UKRAINIAN MIGRATION ABROAD AND FISCAL SUSTAINABILITY: EVIDENCE FROM THE WAR PERIOD

by

Oleksandra Myronenko

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Thesis Supervisor: _____ Professor Maksym Solodarenko

Approved by _____
Head of the KSE Defense Committee, Professor

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Date _____

Kyiv School of Economics

Abstract

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This thesis examines the fiscal consequences of massive outward migration as a result of full-scale invasion. Since February 2022, Ukraine has experienced one of the largest migration shock in Europe since World War II, which raises concerns for fiscal and economic sustainability in long-term. Such people outflow affects public finances from two sides: on one hand it decreases the tax base, and on the other it reduces the demand for public goods. Such estimations of migration effects on public finances have not been done in the Ukrainian context before. This thesis addresses this gap and investigates whether migration intensified the existing trends in public finances of Ukraine during the wartime period.

The empirical strategy introduces a two-stage approach, whereby the first stage involves the construction of three distinct synthetic control models (SCMs), which have been independently optimized to estimate the effect of the war on the non-military balance, revenues excluding grants, and non-military expenditures. In the second stage, the resulting gaps between actual and counterfactual outcomes are then regressed on net migration using nonparametric Bayesian bootstrapping and HAC estimation.

The results suggest that war has had a significant effect on Ukraine's civilian budget indicators, mainly through reduced non-military expenditures rather than

increased revenues. Consequently, the non-military balance (revenues minus expenditures) performed better than the expected counterfactual scenario without the war. However, the study failed to find statistically robust evidence, that migration worsened the existing fiscal trends.

The study reveals strategic prioritization of fiscal resources toward war needs, reducing non-military expenditures and shifting more of the budget's own revenues toward defence. At the same time, this raises an identification challenge: migration and war effects are highly collinear and could not be separated in the short run. However, this thesis contributes to the literature, providing the first empirical assessment of relation between wartime migration shock and fiscal sustainability.

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AI USE DECLARATION

During the preparation of this thesis, Generative AI (ChatGPT, Gemini, and Claude) was used as a supplementary tool to:

- support grammar correction and improvement of sentence clarity in Chapters 1-5 of this thesis;
- idea brainstorming for the methodology part;
- coding for synthetic control models and regressions.

The tool was not used to generate research findings, produce literature summaries used directly in the thesis, create citations, or conduct any form of data analysis. All research questions, theoretical framing, methodology, analysis, interpretation of results, and conclusions were developed independently by the author. I take full responsibility for the originality, validity, and academic integrity of the work presented in this thesis.

Chapter 1.

INTRODUCTION

The full-scale invasion in February 2022 has posed unprecedented challenges for the Ukrainian people, the economy as a whole, and public finances specifically. The war has led to a sharp increase in public expenditures – particularly on defence and security – while simultaneously disrupting economic activity and reducing the domestic tax base. As a result, the state budget deficit is planned to reach 18.4% of GDP in 2026[1], up from 3.6% in 2021. In this context, maintaining fiscal sustainability has become one of the central macroeconomic and governmental challenges in Ukraine.

At the same time, the war has triggered one of the largest migration flows in Europe since World War II. According to the Centre for Economic Strategy's estimates in February 2026, 5.6 million Ukrainians were abroad. A significant share of these individuals is working age and highly educated, implying potential loss of human capital and tax base. This massive emigration has reinforced the existing demographic challenges, including population decline and aging, both sufficiently influenced the public finances.

The fiscal consequences of migration occur through multiple channels. On the revenue side, population decline reduces the domestic tax base, particularly if migrants are economically active. On the expenditure side, a declining population may reduce demand for public services, potentially easing fiscal pressure. The net effect on the budget balance is therefore ambiguous and depends on the magnitude

[1] «Держбюджет: національний кешбек, телемарафон і дефіцит 18,4%» Centre for Economic Strategy, December 10, 2025, https://ces.org.ua/derzhbyudzhet-naczionalnyj-keshbek-telemarafon-i-deficzyt-184/

of both channels. Understanding this relationship is important for post-war fiscal sustainability and recovery policy.

Despite the extensive literature on receiving-country effects, the fiscal implications of emigration on sending countries remain understudied — especially in a wartime context.

This thesis aims to fill this gap and to investigate the following research questions: How has emigration as a result of large-scale invasion affected the Ukrainian civilian fiscal indicators? To what extent has outward migration contributed to the observed fiscal dynamics?

To answer these questions, the study adopts a two-stage approach. First, a synthetic control method is used to construct the Ukrainian fiscal trajectory in the absence of a full-scale invasion to assess the overall impact of the war on key budget indicators. Second, the resulting fiscal gaps between actual and counterfactual outcomes are regressed on migration dynamics to assess whether population outflow has influenced fiscal outcomes.

The originality of the research for this thesis is threefold. Firstly, compared with existing literature, which mainly focuses on migration from a perspective of labor markets, growth, or development, this thesis focuses on the fiscal effects of migration in a wartime economy. Secondly, it combines a methodological framework that integrates the synthetic control method with regression analysis to study the reasons for fiscal dynamics. Thirdly, it provides empirical evidence from Ukraine, contributing to the limited literature on emigration and fiscal sustainability under conditions of large displacement of people and full-scale invasion.

This thesis is structured as follows: Chapter 2 discusses the relevant literature on previous migration studies and their impact on different economic variables, particularly public finances; Chapter 3 describes the methodology used; Chapter 4

summarizes the data; Chapter 5 presents the estimation results and their limitations; Chapter 6 covers the conclusions and recommendations.

Chapter 2.

LITERATURE REVIEW

In this section, I present the reviewed literature related to the topic of this master's thesis, including its research questions and methodological approaches, within the possibility of applying it to this thesis. Having this literature review, I define the gap in the existing research and confirm the need for this topic to be explored.

2.1. Studies on migration

2.1.1. Studies on immigration

There is a lot of research that studies the effects of immigration, especially in such migrant-attractive developed countries such as the United States, the United Kingdom, etc. Different authors studied this topic: Storesletten (2000), Dustmann and Frattini (2013), European Commission (2020), and Nowrasteh et al. (2020). Some studies cover both immigrants' and emigrants' effects on fiscal policy – Cristea and Grabara (2019).

A lot of studies analyze the effect of migrations (whether immigration or emigration) using a general equilibrium approach. Storesletten (2000) uses a calibrated general equilibrium overlapping generations model to account for differences between immigrants and natives. The purpose of the paper is to investigate whether a reform of immigration could alone resolve the fiscal problems associated with the aging of the baby boom generation. The outcome implies that the budget can be balanced with sufficient inflow of any age group of high-skilled immigrants between 20 and 54. Kiiashko and Kopiec (2020) also used overlapping generations, but with two-period-lived agents. Authors mention

undesirable fiscal consequences of migration in sending countries: challenges for social security systems, increase of public debt per capita, and decrease of the marginal productivity of capital. The results showed that the global effects of migration were encountered in a lower average Debt-to-GDP ratio (80% vs 72%), higher outputs (1.5% over 1.2%), and welfare improvement.

Overall, the general equilibrium approach is commonly used in the estimation of the macroeconomic effects of migration on different variables of interest. Olovsson et al. (2025), for instance, study dynamic macroeconomic implications of immigration using a general equilibrium model.

Dustmann and Frattini (2013) investigate the fiscal impact of immigration in the UK since 1995 using a classic linear regression model. For immigrants since 2000, there is a distinction between immigrants from European versus non-European countries. The general finding is that immigrants from the European Economic Area (EEA) have made a positive fiscal contribution, even in periods of fiscal deficits. The authors came up with the same conclusion that there is a positive fiscal effect of highly educated immigrants. Since they completed their education abroad (in sending countries), the discounted net value of their future net fiscal payments is positive.

The effects of immigration were also studied in the case of Jordan by Nowrasteh et al. (2019). Authors tried to find out to what extent immigration affects the economic institutions in destination countries using the Synthetic Control Method. The results showed long-term positive effects on Jordanian economic institutions because refugees could work, live, and vote. The method used here is commonly used for the estimation of causal impacts of policy or interventions by constructing a counterfactual "synthetic" dataset as an average of control units. This approach will be useful in this study and is discussed in the next sub-chapter about the Synthetic Control Model.

