted regional per-capita personal income tax revenues for the counterfactual ("synthetic") Ukraine and compare it to the actual Ukraine. Figure 9 plots the trajectories of changes in the average regional PIC per capita and average synthetic regional PIC per capita for the period 2005-2024.

Again, we note that the trajectories for actual and synthetic Ukraine closely track each other prior to the first intervention. However, when the first military insurgence occurs, the actual and synthetic Ukraine diverge. Ukraine's PIC per capita experiences a sharp decline by around 20 euros, corresponding to a reduction of around 20 per cent. Although a partial recovery follows, the series subsequently returns to a negative trend, characterised by several pronounced declines through to the end of the observed period.

By the end of the observed period (i.e. 2024) the gap between actual and synthetic regional per-capita PIC increases to more than 40 per cent. These results suggest a loss of around 40 per cent in the regional PIC per capita due to the negative impact of military conflict, regional share of PWD and other contributing factors.

Taken together, these findings demonstrate that military conflict and associated demographic changes, particularly the sharp increase in disability, have eroded Ukraine's regional personal income tax base. This erosion has generated adverse consequences for both local and national economies. Across both aggregate and per-capita measures, conflict intensity and rising disability prevalence exert consistent and economically meaningful downward pressure on revenues. The disability channel alone reduces PIC by approximately 1.2 per cent and PIC per capita by 1.75 for every 10 per cent increase in the regional share of PWD. The widening divergence between actual and synthetic Ukraine, exceeding 60 per cent for aggregate PIC and over 40 per cent for PIC per capita by 2024, illustrates how conflict, population displacement, and disability jointly weaken fiscal capacity. These results underscore that disability is not only a social consequence of war, but also an important fiscal transmission channel, with direct implications for Ukraine's ability to mobilise domestic resources for recovery and development.



7. Conclusions, Policy Implications and Directions for Future Research

7.1 Summary of Findings

This report examines how the ongoing military conflict in Ukraine has affected regional PIC revenues, with particular attention to the fiscal implications of the rising number of PWD. Using a GSC framework, the study compares the evolution of Ukraine's regional PIC to a counterfactual trajectory constructed from structurally similar EU regions. This methodology enables a credible assessment of the magnitude of fiscal losses attributable to conflict intensity, population displacement, and the expanding share of PwD.

The analysis draws on a combination of Ukrainian administrative data and harmonised European regional statistics. Regional PIC data were obtained from the Ukrainian Ministry of Finance and reconstructed for earlier years using national budget statements and IMF Country Reports. Regional GDP and population data were sourced from the Ukrainian Office of National Statistics and deflated to constant 2015 prices. Official statistics on PWD were taken from the national disability registry. EU regional data, including GDP, population, disability prevalence, and personal income tax revenues, were collected from the European Commission's ARDECO database, Eurostat's EU-SILC survey, and the EC Taxation Trends database. Taken together, these sources enable transparent and comparable measurement of regional economic conditions across Ukraine and EU regions.

The findings of the study highlight three key results. **First,** the conflict has caused substantial and persistent losses in Ukraine's tax base. Both aggregate and per-capita PIC diverge sharply from their synthetic counterparts after 2014, with losses deepening considerably following the full-scale armed conflict in 2022. By 2024, aggregate PIC stands more than 60 per cent below its counterfactual, while PIC per capita is more than 40 per cent lower.

Second, disability emerges as a significant fiscal channel in its own right. An increase in PWD by 0.7 per cent of regional population reduces PIC by 1.2 per cent and PIC per capita by 1.75 per cent. This reflects the reduction in labour market participation and earnings capacity associated with disability, especially given the scale of war-related injuries among civilians and veterans. The analysis therefore confirms that, beyond the broad economic losses brought by military conflict itself, disability constitutes an additional and quantifiable mechanism through which these losses translate into reduced fiscal capacity.

Third, even after controlling for GDP, population, and other factors, the combined effects of conflict exposure and rising disability rates remain strong and statistically robust. These results demonstrate that disability is not merely correlated with conflict intensity, but constitutes a distinct determinant of tax revenue performance. Recognising disability as a fiscal variable is therefore essential not only for a comprehensive understanding of the current and future economic cost of the war, but also for designing policies capable of sustaining Ukraine's economic recovery.

7.2 Policy Implications

The results of this study point to several policy implications. **First**, disability-inclusive labour market interventions, such as vocational rehabilitation, reskilling programmes, workplace accommodation, wage-support schemes, and targeted employer incentives, can generate

direct fiscal and economic returns. By expanding the pool of taxpayers and increasing taxable earnings among individuals whose labour market participation is otherwise constrained, these policies can help restore the personal income tax base Given the estimated elasticities, even modest improvements in employment among working-age PWD can offset a meaningful share of the demonstrated revenue losses. In this sense, well-designed disability-inclusive interventions have the potential to finance themselves by restoring segments of the foregone personal income tax base.

Second, investment in rehabilitation, prosthetics, assistive technologies, and early functional recovery should likewise be understood as instruments of tax-base recovery policies. Restoring work capacity - even partially - among war-injured civilians and veterans raises the likelihood of re-entry into employment and therefore enhances the future tax revenue stream. These interventions generate long-run dividends: each individual successfully reintegrated into employment reduces the cumulative fiscal burden and increases future PIC collections, contributing to stronger economic recovery.

Third, the findings indicate the presence of temporary lags between population movement, disability identification, and tax reporting. Streamlining data systems, enhancing digital registries, and improving information-sharing across institutions can reduce revenue leakage and improve the accuracy of fiscal planning.

Fourth, regional heterogeneity in both conflict exposure and disability prevalence implies that the fiscal and, hence, economic payoff of inclusive employment interventions are likely to be highest in the regions where the tax base has contracted most severely. In these areas, targeted investments, such as SME support, subsidised job creation, and reconstruction that incorporates accessibility standards, can simultaneously stimulate economic activity and facilitate the return of PWD to the labour force. Such regionally targeted programmes function not only as instruments of social recovery but also as localised tax-base rebuilding strategies.

Finally, the evidence suggests that accounting for disability prevalence is essential for realistic fiscal planning and revenue forecasting. Incorporating disability dynamics into medium-term revenue projections, budget planning, and reconstruction strategies will allow policymakers to better quantify the expected returns to disability-inclusive labour market policies. Framing such measures as investments that expand the tax base, rather than as purely social expenditures, enables the design of policies that are both socially equitable and fiscally self-sustaining.

Overall, the results indicate that disability-inclusive policies are central to restoring Ukraine's long-term fiscal capacity. By increasing the employability and earnings potential of PWD, these interventions offer a pathway for the government to recover lost PIC revenues, enhance state capacity, and promote inclusive, sustainable economic reconstruction.

7.3 Directions for Future Research

The findings of this study underscore the need for further research, with a specific focus on the ex-ante impact assessment of the fiscal and economic benefits of disability-inclusive labour market interventions. While the present analysis quantifies the revenue losses associated with rising disability prevalence, it does not estimate the potential fiscal gains from reintegrating PWD, whose conditions are compatible with employment into the labour force.

Future research should therefore model the expected fiscal returns of such measures, assess their cost-effectiveness, and simulate alternate policy scenarios under different labour market and recovery conditions. Developing this evidence base would support the Government of Ukraine and development partners, in crafting forward-looking strategies that strengthen state capacity, promote inclusive growth, and accelerate fiscal recovery - not only in Ukraine, but in other conflict-affected settings.

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