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PUBLIC POLICY AND GOVERNANCE

THESIS

IMPACT OF INTERNATIONAL FINANCIAL ASSISTANCE ON UKRAINE'S ECONOMY

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TABLE OF CONTENTS

At a time when the global order is shaken and Ukraine faces an unprecedented level of aggression from the Russian Federation, it is easy to take for granted the support offered by international allies. I write these words with profound gratitude and hope for enduring international solidarity in the face of evil.

First and foremost, I owe an immeasurable debt to the defenders of Ukraine. Their courage and sacrifice have made it possible for me and many fellow students to continue our education in and for Ukraine.

I am deeply thankful to my academic advisor, Professor Vira Usyk, whose guidance and encouragement were invaluable throughout this research journey. I also extend my sincere thanks to the lecturers at the Kyiv School of Economics and the Munk School at the University of Toronto. Your insights, patience, and support helped me shape this work.

Last, but by no means least, to my family and friends – thank you for being my safe haven in times of doubt and despair. Your constant support, your readiness to listen to my ideas (and complaints), and your steady presence mean the world to me.

Abstract. This thesis aims to explore the macroeconomic effects of international financial assistance on Ukraine's economy from 2019 to 2024, using various quantitative methods. Results show no significant immediate effects of EBF on GDP, inflation, unemployment, or exchange rates – which are highlighted in the original hypotheses, but identify delayed positive effects on GDP growth and robust impacts on state budget expenditures, military spending, and foreign reserves. The research findings highlight EBF's indirect stabilizing role in wartime, underscore the need for high-frequency fiscal data to inform crisis response and future reconstruction planning as well as provide insights on policy options in case of decline in international financial assistance to Ukraine.

Key words: Ukraine, international financial assistance, external budget financing, GDP growth, inflation, state budget expenditures, economic shocks, recovery.

Word count: 14 975

INTRODUCTION

It is often said that while armies win battles, it is the economy that wins wars. The Russo-Ukrainian war can certainly draw parallels with the biblical tale of David and Goliath, where the disproportionate powers of the opponents mean that only faith, creativity, and solidarity can alter the course of the conflict. Yet, by launching a full-scale invasion against Ukraine, the Russian Federation triggered a series of global events that have drawn in the world's largest geopolitical powers and may ultimately influence the war's outcome.

Since the onset of Russia's full-scale invasion of Ukraine in 2022, economic challenges have emerged as the country's second greatest concern after national security. Nevertheless, the world has witnessed an unprecedented display of global unity, with international support flowing in to help Ukraine sustain its fight for survival.

Russian aggression has caused immeasurable damage to Ukraine's infrastructure, population, and economy. To assess the scope of destruction and estimate the resources required for recovery, the World Bank, together with the Government of Ukraine, the European Union, and the United Nations, conducts an annual Rapid Damage and Needs Assessment (RDNA). According to RDNA4 (as of the end of 2024), the direct damage caused by Russian aggression amounts to nearly USD 176 billion, with economic losses exceeding USD 589 billion, and reconstruction and recovery needs estimated at approximately USD 524 billion (RDNA, 2024).

The war has not only compromised Ukraine's territorial integrity and the safety of its citizens but also severely disrupted economic activity in both domestic and foreign markets. With parts of the country under occupation, millions of people displaced, and businesses operating under insecure and unpredictable conditions due to the constant threat of missile attacks, both economic activity and potential output have fallen sharply.

Compared to 2021—a year already affected by the lingering impacts of the COVID-19 pandemic—Ukraine's GDP contracted by a steep 28.8% in 2022. Although the economy began to stabilize, GDP in 2023 reached only 74% of 2021 levels and is projected to grow to 78% in 2024 (RDNA, 2024). According to the State Statistics Service and the Centre for Economic Strategy, Ukraine's GDP growth rate has been modest, with a 5.3% increase in 2023 and a slight rise of 3.4–3.6% in 2024.

The war has also triggered a series of adverse macroeconomic effects. Lower economic activity has driven up prices, while reduced revenues have limited tax collections. As a result, Ukraine's state budget—which is critical for sustaining military efforts and providing social services during wartime—has faced persistent financing gaps. The primary driver of this fiscal deficit is the unprecedented scale of military spending, which accounts for more than half of the national budget. These expenditures include the purchase of ammunition and payment of military personnel salaries, both essential for Ukraine's defense against continued Russian aggression. Additionally, the destruction of energy infrastructure and a shortage of skilled labor have negatively impacted domestic production, while export volumes remain at roughly 50% of their 2021 levels.

At the same time, Ukraine's inflation rate rose to 12% by the end of 2024, despite a relatively controlled dynamic in the second quarter of the year, during which inflation did not exceed the National Bank's target of 5%. In 2024, Ukraine's national currency, the hryvnia, gradually depreciated, surpassing the threshold of UAH 42 per USD. Nevertheless, Ukraine's foreign reserves reached at the time a record high of USD 43.8 billion, largely due to the consistent inflow of international financial aid (Samoliuk, 2025).

Despite these significant support measures, Ukraine continues to face the recurring challenge of covering roughly one-third of its annual state budget. To address this, international partners provide direct budget support in the form of grants, loans, and guarantees. In 2022, external financial aid amounted to USD 31.1 billion, increasing to USD 42.5 billion in 2023 and reaching USD 41.6 billion in 2024 (Ministry of Finance of Ukraine, 2024).

In 2024, G7 countries—among Ukraine's largest donors—reached an agreement to utilize windfall revenues generated from frozen Russian state assets held in Euroclear (Belgium), repositories in the United States, and other partner countries. This decision marked a shift in the approach to financing Ukraine's budget, moving from purely donor-based support to utilizing resources of the aggressor state. This precedent signals a positive shift in the international community's approach, which could eventually lead to the full confiscation of Russian assets and their transfer to Ukraine as reparations for war damages. (G7, 2024)

Despite the Ukrainian government's rapid response and remarkable resilience during the first three years of the full-scale war, it is clear that to sustain current levels

of government spending, finance the functioning of the armed forces, and maintain basic social services for its citizens, Ukraine must carefully manage its use of donor funds. These resources are limited and are likely to decline over time. Therefore, it is crucial to understand how inflows of international financial aid have influenced the country's macroeconomic indicators in the short term. The results of such analysis can offer critical insights for developing strategies to optimize the use of these resources.

Accordingly, this thesis investigates the following research question: ***How does international financial assistance affect Ukraine's economy during wartime?***

While existing literature offers extensive insight into the role of foreign aid in post-conflict recovery and budget stabilization, it largely assumes a post-war setting. Studies emphasize how international support helps rebuild infrastructure, stimulate growth, and address fiscal deficits once hostilities have ended. However, a critical gap exists in understanding how such assistance functions in the context of an active, large-scale war.

This gap is especially relevant for Ukraine, where the economy must simultaneously maintain fiscal stability, fund wartime needs, and prepare for long-term recovery. Most macroeconomic research has focused either on stable economies or post-conflict transitions. Far less is known about how aid affects an economy still under attack—one faced with rising military expenditures, reduced trade, damaged infrastructure, and the unpredictability of ongoing aggression. As a result, there is little empirical evidence to guide policymakers on how to manage international financial support to meet urgent fiscal demands without undermining long-term sustainability.

This thesis addresses that gap by analyzing the macroeconomic effects of international financial assistance, also mentioned in the text as external budget financing (EBF) — grants and loans received from international partners — on Ukraine's economy between 2019 and 2024. Specifically, it evaluates the short-term and delayed impact of EBF on GDP growth, inflation, exchange rates, and unemployment. Given that international assistance has become a significant source of state budget revenue during the war, understanding its macroeconomic implications is essential for both current crisis management and future budget planning.

The analytical problem of this study lies in the limited understanding of how wartime financial inflows interact with core macroeconomic indicators. While it is widely recognized that international aid is vital for maintaining public spending and covering critical wartime needs, its influence on economic variables such as output, inflation, currency stability, and employment remains unclear. Furthermore, Ukraine's economic response may differ from standard models due to the buffering role of state institutions, particularly the Ministry of Finance and the National Bank of Ukraine, which regulate aid distribution and manage its effects through fiscal and monetary channels.

To test these relationships, this study adopts a confirmatory, hypothesis-driven approach. The null hypothesis assumes no significant relationship between external budget financing and the selected macroeconomic indicators. In contrast, the alternative hypotheses propose that international aid: (1) positively contributes to GDP growth by sustaining public demand; (2) reduces inflationary pressures by substituting for domestic borrowing or money emission; (3) stabilizes the exchange rate by increasing foreign reserves; and (4) supports employment by maintaining economic activity during wartime.

These hypotheses are tested using a combination of time series techniques, including ARIMAX modeling, Vector Autoregression (VAR), impulse response analysis, Granger causality tests, and lagged OLS regressions, all implemented in RStudio. VAR modeling serves as the core methodological tool, allowing the analysis to capture both contemporaneous and dynamic relationships among variables, including delayed and indirect effects. The analysis focuses on monthly external budget financing volumes from 2019 to 2024 as the main independent variable, while GDP growth, inflation, exchange rate, and unemployment serve as dependent variables. To control for additional influences, the model also incorporates key fiscal and monetary variables such as state budget expenditures, military spending, foreign exchange reserves, and trade balance.

This research contributes not only to academic literature but also to evidence-based policymaking. By empirically analyzing the macroeconomic effects of external budget financing during wartime, the study provides a foundation for more informed and adaptive fiscal strategies. The findings offer practical value to Ukrainian governmental authorities by outlining potential response scenarios under varying levels of international support. At the same time, they may help international donors better understand the macroeconomic consequences of their financial commitments.

The findings could motivate both domestic and external stakeholders to reconsider the design, timing, and targeting of budget support in order to maximize its effectiveness in wartime and recovery contexts.

The thesis will be structured in the following way:

The Introduction presents the research question and provides the necessary context, outlining the study's background, relevance, and objectives. The Literature Review synthesizes key findings from existing research, identifies gaps in the current knowledge, and establishes the theoretical framework guiding the analysis. The Data and Methodology chapter describes the data sources, variable definitions, and empirical strategy, with particular attention to the use of OLS regressions, ARIMAX, Vector Autoregression (VAR), impulse response functions, and Granger causality testing. The Results and Discussion sections present the descriptive statistics, highlight the main findings of models, interpret the macroeconomic effects of external budget financing, and draw out policy-relevant implications. The Policy Recommendations chapter proposes data-driven strategies for the Ukrainian government to manage international financial assistance and ensure fiscal resilience in the event of reduced donor support. Finally, the Conclusion summarizes the study's key insights, acknowledges methodological limitations, and suggests directions for future research.

1. LITERATURE REVIEW

The fundamental ideas of John Maynard Keynes and Friedrich Hayek offer two main perspectives for understanding how Ukraine can navigate its immediate economic challenges while planning for sustainable post-war recovery. Keynes, in *The General Theory of Employment, Interest, and Money* (1937), highlights the role of government in addressing economic downturns by actively stimulating demand through public spending and investment. He argues that, during crises, such interventions are essential to counteract unemployment and drive economic recovery. For Ukraine, this perspective underscores the importance of external financial assistance to support immediate reconstruction efforts, sustain economic activity, and stabilize critical macroeconomic indicators like GDP and employment.

On the other hand, Hayek, in works like *The Road to Serfdom* (1944) and *Prices and Production* (1931), cautions against the risks of over-centralized economic planning and excessive reliance on government intervention. He emphasizes the importance of preserving market mechanisms, which he argues are crucial for efficient resource allocation and long-term growth. Hayek's insights highlight the potential dangers of inflationary policies and inefficiencies that may arise from poorly managed external aid, underscoring the need for Ukraine to implement robust institutional reforms and accountability measures to ensure that financial assistance is effectively utilized.

Being cautious of the two sides of the economic theories mentioned above provides a balanced framework for Ukraine's reconstruction strategy. Keynes' theories justify the need for fiscal interventions and targeted use of international assistance to address immediate wartime economic challenges. Meanwhile, Hayek's cautionary approach emphasizes the importance of fostering market-driven growth, ensuring transparency, and avoiding dependency on external support. Balancing short-term stabilization with long-term resilience while staying aware of the direct impact of aid on Ukraine's economy is key to shaping Ukraine's recovery strategy.

It is no surprise that wars of aggression cause profound losses, and even after hostilities cease, affected countries face the monumental task of recovery and reconstruction. During this phase, international donors, partner states, and financial institutions often play a pivotal role in facilitating recovery efforts. However, while fighting a war is difficult, rebuilding from its aftermath presents even greater challenges. Security and economic stability are mutually reinforcing, as insecurity

raises business costs, discourages investment, and hampers economic growth (OECD, 2005). Historical cases, such as post-war Germany and Japan, show that stability enabled rapid recovery, while ongoing insecurity in Iraq and Afghanistan has impeded growth. For Ukraine, ensuring financial stability and reconstruction will require addressing security challenges alongside economic policies.

In studies of post-war recovery, Galtung and Tisné (2009) underscore the critical importance of the first one to three years following the cessation of conflict, noting the accelerated pace of a country's growing needs during this period and the corresponding international aid provided by donors. They highlight two distinct phases of recovery that may pose significant risks:

1. The "Potlatch Effect" – This occurs when foreign partners inject substantial funds into reconstruction, expecting swift progress, but the recipient state lacks the institutional capacity to efficiently allocate and implement these funds, raising the risk of corruption and mismanagement.

2. "Late Awakening" – This phase marks a period where initial euphoria fades, donor trust diminishes due to inefficient spending, corruption becomes entrenched, and the need for structural reforms becomes urgent, increasing the risk of renewed conflict.

McAndrew (1996) further points out that international donors often pursue their own foreign policy objectives rather than addressing the actual needs of the recipient country, imposing conditionalities that the recipient must meet to access financing.

Guttal (2005) argues that post-war recovery often requires the establishment of a market-based capitalist system, characterized by neoliberalism, privatization, and deregulation. He suggests that this model redefines the state's role, emphasizing wealth creation, much of which is captured by foreign investors or domestic elites. Moreover, de Zeeuw (2001) notes that a country's ability to meet its financial obligations is a prerequisite for sustainable peace and preventing the recurrence of conflict.

Collier and Hoeffler (2004) significantly expand this discussion, arguing that post-war aid environments are fundamentally different from standard development contexts. Recovery phases offer "supra-normal" opportunities for economic growth and unusually high aid effectiveness, but only when peace, policy alignment, sustained

donor commitment, and sufficient time coincide. Drawing on historical data, they find that recovery is typically slow and constrained by limited absorptive capacity, while donors often exit prematurely – before returns on their investments materialize.

In their follow-up research, Collier and Hoeffler (2008) identify economic recovery and the prevention of conflict recurrence as two central policy priorities in post-conflict contexts. Collier (2003) further highlights that nearly half of civil wars relapse into violence, often driven by economic decline and weak institutions. Although the war in Ukraine is not a civil conflict but a case of external aggression by Russia, these insights remain highly relevant. Economic stabilization is essential not only for long-term recovery, but also for reducing vulnerability to future aggression and mitigating the risk of renewed instability or conflict.

The inflow of external financing, both public and private, typically stimulates investment and production (Butler & Cornaggia, 2011). Yet in Ukraine's case, monetary conditions, such as the NBU's high policy rate (13,5% as of December 2024), limit domestic borrowing. As a result, foreign assistance and investment are essential to economic revitalization.

Galtung and Tisné (2009), drawing on examples from Afghanistan and Bosnia, emphasize that donor funds are effective only when accountability mechanisms are robust, corruption is curbed through institutional reforms, and there is a transition toward democratic governance. Del Castillo (2008) distinguishes post-war reconstruction aid from humanitarian aid, noting that the former is aimed at long-term institutional change, including the transition to liberal market economies and the establishment of transparent legal systems. Vonyo (2008) similarly highlights the importance of human capital, suggesting that investment in large enterprises and the resulting GDP growth can spur migration and productivity, laying the groundwork for sustainable recovery.

However, the literature also warns of potential pitfalls. Geipel (1991) cautions that ineffective disaster recovery efforts can lead to the rapid depletion of aid, mid-term donor apathy, and long-term economic and social decline. Maynard (1999) underscores the stigma often attached to international aid, which, despite its benefits, is frequently seen as a failure when recovery falls short of expectations.

Toledo Gomes (2017), in his work on Afghanistan's budget politics, underscores the central role of the state in budgetary matters, emphasizing output-oriented

legitimacy linked to the provision of public goods. He points out that Afghanistan faced challenges in absorbing aid due to rigid and hierarchical state structures, resulting in ineffective use of funds. Linda Bilmes (2013) expands on this issue in her study of Iraq and Afghanistan, noting that post-war economies do not immediately revert to pre-war conditions. High defense spending, even after the cessation of hostilities, continues to strain national budgets, with only a portion of these expenditures directly tied to defense needs.

Overall, the literature highlights that aid effectiveness in recovery depends on strong institutions, transparency, and sustained donor engagement. Yet Ukraine presents a unique case: unlike typical post-conflict contexts, it receives major international support amid ongoing war. This thesis therefore focuses on wartime fiscal stabilization, assessing how direct budget support affects key macroeconomic indicators in real time. By addressing this gap, the study offers insights for both Ukrainian policymakers and international donors navigating economic recovery during active conflict.