The topic of the fiscal impact of migration was discovered severely in the context of the European Union. The free movement of people between all EU countries has caused an increasing number of emigrants from emerging to more developed markets, and consequently, the budgetary revenues and implementation should have been changed. This phenomenon was studied by Cristea and Grabara (2019). The authors suggest two ways of the migration effect on government budgets: positive – a higher number of employed migrants causes higher fiscal revenues per capita, while reducing the public debt and government spending; negative – fiscal expenditures on retired immigrants will be positive, and the impact of the income of those immigrants will be negative.

In this study, I adopt a similar framework but reverse the direction — examining the sending country (Ukraine) rather than the host country: negative – a smaller number of employed individuals causes smaller fiscal revenues per capita; positive – a smaller population causes fewer users of public goods and services, which causes less budget expenditures.

Overall, the literature on immigration provides consistent evidence that the fiscal impact of migration depends critically on migrants' characteristics, particularly their age, education, and labor market participation. While general equilibrium models highlight long-run fiscal sustainability channels, empirical studies tend to find positive or neutral fiscal effects of immigration in receiving countries, especially when migrants are highly skilled. However, this body of research is predominantly focused on destination countries, leaving the fiscal consequences for sending countries significantly less explored.

2.1.2. Studies on emigration

There is still a huge gap in studying the effect of migration on sending countries. Katseli et al. (2006) for the OECD Development Centre tried to evaluate evidence

on how migration may promote or hinder economic development in sending countries and what possible win-win solutions are for both receiving countries and countries of origin. OECD identifies fiscal losses as one of the costs associated with brain drain. Since many countries spend a lot of their revenues on education, the outflow of highly educated labor is considered an export of human capital, in which the nation has invested. Also, this outflow is associated with potential tax revenue losses that are a consequence of the potential incomes of emigrants. But there are no quantitative estimations of such fiscal effects in this paper.

The impact of emigration on fiscal stability is studied in Carare et al. (2024). The author analyzes how emigration impacts the fiscal gap of the population-exporting region of North China in the long term through a general equilibrium model. The results of the paper showed that the economic losses related to emigration have an immediate effect on widening the fiscal gap; in the short- and long-term emigration can cause a decrease in tax revenues due to a lower tax base.

Still, there are no study which explored the effect of the emigration phenomenon on public finances in Ukraine during the full-scale invasion. That's why it is especially timely concerning the total number of features of the current emigration issue, since it directly influences both public finance revenue means and the structure of public finance expenditures.

In contrast to extensive literature on immigration, studies on emigration are limited. Existing studies suggest a negative effect on public finances in sending countries due to a reduction in the tax base and loss of human capital. However, there is no empirical evidence quantifying such effects as a result of sudden migration shock, especially within a country at war.

2.2. Synthetic Control Approach

2.2.1 SCM in world literature

First, the Synthetic Control Model (SCM) was developed by Abadie and Gardeazabal (2003) for investigating the economic effects of the conflict on economic development in the Basque Country. The author used a combination of Spanish regions to construct the "synthetic" control region, which was hypothetically not affected by terrorist attacks. This is a constructed counterfactual Basque Country without terrorism, compared to the actual outcomes of GDP per capita. The results showed that due to the conflict, the GDP per capita decreased by 10 p.p. compared to the synthetic control region.

Further, the idea of SCM was used in Abadie et al. (2010) for estimating the impact of the Tobacco Control Program in California. The authors used a previously developed model to investigate the causal effects of the imposition of anti-tobacco legislation on annual per capita cigarette consumption. The synthetic California was constructed to introduce the observed smoking rates in the absence of intervention using a weighted average of control states without the regulation. The outcome variable of interest is annual per capita cigarette sales; predictors are: average retail price of cigarettes, per capita personal income (logged), the percentage of population age 15-24, and per capita beer consumption. These predictors are averaged over the pre-treatment period and are augmented by adding three years of lagged cigarette consumption. The results showed that after the intervention, the tobacco consumption decreased much faster compared to a hypothetical synthetic counterfactual, even taking into account the already existing downward trend in cigarette consumption.

The developed SCM approach, after its invention, was used in different spheres. The most closely related research I found is presented by the German Center for

Economic Studies, particularly the study by Langer et al. (2025). The paper estimated the effect of the imposition of the German debt brake on the efficiency of public finances using the synthetic control approach, developed by Abadie et al. (2010). The authors take five outcome variables related to the debt effectiveness and compare them to their own counterfactual outcomes without the debt brake. The results showed that the introduction of the fiscal rule had a strong positive effect on fiscal improvements and overall fiscal discipline.

The existing literature demonstrates that the Synthetic Control Method is a powerful tool for causal inference in settings where randomized experiments are not feasible and a single treated unit is analyzed. Its ability to construct a credible counterfactual makes it particularly suitable for evaluating the impact of policy interventions or external shocks at the macroeconomic level.

2.2.2. SCM in Ukrainian studies

The synthetic control method is widely used to estimate the causal effect of sudden policy interventions or external shocks. There are a lot of examples of using SCM in international academic literature, outlined in Chapter 2.2.1. However, it is crucial to discuss whether this method is commonly employed within Ukrainian academic research or applied to the Ukrainian context. The evidence shows – yes, it is used, most frequently for estimating the economic effect of Russian aggression against Ukraine.

McCannon (2022) studies the impact of the "conflict" beginning from Russian aggression in 2014 on the Ukrainian economy between 2014 and 2020. In the paper, the Synthetic Control Method introduced by Abadie and Gardeazabal (2003) is used to estimate war consequences. The dependent variable is GDP per capita, and the list of predictors was used: percentage of economy in agriculture; export percentage of GDP to measure openness; unemployment rate for

estimating labor market; female labor force participation rate to recognize differences in women economic roles; population (in nominal terms) and percentage of population in urban areas to capture the size; life expectancy for quality of life; Economic Freedom of the World index to account for economic institutions; Varieties of Democracy index to account for political institutions. Data was collected from the World Bank; however, the given data was not comprehensive for all datapoints in the period of concern (1991 to 2020), so the linear interpolation was used to fill in these missing values.

The results suggest that the real GDP per capita has been almost 25.7% lower each year as a result of intervention compared to the counterfactual outcome.

Also, a similar research question on the economic costs of war was posted by Bluszcz and Valente (2022). The paper examines the causal effect of the Donbas war on Ukraine`s GDP using cross-country panel data over the period 1995-2017. The dependent variable is the same as for the previous study discussed – GDP per capita. The authors used as predictors the consumer price index due to hyperinflation in post-Soviet states, gross fixed capital formation, trade dependency on Russia, total international trade, Human Development Index, and an indicator for democracy. The resulting Synthetic Ukraine was constructed by Armenia, Bulgaria, Moldova, and Slovenia, with Moldova and Armenia having the highest weights. The results showed slightly less negative impact than McCannon did – 15.1% of GDP per capita forgone in 2013-2016 due to the war.

Some papers try to estimate the causal effect of the European integration process on trade flows – Hansen (2023). One paper provides an estimate of counterfactual Ukrainian trade flows to the EU in case Ukraine had joined the EU in 2004. The author used SCM with the outcome variable as export volumes, and such predictors were used as the logarithm of real GDP (current US dollars), average lagged exports between 1993 and 2003, distance between the trade pairs, and a

dummy variable for sharing a border. The paper examined the treatment effect in two models – with the average of lagged exports and the three-lag model as specific predictors, following a similar approach to Abadie et al. (2010). The results of SCM showed that the aggregate export volumes from Ukraine to the EU would have been 34.6% higher if Ukraine had joined the EU in 2004.

To sum up, there are studies covering the impact of war on the Ukrainian economy, but there is no separate assessment of the causal effect on fiscal indicators. Furthermore, there is no empirical counterfactual evidence on the fiscal impact of Ukrainian emigration.

2.3. Regression analysis

As described earlier in Chapter 2.1.1, regression estimates are also used as an analysis tool for migration effect on public finances. The ordinary least squares remains the workhorse for linear time-series regressions. However, as it relies on asymptotic assumptions and is invalid in the case of heteroscedasticity and autocorrelation, the classical inference is invalid for short-period time series. Therefore, the alternative regression approaches, which will address the challenge of small sample size, should be discussed.

One of the most promising models in this context – Heteroskedasticity and autocorrelation consistent (HAC) covariance estimator, usually known as the Newey-West estimator. It provides a general correction to the OLS variance–covariance matrix under serial correlation and heteroskedasticity (Newey, West, 1987). Its finite-sample behavior is well known to depend heavily on the choice of bandwidth and kernel (when one is used). In small samples, HAC estimators have downward-biased standard errors and size distortions in hypothesis tests. Subsequent studies have suggested computational refinements – such as

prewhitening techniques and different kernel functions – but these improvements do not completely alleviate small-sample issues.

Simultaneously, bootstrap methods have been advanced as an inference-oriented method with less reliance on asymptotic approximations. One such method, known as the Bayesian bootstrap and first proposed by Rubin (1981), provides a nonparametric, likelihood-free alternative in which observations are resampled with Dirichlet-distributed weights. In contrast to the classical bootstrap, which resamples observations with replacement, the Bayesian bootstrap reweights the empirical distribution so that it is especially attractive for regression settings where we want to preserve our dependence structure on data.

In conclusion, such regression analysis tools as Bayesian bootstrap and HAC standard error can mitigate the heteroscedasticity and autocorrelation challenges in the small-sample setting of annual public finances and migration data.

2.4 Research gap and development of hypotheses

The reviewed literature highlights two main research gaps: the study of emigration effect on public finances, since most similar studies discover how immigration affects fiscal sustainability, not outflows of people; and second, and most importantly, there are no studies exploring the question of the migration impact on public finances in Ukraine.

Therefore, taking into account the assumptions made in the studies reviewed in the literature, I formulate the following research hypotheses:

H1. The full-scale invasion caused the non-military balance to increase (decreasing the deficit).

H2. The migration shock has a negative effect on the revenues of the state budget.

H3. The migration shock has a negative effect on the expenditures of the state budget.

H4. The resulting effect from population decline on the balance of the budget is negative: the reduction of the state budget expenditures is less than the decrease in state budget revenues, so, the total balance is negative.

With this in mind, I proceed to the next step of the research – development of the methodology.

Chapter 3.

METHODOLOGY

The objective of this research is to estimate the causal effect of the emigration shock on the fiscal policy in Ukraine during the full-scale invasion, namely the impact of Ukraine's population decline on budget indicators. However, since the war has affected Ukraine's economic and social life in many ways, it is very difficult to separate the effects of war from those of migration. Therefore, in order to understand whether migration intensifies the impact of the war on public finances, this thesis adopts a two-stage approach. **First**, a construction of a counterfactual "Synthetic Ukraine" is developed to isolate the war effect on public finances. **Second**, the fiscal gaps from stage 1 are regressed on migration trends to identify the marginal effect of population outflows. Below, I outline the hypothesis-to-test map, the methodology used for each of these stages, and the potential outcomes.

3.1. Hypothesis testing map

The empirical strategy is defined to test the hypothesis H1-H4 outlined in the previous chapter. This is done by a combination of the synthetic control approach and regression estimation.

H1. For the evaluation of the non-military balance, the Synthetic control model is used, particularly the SCM_1. It estimates the counterfactual non-military balance of the Ukrainian budget in the absence of a full-scale invasion. The resulting difference (gap) between actual and counterfactual is the object of interest for me. If it is positive, this indicates that the actual balance is larger than the counterfactual, implying that the non-military budget deficit is narrower during the wartime.

H2. The estimation of migration effects on revenues relies on the regression model for the revenues without grants (associated with SCM_2). Firstly, the counterfactual revenues are assessed, and then they are regressed on the migration trends. The statistically significant negative migration effect ($\beta_0 + \beta_2 < 0$) would indicate that population decline reduces the revenues without grants.

H3. Similar to H2, migration effects on expenditures rely on the regression model for the non-military expenditures (SCM_3). Firstly, the counterfactual is estimated and regressed on the migration. The statistically significant negative migration effect ($\beta_0 + \beta_2 < 0$) would indicate that population decline reduces the expenditures.

H4. The estimation of the migration effect on the non-military budget balance requires joint comparison of the results from SCM_1, SCM_2 and SCM_3. If the negative effect of migration on revenues is bigger than the effect on expenditures, then the impact on the non-military balance is negative.

3.2. Synthetic control model

In the first stage of the analysis, the causal effect of full-scale invasion is estimated. In such types of research, it is appropriate to use the synthetic control approach as it is a strong estimator for the intervention effect on the dependent variable. In this thesis, I use the SCM, firstly outlined by Abadie and Gardeazabal (2003), to create the counterfactual Ukraine without war.

Importantly, three counterfactual models are developed: for non-military balance, revenues without grants, and non-military expenditures. They are independently optimized, so each has its own predictors and donor weights. Therefore, the total non-military budget balance does not mechanically follow from the revenue and expenditure estimates. Three synthetic models should be considered as separate

counterfactual outcomes that can be compared but describe different aspects of the budget.

The Synthetic Control Model is used in comparative case studies to estimate the impact of an intervention on the treated unit and has been called *"arguably the most important innovation in the policy evaluation literature in the last 15 years"* by Athey and Imbens (2017).

Synthetic control method constructs a counterfactual outcome, "Synthetic Ukraine" – $Y_{1,t}^{N}$, which represents the fiscal trajectory in Ukraine in case the full-scale invasion does not occur. This synthetic counterfactual unit is defined as a weighted average of several comparable countries from the donor pool that best match Ukraine's budget dynamics in the pre-intervention period.

$$Y_{1,t}^{N} = \sum_{j=2}^{J+1} w_j Y_{j,t} \quad (1)$$

where:

- $Y_{1,t}^{N}$ is the estimated counterfactual outcome for Ukraine at time t.
- J is the number of countries in the control pool;
- w_j is the optimal weight assigned to country j;
- $Y_{j,t}$ is the observed outcome for control country j at time t.

Optimization problem

To best capture the pre-intervention dynamics of the variable of interest, it is necessary to select the optimal weights of the donor units (countries) unaffected by the full-scale invasion. This raises the optimization problem in SCM. This

problem is solved by the Synth package in R (Abadie et al., 2011) by choosing the set of weights that generate the best-fitting convex combination of control units.

These weights are selected to minimize the mean squared prediction error (MSPE) between the pre-treated outcome of the actual Ukraine and the synthetic unit. The weights in the classic Synthetic Control Model are strictly positive and should sum up to one. The optimization problem is defined as:

$$min \sum_{m=1}^{k} v_m (X_{1m} - X_{0m} W)^2 \quad (2)$$

where:

- X_1 is $(k \times 1)$ vector of values of pre-intervention treated unit;
- X_0 is $(k \times 1)$ matrix of the same values of units from the donor pool;
- W minimizes the size of the difference between X_1 and $X_0 W$;
- v_m is the importance we assign to each predictor (the m-variable) to measure the discrepancy between X_1 and $X_0 W$.

The solution to our problem is a vector W, that defines the weights which are assigned to each donor unit. Then this vector forms a combination of the weighted averages of the donor pool for the synthetic control. The estimated treatment effect can be measured by the difference between the actual observed outcome and the synthetic counterfactual:

$$r_t = Y_{1,t} - Y_{1,t}^N \quad (3)$$

where:

- $Y_{1,t}$ is the actual outcome of the treated unit;
- $Y_{1,t}^{N}$ is the estimated counterfactual outcome.

In this design, "Synthetic Ukraine" – counterfactual outcome – represents the fiscal performance of Ukraine if war had not occurred at the beginning of 2022. Therefore, the r_t measures the total net effect of war (treatment) or "war-induced gap". This gap illustrates how full-scale invasion has affected Ukraine's non-military expenditures and its own revenues of the general government budget.[2].

Variables of interest

For the purpose of this thesis, I develop three synthetic outcomes for specific general budget indicators, to provide a comprehensive overview of the situation: *revenues without grants*, *non-military expenditures,* and their balance – *non-military balance*. These indicators are key variables in this study, reflecting the "civilian" component of Ukraine's public finances during the war. I have deliberately excluded expenditures on defence and public order, as these have undergone significant changes since the start of the invasion. Similarly, the grants are excluded from revenue to prevent the synthetic outcome from being skewed by significantly higher international aid during the war. However, revenues also count international aid received in kind (weapons, ammunition, etc.), as well as humanitarian aid. Unfortunately, it is impossible to separate these receipts from the budget's own

[2] General government budget covers all levels of public finances – state, local and budgets of social funds.

revenues within the scope of this study. Therefore, this is one of the limitations of the study.