2. ANALYTICAL FRAMEWORK

2.1. Research Gap

While previous studies have examined the role of budget spending and state institutions, few have explored the impact of budget financing on macroeconomic or monetary indicators. Eldepcy (2022) used a structural vector autoregressive (SVAR) framework to investigate the relationship between the money supply-to-GDP ratio and exchange rates in Egypt, finding that heavy reliance on domestic financing influenced the exchange rate. Otieno, Odhiambo, and Ombok (2019) explored the negative consequences of external financing, concluding that in Kenya, reliance on external deficit financing hindered economic growth, suggesting that the government should seek alternative revenue sources to finance the deficit.

The existing body of literature provides a vast understanding of the interplay between international aid, post-conflict recovery efforts, and the challenges of budget deficits. Various studies have analyzed how foreign assistance contributes to rebuilding economies and stabilizing fiscal capacity in the post-war era. These works highlight the importance of international support in facilitating infrastructure reconstruction, stimulating economic growth, and addressing urgent fiscal needs conditional that the war is over. However, a significant *research gap* is vivid in the literature concerning the immediate impacts of international financial assistance on economies actively experiencing large-scale war, such as Ukraine. While much of the existing research focuses on peacetime economies or post-conflict recovery, the unique challenges and dynamics of wartime economic management are less explored.

This gap is particularly important for the context of Ukraine, where the economy faces the multiple pressures of maintaining economic stability and addressing urgent fiscal demands during an ongoing war against Russian aggression. The mechanisms through which external financing affects key macroeconomic indicators, such as GDP growth, inflation, unemployment, and exchange rates, have not been examined closely. As a result, there is limited understanding of how such financing interacts with wartime factors, including elevated military expenditures, disrupted trade flows, and constant war-related risks. This lack of research leaves policymakers without data on how to manage the use of international aid for current fiscal challenges and prepare for fiscal challenges that await Ukraine in the long-run.

2.2. Analytical Problem

The analytical problem of this study revolves around the fact that the impact of external budget financing on Ukraine's economy during wartime remains poorly understood. While international aid is critical for stabilizing public finances and supporting essential needs, its effects on key macroeconomic indicators like GDP growth, inflation, exchange rates, and unemployment are unclear. The pressures of war such as increased military spending, damages to infrastructure, decrease in business activity add complexity to this issue, leaving policymakers with limited guidance on how to manage available aid for both immediate needs and long-term recovery.

This study aims to discover the effects of international financial budget support triggered by Russian full-scale invasion on Ukraine's macroeconomic indicators and suggest policy recommendations which could be used for post-war budget planning. The results of this research will give further insights into the long-term impacts of aid, such as debt sustainability and options for domestic budget revenue generation post war. Knowing in detail how the economy reacts to the influxes of financial aid will allow us to estimate the effects of alternative strategies for raising port-war budget revenues like tax policy reforms, expansion of domestic borrowings or even emission of Hryvnia.

2.3. Hypotheses

The research approach will follow a confirmatory (hypothesis-testing) design, formulating a null hypothesis and alternative hypotheses to explore the relationship between external financing and economic indicators.

Based on the literature review and available data it was possible to identify specific, pre-defined hypotheses that are grounded in theory. Given that in literature review certain established relationships were highlighted (e.g., external financing influencing GDP growth, inflation, and exchange rates), hypothesis testing will be used to confirm or refute these ideas in the Ukrainian context.

Hypothesis 0: There is no significant relationship between the levels of international financial assistance and Ukraine's macroeconomic indicators, such as GDP growth, inflation, exchange rates and unemployment.

Hypothesis 1: International financial assistance positively influences Ukraine's GDP growth by providing necessary capital for economic recovery and stabilizing public spending during the war

Hypothesis 2: International financial assistance reduces inflationary pressures in Ukraine by providing funds that prevent excessive money printing and borrowing from domestic sources.

Hypothesis 3: International financial assistance helps stabilize the Ukrainian exchange rate by strengthening foreign reserves and reducing pressure on the national currency.

Hypothesis 4: International financial assistance helps keep the level of unemployment in Ukraine stable, preventing significant increases during wartime.

3. RESEARCH DESIGN

3.1. Data

This study is conducted to measure the impact of external budget financing on Ukraine's economy since the beginning of the full-scale invasion. However, the data will include indicators from 2019 to 2024 to capture the effects of war and the extraordinary financing measures implemented to finance Ukraine's budget. Although large influxes of foreign aid began in 2022, it is vital to examine past trends and compare them to periods when the economy functioned without significant economic shocks. Looking back, 2019 represents the closest point of economic situation, which could be taken as a reference level, preceding both the COVID-19 pandemic and the war-induced crisis.

To operationalize this research, the independent variable is defined as the volume of external budget financing, including grants, loans, and guarantees provided to Ukraine from 2019 to 2024. The monthly data is collected from statistical reports on Public Finances (State Budget) provided by the National Bank of Ukraine (NBU, 2025) and verified through Open Budget Portal. The EBF data combines both External Financing which accounts for loans (code 300000 of budget classification) and State Budget Revenues received from the European Union, foreign governments, international organizations, donor agencies (code 42000000 of budget classification).

For the purpose of this study, differences between grants, loans, and guarantees, as well as their associated conditionalities, will not be considered. Accordingly, debt sustainability is not the focus of this research; instead, the study aims to assess the macroeconomic effects of monetary inflows.

Ukraine's economy is operationalized through four key macroeconomic indicators - GDP growth (GDPG), inflation rate (INF) - month on month and year on year indicators, exchange rate (EXR), and unemployment level (UNEMP), which are all reflected in the hypotheses.

The first dependent variable is GDP growth, which is measured on a quarterly basis using data provided by the National Bank of Ukraine (NBU) in its regular Inflation Report. This indicator shows the overall level of economic output and serves as a primary measure of economic performance.

The second variable is the inflation rate, which is assessed using the monthly Consumer Price Index (CPI). The original CPI data is compiled by the State Statistics Service of Ukraine and further processed by the NBU. For the purpose of this study, I will use month on month and year on year indicators to learn which of them - short-term or cumulative long-term - tend to change with the change in volume of external budget financing.

The third variable, the exchange rate, is measured using the official NBU exchange rate of the Ukrainian hryvnia to the US dollar, calculated as a monthly period average. This captures fluctuations in Ukraine's currency value and reflects external economic pressures and investor confidence.

Lastly, the unemployment level is used as an indicator of labor market conditions. Since the beginning of the full-scale Russian invasion in 2022, comprehensive labor force surveys have not been published by the State Statistics Service of Ukraine (Derzhstat). However, there is available data collected and processed by the Info Sapiens research agency and supported by PrivatBank, which is aggregated and published regularly in the Ukraine War Economy Tracker by Centre for Economic Strategy. The data is collected through phone interviews and represents the share of unemployed people within the labour force.

To ensure that the analysis is robust, the study includes several control variables that may influence macroeconomic performance. These include the level of state budget expenditures (SBE), which indicates the government's ability to finance planned public sector expenses, and the volume of military expenditures (ME) as a large share of the budget, which reflects the allocation of financial resources toward defense - data for both of the variables are collected from NBU reports on Public Finances and cross-verified via Open Budget portal.

Additionally, trade balance (TB) is accounted for by including data on exports and imports of goods and services, which illustrates trade dynamics under wartime conditions. It is collected by NBU and is presented in their Balance of Payments statistics. For this study, total exports and imports of goods and services are aggregated, and the trade balance is defined as the difference between total exports and imports.

Another important control variable is the level of gross foreign exchange reserves (FER), measured on a monthly basis. These reserves, consisting of liquid assets in foreign currency and gold, are managed by the NBU for foreign exchange interventions and government payments.

All variables used in this study are numeric and continuous, and structured as time series observed at monthly frequency.

3.2. Methodology

The empirical analysis conducted in this thesis comprises several critical components: data preprocessing and transformation, stationarity testing, ordinary least squares (OLS) regressions, estimation of ARIMA and VAR models, impulse response function (IRF) analysis and Granger causality testing. All statistical procedures were performed using RStudio software.

3.2.1. Data preprocessing

Given that two key macroeconomic indicators – GDP growth and the unemployment rate — are collected and published on a quarterly basis, it was essential to align these with the monthly frequency of the broader dataset. Therefore, quarterly data for GDP and unemployment were interpolated into monthly observations, ensuring temporal consistency across all variables.

To address substantial differences in magnitude across indicators, scaling was applied where appropriate (expressed in billions of UAH), followed by logarithmic transformations. Log transformations required slight adjustments (additive shifts) to handle potential zero-value observations and to avoid computational errors.

Additionally, to identify the order of integration of each series and prepare the dataset to be used for VAR and ARIMAX models, the Augmented Dickey-Fuller (ADF) test was systematically applied. Initially, all variables were tested at their original levels. For those series demonstrating non-stationarity, first differencing was conducted, followed by a repeated ADF test. Variables that remained non-stationary after first differencing were differenced a second time and retested. Consequently, each time series was confirmed as stationary either at the first or second difference before inclusion in the next modeling steps.

3.2.2. Multivariate OLS regressions with lagged EBF

To conduct an initial assessment of the delayed effects of fiscal support on macroeconomic performance, a set of multivariate Ordinary Least Squares (OLS) regressions was estimated using one-, three-, and six-month lags of logged external budget financing (log-EBF) as the primary explanatory variables. These regressions were performed separately for each of the four dependent variables: GDP growth, year-on-year inflation, unemployment rate, and the nominal exchange rate. Control variables included the central bank policy rate, trade balance, state budget expenditures (SBE), military expenditures (ME), and gross foreign exchange reserves (FER).

The equation of the regression model is presented below:

$$\mathbf{Y}\boldsymbol{t} = \boldsymbol{\beta}\mathbf{0} + \boldsymbol{\beta}\mathbf{1}log(\boldsymbol{EBFt} - \mathbf{1}) + \boldsymbol{\beta}\mathbf{2}log(\boldsymbol{EBFt} - \mathbf{3}) + \boldsymbol{\beta}\mathbf{3}log(\boldsymbol{EBFt} - \mathbf{6}) + \boldsymbol{\beta}\mathbf{4}PolicyRate\boldsymbol{t} + \boldsymbol{\beta}\mathbf{5}TradeBalance\boldsymbol{t} + \boldsymbol{\beta}\mathbf{6}SBE\boldsymbol{t} + \boldsymbol{\beta}\mathbf{7}ME\boldsymbol{t} + \boldsymbol{\beta}\mathbf{8}FER\boldsymbol{t} + \boldsymbol{\varepsilon t}/$$

In this specification, *Yt* denotes the dependent variable at time *t* – equations were the same for all dependent variables, while the lagged terms of *log(EBF)* capture potential short- and medium-term fiscal effects. The remaining terms represent macro-financial controls aimed at isolating the influence of EBF from other concurrent economic forces.

This modeling approach allowed for a direct quantification of the transmission effects of EBF on core macroeconomic indicators, while holding other policy and structural variables constant. Coefficient estimates were interpreted alongside robust standard errors and assessed for statistical significance using standard hypothesis testing procedures.

3.2.3. ARIMA/ARIMAX modeling

As a next step ARIMA models which incorporate external regressors (ARIMAX) were estimated to investigate the potential direct linear influence of EBF on selected macroeconomic indicators. Specifically, ARIMAX models were estimated for monthly GDP growth and monthly inflation (month-over-month), with EBF included as the exogenous explanatory variable. The selection of optimal model specifications (order of autoregressive and moving-average components) was determined using the Akaike

Information Criterion (AIC) and Bayesian Information Criterion (BIC). The automated model selection procedure was implemented using the *auto.arima* function in R. The resulting ARIMAX models provided an initial linear assessment of the immediate short-term relationships between EBF and macroeconomic indicators.

3.2.4. VAR modeling

The core empirical approach of this thesis relied on Vector Autoregressive (VAR) modeling, capturing dynamic interactions among multiple macroeconomic variables. It allows us to identify both contemporaneous and lagged effects among endogenous variables without requiring strong assumptions about the direction of causality (Sims, 1980; Enders, 2015). This makes it an ideal tool for examining how external budget financing influences key macroeconomic indicators over time, especially in the context of delayed fiscal effects.

Given stationarity results from the first data preparation stage, all variables were transformed into their stationary forms (first or second differences, as necessary) before inclusion in the VAR. Specifically, the final VAR model encompassed both first-differenced variables (EBF, month-over-month inflation, state budget expenditures, trade balance) and second-differenced variables (GDP growth, year-on-year inflation, unemployment rate, exchange rate, policy rate, foreign exchange reserves, military expenditures).

The optimal number of lags (p) for the VAR model was selected using the Akaike Information Criterion (AIC), as implemented by the *"VARselect"* function in R. The final VAR model included a constant term and was estimated in the standard form VAR(p), with "p" denoting the optimal lag length determined through this process. This comprehensive model enabled detailed examination of the dynamic and potentially delayed impacts of external budget financing and other macroeconomic variables.

3.2.5. Impulse Response Function (IRF)

Impulse response functions were estimated from the final VAR model to explicitly capture the dynamic effects of external budget financing shocks on macroeconomic indicators. IRFs specifically traced the delayed and evolving responses of GDP growth, inflation, exchange rate, and unemployment to EBF shocks over a 12-month time horizon. Statistical significance of IRF estimates was assessed through

confidence intervals obtained via bootstrap resampling methods, providing robust inference on the direction, magnitude, and timing of macroeconomic responses to changes in external financial flows.

3.2.6. Granger Causality Testing

To further validate and complement VAR findings, Granger causality tests were conducted using bivariate VAR models. These tests explicitly assessed whether past values of external budget financing (first differences) could significantly predict future changes in key macroeconomic indicators such as GDP growth, year-on-year inflation, exchange rate, and unemployment. The analysis was conducted at an optimal lag length of two months, as determined by earlier model selection steps. The statistical significance of lagged terms was evaluated to identify potential predictive or causal relationships, thus clarifying the short-term forecasting power of EBF over critical macroeconomic outcomes.

4. RESULTS

4. 1. Data preprocessing

To address the issue of differing data frequencies across variables, especially those available only on a quarterly basis, such as GDP growth and unemployment, I generated monthly equivalents to align them with the other variables observed at monthly frequency. This allowed for consistent time series modeling and enabled the inclusion of these macroeconomic indicators in both descriptive and regression analysis.

Specifically, for GDP growth (GDPG) and the unemployment rate (UNEMP), I applied two transformation methods:

1. Quarterly replication: The original quarterly values were assigned to each of the three corresponding months within the quarter. These replicated variables (GDPG_monthly_rep and UNEMP_monthly_rep) were included for comparison and to serve as a control format in model diagnostics.
2. Linear interpolation: To provide a smoother approximation of how these indicators evolve on a monthly basis, I used linear interpolation *(zoo::na.approx)* to fill in monthly values between each quarterly data point. This method assumes a constant rate of change between quarters, generating a more continuous time series for models that are sensitive to artificial flatness. The interpolated versions (GDPG_monthly_interp and UNEMP_monthly_interp) were modeled in R and the resulting columns were added to the main dataset.

Since linear interpolation gave smoother results that showed more accurate dynamics over time, the interpolated variable (UNEMP_m) was used in all models of the quantitative study.

4. 2. Descriptive statistics

4.2.1. General Findings

Descriptive statistics for all variables used in the analysis are presented in *Appendix 1*. The dataset comprises 72 monthly observations from January 2019 to December 2024 and captures critical developments in Ukraine's macroeconomic

conditions, fiscal stance, labor market, and monetary environment during a period marked by multiple external shocks and wartime disruption.

External Budget Financing displays considerable variation, with a mean of 147.6 billion UAH and a standard deviation of 190.5 billion UAH. The variable is right-skewed (skewness = 1.14), with a maximum monthly inflow of nearly 687 billion UAH, reflecting intense concentration of international aid disbursements, especially after 2022. State Budget Expenditures (SBE) and Military Expenditures (ME) show similarly skewed distributions, with ME reaching a maximum of 403.9 billion UAH and a relatively high kurtosis, pointing to episodic spikes in defense spending.

Inflation is moderate but exhibits episodic surges. Month-on-month (MoM) inflation averages 0.82%, peaking at 4.5%, while year-over-year (YoY) inflation reaches a maximum of 26.6%. Both indicators are positively skewed, suggesting that although inflation was typically contained, sudden bursts in prices—those driven by war shocks, supply constraints and unforeseen demand increases—played a big role.

The exchange rate ranged from 23.61 to 41.75 UAH/USD, with a mean of 31.53 and relatively low skewness (0.41), indicating moderate fluctuations under the National Bank of Ukraine's exchange rate management regime. Foreign exchange reserves (FER) fluctuated between 19.4 and 43.8 billion USD, and the policy interest rate averaged 14.5%, with a peak of 25% following the 2022 invasion, reflecting a tightening cycle aimed at curbing inflation and stabilizing the currency.

Labor market indicators demonstrate substantial stress. The unemployment rate (UNEMP_m) averaged 13.15% over the period, ranging from 7.0% to 26.1%, with moderate right skew (0.83). The absolute number of unemployed persons varied significantly, from just over 120,000 to more than 1.24 million, showing the war's considerable impact on employment levels.

The trade balance was consistently negative, with a mean deficit of -1.63 billion USD and a minimum of -4.27 billion USD. Its distribution is close to symmetric (skew = -0.19), suggesting stable, though persistently adverse, external trade dynamics.

GDP growth (GDPG_m) is the most volatile variable, with a standard deviation of 13.14 and a minimum of -37.2%, reflecting a steep contraction during the early months of the full-scale invasion. The left-skewed distribution (skew = -1.33) suggests

that sharp output declines occurred more frequently than growth rebounds during the period under review.