One should expect the counterfactual outcomes for all three variables of interest to be higher than the actual ones. Such expectations are explained by the core hypothesis of the thesis – that the war has had a negative impact on the fiscal state of Ukraine.

Predictors selection

For constructing a good pre-intervention fit, it is necessary to choose good predictors. They should allow for the best possible replication of the economic and fiscal characteristics of pre-war Ukraine.

To achieve this goal, I take into account GDP per capita (in logarithms to reduce skewness in cross-country income differences and improve comparability across countries), real GDP growth, the ratio of public debt to GDP, and the consumer price index – these indicators address the issue of donors' economic closeness to Ukraine and are widely used in the literature when creating SCMs. I also take into account the age dependency ratio (the ratio of people younger than 15 or older than 64 to the working-age population (those ages 15-64)) to address the issue of population structure and population size, which can affect tax revenues. These predictors are common to all three models, but each model will be augmented by adding lagged outcomes of its dependent variable. For instance, SCM on non-military balance will use six years of lagged non-military balance.

Donor pool formation

Developing a robust donor pool for the model requires selecting a control group of untreated units – countries that were not affected by the intervention. These

representatives of the donor pool should have a parallel trend in the outcome variable – the general government budget dynamics – with the treatment group (Ukraine) in the pre-intervention period. The "intervention" is the large-scale migration of Ukrainians abroad, primarily starting after the full-scale Russian invasion in February 2022.

The full-scale invasion affected not only Ukraine and neighboring countries, but also established a world shock, creating huge refugee flows, increasing world prices, and factually affecting almost all countries in the world. Therefore, there are no countries that have remained completely "unaffected," unless they are not part of the global economy, in which case we do not include them either. This is a challenge and limitation of this work, as the parallel trend is one of the main assumptions of SCM.

However, I address this limitation through targeted exclusion of the directly affected countries – Russia and Belarus, because of their direct involvement in the intervention and its results on their economy. The final donor pool is constructed from a comprehensive dataset, excluding these two countries.

3.3. Regression analysis

The objective is to assess whether outward emigration contributed substantially to changes in Ukraine's fiscal trends during the full-scale war. The working hypothesis is that the massive migration shock observed in 2022–2023 weakened fiscal dynamics, leading to a deterioration in the fiscal gap relative to previous years.

Two econometric challenges arise immediately. First, the annual time series is short. Second, the key explanatory variable (emigration) experienced a severe structural shock in 2022, raising concerns about small-sample inference and the sensitivity to influential observations. The methodology is therefore designed to

(i) remove non-stationarity and serial persistence, (ii) allow the effect of emigration to differ during wartime, and (iii) use inference methods that are robust in small samples.

To address potential persistence and autocorrelation in the levels of the variables, the analysis is conducted in first differences.

$$\Delta Gap_t = Gap_t - Gap_{t-1} \tag{4}$$

$$\Delta Migration_t = Migration_t - Migration_{t-1} \tag{5}$$

This transformation focuses on year-to-year changes rather than levels. This reduces the risk of spurious regression driven by trending components and helps mitigate serial correlation in residuals.

To improve interpretability, changes in emigration are scaled to millions of persons:

$$\Delta Migration_m_t = \frac{\Delta Migration_t}{1000000} \tag{6}$$

Thus, estimated coefficients can be interpreted as the change in the fiscal indicator associated with a change of one million persons in net migration.

To test whether the migration-fiscal relationship changed during the full-scale invasion, a war dummy variable is introduced:

$$war_t = 1 \; if \; year \geq 2022, otherwise \; 0 \tag{7}$$

The econometric model allows the slope on emigration to differ between peace and war years through an interaction term.

The model specification is:

$$\Delta Gap_t = \alpha + \beta_0 \times \Delta Migration_m_t + \beta_1 \times war_t + \beta_2 \times (war_t \times \Delta Migration_m_t) + \varepsilon_t \quad (8)$$

where:

- β_0 captures the association between migration changes and fiscal gap changes in non-war years;
- β_1 captures changes which are associated with full-scale invasion;
- β_2 captures how the relationship with migration changes during wartime;
- the total migration war-period effect is $\beta_0 + \beta_2$.

This structure directly tests the core hypothesis: if large-scale emigration worsened fiscal dynamics during the war, then the sum of betas should be negative. One should also expect β_1 to have a negative sign among all variables of interest – revenues without grants, non-military expenditures, and the resulting non-military balance.

Given the limited number of annual observations and the presence of a large structural shock in 2022, classical asymptotic inference may be unreliable. To address this, the primary inferential method is a Bayesian bootstrap.

The procedure operates as follows:

1. For each of 20,000 replications, observation weights are drawn from a Dirichlet distribution.
2. A weighted least squares regression is estimated using those weights.

3. The estimated coefficients are stored.

After all replications, the empirical distribution of coefficients is used to compute:

- posterior mean;
- posterior median;
- standard deviation;
- 95 per cent credible intervals;
- posterior probabilities that the parameter is positive or negative.

The Bayesian bootstrap does not rely on large sample normal approximations. Instead, it repeatedly reweights the observed data, generating a posterior-like distribution for the parameters that reflects sampling uncertainty in small samples. This is particularly appropriate when the sample size is limited, and certain observations (e.g., 2022) may be influential.

The war-period slope ($\beta_0 + \beta_2$) is computed for each bootstrap draw, producing a direct posterior distribution for the effect of emigration during the full-scale war.

As a secondary benchmark, the same regression is estimated using ordinary least squares with Newey–West heteroskedasticity – and autocorrelation-consistent (HAC) standard errors. A Bartlett kernel with an automatically selected lag length is used.

While HAC inference still relies on asymptotic approximations, it provides a conventional time-series baseline that is more appropriate than naïve OLS standard errors when residuals may exhibit serial correlation or heteroskedasticity.

Several diagnostic checks could be implemented:

- Ljung–Box tests at lags 1 and 2 are applied to regression residuals to assess remaining autocorrelation. Non-rejection supports the use of first differences.
- Cook's distance is examined to evaluate whether any single year dominates the regression.
- A leave-one-out sensitivity analysis is performed for the war-period slope. Each year is excluded in turn, and the Bayesian bootstrap is re-estimated. This procedure assesses whether the estimated wartime effect is driven entirely by a single observation.

These steps should ensure that the reported war-period effect is not an artifact of residual autocorrelation or extreme leverage.

Chapter 4.

DATA

This study relies on two main groups of variables: macroeconomic and migration data.

In this study, country-level panel data for the period 2001-2023 is used. The full-scale Russian aggression began at the end of February 2022. In this thesis, the pre-intervention period is considered as 2001-2021, and the treatment period 2022-2023, so the full year of 2022 is taken as treatment. Such timeframes are caused by the availability of data. The data for synthetic control models was taken from the International Monetary Fund (IMF data, 2026) and the World Bank. Unfortunately, there is no data for all years. The first two months of 2022 are also considered to be the treatment period, as the best available data is annual.

The Synthetic Ukraine is constructed as a weighted average of potential control countries (donor units), with the weights such, to best reproduce the non-military balance of Ukraine in the pre-intervention period. This synthetic outcome for Ukraine should represent the non-military balance in the absence of war.

The first sample of countries encountered more than 250 units. Due to insufficient data availability, the pool of donor units should have been cleaned. Countries with missing (NA) values for more than 5 years in the period 2001-2023 were excluded. The resulting sample is 49 countries, including Ukraine. To those donor units, which have NA values at most of 5, the missing values were filled using linear interpolation. Also, the countries that form the donor pool should not have been influenced by war conditions, so Belarus and Russia are excluded.

The outcome variable of interest is annual general government budget indicators, particularly non-military balance, revenues without grants, and non-military expenditures (measured in % of GDP).

The budget system in Ukraine has several classifications: programmed, functional, and economic. I am interested in the functional classification of the budget. It has 10 functions of the state: national functions; defence; public order, security and judiciary; economic activity; environmental protection; housing and communal services; healthcare; spiritual and physical development; education; social protection and social security. For this research, I consider as "non-military" expenditures all functions of the budget except defence and public order, security, and judiciary. So, non-military expenditures are calculated from IMF data as:

$$non - military\ expenditures\ = \\ = total\ outlays\ -\ (defence\ + public\ order\ and\ security) \quad (9)$$

The resulting non-military balance is calculated as:

$$non - military\ balance\ = \\ = revenues\ without\ grants\ -\ non\ military\ expenditures \quad (10)$$

Descriptive statistics

I received data on budget indicators from the IMF, the descriptive statistics for which are presented in Table 1.

Table 1. Descriptive statistics of predictors and variables of interest

	N	Mean	SD	Min	Max
Real GDP growth (% annual change)	1012	2.84	5.30	-54.40	75.31
Debt (% of GDP)	1012	57.76	34.53	0.00	209.90
CPI (annual %)	1012	3.40	3.93	-4.45	48.70
Age-dependency ratio	1012	49.37	7.16	24.14	71.37
Log of GDP per capita	1012	9.94	1.06	6.23	11.81
Total outlays (% of GDP)	1012	40.53	10.17	11.22	74.53
Defence expenditures (% of GDP)	1012	1.50	1.63	0.00	32.08
Public order and security expenditures	1012	1.88	0.70	0.72	9.05
Non-military expenditures (% of	1012	37.15	10.22	8.90	62.84
Revenues without grants (% of GDP)	1012	32.06	8.34	9.49	56.29
Non-military balance (% of GDP)	1012	-5.09	6.89	-32.37	28.44

The data for migration dynamics were obtained from the World Bank. Table 2 reports the descriptive statistics on net migration from Ukraine in the pre-war period (2001-2021), during the war (2022-2023), together and for each year of the war separately.

Table 2. Descriptive statistics on net migration.

Net migration	N	Mean	SD	Min	Max
Pre-war (2001–2021)	21	-3 948	52 823	-111 493	136 442
War (2022–2023)	2	-2 999 703	3 818 012	-5 699 445	-299 961
2022	-	-5 699 445			
2023	-	-299 961			

The evolution of the financial indicators considered in this paper and net migration is shown in Figure 1.

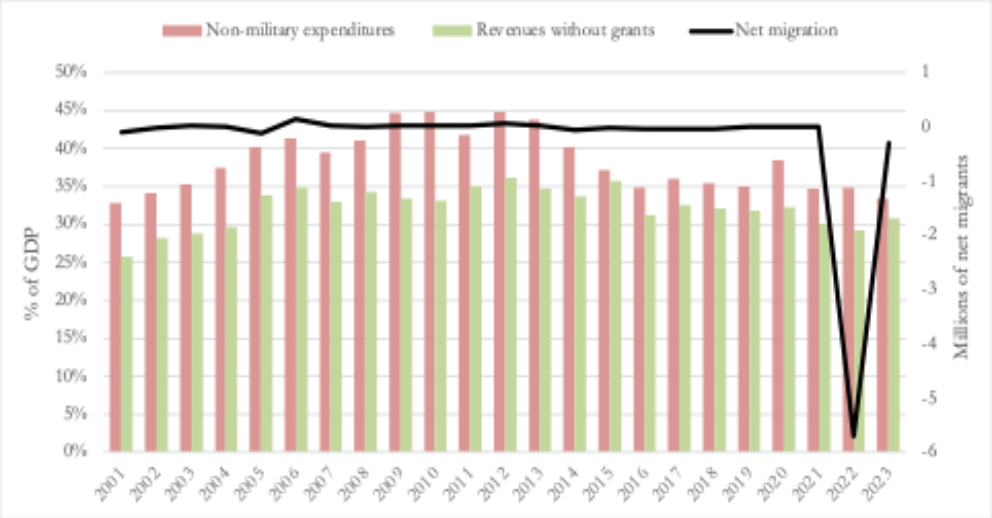


Figure 1. Non-military expenditures, revenues without grants as % of GDP, and migration dynamics.

Source: Own presentation based on the International Monetary Fund and World Bank.

Data limitations

However, there are certain categories that inevitably capture war-related costs. These include economic and social expenditures, through which part of the consequent costs of the war are accounted for, that did not exist before 2022. Such examples are social assistance to military personnel and their families, as well as humanitarian demining.

A similar issue is observed on the revenue side of the budget. Even without accounting for grants, defence aid in-kind remains. Such defence aid, for example, amounted to 8.5% of GDP in 2024 (CES, 2025).

This may affect the interpretation of the results as follows. Because social and economic expenditures have likely increased due to wartime necessities, the "gap" between actual and counterfactual outcomes may be artificially narrowed. In that case, the conclusion regarding the "moderate" negative impact on non-military expenditures might not reflect the inherent stability of budget spending, but rather the absorption of war-related costs. However, this effect is quite limited, as not much of the war expenditure is accounted for through economic and social expenditures. As for the revenue side, the inability to distinguish defence aid provided in-kind may lead to upward bias in observed revenues. Such an outcome could be associated with higher military support, rather than the efficiency of the fiscal policy of a higher tax base.

Since it is impossible within the scope of this thesis to isolate the war's impact on these budget indicators, this stands as one of the limitations in interpreting the results.

An additional limitation of this thesis lies in the number of observations. While the pre-intervention period provides a sufficient number of observations (21 years), the post-treatment horizon is limited to just two years – 2022 and 2023. As of

March 2026, there were no available data on budget indicators for 2024 and beyond. Therefore, the empirical power of both the SCM and the regression estimates is constrained by the limited post-intervention data points, which may influence the interpretation of capturing the fiscal adjustments to war conditions and emigration shock.

Donor pool sensitivity

Resulting from the first stage of the analysis, synthetic counterfactual models have one common specification. The biggest country weight in each synthetic model is assigned to Moldova, from 28.7% to 38.1%. Tables 8, 11, and 14 in Annexes display the weights of the top-6 control countries in the synthetic non-military balance of Ukraine, revenues without grants, and non-military expenditures, respectively.

In comparative case studies, such concentration of donor weights on a single control unit is neither unusual nor methodologically improper. The fundamental goal of the synthetic counterfactual approach is to minimize the pre-intervention MSPE by constructing an optimal convex combination of donor units that best replicates the structural characteristics and baseline trajectory of the treated unit.

In this sense, Moldova is an appealing donor for Ukraine, as the two countries face similar structural and institutional challenges. They have followed similar development paths in the post-Soviet period, and both applied for European Union membership at the same time. The countries also share an integrated energy system.

The main challenge in keeping Moldova in the donor pool is that migration flows could significantly impact its economy. Keeping Moldova in the donor pool may artificially widen the gaps between actual and counterfactual outcomes among all three models. Moldova might spend more budgetary funds on policies to support

Ukrainian refugees; the same applies to SCM_1 – the gap in the non-military balance. As for the revenues, it might be overestimated since refugees moving might boost Moldova's domestic tax revenues, also widening the gap between actual and counterfactual Ukraine.

However, Moldova is primarily a transit country for most refugees. According to the United Nations High Commissioner for Refugees (UNHCR), since February 2022 and as of January 2026, over 2 million border crossings from Ukraine have been recorded. And only around 140,000 Ukrainian refugees remain in the country, which is less than 5% of its domestic population.

To test the sensitivity to weight concentration, a robustness check was performed by excluding Moldova from the donor pool. This specification forced re-evaluation of the donor weights, shifting over 80% to Poland. Since Poland has a radically different economic environment from Ukraine and is the second-largest refugee recipient, such specification could lead to significant misspecification bias. To ensure the empirical validity of the results from overestimating the budget gaps, I prefer to keep the concept of structural co-movement (between Ukraine and Moldova). However, such a specification could also be one of the limitations of the study.

Chapter 5.

RESULTS

In this section, I present the results of a synthetic counterfactual analysis followed by the regressions on the resulting gaps between actual and synthetic outcomes.

Firstly, I will demonstrate the synthetic counterfactual analysis of the non-military balance of the general government, revenues excluding grants, and non-military expenditures. The results for revenues and expenditures will be used to analyze the overall balance. However, it should be noted that each model underwent a complete stage of data preparation and predictors, and used different special predictors. Therefore, the weights of donors for each model are different, so one cannot completely rely on the interpretation of the balance results based on the dynamics of revenue and expenditure results.

Then, the results of the counterfactual analysis are regressed on migration statistics to see whether the migration trends intensify the existing trend in public finances during the war.