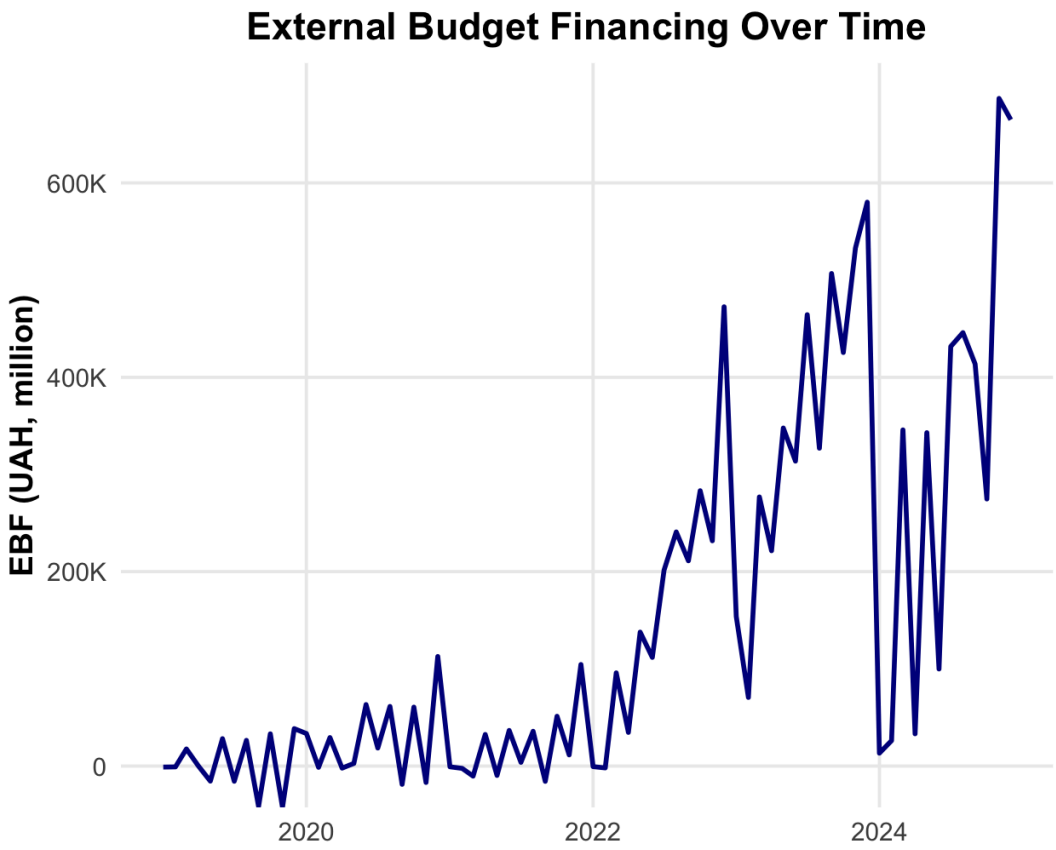
Overall, the descriptive statistics confirm the presence of economic shocks, structural breaks, and non-normal distributions—particularly in variables tied to fiscal flows and macroeconomic performance. These characteristics justify the use of log transformations, differencing, and robust time series methods to ensure reliable estimation of the impact of external budget financing on economic outcomes.

4.2.2. External Budget Financing

Figure 1 illustrates the monthly dynamics of External Budget Financing (EBF) in Ukraine from January 2019 to December 2024. The chart shows that EBF remained relatively low and stable until early 2022, with occasional minor fluctuations, which were caused by COVID-related financial assistance. A sharp and sustained increase begins mid-2022, coinciding with the escalation of the full-scale Russian invasion and reflecting the subsequent intensification of international financial support.

Several pronounced spikes are visible in late 2022 and throughout 2023, with the highest recorded inflow surpassing 650 billion UAH in late 2024. Temporary dips—most likely due to timing delays in donor disbursements—which traditionally reach their peak approaching the end of the year, where international donors catch up with their commitments and make sure that the promised assistance is delivered in the corresponding financial year. Overall, the figure reflects Ukraine's growing reliance on external financing to sustain public spending during wartime and its incredible volatility from month to month which is particularly visible in 2024.

Figure 1. External Budget Financing in Ukraine - Sum of Grants and Loans to the State Budget

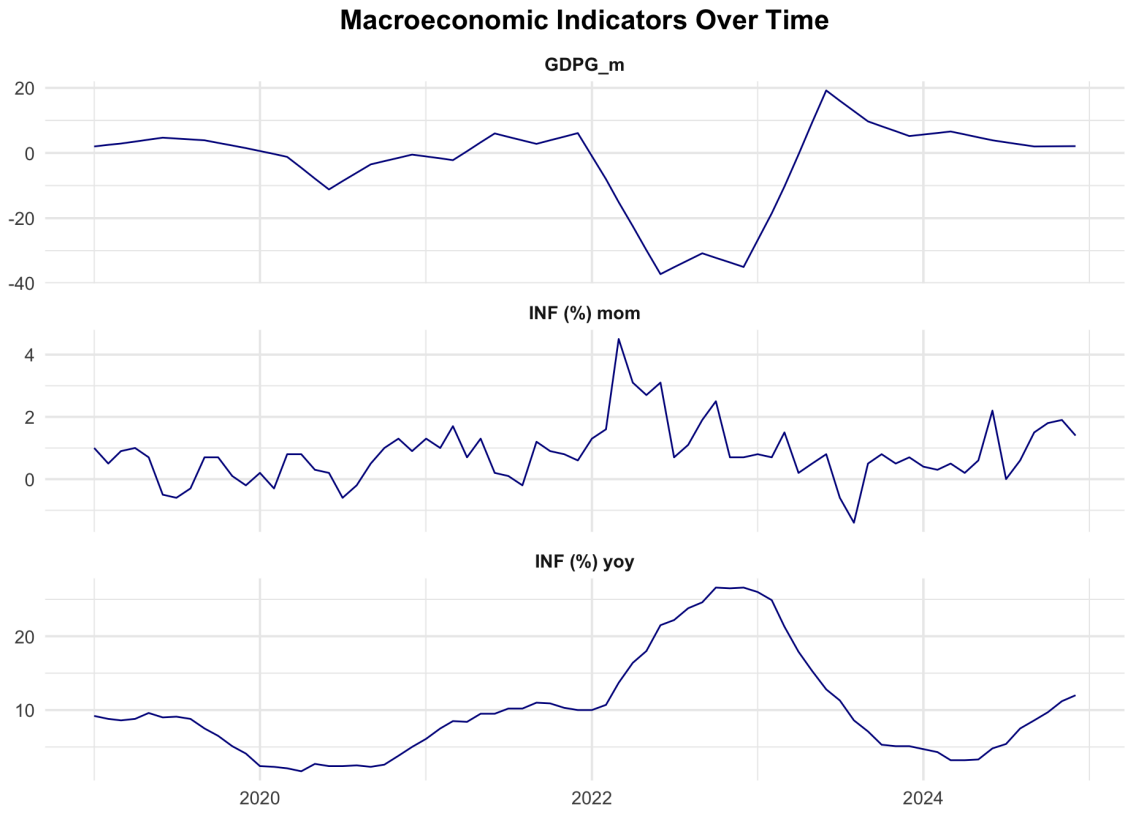


Note: Author's visualization conducted in R-studio based on the collected dataset. Data source: the National Bank of Ukraine and Open Budget platform.

4.2.3. Macroeconomic Indicators

The first panel of *Figure 2* shows GDP growth (GDPG_m), which remains moderately positive until 2020 before experiencing a notable contraction during the early phase of the COVID-19 pandemic. The most dramatic decline occurs in 2022 with the onset of the full-scale invasion, where monthly growth drops to nearly -37%. This is followed by a strong recovery peaking around mid-2023, before stabilizing at modest positive levels through 2024. These movements clearly reflect the macroeconomic shocks caused by the war and subsequent foreign aid-fueled recovery.

Figure 2. Dynamic of Ukraine's Macroeconomic Indicators (GDP Growth and InflationRate)



Note: Author's visualization conducted in R-studio based on the collected dataset. Data source: the National Bank of Ukraine.

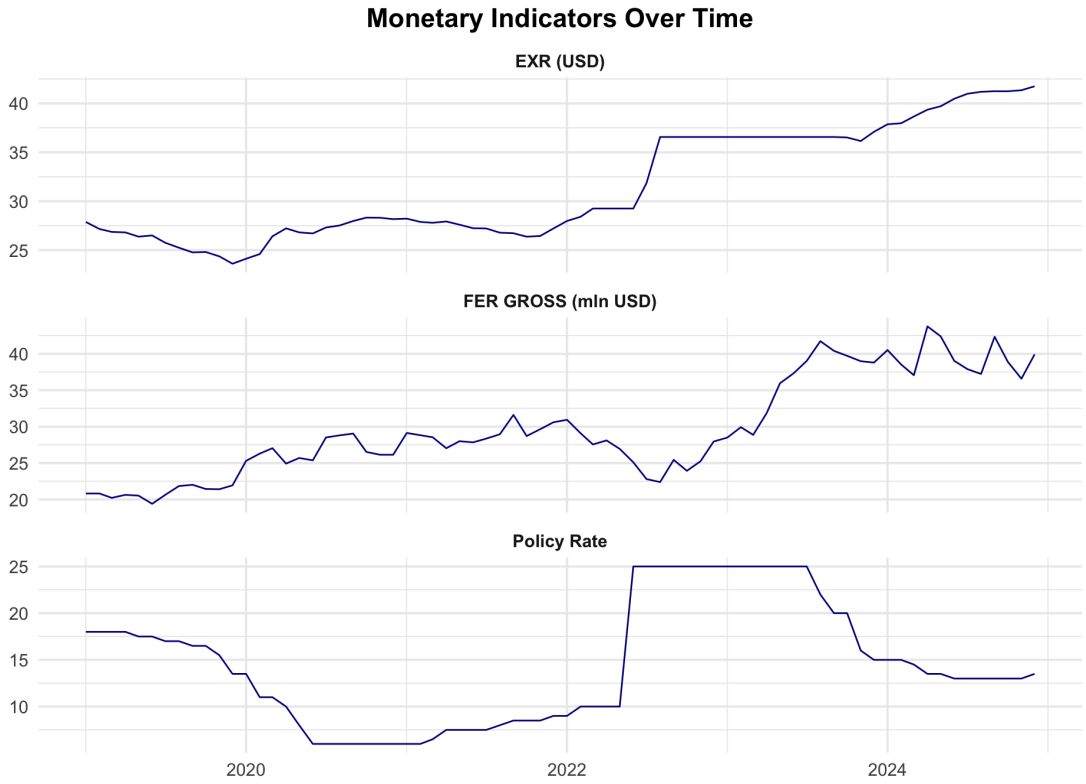
The second panel presents month-on-month inflation (INF mom), which remains low and relatively stable before 2022. Following the invasion, however, inflation spikes sharply, peaking above 4% monthly — a reflection of disrupted supply chains, market panic, currency depreciation, and war shocks. Inflation pressures subside gradually into 2023 and remain under control through 2024.

The third panel tracks year-on-year inflation (INF yoy), which mirrors the MoM trends but with a lag. It rises steeply throughout 2022, reaching a peak near 27% in early 2023. This prolonged inflation spike indicates the cumulative price increases over the war period. A steady decline is observed in 2023 and early 2024, with a mild rebound toward the end of the series, possibly driven by renewed external or internal pressures.

4.2.4. Monetary Indicators

The top panel of Figure 3 presents the official exchange rate (EXR) of the Ukrainian hryvnia (UAH) to the U.S. dollar. From 2019 to early 2022, the exchange rate was relatively stable, fluctuating between 24 and 28 UAH/USD. However, following the full-scale invasion in 2022 and rapid outflow of funds from Ukraine, the National Bank of Ukraine (NBU) introduced a fixed rate at approximately 36.6 UAH/USD, which remained stable through 2023. In 2024, a gradual depreciation trend resumed, reaching above 40 UAH/USD.

Figure 3. Dynamic of Ukraine's Monetary Indicators (Exchange Rate, Gross Foreign Exchange Reserves and NBU's Interest Rate)



Note: Author's visualization conducted in R-studio based on the collected dataset. Data source: the National Bank of Ukraine.

The second panel shows gross foreign exchange reserves (FER), which remained stable around 20–30 billion USD until early 2022. Following a brief dip during the initial months of the war, reserves began to accumulate significantly, peaking above 40 billion USD in 2023. This rise corresponds to the influx of international financial

assistance and more active reserve management by the NBU, enhancing Ukraine's external buffer.

The third panel tracks the NBU's interest rate, which was gradually reduced prior to 2022 in order to stimulate economic activity and investment in recessionary years of pandemic. However, in a decisive move following the invasion, the central bank sharply raised the rate to 25% in mid-2022 to anchor inflation. The rate remained high through most of 2023, then gradually declined in 2024 as inflationary pressures eased and macroeconomic conditions stabilized.

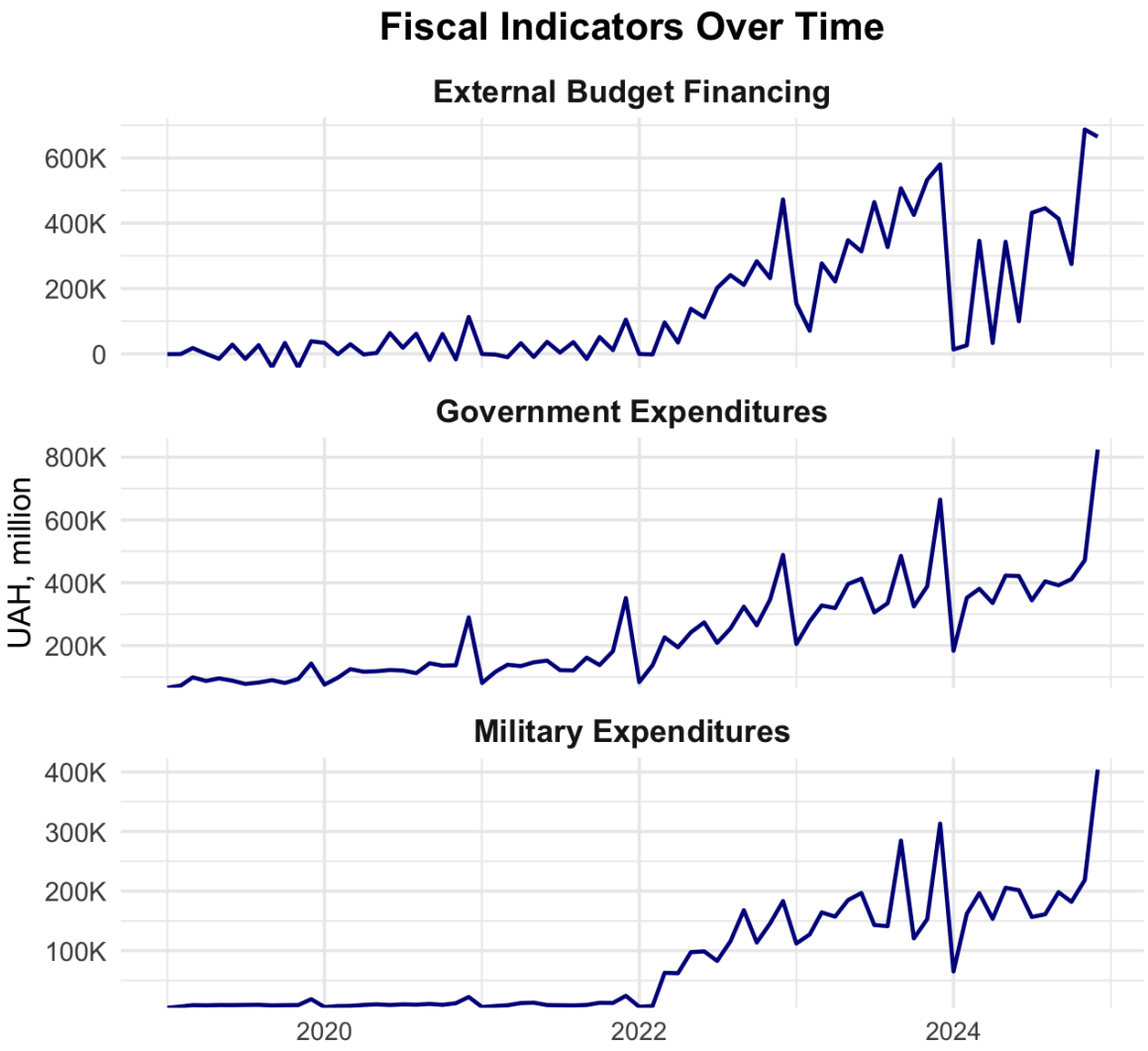
4.2.5. Fiscal Indicators

The visualization in Figure 4 presents the evolution of three key fiscal indicators in Ukraine from January 2019 to December 2024: Government Expenditures (SBE) and Military Expenditures (ME) in addition to previously outlined External Budget Financing (EBF). All values are shown in millions of UAH and reflect monthly disbursements.

Government expenditures show a steadily increasing trend over the entire period, with noticeable spikes starting in 2022. The escalation in public spending corresponds with the need to support defense, social protection, and public services during wartime. Military expenditures also sharply increased from 2022 onward, reflecting Ukraine's growing defense needs. The volatility in ME is more pronounced than in total expenditures, suggesting discretionary spikes linked to procurement cycles or urgent defense allocations.