5.1 Results of synthetic control models

Now I describe the results of the synthetic counterfactual models, the methodology, and data specifications that were discussed in previous chapters.

The synthetic models developed do not perfectly replicate the pre-intervention trends of Ukrainian fiscal indicators. This is particularly noticeable at the beginning of the COVID-19 crisis. To address this issue, some specific predictors for healthcare expenditures were added, but they did not help the model to fully capture the trend. For some years, this specific predictor even fit the model with the actual pre-intervention trend, so it was removed from the model. The lack of a

sufficient match between the results of the synthetic control outcome and the actual one before 2022 is one of the limitations of the models, so the results should be interpreted with caution.

For the validity of the results of SCM, the robustness checks were performed using placebo tests for each model. The results are presented in Annexes. The idea of tests is to run the model for each control unit as treated one and the remaining control units as controls. The resulting models' gaps are expected to be centered around zero. In case large impacts appear for untreated units, this indicates statistical insignificance of the results of the synthetic control method. Therefore, if the gap between Ukraine's actual and counterfactual fiscal indicators falls outside the general distribution, this means that the result is robust and not due to chance.

SCM on non-military balance

For the non-military balance, the synthetic control method shows that, as a result of the full-scale invasion, the non-military balance in 2022 remained largely unchanged (see Figure 2). In 2022, the actual and synthetic balances are essentially identical (gap −0.03 p.p.). By 2023, the actual non-military deficit is ≈3 p.p. narrower than the synthetic counterfactual (actual −2.56 %, synthetic −5.57 %; gap +3.02 p.p.) – the result consistent with H1.

Since the number of observed years is limited to only two intervention periods, the effect of the full-scale invasion on the non-military balance of Ukraine in the following years could not be estimated. However, one can expect that this gap would widen in 2024 and 2025 even more.



Figure 2. Synthetic counterfactual results for the non-military balance of Ukraine.

The placebo test indicates that the resulting gap for Ukraine in the post-intervention period does not clearly exceed the distribution of placebo gaps for untreated countries. This gap shows a slight increase in treated units; it does not, however, deviate much from the distribution of untreated units. This supports one of the limitations of this study – the small number of observations during the treatment period.

SCM on revenues without grants

For revenues without grant assistance, the synthetic control model shows the expected outcome – the actual revenues are less than counterfactual (see Figure 3). This negative impact of the war on the revenue side of the Ukrainian budget is observed already in the first year of the full-scale invasion – in 2022, Ukraine could under-received 0.95% and in 2023 around 0.8% of GDP in revenues without grants.



Figure 3. Synthetic counterfactual results for revenues without grants (SCM_2).

However, the placebo test demonstrates that the estimated gap of revenues without grants is between the distribution of placebo gaps for untreated units. This suggests that the estimated effect of full-scale invasion may be due to chance, reflecting model limitations.

SCM on non-military expenditures

For non-military expenditures (expenditures of general government excluding defence and public order), the synthetic control model shows large discrepancies between actual and counterfactual outcomes already in the first years of full-scale invasion (Figure 4). In 2022, the synthetic non-military expenditures were 1.35% of GDP higher than the actual ones. In 2023 this negative impact of the war on non-military expenditures intensified to 4.07%.



Figure 4. Synthetic counterfactual results for non-military expenditures (SCM_3).

The results of the placebo test indicate that the findings for the third SCM on non-military expenditures are robust, although the model did not fully capture the pre-intervention trend.

5.2 Regression analysis results

In this section I present the results of migration for each counterfactual model. Overall, the only statistically significant estimates are wartime coefficients, which is expected to be given small number of observations and other limitations of the analysis. In contrast, the migration coefficients among all three counterfactual models are statistically insignificant. The summary of the only statistically significant results from all regressions are presented in Table 3.

Table 3. Summary table of war slopes (β_1) from regression results for each SCM.

	Outcome variable	HAC		Interpretation
		Estimate	P-value	
SCM_1	Non-military balance	1.138	0.000	Non-military deficit is narrower than counterfactual
SCM_2	Revenues without grants	-0.128	0.604	Revenues lower than synthetic outcome, but not statistically robust
SCM_3	Non-military expenditures	-0.674	0.038	Non-military expenditures below counterfactual

The complete results for each model are provided below – the two different regression approaches and the diagnosis tests for each of the synthetic control models. Bayesian Bootstrap based on 20,000 Dirichlet-weighted replications; HAC = Newey–West heteroskedasticity- and autocorrelation-consistent SE with Bartlett kernel.

Regression on non-military balance

In this section I present the results of the two different regression approaches and the diagnosis tests for each of the synthetic control models. Table 4 provides the first regression estimates – on the gap between actual and counterfactual non-military balance.

Table 4. Results of the regression analysis on SCM_1 gap on non-military balance.

	Bayesian Bootstrap				HAC			Robustness checks	
	Mean	SD	95% CI	PP (negative)[3]	Esti-mate	SE	P-value	Ljung-Box	Cook`s distance
Migration peace slope (β_0)	0.037	0.316	[-0.597; 0.637]	0.450	0.041	0.242	0.869		
War slope (β_1)	1.142	0.316	[0.5416; 1.776]	0.000	1.138	0.242	0.000		
Migration war slope (β_2)	-0.993	3.793	[-8.596; 7.203]	0.643	-1.019	2.012	0.619	0.243	0.096
Total effect of migration ($\beta_0 + \beta_2$)	1.339	3.793	[-6.857; 8.943]	0.312	1.366	2.012	0.506		

The regression results show that migration has no statistically significant impact on non-military balance in both the pre-war period (p-value = 0.869 > 0.05) and after 2022 (p-value = 0.619 > 0.05). However, the effect of full-scale invasion itself, independent of migration, is statistically significant. It suggests that the non-military balance improved after 2022, during the full-scale invasion, the non-military deficit is narrower than the synthetic one. Bayesian Bootstrap suggests that during the full-scale invasion, the fiscal gap even improved. War dummy itself could have such a profound effect on the fiscal trajectory that it effectively captured the variance that could be attributed to population decline. Also, these two factors – war and migration shock – are highly collinear, since one is the result of the other, and it is difficult to isolate the fiscal result from emigration.

[3] PP (negative) = posterior probability that the coefficient is negative under the Bayesian bootstrap (20,000 Dirichlet-weighted replications)

Regression on revenues without grants

For the revenue gap, the Bayesian Bootstrap also failed to provide strong evidence that migration significantly impacted fiscal outcomes in both pre- and after-intervention periods (see Table 5). HAC estimates are consistent with these findings, since it also found no statistically significant results for the relationship between migration and revenues without grants in both pre-war and war periods (all p-values > 0.05). Unlike with the non-military balance model, no statistically significant effects were found here, even for the standalone war slope.

Table 5. Results of the regression analysis on SCM_2 on revenues without grants.

	Bayesian Bootstrap				HAC			Robustness checks	
	Mean	SD	95% CI	PP (negative)	Esti-mate	SE	P-value	Ljung-Box	Cook`s distance
Migration peace slope	0.019	0.267	[-0.475; 0.576]	0.490	0.020	0.242	0.935	0.022	0.206
War slope (β_1)	-0.126	0.267	[-0.683; 0.3678]	0.68	-0.128	0.242	0.604		
Migration war slope (β_2)	6.624	5.458	[-3.176; 18.879]	0.081	5.741	4.927	0.259		
Total effect of migration (β_0	-6.576	5.458	[-18.83; 3.225]	0.918	-5.693	4.927	0.263		

Regression on non-military expenditures

As was confirmed in the previous sub-chapter, the synthetic counterfactual non-military expenditures are higher than actual ones in war years. This could be explained by the fact that all existing internal resources of the budget should have been dedicated to defence. One should expect a negative impact of migration on public spending, and consequently a negative effect on the gap between actual and

counterfactual outcomes. The resulting effect confirms the expected one, but most importantly, it is not significant, which is reported in Table 6.

Therefore, the results from the regression on non-military expenditures suggest statistical insignificance in all coefficients except for the war dummy.

Table 6. Results of the regression analysis on SCM_3 on non-military expenditures.