Together, these trends visually confirm the fiscal transformation of the Ukrainian state under war conditions—marked by massive foreign financing, increased defense spending, and overall expansion of public expenditure, which are key variables for analyzing macroeconomic outcomes in the empirical sections that follow.

Figure 4. Dynamics of Ukraine's Fiscal Indicators (External Budget Financing, State Budget Expenditures and Military Expenditures)



Note: Author's visualization conducted in R-studio based on the collected dataset. Data source: the National Bank of Ukraine and Open Budget.

4.2.6. Labor Market

This line graph in Figure 5 illustrates the monthly unemployment rate in Ukraine (interpolated) from January 2019 to December 2024. The unemployment rate remains relatively stable and low (between 7% and 11%) from 2019 through early 2022, reflecting normal labor market conditions prior to the full-scale war.

Figure 5. Dynamics of Ukraine's Unemployment Rate

Note: Author's visualization conducted in R-studio based on the collected dataset. Data source: the National Bank of Ukraine.

However, starting in early 2022, the unemployment rate spikes dramatically, peaking at over 26% — a clear reflection of the labor market shock caused by the Russian invasion. This surge captures massive displacement, business shutdowns, and widespread economic disruption. Following the peak, the unemployment rate begins a steady decline, suggesting a gradual labor market recovery. Yet, such dynamic is also influenced by the specific war-time regulations of the labor market, outflow of male labor force to Armed Forces of Ukraine and tendency to avoid unemployment registration and potential conscription. Nevertheless, by late 2024, unemployment

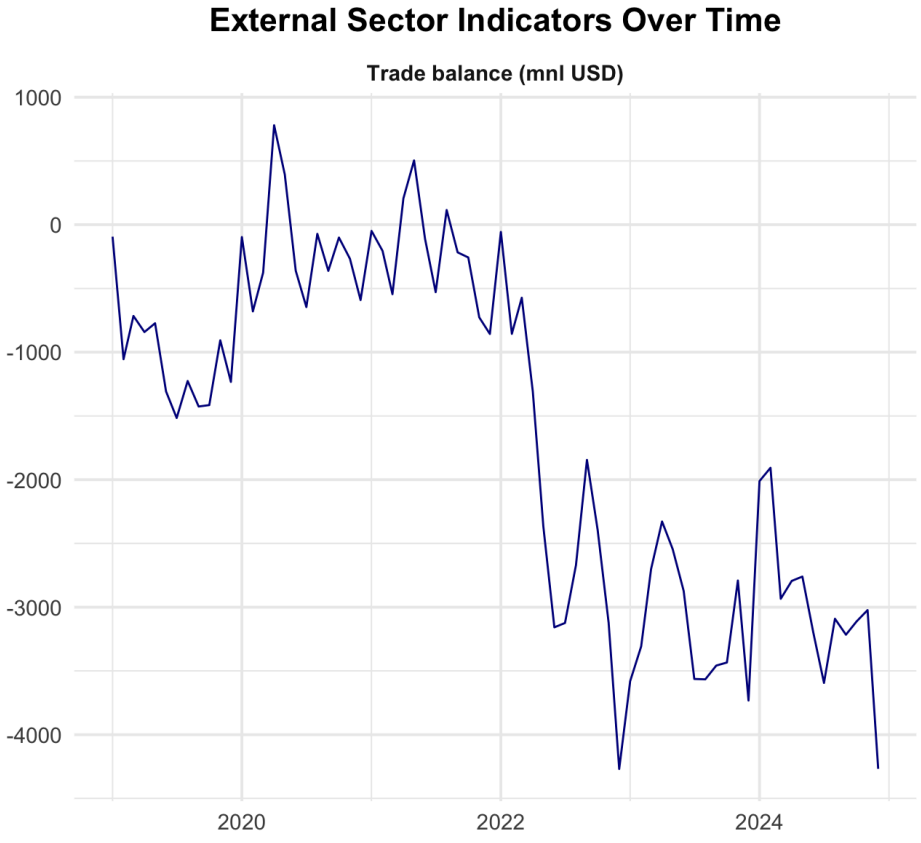
remains significantly above pre-war levels, hovering around 13%, which still indicates persistent structural challenges in the labor market.

This pattern highlights the need for targeted labor market interventions and supports the inclusion of unemployment as a key dependent variable in the empirical analysis of external budget support's macroeconomic impact.

4.2.7. External Sector

Figure 6 shows the monthly trade balance of Ukraine (in million USD) from January 2019 to December 2024, serving as a key indicator of external sector dynamics.

Figure 6. Dynamics of Ukraine's External Sector (Trade Balance of Goods and Services in USD mln)



Note: Author's visualization conducted in R-studio based on the collected dataset. Data source: the National Bank of Ukraine.

From 2019 to late 2021, Ukraine's trade balance fluctuated around the -500 to 0 million USD range, with occasional positive months, indicating a relatively stable—though slightly negative—external trade position. However, from early 2022 onward, a dramatic and persistent decline is observed. The deficit deepens significantly, dropping below -3 billion USD at multiple points, with the lowest values nearing -4.3 billion USD.

This steep deterioration in the trade balance reflects the severe disruption to Ukraine's exports and supply chains caused by the full-scale war, compounded by heightened import needs (especially military and humanitarian). Despite slight improvements during some months, the negative trajectory persists through 2024, suggesting ongoing challenges in restoring export capacity and reducing import dependency.

4.3. Correlation Analysis.

The heatmap in Figure 7 presents the pairwise Pearson correlations among Ukraine's macroeconomic indicators that are considered in this study. War-related shocks and policy responses are reflected in both the strength and direction of these relationships.

As expected, external budget financing (EBF) shows a moderate positive correlation with both state budget expenditures (SBE) and military expenditures (ME), confirming that donor support plays a crucial role in funding Ukraine's fiscal needs. However, its correlation with other macroeconomic variables, such as GDP growth, inflation, or the exchange rate, appears relatively weak—likely reflecting complex time lags and the influence of additional factors.

GDP growth (GDPG_m) is negatively correlated with unemployment (UNEMP_m) and positively correlated with trade balance, aligning with theoretical expectations. Interestingly, GDP growth also shows negative associations with inflation (INF) and the exchange rate (EXR), indicating that downturns in output tend to coincide with currency depreciation and price instability.

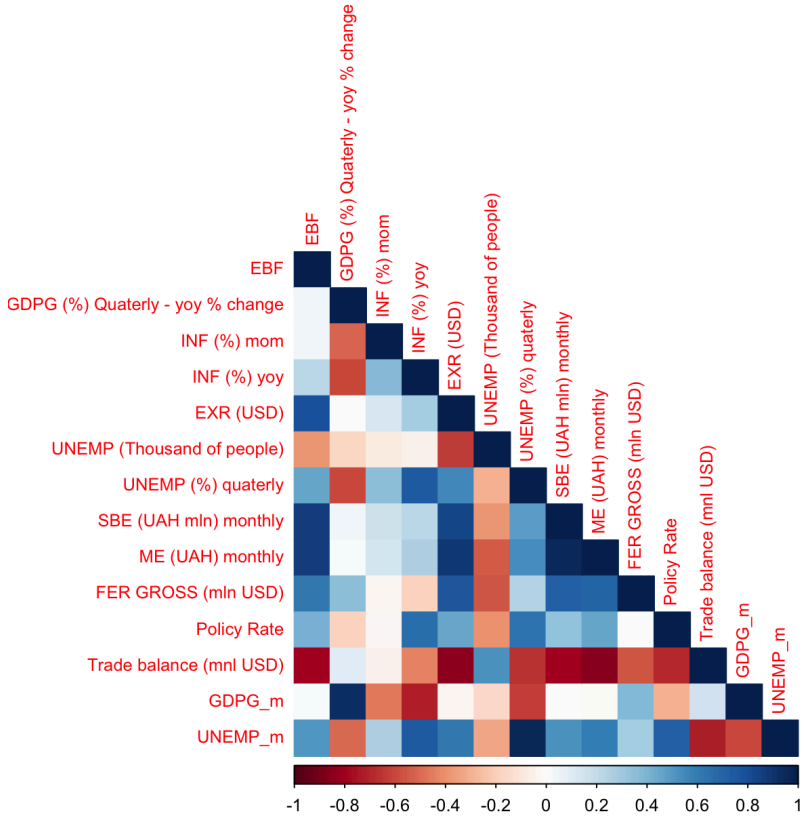
Inflation (both MoM and YoY) correlates positively with the exchange rate, reflecting the effects of depreciation on domestic prices. Meanwhile, the policy rate is moderately correlated with inflation and the exchange rate, signaling that the National

Bank of Ukraine adjusted interest rates to manage inflationary pressures and stabilize the hryvnia.

A particularly strong positive correlation exists between different measures of unemployment (absolute and percentage terms), validating the consistency of labor market indicators. Likewise, inflation indicators and GDP metrics are clustered in correlated blocks, illustrating shared economic dynamics during periods of crisis and recovery.

Overall, the correlation analysis matrix provides an overview of interdependencies in Ukraine's wartime economy and is useful for further modeling of economic effects.

Figure 7. Correlation Matrix.



Note: graph created by the author in R-studio based on the collected dataset.

4.4. Multivariate OLS regressions with lagged EBF

As a first step in the empirical analysis, a set of multivariate Ordinary Least Squares (OLS) regressions was created to explore the general relationships between external budget financing (EBF) and key macroeconomic indicators. This initial model served to identify broad correlations and potential short- to medium-term fiscal transmission channels, prior to implementing more complex dynamic time-series models.

Each regression included the one-, three-, and six-month lags of logged external budget financing (log_EBF) as explanatory variables, intended to capture both immediate and delayed impacts on dependent variables: GDP growth, year-on-year inflation, the unemployment rate, and the nominal exchange rate. To account for key policy and macro-financial conditions, the regressions also included the central bank policy rate, trade balance, state budget expenditures (SBE), military expenditures (ME), and gross foreign exchange reserves (FER) as controls.

The results, presented in Table 1 revealed that GDP growth exhibited a consistent negative association with lagged EBF values. Notably, the coefficient on the three-month lag of log_EBF was marginally significant ($p < 0.10$), suggesting a delayed contractionary effect of external fiscal inflows on output. This finding may reflect temporary inefficiencies in fund absorption or sterilization effects through monetary operations. In the case of the exchange rate, the three-month lag of EBF was positively and significantly associated with depreciation pressures, implying that higher external financing may lead to short-run currency weakening, potentially driven by liquidity expansions or speculative reactions.

By contrast, year-on-year inflation and unemployment did not display statistically significant responses to EBF at any lag. However, the inflation model demonstrated relatively strong explanatory power (Adjusted $R^2 \approx 0.55$), driven primarily by the monetary policy rate and foreign exchange reserves. In the unemployment regression, EBF coefficients were consistently positive but statistically insignificant, indicating either delayed labor market effects or structural rigidity in employment dynamics.

Among control variables, foreign exchange reserves (FER) were a strong predictor of higher GDP growth and lower inflation, aligning with expectations around macroeconomic stability and policy buffers. The policy rate was positively associated

with both inflation and unemployment, consistent with its role as a contractionary instrument. Trade balance appears moderately significant in the exchange rate model, confirming its importance in external sector dynamics.

Table 1. Multivariate OLS regressions results

	GDP Growth	Inflation YoY	Unemployment	Exchange Rate
EBF (1m Lag)	-0.230	0.074	0.061	0.007
	(0.183)	(0.092)	(0.055)	(0.043)
EBF (3m Lag)	*-0.299*	0.027	0.041	**0.093***
	(0.179)	(0.090)	(0.053)	(0.043)
EBF (6m Lag)	-0.216	0.048	0.082	0.044
	(0.167)	(0.084)	(0.050)	(0.040)
Policy Rate	0.364	0.559**	0.406**	0.078
	(0.335)	(0.168)	(0.100)	(0.080)
Trade Balance	0.005*	-0.000	-0.001	-0.001
	(0.002)	(0.001)	(0.001)	(0.001)
SBE	-0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
ME	0.000	-0.000	-0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
FER	2.230**	-0.642**	-0.134	0.299**
	(0.317)	(0.159)	(0.095)	(0.075)
Num.Obs.	66.000	66.000	66.000	66.000
R2	0.547	0.601	0.717	0.857
R2 Adj.	0.483	0.545	0.678	0.837
AIC	498.500	407.500	339.000	308.900
BIC	520.400	429.400	360.900	330.800
Log.Lik.	-239.227	-193.754	-159.481	-144.454
F	8.603	10.715	18.078	42.599
RMSE	9.080	4.560	2.710	2.160

*Note: Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$*

Taken together, the OLS regression results highlight that external budget financing can have meaningful but lagged effects on output and exchange rate stability. These exploratory findings provided a foundation for the more advanced time-series models that follow, which further assess the dynamic interplay between fiscal inflows and macroeconomic performance.

4.5. Stationarity Testing and Differencing

4.4.1. Augmented Dickey-Fuller (ADF) Test for Stationarity

Before performing time series analyses, the Augmented Dickey-Fuller (ADF) test was conducted to examine the stationarity of all variables. Stationarity, a key prerequisite for time series modeling (e.g., ARIMA, VAR, and Granger causality), implies constant statistical properties such as mean, variance, and autocorrelation over time. Non-stationary data can lead to unreliable model estimations and spurious results.

According to Appendix 2, all variables exhibited non-stationarity at levels (p-values > 0.05), thus requiring differencing for further analysis.

4.4.2. Stationarity of First-Differenced Series

Appendix 3 illustrates the ADF test results for the first-differenced series. Variables such as External Budget Financing (d_EBF), monthly inflation (d_INF_mom), State Budget Expenditures (d_SBE), and Trade Balance (d_TB) became stationary after first differencing, as indicated by their significant ADF statistics ($p < 0.05$). These variables were suitable for inclusion in VAR and Granger causality models at first difference.

However, GDP growth (d_GDPG), year-on-year inflation (d_INF_yoy), unemployment (d_UNEMP), exchange rate (d_EXR), policy rate (d_Policy), foreign exchange reserves (d_FER), and military expenditures (d_ME) remained non-stationary ($p > 0.05$), requiring additional differencing.

4.4.3. Stationarity of Second-Differenced Series

Appendix 4 presents the results of ADF tests on second-differenced series. All previously non-stationary variables achieved stationarity after second differencing, with p-values below the 5% significance threshold. Thus, these variables are integrated of order two (I(2)), confirming their readiness for use in subsequent VAR modeling, Granger causality testing, and OLS regressions.

4.5. ARIMA/ARIMAX Modeling

4.5.1. Model Description

To evaluate the short-term impact of external budget financing (EBF) on key macroeconomic variables, ARIMA models with exogenous regressors (ARIMAX) were employed. The ARIMA framework effectively captures the autoregressive and moving average components of a single time series, while the ARIMAX extension allows for the inclusion of external variables, enhancing the analysis of external shocks on dependent variables.

In this study, EBF was used as an exogenous regressor in separate ARIMAX models for GDP growth (GDPG) and monthly inflation (INF_mom). These indicators were chosen due to their responsiveness to fiscal changes, suitability for monthly analysis, and centrality to evaluating short-term stabilization effects during wartime.

Structural variables, such as unemployment and the exchange rate, were excluded from ARIMA modeling due to their inherent characteristics: unemployment tends to evolve slowly and exchange rates in Ukraine are influenced significantly by central bank interventions.

4.5.2. Model Results

The ARIMAX models were estimated using the auto.arima() function in R. Both GDP growth and monthly inflation models were identified as ARIMA(0,0,0), essentially representing linear regressions with white noise residuals (see Appendix 5).

As shown in Appendix 5, EBF does not exhibit statistically significant short-term effects on GDP growth or monthly inflation. The coefficients for EBF were effectively zero (0e+00) with very low standard errors (~0.0001). Specifically, the intercept terms dominated the explanatory power, with estimates of -3.215 (SE = 1.9498) for GDPG and 0.7812 (SE = 0.1397) for INF_mom.

The GDP growth model reported a high variance ($Sigma^2$ = 175) and RMSE of approximately 13.05, whereas the monthly inflation model had a lower variance ($Sigma^2$ = 0.8982) and moderate RMSE of 0.93. High residual autocorrelation (ACF1 ~0.96 for GDPG and 0.58 for INF_mom) suggests that the models lack sufficient dynamic structure to fully capture temporal patterns.

These findings imply limited immediate responsiveness of GDP growth and inflation to EBF, potentially due to delayed transmission mechanisms or intervening factors not captured within the simple ARIMAX framework.

4.6. VAR-analysis

Following the stationarity tests and ARIMAX modeling, a Vector Autoregression (VAR) analysis was conducted to further explore macroeconomic interactions involving external budget financing (EBF). Based on the outcomes of the stationarity tests, variables were categorized into two groups: those stationary after first differencing (d_EBF, d_INF_mom, d_SBE, d_TB), and those requiring second differencing (d2_GDPG, d2_INF_yoy, d2_UNEMP, d2_EXR, d2_Policy, d2_FER, d2_ME). Initially, three distinct VAR models were proposed: one focused solely on second-differenced variables, one limited to first-differenced variables, and one comprehensive model combining both sets of variables. Although the second-difference-only VAR model was estimated (see Appendix 6), it was excluded due to its limited interpretability and inability to properly assess the effects of EBF. Consequently, the combined VAR model that incorporates both first- and second-differenced variables—was selected as the main analytical framework, providing a comprehensive perspective of the interdependencies within Ukraine's wartime economy.

4.6.1. Model Fit and Explanatory Power

The results of this comprehensive VAR analysis are presented in Appendix 7. The model demonstrates robust explanatory capabilities, as evidenced by the fit statistics summarized in Appendix 8. Adjusted R-squared values highlight substantial explanatory power, particularly for key macroeconomic variables such as GDP growth (Adjusted $R^2 = 0.70$), unemployment (Adjusted $R^2 = 0.70$), military expenditures (Adjusted $R^2 = 0.91$), and the central bank's policy rate (Adjusted $R^2 = 0.84$). Additionally, the low p-values of joint F-statistics across equations underscore the overall statistical significance and reliability of the VAR framework, confirming that the model effectively captures the dynamic relationships among the variables analyzed.

4.6.2. Influence of External Budget Financing (EBF)

Importantly, external budget financing emerged as a statistically significant predictor of various critical macroeconomic indicators, thereby highlighting its

essential stabilizing role. Specifically, lagged values of EBF demonstrate meaningful autocorrelation effects (d_EBF.l4 → d_EBF; t-value = 2.41, p = 0.025), indicating persistence in external funding inflows, potentially reflecting delayed disbursements or ongoing donor commitments. Additionally, increases in external financing significantly and positively affect state budget expenditures (d_EBF.l1 → d_SBE; t-value = 3.22, p = 0.004), proving that external funds directly support the fiscal capacity of the Ukrainian government in periods of crisis.

EBF also positively and significantly impacts foreign exchange reserves (d_EBF.l1 → d2_FER; t-value = 3.56, p = 0.002), illustrating the crucial role external financial assistance plays in stabilizing Ukraine's currency market and macroeconomic environment more broadly. This effect underscores EBF's indirect role in mitigating currency volatility and preserving macroeconomic stability during wartime shocks.

Finally, external budget financing shows a direct and statistically significant positive relationship with military expenditures (d_EBF.l1 → d2_ME; t-value = 3.41, p = 0.003). This relationship indicates that external assistance not only directly facilitates increased defense spending but also indirectly allows the government to reallocate its own resources toward critical defense needs by reducing fiscal pressures in other sectors.

Collectively, these results confirm that external budget financing plays a significant role in supporting fiscal capacity and monetary reserves, particularly by increasing state budget expenditures, foreign exchange reserves, and military spending. These fiscal channels appear to be the primary transmission mechanisms through which EBF operates in Ukraine's wartime economy. However, it is important to note that the effects of EBF on the core macroeconomic indicators at the center of this thesis—GDP growth, inflation, exchange rate, and unemployment—are less direct and not consistently statistically significant within the VAR framework. This finding suggests that while EBF has a strong stabilizing function, its macroeconomic impact is largely mediated through fiscal and financial buffers, rather than through immediate shifts in output or prices. These findings reinforce the importance of institutional absorption capacity and policy coordination in translating external financing into broader economic outcomes.

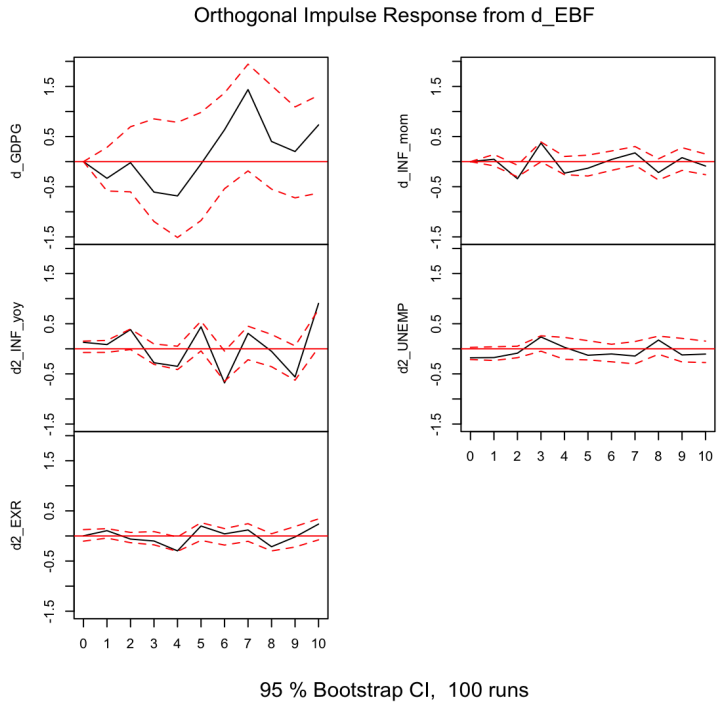
4.7. Impulse Response Analysis

4.7.1. Impulse Response of Key Dependent Variables

To assess the dynamic effects of external budget financing (d_EBF) on key macroeconomic indicators, orthogonalized impulse response functions (IRFs) were estimated over a 10-month horizon with 95% bootstrap confidence intervals (100 simulations). A positive d_EBF shock significantly increases GDP growth (d_GDPG) between the 6th and 8th months, with the response exceeding the upper confidence band – supporting the hypothesis that external inflows stimulate short-term economic activity.

In contrast, responses of monthly inflation (d_INF_mom), year-on-year inflation (d2_INF_yoy), and unemployment (d2_UNEMP) remain within the bands, indicating no significant effect. The exchange rate (d2_EXR) also shows minor, statistically insignificant fluctuations, suggesting external budget support does not drive short-term exchange rate volatility.

Figure 8. Orthogonal Impulse Response from External Budget Financing on Key Dependent Variables



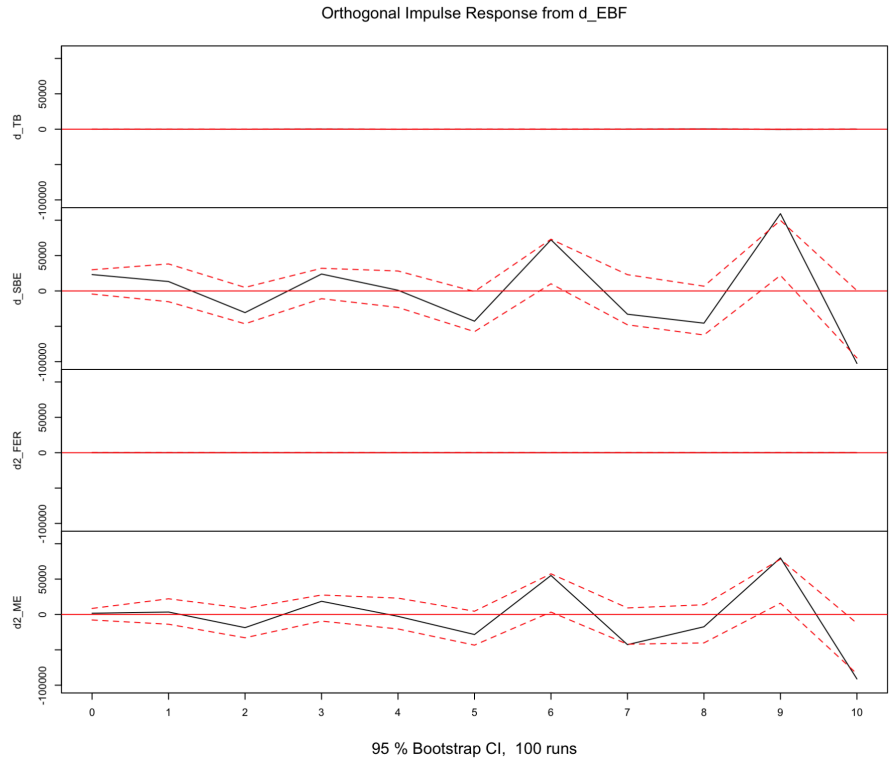
Note: graph created by the author in R-studio based on the collected dataset.

These findings reinforce the notion that external financing primarily boosts real economic activity (GDP growth), while its transmission to prices, labor markets, and exchange rate dynamics is more muted or delayed.

4.7.2. Impulse Response of Other Macroindicators

Figure 9 presents the orthogonal impulse responses of remaining fiscal and financial variables—military expenditures (d2_ME), state budget expenditures (d_SBE), foreign exchange reserves (d2_FER), and the trade balance (d_TB)—to a one-unit shock in external budget financing (d_EBF). The analysis uses a 10-period horizon with 95% bootstrap confidence intervals (100 runs).

Figure 9. Orthogonal Impulse Response from External Budget Financing on Control Variables



Note: graph created by the author in R-studio based on the collected dataset.

The impulse response of military expenditures (ME) demonstrates a statistically significant and positive reaction to a shock in external financing, particularly in

periods 6–10. This suggests that increases in external budget support are associated with subsequent increases in military spending, potentially reflecting donor earmarking or fiscal prioritization during wartime.

The response of state budget expenditures (SBE) is also generally positive, with a statistically significant increase in later periods. While the response is somewhat volatile, the upper bound of the confidence interval is consistently above zero in multiple periods, indicating a moderately strong relationship between EBF and domestic fiscal expansion.

In contrast, the foreign exchange reserves (FER) and trade balance (TB) show no statistically significant response to EBF shocks. Their impulse response lines remain close to zero and within the confidence bands throughout the horizon. This implies that short-term increases in external financing do not immediately affect Ukraine's external balances.

Taken together, these findings highlight that external budget financing primarily drives fiscal policy responses, especially military and general budgetary spending, while exerting limited influence on the country's external sector.

4.8. Granger-tests

To complement the VAR analysis, Granger causality tests were performed using bivariate VAR models to determine whether external budget financing (EBF) provides predictive information about key macroeconomic indicators in Ukraine. The results (Appendix 10) indicate that changes in external budget financing (d_EBF) do not Granger-cause any of the selected macroeconomic indicators—specifically GDP growth (d_GDPG), year-on-year inflation (d2_INF_yoy), the exchange rate (d2_EXR), or unemployment (d2_UNEMP). The null hypothesis, stating that d_EBF does not Granger-cause these variables, cannot be rejected at conventional significance levels, as evidenced by p-values well above the 0.10 threshold (ranging from approximately 0.39 to 0.94).

These findings suggest that historical values of external budget financing, when analyzed in isolation from other economic factors, have limited short-term predictive power over the core real-sector macroeconomic variables examined. Consequently, while EBF has demonstrated broader macro-fiscal relevance and significant contemporaneous impacts within the VAR framework, it does not appear to

independently forecast immediate changes in GDP growth, inflation dynamics, currency movements, or unemployment levels. This underscores the complexity of transmission channels and indicates potential time lags or mediating factors that warrant deeper multivariate exploration.

5. DISCUSSION OF RESULTS

5.1. Discussion of Hypotheses-testing

The empirical analysis examined the impact of external budget financing (EBF) on Ukraine's wartime macroeconomic dynamics. Four hypotheses were proposed, expecting EBF to (H_1) stimulate GDP growth, (H_2) reduce inflation, (H_3) stabilize the exchange rate, and (H_4) reduce unemployment. A null hypothesis (H_0) assumed no significant macroeconomic effect. To evaluate these, five econometric approaches were applied. Table 2 summarizes the outcomes by method and hypothesis.

The results were inconsistent across models, with some methods showing no effect and others revealing delayed or indirect linkages. This inconsistency drove the use of multiple techniques to double-check findings and uncover complex or time-lagged effects that simpler models might overlook.

The analysis began with multivariate OLS regressions, estimating the impact of EBF using its 1-, 3-, and 6-month lags. These models served as a foundational check on direct linear relationships between EBF and the main macroeconomic outcomes. The results for GDP growth revealed no statistically significant effects, although the three-month lag approached significance at the 10% level with a negative sign. This unexpected result may reflect factors such as delayed fund absorption during wartime, monetary tightening in response to foreign inflows, or reverse causality, where EBF increases during downturns. These dynamics suggest a short-term contractionary effect that does not necessarily contradict the longer-term positive impacts of EBF identified in the VAR analysis, thereby offering only limited support for Hypothesis 1. In the models for inflation and unemployment, none of the lagged EBF coefficients were statistically significant, indicating an absence of influence on price levels or labor market conditions and thus offering no support for Hypotheses 2 and 4.

However, a notable and statistically significant finding emerged in the model for the nominal exchange rate. The three-month lag of EBF showed a positive and statistically significant coefficient, indicating that higher EBF inflows were associated with a depreciation of the hryvnia, as measured by an increase in the UAH/USD exchange rate. This result contradicted the initial expectation that EBF would stabilize the currency, suggesting instead that EBF may pose short-term liquidity pressures or trigger market uncertainty. Consequently, while the OLS results provided no consistent support for the real-sector hypotheses, they did partially reject the null

hypothesis by uncovering a significant short-term relationship between EBF and exchange rate dynamics, thereby also partially rejecting Hypothesis 3.

Table 2. Empirical Results by Method and Hypothesis

Hypothesis / Method	OLS Regressions	ARIMA/ ARIMAX	VAR Analysis	Impulse Response Analysis	Granger causality	Overall Result
H0: No significant relationship between EBF and macroeconomic indicators	**Partially rejected**	**Supported** (no significant effect)	**Partially rejected** (significant for fiscal and reserves indicators)	**Partially rejected** (GDP, military, fiscal indicators significant)	**Supported** (no causality found)	**Partially rejected** (EBF significantly affects fiscal indicators and reserves)
H1: Positive influence on GDP growth	Not supported	Not supported	**Partially supported** (significant delayed coefficients)	**Partially supported** (delayed positive effect from 6-8 months)	Not supported	**Partially supported** (significant delayed indirect effects)
H2: Reduces inflationary pressures	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported
H3: Stabilizes exchange rate	**Partially rejected** (significant negative effect with a 3 month lag)	-	Not supported	Not supported	Not supported	**Partially rejected** (significant delayed negative effect)
H4: Stabilizes unemployment	Not supported	-	Not supported	Not supported	Not supported	Not supported

Note: Author's summary of results of hypothesis testing across different econometric methods.

The findings from ARIMA/ARIMAX modeling initially supported the null hypothesis, suggesting no statistically significant immediate or short-term linear relationship between external budget financing and critical real-sector macroeconomic

indicators, particularly GDP growth and inflation. Similarly, Granger causality tests also confirmed this absence of direct short-term predictive power or significant linear association. These methods, characterized by their univariate or simpler structure, indicated that immediate impacts of EBF might be obscured by more complex interactions or delayed economic transmissions.

Despite these preliminary results supporting the null hypothesis, VAR modeling and impulse response functions (IRF) revealed notable differences in results and indirect effects that partially reject the null hypothesis. The VAR analysis identified significant delayed and indirect relationships, particularly between EBF and GDP growth. Specifically, IRFs highlighted a statistically significant positive GDP growth response around six to eight months following external financing shocks. This finding partially aligns with the original hypothesis (H1), implying that external budget assistance indeed promotes economic recovery and public spending stabilization, albeit with considerable time lags and through indirect transmission mechanisms.

Contrary to theoretical expectations articulated in Hypothesis 2 (inflation reduction), external budget financing demonstrated no significant ability to mitigate inflationary pressures in Ukraine's wartime context. Across all methodological approaches—OLS, ARIMAX, VAR, IRF, and Granger causality—there was unanimous evidence of non-significance. Inflation dynamics during the analyzed period seem predominantly driven by structural supply disruptions, currency devaluations, and other wartime factors rather than fiscal inflows. Thus, the research conclusively rejects the hypothesis of external budget support exerting a meaningful short-term anti-inflationary impact.

In the case of the exchange rate, OLS results revealed a significant depreciation effect, but this was not replicated in VAR or IRF models. The discrepancy suggests that any short-run exchange rate pressure from EBF inflows is likely offset over time, potentially by central bank interventions or the managed exchange rate regime. Therefore, while OLS partially rejected Hypothesis 3, the broader evidence does not support the idea that EBF stabilized the currency.

Additionally, external financing displayed no statistically significant relationship with unemployment levels in Ukraine, thus not supporting Hypothesis 4. The analyses—VAR, IRF, Granger causality, and OLS regressions—were consistently aligned, confirming that unemployment patterns during the war were driven primarily

by structural disruptions, demographic shifts, and wartime regulations rather than by variations in external financial assistance.

Importantly, while EBF's direct impact on core real-sector variables was limited, this study uncovered significant broader implications related to Ukraine's fiscal stability and monetary buffer. VAR analysis and IRFs *indicated a substantial positive influence of external financing on state budget expenditures, military spending, and foreign exchange reserves*. These effects, although indirect, reinforce EBF's critical role in preserving Ukraine's fiscal capacity and financial stability during the war, and thus partially reject the null hypothesis through non-growth channels.

Taken together, these results underscore the complexity in the macroeconomic transmission mechanisms during war. The limited direct short-term effects of external budget financing on real macroeconomic variables indicate that wartime shocks and policy responses likely dominate immediate economic conditions. However, the delayed and indirect effects observed, particularly in supporting GDP recovery and enhancing fiscal capacity, underline the essential role external assistance plays in stabilizing public spending, financing defense needs, and maintaining critical monetary reserves.

5.2. Limitations of the Study

Despite the careful methodological approach applied in this research, several important limitations must be acknowledged, particularly concerning data availability, quality, and consistency.

One major limitation concerns the measurement and accuracy of external budget financing data. Detailed, disaggregated monthly data on grants and loans from international donors is not officially published by either the Ministry of Finance or the National Bank of Ukraine (NBU). In practice, the Ministry of Finance announces each tranche on the day of disbursement, often combining grants and loans into a single figure without disclosing the financial terms. The NBU briefly references EBF figures in its Inflation Reports, typically based on Ministry of Finance announcements and internal estimates. The lack of transparency—particularly regarding loan repayment terms—renders this data suitable only for assessing short-term impacts, while long-term implications, such as debt sustainability, remain obscured.