	Bayesian Bootstrap				HAC			Robustness checks	
	Mean	SD	95% CI	PP (negative)	Estimate	SE	P-value	Ljung-Box	Cook`s distance
Migration peace slope (β_0)	-0.052	0.297	[-0.654; 0.514]	0.563	-0.052	0.300	0.864		
War slope (β_1)	-0.674	0.297	[-1.24; -0.0711]	0.98	-0.674	0.300	0.038		
								0.782	0.251
Migration war slope (β_2)	3.792	5.045	[-5.857; 14.711]	0.206	3.265	4.112	0.438		
Total effect of migration ($\beta_0 + \beta_2$)	-4.160	5.045	[-15.079; 5.489]	0.819	-3.633	4.112	0.389		

In summary, most of the findings from Bayesian Bootstrap show statistically insignificant results for most of the terms, except for the standalone war terms. For instance, in SCM_3, in 98% of bootstrapping, the war dummy is negatively associated with the non-military expenditures. So, wartime non-military expenditures in actual Ukraine were lower than in the counterfactual one. Standard deviations here are around zero but not so small, so I can conclude that this result is credible and is aligned with the public spending policy in a war country. However, there is no significant evidence that migration has exacerbated this fiscal gap.

HAC standard error estimates are approximately the same as in Bayesian bootstrap – almost all results are statistically insignificant. Only two terms have p-value < 0.05 – war terms in SCM_1 and SCM_3. The results suggest that in war time period, the non-military balance is 1.14% higher in actual Ukraine compared to counterfactual, which could be associated with lower non-military expenditures (in actual Ukraine, they are 0.67% less than in counterfactual), rather than the revenues increase. Unlike SCM_1 and SCM_3, war standalone has no statistically significant impact on revenues without grants, so the actual Ukraine does not deviate from the synthetic one.

Residuals diagnostics indicate no remaining autocorrelation in SCM_1 and SCM_3. This is not the case for the SCM_2, where at the first lag there is significant autocorrelation in residuals. Cook's distances suggest there are no influential outliers in any model.

Chapter 6.

CONCLUSIONS

This thesis analyses the fiscal consequences of a massive migration shock resulting from the full-scale invasion of Ukraine. To address this question, a two-stage approach is applied. First, synthetic control methods were used to construct counterfactual fiscal trajectories for Ukraine in the absence of the war. Secondly, the resulting fiscal gaps were regressed on migration dynamics to test whether the outflow of population has worsened the existing fiscal trends.

The results from the synthetic control models have shown that replicating fiscal trends in Ukraine is not that straightforward. However, despite the incomplete alignment of the counterfactual Ukraine with the actual pre-war trend, the trend following the intervention shows the expected results.

An empirical analysis of Ukrainians' wartime budget dynamics reveals that the H1 is confirmed. SCM_1 is directionally consistent with H1 but falls within the placebo distribution and therefore is not statistically robust as a standalone finding. The standalone war regression coefficient ($\beta_1 = 1.14$, $p < 0.001$) is a credible source of evidence for H1. In the first year of the full-scale invasion, the non-military deficit remained almost unchanged despite the military threat. This is explained, in particular, by the fact that the budget was unable to adjust so quickly. Meanwhile, war expenditure in 2023 and subsequent years increased significantly, reducing the fiscal space for non-military expenditures, which remained mostly frozen at pre-war levels. This could indicate the essential expenditures prioritization – actual non-military spending fell 4.06% of GDP compared to the counterfactual one in 2023.

On the contrary, H4 cannot be tested separately from the dominant war reallocation effect — with two post-treatment years and the high collinearity between war and migration shocks that I acknowledged above, the migration

channel cannot be isolated. The analysis does not detect a statistically significant revenue effect; the −0.80 p.p. SCM gap is directional but not placebo-robust.

In contrast, the fiscal impacts from outward migration under H2 and H3 remain inconclusive. The second-stage regression analysis does not provide statistically credible evidence that year-to-year changes in migration systematically affected fiscal gap dynamics in non-war years. Across specifications, the estimated coefficients on migration are imprecise and not statistically significant, while the war indicator consistently captures the dominant variation in fiscal outcomes. Both the Bayesian credible interval and HAC confidence interval comfortably include zero.

This demonstrates a serious issue of identification: the mass outflow of the population is closely linked to the start of the full-scale invasion, so it is difficult to distinguish between the shock caused by the war and the migration effect. Although the study's results have significant limitations due to the small number of observations, the impact of migration on fiscal deterioration should be the subject of future research with a greater amount of data.

In conclusion, the full-scale invasion has affected Ukraine's public finances not only through increased war-related expenditure but also by impacting the civilian budget. Non-military expenditure had to be cut or 'frozen' at pre-war levels in order to devote all domestic resources to defence and security. However, the study's findings did not provide sufficient evidence of a relationship between the narrowing of fiscal space and migration dynamics, due to limited sample data in the after-intervention period.

From a policy perspective, the results do not detect a statistically significant short-term impact of population decline on budgetary indicators. Still, migration and overall population decline may affect fiscal policy in the medium to long term. Firstly, an ageing population increasingly points to a greater tax burden on the

younger generation and a rise in non-military social expenditures. Secondly, population decline shrinks the labor market, which negatively affects budget revenues. It is therefore essential to focus efforts on encouraging Ukrainians to return and integrating them into the labor market.

Future studies should re-evaluate the impact of the war on fiscal indicators and assess the intensification of existing trends through population statistics. These studies should cover a larger number of observations – primarily in the after-intervention period (after 2022). It would be useful to examine the various categories of expenditure and revenue in greater detail and to identify the areas where the war had the greatest impact. In addition, the predictors used in synthetic models should be reviewed, incorporating more labor market data, as well as the specification of the regression model. Such studies should make a significant contribution to fiscal policy decision-making.

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APPENDIX A

Table 7. Non-military balance predictor mean (SCM_1).

Variables	Ukraine		Average of 43 control countries
	Actual	Synthetic	
Real GDP growth (% annual change)	2.02	3.38	2.84
Debt (% of GDP)	42.93	58.47	57.26
CPI (annual %)	11.49	4.09	2.73
Age-dependency ratio	43.56	46.45	49.10
Log of GDP per capita	7.82	9.01	9.95
Non-military expenditures in 2001	-7.16	-7.20	-4.00
Non-military expenditures in 2004	-7.77	-6.19	-4.24
Non-military expenditures in 2008	-6.84	-6.49	-3.70
Non-military expenditures in 2010	-11.67	-11.19	-7.27
Non-military expenditures in 2014	-6.54	-6.52	-5.12
Non-military expenditures in 2019	-3.08	-3.41	-3.54

Table 8. Control units in donor pool and their weights in SCM on non-military balance (SCM_1).

Country	Weight
Moldova	0.3811
Poland	0.2993
Portugal	0.1070
Germany	0.0923
Ireland	0.0738
Greece	0.0465

Table 9. The resulting outcomes of non-military balance of general government budget for actual and counterfactual (synthetic) Ukraine (% of GPD).

Year	Ukraine		Gap in non-military balance[4]
	Actual	Synthetic	
2022	-5.6256	-5.5913	-0.0343
2023	-2.5585	-5.5748	3.0164

[4] 'Gap = actual − synthetic; positive value means actual exceeds counterfactual (deficit narrower).

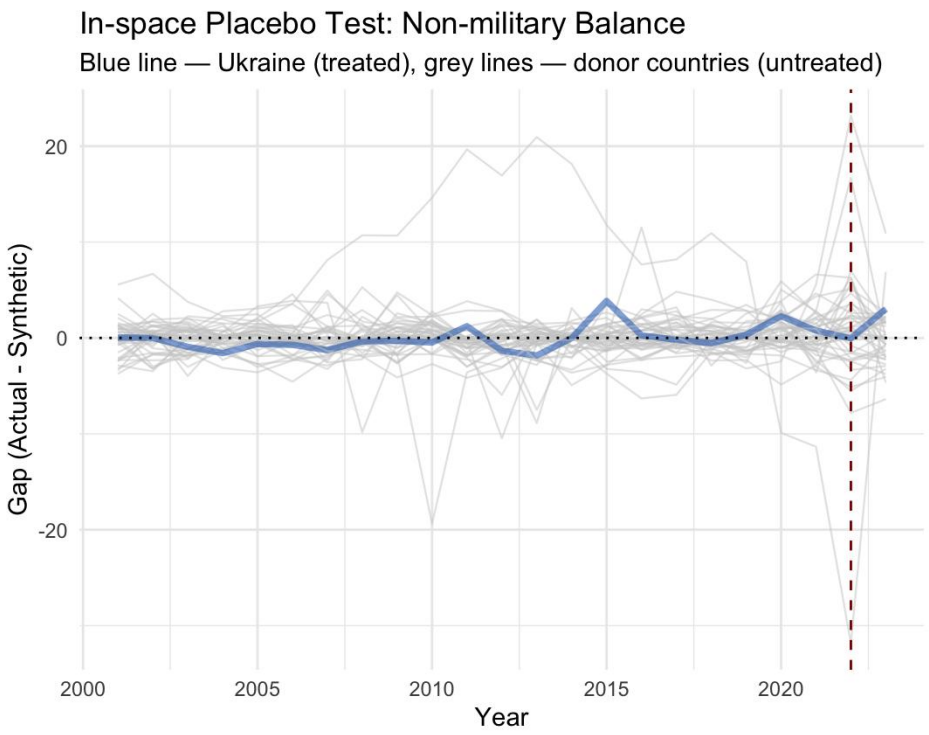


Figure 5. Placebo test for a synthetic counterfactual of Ukrainian non-military balance.