As a result, this study relies on a dataset indirectly compiled from publicly available state budget revenue data. While this dataset represents the most consistent and replicable source available from official Ukrainian institutions, it carries inherent measurement uncertainty. To evaluate reliability, two additional EBF datasets were collected and compared. Although they correlated with the primary dataset, notable discrepancies persisted. The decision to use government-published data was made to ensure methodological consistency and to reflect the information available to domestic policymakers. Nonetheless, it is striking that one of the most detailed and frequently updated datasets on financial aid to Ukraine is produced not by the state, but by the Ukraine Support Tracker at the Kiel Institute (Germany). This resource systematically compiles foreign donor commitments, links them to Ministry of Finance announcements, and provides monthly updates segmented by donor, aid type, and disbursement status. However, its primary shortcoming is the inability to verify the actual receipt and disbursement of funds via the Ukrainian State Treasury, limiting its use in official fiscal tracking.

This ambiguity in EBF reporting diminishes the precision of monthly inflow measurements and undermines the robustness of empirical results—particularly in models sensitive to short-term macroeconomic fluctuations.

Another limitation arises from the availability of high-frequency data for GDP growth and unemployment. Because both are officially reported on a quarterly basis, interpolation was required to generate monthly values for analysis. While this technique addresses the frequency mismatch, it introduces smoothing effects that may dampen real short-term volatility and mask important relationships. This limitation is especially consequential during wartime: economic shocks caused by missile attacks, infrastructure destruction, or sharp behavioral responses to political or military events are likely invisible in interpolated datasets. Consequently, the statistical models may fail to detect immediate dynamics linked to these discrete shocks.

In addition, the unemployment indicator itself is structurally limited under wartime conditions. Ideally, labor market participation or employment rates would serve as more accurate metrics for capturing the economic effects of financial assistance. However, the Ukrainian labor market is currently distorted by temporary regulations, widespread avoidance of unemployment registration (particularly among men avoiding conscription), mass mobilization into the armed forces, significant migration, and the absence of reliable real-time population data. These factors severely

compromise the interpretability of official unemployment figures and likely explain the variable's limited statistical significance in this study's regression results.

Although the study encompasses a five-year period and a broad set of macroeconomic indicators, its explanatory power remains constrained due to the highly endogenous nature of macroeconomic policy. Even advanced models such as VAR face challenges in distinguishing causality in a setting where shocks are large, persistent, and often unpredictable. The war environment introduces wide error margins, complicating the interpretation of statistical relationships. A follow-up study, conducted in a more stable post-war context with a larger sample size, could help confirm and expand these findings.

Finally, a broader limitation observed during the research process is the insufficient availability of high-quality, regularly updated domestic economic data that is publicly accessible and replicable. This gap significantly impedes robust empirical analysis, particularly in times of crisis when informed policy decisions are most critical. Enhancing transparency and data infrastructure should be a strategic priority for Ukrainian institutions to enable more reliable economic monitoring and planning—both during wartime and in post-war recovery.

It is also important to note that the findings of this thesis are highly context-specific to wartime Ukraine and may not be generalizable to other countries or post-conflict periods. The study was conducted during an exceptionally volatile economic and geopolitical environment. The most recent data includes a notable spike in international aid at the end of 2024, likely driven by accelerated disbursements from the Biden administration and urgent responses from other allies. However, just five months later, the situation has already shifted. With the emergence of peace negotiations, changes in U.S. foreign policy, and the cessation of direct U.S. financial support, the dynamics of international aid are evolving rapidly. European Union and European state contributions appear to be increasing to fill the gap. Under such conditions, a study conducted even a year later—with new data—might yield materially different results, underscoring the time-sensitivity of the conclusions drawn here.

6. CONCLUSIONS

This thesis examined the impact of external budget financing on Ukraine's key macroeconomic indicators during the period of 2019–2024, capturing both pre-war relative stability and wartime volatility. Grounded in the hypothesis that international financial inflows significantly influence economic performance, the research employed a comprehensive empirical approach, including OLS regressions, ARIMA/ARIMAX modeling, Vector Autoregression (VAR), impulse response analysis, and Granger causality testing.

The empirical results offer nuanced insights into the role of international financial support during a period of profound crisis. While initial models such as ARIMAX and Granger causality tests found no immediate or linear effects of EBF on core indicators—GDP growth, inflation, exchange rate, and unemployment—more advanced methods, including lagged OLS regressions, VAR modeling, and impulse response functions, revealed important delayed and indirect effects. Specifically, the findings indicate a positive influence of EBF on GDP growth with a lag of six to eight months, and a depreciation effect on the exchange rate with a three-month lag. Moreover, the VAR results highlighted a strong positive relationship between EBF and state budget expenditures, military spending, and foreign exchange reserves. These outcomes underscore the fiscal and monetary stabilizing role of EBF, especially in enhancing Ukraine's resilience during wartime.

The absence of significant impacts on inflation and unemployment points to the dominance of structural shocks and policy-driven factors in shaping wartime macroeconomic dynamics. This highlights that external assistance, while critical, is not sufficient in isolation—it must be coupled with institutional capacity and complementary policies to be effective in the short term.

One of the key institutional buffers mediating the effects of external assistance is the National Bank of Ukraine. Since 2022, the NBU has shifted from a conventional inflation-targeting regime with a floating exchange rate to a more conservative and adaptive framework. This includes pegging the exchange rate for over a year, combining interest rate policy, currency interventions, foreign exchange restrictions, and other monetary instruments to mitigate inflationary pressures and stabilize expectations.

The NBU's steep increase of the key policy rate to 25% in response to inflationary shocks and its issuance of high-return military bonds reflect a contractionary stance aimed at suppressing aggregate demand to maintain price stability. This trade-off—between suppressing inflation and constraining growth—illustrates the complexity of policy management during war.

Additionally, regular and targeted foreign exchange interventions became an essential tool to maintain exchange rate stability. While the war created a structural foreign currency shortage in the private sector—partly due to regulatory restrictions—Ukraine managed to accumulate substantial international reserves. These reserves act as a non-market buffer, shielding the economy from immediate exchange rate volatility while serving as a stabilization fund. The NBU's strategy, which involves gradually returning to a floating exchange rate regime once economic conditions permit, reflects its active and cautious approach in managing EBF inflows and shielding the economy from potential shocks.

In general, the inflation observed in Ukraine between 2022 and 2024 appears to be structural rather than purely monetary. The hypothesis that high donor inflows combined with domestic deficit financing would trigger inflation through excessive liquidity creation was not supported by the study's findings. Instead, VAR model results show that inflation dynamics are largely driven by supply-side disruptions—such as exchange rate depreciation, unemployment, and military spending—rather than demand overheating. Short-term inflation increases appear to coincide with GDP contractions, indicating that inflationary pressure is tied to output loss and war-related bottlenecks, rather than excessive consumer demand.

The second key intermediary that buffers the impact of international financial assistance is the state budget, managed by the Ministry of Finance and the State Treasury. The VAR model showed that EBF has significant direct effects on budgetary and defense expenditures and foreign exchange reserves. Consequently, any disruption in external funding first affects public spending, before rippling through to the wider economy. This finding mirrors the Ministry of Finance's frequent communications with donors, emphasizing that predictable and timely financial inflows are essential to sustaining core public functions and delivering socio-economic support during wartime. That these systems have held together despite intense fiscal pressure and military threats is a testament to Ukraine's institutional resilience and contributes to public confidence, helping reduce panic and outmigration.

Nonetheless, the study faced important limitations—particularly in data availability and reliability. Monthly disaggregated data on EBF from official sources was not available, requiring indirect estimations. GDP and unemployment data, published only quarterly, had to be interpolated for monthly analysis, introducing smoothing effects that may have masked short-term relationships. Unemployment data was further distorted by wartime labor market anomalies, population displacement, and irregular registration practices, reducing the precision of estimates related to labor dynamics.

Despite these constraints, the research contributes important empirical insights for both policymakers and scholars. It underscores the value of strategic timing, allocation, and management of financial assistance, and the importance of reinforcing institutional mechanisms that mediate its effects. The findings also highlight the urgent need to improve domestic economic data infrastructure, which is critical for timely and informed decision-making under crisis conditions.

In conclusion, this study highlights the complex and often indirect role that external financial assistance plays in supporting Ukraine's wartime economy. While donor funding has proven essential in sustaining public spending and foreign reserves, its effects on broader macroeconomic indicators depend heavily on institutional management and structural conditions. Going forward, future research should continue to examine not only whether aid matters, but how it flows through public systems and interacts with domestic policy tools. As Ukraine moves toward eventual recovery, understanding these dynamics will be critical for designing effective financial support strategies that strengthen both resilience during crisis and long-term economic stability.

7. POLICY PROPOSAL

The empirical findings of this thesis highlight several critical challenges and opportunities in Ukraine's wartime economic management, particularly regarding the role and impacts of external budget financing. To effectively leverage international assistance and to prepare robust contingencies in case external support diminishes, policymakers must address two central priorities: (1) the urgent need for improved transparency and accessibility of economic and fiscal data, and (2) clear and actionable strategies for maintaining fiscal stability in case of various scenarios.

7.1. Improvement of Data Transparency and Accessibility

One of the most persistent challenges identified in this research is the lack of timely, reliable, and disaggregated data on external budget financing in Ukraine. As highlighted in the limitations chapter, the absence of standardized monthly records on grants, loans, and guarantees—combined with limited information on financial terms, disbursement timelines, and budget allocation—undermines the quality of economic analysis and constrains sound fiscal planning. This gap not only affected the empirical robustness of this thesis but poses a systemic risk to national budget governance and weakens the confidence of international partners.

To address this, Ukraine must prioritize the institutionalization of a centralized, open-access EBF database, jointly managed by the Ministry of Finance and the National Bank of Ukraine (NBU). The platform should be integrated into the existing OpenBudget portal and include:

- Monthly disaggregation of EBF by type (grants, loans, guarantees), donor source, and financing terms;
- Linkages between received funds and actual expenditures, broken down by programmatic purpose;
- Real-time updates on the status of commitments (pledged, approved, disbursed).

To create a transparent link between external financing and measurable recovery outcomes, this platform should be connected to the DREAM system administered by the Ministry for Communities, Territories and Infrastructure Development. This integration would establish a unified accountability framework—from donor contributions to public spending and on-the-ground

implementation—enabling both domestic institutions and international donors to monitor not only what is received, but also what is delivered.

Crucially, the platform must allow public access and enable data downloads in user-friendly formats. This would foster independent analysis by researchers, civil society organizations, and journalists, promoting accountability and improving the evidence base for policy decisions. Demonstrating a clear commitment to open data will also reinforce Ukraine's case for multi-year donor commitments—one of the key policy implications arising from this thesis, given the delayed but significant macroeconomic effects of EBF.

The value of such data transparency in a war-affected context cannot be overstated. Experience from other post-conflict economies shows a direct correlation between the availability of detailed economic data and the success of recovery and reconstruction efforts. To attract and sustain large-scale donor support, Ukraine must credibly document the scale of wartime destruction, the structure of ongoing public expenditures, and the progress made in recovery. Without reliable baseline data—on infrastructure damage, regional economic disruptions, and demographic changes—even well-funded programs risk inefficiency, misallocation of resources, and reputational setbacks.

Accordingly, the government should adopt additional institutional measures to build trust and improve oversight:

- Quarterly public reporting on macroeconomic and social outcomes linked to EBF;
- Independent external audits assessing the effectiveness and multiplier impact of budget support;
- Development of a return-on-assistance (ROA) framework to evaluate aid effectiveness in both economic and social dimensions.

International financial institutions and partner governments consistently stress transparency as a prerequisite for continued support. Proactive steps toward standardized, timely, and publicly accessible fiscal reporting would not only strengthen Ukraine's wartime economic governance but also establish a durable foundation for a coordinated and credible post-war recovery strategy.

7.2. Strategic Policy Response in the Event of Declining International Support

The findings of this thesis carry significant implications for a scenario in which external budget financing declines or ceases entirely. As demonstrated by VAR and impulse response analyses, EBF plays a stabilizing role in Ukraine's wartime economy—primarily through fiscal channels that expand state budget capacity, bolster foreign exchange reserves, and sustain military spending. However, these effects materialize with a 6–8 month delay, highlighting the importance of predictable, sustained, and institutionally embedded financial inflows to support macroeconomic stability and fiscal planning.

In the event of a sharp reduction or disruption in donor financing, Ukraine must be prepared to implement a coordinated response across monetary, fiscal, and institutional domains.

7.2.1. Prioritize Institutional Budget Support Over Project-Based Aid

Given the demonstrated positive effects of EBF on GDP growth and fiscal capacity, Ukraine's international partners should prioritize direct budget support over narrowly targeted sectoral or project-based assistance. Grants, in particular, are highly effective in wartime, as they strengthen the government's ability to meet essential obligations without increasing future debt burdens. Future EBF arrangements should emphasize unconditional or moderately conditional macro-financial support, tied to transparency and institutional performance rather than short-term output indicators. This approach provides necessary flexibility for national budget planning while reinforcing mutual accountability with donors.

7.2.2. Ensure Predictability and Cyclical Alignment of Aid Disbursement

Because EBF impacts emerge gradually, irregular or delayed disbursements weaken its stabilizing role. To mitigate this, Ukraine and its partners should institutionalize multi-year financial commitments, ideally spanning 12–18 months, to reduce uncertainty and improve expenditure planning. Furthermore, aid disbursements should be synchronized with Ukraine's budgetary and monetary cycles, allowing for greater consistency between fiscal operations and central bank policy.

7.2.3. Prepare Contingency Mechanisms for Temporary Fiscal Gaps

In cases where external support declines unexpectedly, Ukraine may need to temporarily rely on limited monetary financing, such as direct central bank support or quantitative easing by the National Bank of Ukraine (NBU). While such tools carry inflationary risks, this study finds that even large-scale external inflows, unaccompanied by commensurate output growth, have not caused significant inflationary pressures. This suggests that carefully managed monetary interventions, deployed with clear communication and time-bound targets, could serve as a short-term fiscal backstop.

To limit risks, monetary emissions should be targeted at investment-oriented public programs that enhance productive capacity and employment. The NBU must maintain its operational independence, transparently communicate its objectives, and implement a credible exit strategy once fiscal conditions stabilize.

A more sustainable option is to expand domestic borrowing through war bonds, mobilizing savings from the public and institutional investors. This classical Keynesian approach can channel domestic capital toward defense and essential public services. However, the issuance of such bonds must be managed carefully to avoid crowding out private credit or raising borrowing costs beyond sustainable levels.

7.2.4. Link EBF to Domestic Investment and Resilience Building

To reduce aid dependency and increase the long-term impact of donor funds, Ukraine should align EBF with national investment programs in sectors with high economic and social returns—particularly energy, housing, and healthcare. In addition, the government should allocate a portion of foreign reserve inflows toward a fiscal resilience fund, designed to accumulate surplus EBF during high-inflow periods. This buffer would increase the country's capacity to absorb external shocks, smooth volatility, and reduce the need for emergency interventions in future downturns.

7.2.5. Avoid Premature or Uncoordinated Austerity

The least desirable, yet potentially unavoidable, scenario involves a shift toward fiscal austerity to adjust expenditures in line with reduced revenue. While such a response may preserve formal macroeconomic balances, the social and political costs can be severe—disrupting public services, delaying reconstruction, and deepening unemployment. According to IMF data, Ukraine's primary government expenditures

reached 70.5% of GDP in 2023, indicating that public spending remains the backbone of wartime economic resilience. (IMF, 2025) Large-scale cuts would not only undermine vulnerable populations but also depress aggregate demand, increasing the risk of a recessionary spiral. As such, austerity should remain a policy of last resort, pursued only with strong social safety nets and selective expenditure prioritization.

In sum, navigating a decline in EBF will require a delicate balance of fiscal flexibility and long-term institutional reforms. Ukraine must collaborate with donors to sustain grant-based, transparent, and multi-year budget support, while simultaneously strengthening domestic mechanisms that build fiscal resilience. Coordinating aid flows with national policy cycles, anchoring assistance in domestic investment priorities, and maintaining public trust through accountable institutions will be key to managing economic uncertainty.

7. 3. Policy Options Under Three Strategic Scenarios

This section outlines three plausible fiscal scenarios for Ukraine through 2025–2026, drawing from both the empirical findings of this thesis and broader macroeconomic theory. The VAR and impulse response analyses in this study demonstrate that external budget financing contributes to GDP growth, increases public spending, and boosts reserves—primarily through delayed and indirect channels, with effects materializing 6–8 months after disbursement. These findings align with fiscal transmission theory, where aid operates as a delayed stabilizer in economies under stress. Moreover, the study found no significant inflationary response to EBF, indicating the role of institutional controls and supply-side constraints during wartime. The scenarios below apply these findings to Ukraine's current and projected wartime conditions.

7.3.1. Stable External Support During Ongoing Conflict

This scenario assumes international donors maintain consistent levels of budget support through at least the end of 2025. According to this thesis's findings, such support—when predictable and institutionally managed—contributes to macroeconomic stability by sustaining fiscal capacity and stimulating GDP growth, even in wartime conditions. This reflects Keynesian countercyclical principles: external aid functions as a fiscal buffer when domestic revenues fall short.