APPENDIX B

Table 10. Revenues without grants predictor mean (SCM_2).

Variables	Ukraine		Average of 43 control
	Actual	Synthetic	
Real GDP growth (% annual change)	2.02	4.03	2.84
Debt (% of GDP)	42.93	36.00	57.26
CPI (annual %)	11.49	4.79	2.73
Age-dependency ratio	43.56	42.81	49.10
Log of GDP per capita	7.82	9.36	9.95
Revenues without grants in 2001	25.69	27.19	31.25
Revenues without grants in 2005	33.89	32.37	31.77
Revenues without grants in 2008	34.28	35.14	32.61
Revenues without grants in 2012	36.10	34.52	32.23
Revenues without grants in 2019	31.87	32.29	32.45

Table 11. Control units in donor pool and their weights in SCM on revenues (SCM_2).

Country	Weight
Moldova	0.3047
Slovenia	0.2932
Macao	0.2305
Kazakhstan	0.0965
Iceland	0.0617
Greece	0.0127

Table 12. The resulting outcomes of revenues of general government budget for actual and counterfactual (synthetic) Ukraine (% of GPD)

Year	Ukraine		Gap in revenues without grants
	Actual	Synthetic	
2022	29.2811	30.2304	-0.9493
2023	30.8350	31.6320	-0.7970

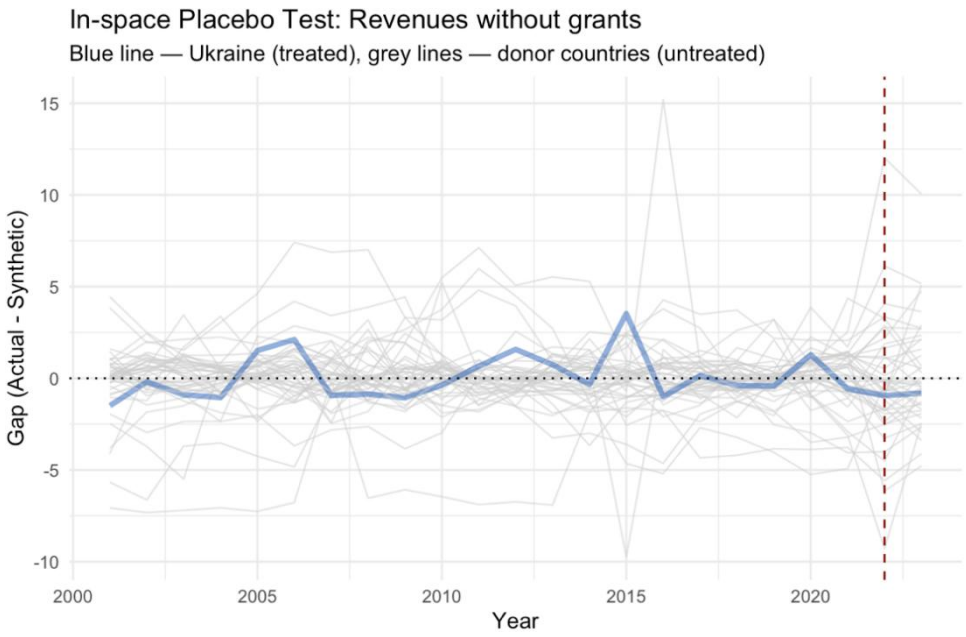


Figure 6. Placebo test for a synthetic counterfactual of Ukrainian revenues without grants.

APPENDIX C

Table 13. Non-military expenditures predictor mean (SCM_3).

Variables	Ukraine		Average of 43 control countries
	Actual	Synthetic	
Real GDP growth (% annual change)	2.02	3.31	2.84
Debt (% of GDP)	42.93	73.70	57.26
CPI (annual %)	11.49	3.72	2.73
Age-dependency ratio	43.56	46.56	49.10
Log of GDP per capita	7.82	9.41	9.95
Non-military expenditures in 2001	32.85	34.83	35.25
Non-military expenditures in 2004	37.41	37.13	35.42
Non-military expenditures in 2008	41.12	40.93	36.31
Non-military expenditures in 2010	44.83	44.26	38.83
Non-military expenditures in 2014	40.23	40.53	37.92
Non-military expenditures in 2019	34.94	34.52	35.99

Table 14. Control units in donor pool and their weights in SCM on non-military expenditures (SCM_3).

Country	Weight
Moldova	0.2873
Cyprus	0.1971
Hungary	0.1820
Ireland	0.1802
Greece	0.1532
Austria	0.0002

Table 15. The resulting outcomes of non-military expenditures of general government budget for actual and counterfactual (synthetic) Ukraine (% of GPD).

Year	Ukraine		Gap in non-military expenditures
	Actual	Synthetic	
2022	34.9067	36.2589	-1.3523
2023	33.3934	37.4592	-4.0658

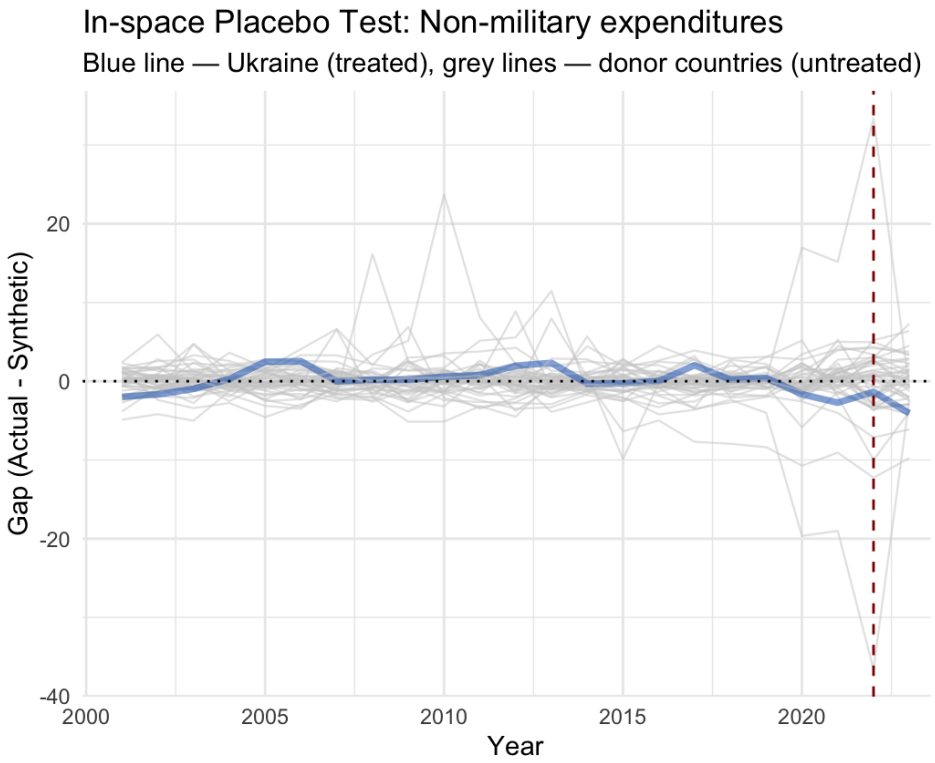


Figure 7. Placebo test for a synthetic counterfactual of Ukrainian non-military expenditures.