Moreover, since macro effects of EBF emerge with a delay, stable inflows allow policymakers to plan, sequence reforms, and avoid procyclical cuts. The absence of EBF-induced inflation also suggests that moderate fiscal expansion remains feasible.

Policy recommendations:

- Preserve full funding for defense and essential services.
- Use the fiscal space from EBF to support targeted stimulus (e.g., SME support, infrastructure maintenance) without breaching inflationary thresholds.
- Launch structural reforms in taxation, budget planning, and public investment management, leveraging predictable aid to build long-term capacity.
- Begin designing a medium-term debt strategy that balances war-related liabilities with economic recovery targets.

7.3.2. Declining External Support Amid Continued Conflict

This scenario reflects a partial or sudden reduction in donor support, while hostilities continue. Empirically, this is the most fragile environment, because EBF's delayed benefits will not offset an immediate revenue shortfall. This dynamic aligns with liquidity constraint theory: sudden drops in financing can trigger forced expenditure cuts and increase fiscal pressure before stabilizing forces take effect. In wartime, these shocks are magnified due to limited domestic financing options and high social spending needs.

Although the thesis finds no direct inflationary effects from EBF, it also shows that unemployment and exchange rate pressures do contribute to inflation. In such a constrained environment, fiscal policy tends to become reactive rather than strategic.

Policy recommendations:

- Reprioritize spending toward military readiness and essential social functions.
- Scale back or defer lower-priority programs and streamline public administration to preserve liquidity.
- Expand issuance of domestic war bonds, especially to households and institutional investors, ensuring yields are calibrated to preserve financial stability.
- Consider targeted monetary interventions in sectors with high short-term employment or production multipliers (e.g., repair infrastructure, agriculture).

- Strengthen fiscal buffers by negotiating multi-year aid frameworks to reduce future volatility and restore planning credibility.

7.3.3. Post-War Transition with Gradual Decline in Budget Support

This scenario assumes a cessation of large-scale hostilities and a gradual reduction in direct EBF as Ukraine transitions to a recovery phase. Historically, such transitions are marked by a "golden window" in which international goodwill, donor availability, and political unity can converge to accelerate structural reforms (Blanchard & Fischer, 1989).

This thesis's findings that EBF boosts reserves and public expenditure support a recovery-oriented reallocation. However, the delayed GDP effect also implies that short-term donor financing should be leveraged for medium-term growth returns, not just short-term stabilization.

Policy recommendations:

- Prioritize investments in productive, high value-added, export-oriented sectors (e.g., dual-use defense, green tech, IT).
- Expand fiscal resilience through stocking international reserves to prepare for future shocks or cyclical downturns.
- Shift EBF usage from gap-filling toward sustainable long-term investments with private sector participation.
- Target public investment in human capital recovery (education, reskilling, mental health) to address wartime demographic shocks and restore workforce potential.
- Institutionalize return-on-assistance (ROA) evaluation frameworks to measure the impact of international aid on long-term growth and equity.

Each of the described scenarios presents distinct fiscal constraints and opportunities. Yet across all of them, the core insight remains straightforward: external budget financing has a stabilizing effect—but only when it is predictable, transparently managed, and institutionally absorbed into national planning frameworks. Ukraine's policy choices must therefore aim not only to react to changing donor flows, but also to internalize and optimize their delayed effects, linking wartime stabilization to post-war recovery.

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APPENDICES

Appendix 1. Descriptive statistics

vars	mean	sd	median	trimmed	mad	min	max	range	skew	kurtosis	se
EBF (UAH mln)	147596.6	190536.10	44860.7	118700.2	85109.4	-42492.0	686889.9	729381.9	1.14	0.17	22454.90
GDP Growth Quarterly (%)	-2.9	13.81	2.05	-1.0	5.9	-37.2	19.2	56.4	-1.27	0.86	1.63
GDP Growth Monthly (%)	-2.9	13.14	2.05	-1.0	5.3	-37.2	19.2	56.4	-1.33	0.82	1.55
Inflation (%) MoM	0.8	0.94	0.7	0.7	0.7	-1.4	4.5	5.9	1.05	2.56	0.11
Inflation (%) YoY	10.0	6.96	8.8	9.0	5.5	1.7	26.6	24.9	1.07	0.20	0.82
Exchange rate (USD)	31.5	5.68	28.32	31.2	4.9	23.6	41.8	18.1	0.41	-1.45	0.67
Unemployment (Thousands)	607.5	287.96	568.53	595.9	335.9	120.7	1247.2	1126.5	0.29	-1.00	33.94
Unemployment (%) Quarterly	13.2	5.25	11.15	12.6	3.8	7.8	26.1	18.3	0.96	-0.27	0.62
Unemployment Monthly	13.2	5.15	10.35	12.6	3.5	7.0	26.1	19.1	0.83	-0.63	0.61
State Budget Expenditures (UAH mln)	235364.0	152478.90	182806	217779.6	139855.4	65817.4	824157.2	758339.8	1.21	1.73	17969.80

Military Expenditures (UAH mln)	81959.5	90666.79	20437.4	69560.4	22339.1	4206.4	403894.0	399687.6	1.08	0.76	10685.18
Foreign Exchange Reserves (USD bln)	29.7	6.74	28.5	29.4	5.2	19.4	43.8	24.4	0.46	-0.97	0.79
Key Policy Rate (%)	14.5	6.56	13.5	14.3	7.0	6.0	25.0	19.0	0.38	-1.14	0.77
Trade balance (USD mln)	-1626.2	1381.21	-1306.5	-1593.3	1790.2	-4269.0	780.0	5049.0	-0.19	-1.38	162.78
n=72											

Appendix 2. ADF Test Results

Variable	ADF Statistic	p-value	Stationary at Level?
EBF	-2.3977	0.4134	No
GDPG	-2.9111	0.2044	No
INF_mom	-2.392	0.4157	No
INF_yoy	-2.7468	0.2712	No
UNEMP_m	-1.9618	0.5909	No
EXR (USD)	-2.4657	0.3857	No
Policy Rate	-2.001	0.5749	No
FER GROSS (mln USD)	-2.0655	0.5487	No
ME (UAH mln) monthly	-1.5297	0.7668	No
SBE (UAH mln) monthly	-2.5435	0.354	No
Trade balance (mln USD)	-1.824	0.647	No

Appendix 3. ADF 1st Differences Test Results

Variable	ADF Statistic	p-value	Stationary at Level?
d_EBF	-3.8278	0.0225	Yes
d_GDPG	-3.1127	0.1225	No
d_INF_mom	-5.5309	0.01	Yes
d_INF_yoy	-2.5986	0.3317	No
d_UNEMP	-2.8827	0.2161	No
d_EXR	-3.0436	0.1506	No
d_Policy	-2.8401	0.2334	No
d_FER	-2.9475	0.1897	No
d_ME	-3.2541	0.0862	No
d_SBE	-6.0508	0.01	Yes
d_TB	-4.9565	0.01	Yes

Appendix 4. ADF 2nd Differences Test Results

Variable	ADF_Statistic	p_value	Stationary
d2_GDPG	-4.0178	0.01405	Yes
d2_INF_yoy	-3.9319	0.0179	Yes
d2_UNEMP	-4.6863	0.01	Yes
d2_EXR	-5.6599	0.01	Yes
d2_Policy	-5.7311	0.01	Yes
d2_FER	-6.0094	0.01	Yes
d2_ME	-4.6086	0.01	Yes

Appendix 5. ARIMAX Results

Model	Term	Estimate	Std. Error
GDPG	(Intercept)	-3.215	1.9498
GDPG	EBF	0	0.0001
INF_mom	(Intercept)	0.7812	0.1397
INF_mom	EBF	0	0.0001

Appendix 6. VAR M1 Results

	GDPG		INF		UNEMP		EXR		Policy Rate		FER		ME	
Variable	Coef	pval	Coef	pval	Coef	pval	Coef	pval	Coef	pval	Coef	pval	Coef	pval
d2_GDPG.l1	-0.009	0.95	-0.023	0.64	0.018	0.68	0.009	0.84	0.096	0.44	0.013	0.93	1249.5	0.76
d2_INF_yoy.l1	0.091	0.81	-0.395	0.00	0.013	0.90	0.010	0.93	-0.267	0.39	-0.019	0.96	3349.5	0.75
d2_UNEMP.l1	-0.477	0.33	-0.128	0.43	0.327	0.02	-0.347	0.02	1.190	0.00	0.162	0.73	8709.7	0.52
d2_EXR.l1	0.249	0.56	-0.146	0.31	-0.164	0.19	-0.313	0.01	0.050	0.89	0.626	0.14	-3083.8	0.80
d2_Policy.l1	0.362	0.01	-0.042	0.39	-0.251	0.00	0.039	0.35	-0.644	0.00	-0.083	0.56	-8610.0	0.03
d2_FER.l1	0.066	0.59	-0.020	0.62	0.015	0.68	-0.043	0.22	-0.023	0.82	-0.430	0.00	1426.1	0.67
d2_ME.l1	0.000	0.61	0.000	0.46	0.000	0.96	0.000	0.50	0.000	0.15	0.000	0.75	-0.6	0.00
const	-0.018	0.96	0.024	0.83	-0.007	0.94	0.005	0.96	0.033	0.91	0.038	0.91	3112.3	0.74

Appendix 7. VAR M2 Results

Estimate	Std. Error	t value	Pr(>|t|)	Variable	Equation
0.777351	0.221179	3.514579	0.00206	d_GDPG.l1	d_GDPG
0.761818	0.32066	2.375781	0.027108	d2_Policy.l1	d_GDPG
-0.6045	0.278261	-2.17241	0.04142	d2_FER.l1	d_GDPG
-1.89881	0.794179	-2.39091	0.026251	d_INF_mom.l2	d_GDPG
0.003129	0.001011	3.09647	0.005467	d_TB.l2	d_GDPG
-2.66969	0.889267	-3.00213	0.006789	d2_UNEMP.l2	d_GDPG
-2.80683	0.995676	-2.81902	0.010281	d2_EXR.l2	d_GDPG
-1.92482	0.720408	-2.67185	0.014272	d2_EXR.l3	d_GDPG
-1.64631	0.746483	-2.20543	0.038705	d2_EXR.l4	d_GDPG
-0.20064	0.082095	-2.44396	0.023441	d_GDPG.l2	d_INF_mom
0.754314	0.312474	2.414007	0.024991	d_EBF.l4	d_EBF
-555.636	231.9392	-2.39561	0.02599	d2_UNEMP.l1	d_TB
-0.00693	0.003169	-2.18618	0.040268	d_SBE.l3	d_TB
-260.987	124.5917	-2.09474	0.048501	d2_Policy.l3	d_TB
-0.00773	0.003583	-2.15781	0.042675	d_SBE.l4	d_TB
-237.248	103.3685	-2.29517	0.032126	d2_Policy.l4	d_TB
15645.19	7505.63	2.08446	0.049515	d_GDPG.l1	d_SBE
0.524766	0.163006	3.219308	0.004115	d_EBF.l1	d_SBE
-0.88402	0.329809	-2.68041	0.014004	d_SBE.l1	d_SBE
-27261	9572.925	-2.84772	0.009638	d_GDPG.l2	d_SBE
22923.58	10105.84	2.268351	0.033976	d2_FER.l3	d_SBE
0.72709	0.267129	2.721871	0.012774	d2_UNEMP.l2	d2_INF_yoy
0.724802	0.299093	2.42333	0.024499	d2_EXR.l2	d2_INF_yoy
0.438502	0.188484	2.326474	0.030083	d2_INF_yoy.l3	d2_INF_yoy
1.79E-05	6.63E-06	2.696856	0.013504	d2_ME.l4	d2_INF_yoy
-0.40021	0.083373	-4.80019	9.62E-05	d2_Policy.l1	d2_UNEMP
0.584401	0.206491	2.830157	0.010027	d_INF_mom.l2	d2_UNEMP

-5.80E-06	2.76E-06	-2.09252	0.048718	d_SBE.l2	d2_UNEMP
0.668114	0.231214	2.889592	0.008769	d2_UNEMP.l2	d2_UNEMP
-0.30957	0.14879	-2.08057	0.049904	d2_Policy.l3	d2_EXR
0.300774	0.12069	2.492119	0.021135	d_GDPG.l1	d2_Policy
1.182567	0.448265	2.638095	0.015375	d2_EXR.l1	d2_Policy
-1.20491	0.174973	-6.88623	8.34E-07	d2_Policy.l1	d2_Policy
2.561385	0.485243	5.278561	3.11E-05	d2_UNEMP.l2	d2_Policy
-1.12892	0.289461	-3.90008	0.000825	d2_Policy.l2	d2_Policy
0.779004	0.342383	2.275242	0.033491	d2_INF_yoy.l3	d2_Policy
-0.65499	0.296463	-2.20937	0.038392	d2_Policy.l3	d2_Policy
1.08E-05	3.02E-06	3.562439	0.00184	d_EBF.l1	d2_FER
-0.69295	0.174911	-3.96175	0.000712	d2_FER.l1	d2_FER
-0.36786	0.173767	-2.11698	0.046369	d_GDPG.l3	d2_FER
1.323569	0.522571	2.532804	0.019353	d_INF_mom.l4	d2_FER
8033.285	2999.467	2.678237	0.014072	d_GDPG.l1	d2_ME
0.221836	0.065142	3.405439	0.002664	d_EBF.l1	d2_ME
33.57141	13.68123	2.45383	0.02295	d_TB.l1	d2_ME
45551.18	13716.02	3.32102	0.003246	d2_UNEMP.l1	d2_ME
-1.4696	0.364013	-4.03723	0.000594	d2_ME.l1	d2_ME
-18359.7	3825.619	-4.79915	9.64E-05	d_GDPG.l2	d2_ME
-30403.4	12059.59	-2.5211	0.019851	d2_UNEMP.l2	d2_ME
-1.48901	0.569045	-2.61669	0.016116	d2_ME.l2	d2_ME
15844.85	3748.903	4.22653	0.000378	d_GDPG.l3	d2_ME
29257.01	12112.44	2.415452	0.024914	d_INF_mom.l3	d2_ME
13351.72	4038.586	3.30604	0.003362	d2_FER.l3	d2_ME
-6183.59	2964.092	-2.08617	0.049345	d_GDPG.l4	d2_ME
15114.39	6112.83	2.472569	0.022044	d2_Policy.l4	d2_ME

Appendix 8. VAR M2 Results per Variable

Equation	R_squared	Adjusted_R_squared	F_statistic_p_value
d_GDPG	0.903531	0.701404	0.000242
d_INF_mom	0.844679	0.519246	0.0104
d_EBF	0.870316	0.598598	0.002704
d_TB	0.79058	0.351795	0.073259
d_SBE	0.878485	0.623881	0.001622
d2_INF_yoy	0.873052	0.607065	0.00229
d2_UNEMP	0.903194	0.700362	0.00025
d2_EXR	0.854622	0.550022	0.006427
d2_Policy	0.947326	0.836961	1.03E-06
d2_FER	0.935258	0.799607	7.03E-06
d2_ME	0.970419	0.908441	3.79E-09

Appendix 9. Effects of External Budget Financing

Variable	Equation	Estimate	Std. Error	t value	Pr(>|t|)	Significance
d_EBF.l4	d_EBF	0.754314	0.312474	2.414007	0.024991	*
d_EBF.l1	d_SBE	0.524766	0.163006	3.219308	0.004115	**
d_EBF.l1	d2_FER	1.08E-05	3.02E-06	3.562439	0.00184	**
d_EBF.l1	d2_ME	0.221836	0.065142	3.405439	0.002664	**

Appendix 10. Granger test results

Response Variable	F-statistic	p-value	Significance
d_GDPG	0.1871	0.8296	-
d2_INF_yoy	0.9248	0.3993	-
d2_EXR	0.5693	0.5674	-
d2_UNEMP	0.0632	0.9388	-

Appendix 12. Code in R-studio

```
# 1. Load Required Packages
# ----------------------------------------
required_packages <- c("readxl", "zoo", "dplyr", "writexl")
new_packages <- required_packages[!(required_packages %in%
installed.packages()[,"Package"])]
if(length(new_packages)) install.packages(new_packages)
lapply(required_packages, library, character.only = TRUE)
# 2. Load Dataset from Excel
# ----------------------------------------
df <- read_excel("Desktop/05.04 - Thesis Data.xlsx", sheet = "Original ")
df$Date <- as.Date(df$`Date (YYYY-MM)`)
# 3. GDPG Interpolation and Replication
# ----------------------------------------
gdp_quarterly <- df$`GDPG (%) Quarterly - yoy % change`[seq(3, nrow(df), 3)]
gdp_monthly_rep <- rep(gdp_quarterly, each = 3)
gdp_monthly_rep <- c(gdp_monthly_rep, rep(NA, nrow(df) - length(gdp_monthly_rep)))
gdp_monthly_na <- rep(NA, nrow(df))
gdp_monthly_na[seq(3, nrow(df), 3)] <- gdp_quarterly
gdp_monthly_interp <- na.approx(gdp_monthly_na, na.rm = FALSE)
# 4. UNEMP Interpolation and Replication
# ----------------------------------------
df$UNEMP_clean <- as.numeric(gsub(",", ".", df$`UNEMP (%) quarterly`))
unemp_quarterly <- df$UNEMP_clean[seq(3, nrow(df), 3)]
unemp_monthly_rep <- rep(unemp_quarterly, each = 3)
```

```
unemp_monthly_rep <- c(unemp_monthly_rep, rep(NA, nrow(df)
length(unemp_monthly_rep)))
# Monthly interpolation
unemp_monthly_na <- rep(NA, nrow(df))
unemp_monthly_na[seq(3, nrow(df), 3)] <- unemp_quarterly
unemp_monthly_interp <- na.approx(unemp_monthly_na, na.rm = FALSE)
# 5. Append Transformed Variables to Dataset
# ----------------------------------------
df <- df %>%
 mutate(
   GDPG_monthly_rep     = gdp_monthly_rep,
   GDPG_monthly_interp  = gdp_monthly_interp,
   UNEMP_monthly_rep    = unemp_monthly_rep,
   UNEMP_monthly_interp = unemp_monthly_interp  )
# 6. Save Dataset to Excel
# ----------------------------------------
write_xlsx(df, "updated_thesis_data.xlsx")
# 7. Additional Transformations: Scaling and Lags
# ----------------------------------------
# Scaling EBF to billions and generating lagged variables
df <- df %>%
 arrange(Date) %>%
 mutate(
   ebf_bln  = EBF / 1e9,
   ebf_lag1 = lag(EBF, 1) / 1e9,
   ebf_lag2 = lag(EBF, 2) / 1e9
 )
```

Descriptive Statistics

```
# Load packages
# ------------------------------
install.packages(c("readxl", "dplyr", "ggplot2", "psych", "tidyr"))
install.packages("psych")
library(readxl)
library(dplyr)
library(ggplot2)
library(psych)
library(tidyr)
#  Load data
```

```
# ------------------------------
df <- read_excel("Desktop/Thesis data.xlsx", sheet = "Sheet1")
# Convert date column
df$Date <- as.Date(df$`Date (YYYY-MM)`)
# Clean UNEMP
df$`UNEMP (%) quarterly` <- as.numeric(gsub(",", ".", df$`UNEMP (%) quarterly`))
# Descriptive statistics
# ------------------------------
# Select only numeric columns
numeric_vars <- df %>% select(where(is.numeric))
library(psych)
# Descriptive summary
describe(numeric_vars)
install.packages("writexl")
library(writexl)
write_xlsx(as.data.frame(describe(numeric_vars)), "descriptive_stats.xlsx")
#Visualizations
# ------------------------------
# A. Time series plot of variables
library(ggplot2)
library(scales)  # for label formatting
# Custom theme
my_theme <- theme_minimal(base_size = 14) +
 theme(
   plot.title = element_text(face = "bold", hjust = 0.5),
   axis.title.y = element_text(face = "bold"),
   panel.grid.minor = element_blank()
 )
#Correlation matrix
install.packages("corrplot")
library(corrplot)
cor_matrix <- cor(numeric_vars, use = "complete.obs")
corrplot(cor_matrix, method = "color", type = "lower", tl.cex = 0.8)
# Load packages
# -------------------------------
library(tidyverse)
library(readxl)
library(scales)
```

```
# Load and clean data
# --------------------------------
df <- read_excel("Desktop/Thesis data.xlsx", sheet = "Sheet1")
df$Date <- as.Date(df$`Date (YYYY-MM)`)
df <- df %>%
 rename(
   EBF_mln  = EBF,
   SBE_mln  = `SBE (UAH mln) monthly`,
   ME_mln   = `ME (UAH) monthly`
 )
# Define themes
# --------------------------------
macro_vars <- c("GDPG_m", "INF (%) yoy", "INF (%) mom")
monetary_vars <- c("EXR (USD)", "Policy Rate", "FER GROSS (mln USD)")
fiscal_vars <- c("EBF_mln", "SBE_mln", "ME_mln")
labour_vars <- c("UNEMP_m")
external_vars <- c("Trade balance (mln USD)")
# Define the plotting function
# -------------------------------------
plot_faceted <- function(df, vars, title = "Time Series Plot") {
 df_long <- df %>%
   select(Date, all_of(vars)) %>%
   pivot_longer(-Date, names_to = "Variable", values_to = "Value")
   ggplot(df_long, aes(x = Date, y = Value)) +
   geom_line(color = "darkblue") +
   facet_wrap(~Variable, scales = "free_y", ncol = 1) +
   theme_minimal(base_size = 14) +
   labs(title = title, y = NULL, x = NULL) +
   theme(
     plot.title = element_text(face = "bold", hjust = 0.5),
     strip.text = element_text(face = "bold")  )}
# Function for each theme
# -------------------------------------
plot_faceted(df, macro_vars, "Macroeconomic Indicators Over Time")
plot_faceted(df, monetary_vars, "Monetary Indicators Over Time")
# Load required packages
library(ggplot2)
library(scales)
```

```
library(dplyr)
library(tidyr)
# Optional: create renamed variables
df_plot <- df %>%
  select(Date,
         `External Budget Financing` = EBF_mln,
         `Military Expenditures` = ME_mln,
         `Government Expenditures` = SBE_mln) %>%
  pivot_longer(-Date, names_to = "Variable", values_to = "Value")
# Plot with improved scale and labels
ggplot(df_plot, aes(x = Date, y = Value)) +
  geom_line(color = "darkblue", linewidth = 0.8) +
  facet_wrap(~Variable, scales = "free_y", ncol = 1) +
  scale_y_continuous(
    labels = label_number(scale_cut = cut_short_scale()),  # E.g. 100K, 1M
    expand = expansion(mult = c(0, 0.05))
  ) +
  labs(
    title = "Fiscal Indicators Over Time",
    y = "UAH, million",
    x = NULL
  ) +
  theme_minimal(base_size = 13) +
  theme(
    strip.text = element_text(size = 13, face = "bold"),
    plot.title = element_text(size = 16, face = "bold", hjust = 0.5),
    axis.text.y = element_text(size = 11)
  )
plot_faceted(df, labour_vars, "Labor Market Indicators Over Time")
custom_labels <- c(UNEMP_m = "Unemployment Rate - interpolated (%)")
df %>%
  select(Date, UNEMP_m) %>%
  pivot_longer(-Date, names_to = "Variable", values_to = "Value") %>%
  ggplot(aes(x = Date, y = Value)) +
  geom_line(color = "darkblue", linewidth = 1) +
  facet_wrap(~Variable, scales = "free_y", ncol = 1, labeller = labeller(Variable =
custom_labels)) +
  scale_y_continuous(
```

```
  expand = expansion(mult = c(0, 0.05))
 ) +
 labs(title = "Labor Market Indicators Over Time", y = NULL, x = NULL) +
 theme_minimal(base_size = 14)
plot_faceted(df, external_vars, "External Sector Indicators Over Time")
```

Models

```
# ====================================================
# Thesis Analysis Code – Macroeconomic Modeling in R
# ====================================================
# 1. Load Required Libraries
# ----------------------------------------
required_packages <- c(
 "tseries", "forecast", "vars", "lmtest", "dplyr",
 "readxl", "writexl", "modelsummary", "broom", "tidyr")
new_packages <- required_packages[!(required_packages %in% installed.packages()[,
"Package"])]
if (length(new_packages)) install.packages(new_packages)
# Load libraries
lapply(required_packages, library, character.only = TRUE)
library(readxl)
library(dplyr)
library(modelsummary)
library(stargazer)
library(car)
library(flextable)
library(broom)
library(writexl)
# 2. Load Dataset
# ----------------------------------------
df_raw <- read_excel("Desktop/Thesis Data.xlsx")
df_raw <- df_raw %>%
 mutate(Date = as.Date(Date)) %>%
 rename(
  Policy.Rate = `Policy Rate`,
  Trade.balance = `Trade balance` )
# 3. OLS
# ----------------------------------------
```

```
#  Transform and Lag EBF
df_ebf <- df_raw %>%
 arrange(Date) %>%
 mutate(
   log_signed_EBF  = sign(EBF) * log1p(abs(EBF)),
   log_EBF_lag_1m  = lag(log_signed_EBF, 1),
   log_EBF_lag_3m  = lag(log_signed_EBF, 3),
   log_EBF_lag_6m  = lag(log_signed_EBF, 6)  )
#  Run OLS Regressions for Each Dependent Variable
model_gdp <- lm(GDPG_m ~ log_EBF_lag_1m + log_EBF_lag_3m + log_EBF_lag_6m +
                 Policy.Rate + Trade.balance + SBE + ME + FER,
               data = df_ebf)
model_inf <- lm(INF_yoy ~ log_EBF_lag_1m + log_EBF_lag_3m + log_EBF_lag_6m +
                 Policy.Rate + Trade.balance + SBE + ME + FER,
               data = df_ebf)
model_unem <- lm(UNEMP_m ~ log_EBF_lag_1m + log_EBF_lag_3m + log_EBF_lag_6m +
                  Policy.Rate + Trade.balance + SBE + ME + FER,
                data = df_ebf)
model_exr <- lm(EXR ~ log_EBF_lag_1m + log_EBF_lag_3m + log_EBF_lag_6m +
                 Policy.Rate + Trade.balance + SBE + ME + FER,
               data = df_ebf)
#  Check Multicollinearity (VIF)
vif(model_gdp)
#  Export to Word
models <- list(
  "GDP Growth"    = model_gdp,
  "Inflation YoY" = model_inf,
  "Unemployment"  = model_unem,
  "Exchange Rate" = model_exr)
modelsummary(models,
             output = "regression_results.docx",
             coef_map = c(
               "log_EBF_lag_1m" = "EBF (1m Lag)",
               "log_EBF_lag_3m" = "EBF (3m Lag)",
               "log_EBF_lag_6m" = "EBF (6m Lag)",
               "Policy.Rate" = "Policy Rate",
               "Trade.balance" = "Trade Balance",
               "SBE" = "SBE", "ME" = "ME", "FER" = "FER"))
```

```
# Format and Export to Excel with Stars and SE
add_stars <- function(p) {
  ifelse(p < 0.001, "***",
         ifelse(p < 0.01,  "**",
                ifelse(p < 0.05,  "*",
                       ifelse(p < 0.1, ".", ""))))}
formatted_models <- lapply(models, function(mod) {
  tidy_mod <- tidy(mod)
  tidy_mod$est_se <- paste0(
    sprintf("%.3f", tidy_mod$estimate),
    add_stars(tidy_mod$p.value),
    "\n(",
    sprintf("%.3f", tidy_mod$std.error),
    ")"  )
  tidy_mod})
table_df <- Reduce(function(x, y) {
  merge(x[, c("term", "est_se")], y[, c("term", "est_se")], by = "term", all = TRUE)
}, formatted_models)
colnames(table_df) <- c("Variable", "GDP Growth", "Inflation YoY", "Unemployment",
"Exchange Rate")
ordered_vars <- c("log_EBF_lag_1m", "log_EBF_lag_3m", "log_EBF_lag_6m",
                  "Policy.Rate", "Trade.balance", "SBE", "ME", "FER")
table_df <- table_df[match(ordered_vars, table_df$Variable), ]
# Save as Excel file
write_xlsx(table_df, "formatted_regression_table.xlsx")
# 4. ADF Tests
# ---------------------------------------
variables_to_test <- c(
  "EBF", "GDPG", "INF_mom", "INF_yoy", "UNEMP_m",
  "EXR (USD)", "Policy Rate", "FER GROSS (mln USD)",
  "ME (UAH) monthly", "SBE (UAH mln) monthly",
  "Trade balance (mnl USD)"
)
cat("=== ADF Test Results: Levels ===\n\n")
for (var in variables_to_test) {
  cat("ADF test for", var, ":\n")
  print(adf.test(df[[var]]))
  cat("\n------------------------------\n")
```

```
}
# 5. First and Second Differences
# ---------------------------------------
df_diff <- df %>%
 arrange(Date) %>%
 mutate(
   d_EBF       = EBF - lag(EBF),
   d_GDPG      = GDPG - lag(GDPG),
   d_INF_mom   = INF_mom - lag(INF_mom),
   d_INF_yoy   = INF_yoy - lag(INF_yoy),
   d_UNEMP     = UNEMP_m - lag(UNEMP_m),
   d_EXR       = `EXR (USD)` - lag(`EXR (USD)`),
   d_Policy    = `Policy Rate` - lag(`Policy Rate`),
   d_FER       = `FER GROSS (mln USD)` - lag(`FER GROSS (mln USD)`),
   d_ME        = `ME (UAH) monthly` - lag(`ME (UAH) monthly`),
   d_SBE       = `SBE (UAH mln) monthly` - lag(`SBE (UAH mln) monthly`),
   d_TB        = `Trade balance (mnl USD)` - lag(`Trade balance (mln USD)`),
   # Second differences
   d2_GDPG     = c(NA, diff(d_GDPG)),
   d2_INF_yoy  = c(NA, diff(d_INF_yoy)),
   d2_UNEMP    = c(NA, diff(d_UNEMP)),
   d2_EXR      = c(NA, diff(d_EXR)),
   d2_Policy   = c(NA, diff(d_Policy)),
   d2_FER      = c(NA, diff(d_FER)),
   d2_ME       = c(NA, diff(d_ME))  )
# 6. ADF Tests
# ---------------------------------------
diff_vars <- c("d_EBF", "d_GDPG", "d_INF_mom", "d_INF_yoy", "d_UNEMP",
               "d_EXR", "d_Policy", "d_FER", "d_ME", "d_SBE", "d_TB")
adf_results_diff <- lapply(diff_vars, function(var) {
 result <- adf.test(na.omit(df_diff[[var]]))
 data.frame(
   Variable = var,
   ADF_Statistic = round(result$statistic, 4),
   p_value = round(result$p.value, 4),
   Stationary = ifelse(result$p.value < 0.05, "Yes", "No")  )})
adf_table_diff <- bind_rows(adf_results_diff)
write_xlsx(adf_table_diff, "ADF_First_Difference_Results.xlsx")
```

```
# ADF test on second-differenced variables
second_diff_vars <- c("d2_GDPG", "d2_INF_yoy", "d2_UNEMP", "d2_EXR", "d2_Policy",
"d2_FER", "d2_ME")
for (var in second_diff_vars) {
 cat("ADF test for", var, ":\n")
 print(adf.test(na.omit(df_diff[[var]])))
 cat("\n----------------------------\n")}
# 7. ARIMAX Models with EBF as Regressor
# ---------------------------------------
ts_gdpg    <- ts(df$GDPG, frequency = 12, start = c(2019, 1))
ts_inf_mom <- ts(df$INF_mom, frequency = 12, start = c(2019, 1))
xreg_ebf   <- df$EBF
model_arima_gdp <- auto.arima(ts_gdpg, xreg = xreg_ebf)
model_arima_inf <- auto.arima(ts_inf_mom, xreg = xreg_ebf)
summary(model_arima_gdp)
summary(model_arima_inf)
modelsummary(
 list("GDP Growth" = model_arima_gdp, "Inflation (MoM)" = model_arima_inf),
 coef_map = c("(Intercept)" = "Intercept", "xreg" = "EBF"),
 stars = TRUE,
 statistic = "std.error",
 gof_omit = ".*")
# 8. VAR Model – First and Second Differences
# ---------------------------------------
model2_data <- df_diff %>%
 select(
   d_GDPG, d_INF_mom, d_EBF, d_TB, d_SBE,
   d2_INF_yoy, d2_UNEMP, d2_EXR, d2_Policy, d2_FER, d2_ME
 ) %>%
 drop_na()
# Select optimal lag
lag2_selection <- VARselect(model2_data, lag.max = 4, type = "const")
selected_lag <- lag2_selection$selection["AIC(n)"]
model_var_combined <- VAR(model2_data, p = selected_lag, type = "const")
summary(model_var_combined)
# Extract significant coefficients
coef_tables <- lapply(model_var_combined$varresult, function(eq) coef(summary(eq)))
sig_effects <- lapply(names(coef_tables), function(name) {
```

```
  table <- as.data.frame(coef_tables[[name]])
  table$Variable <- rownames(table)
  table$Equation <- name
  subset(table, `Pr(>|t|)` < 0.05)
})
sig_effects_df <- bind_rows(sig_effects)
write_xlsx(sig_effects_df, "Significant_VAR_Coefficients.xlsx")
# Model stats: R2 and p-values
model_stats <- lapply(model_var_combined$varresult, function(eq) {
  summ <- summary(eq)
  data.frame(
    R_squared = summ$r.squared,
    Adjusted_R_squared = summ$adj.r.squared,
    F_statistic_p_value = pf(summ$fstatistic[1], summ$fstatistic[2], summ$fstatistic[3],
lower.tail = FALSE) )})
model_stats_df <- bind_rows(model_stats, .id = "Equation")
write_xlsx(model_stats_df, "VAR_Equation_R2_and_Pvalues.xlsx")
# 9. Impulse Response Functions (IRF)
# ---------------------------------------
irf_main <- irf(
  model_var_combined,
  impulse = "d_EBF",
  response = c("d_INF_mom", "d2_INF_yoy", "d_GDPG", "d2_UNEMP", "d2_EXR"),
  n.ahead = 10,
  boot = TRUE,
  ci = 0.95
)
plot(irf_main)
irf_additional <- irf(
  model_var_combined,
  impulse = "d_EBF",
  response = c("d2_ME", "d_SBE", "d2_FER", "d_TB"),
  n.ahead = 10,
  boot = TRUE,
  ci = 0.95
)
plot(irf_additional)
# 10. Granger Causality Tests (d_EBF)
```

```
# ---------------------------------------
response_vars <- c("d_GDPG", "d2_INF_yoy", "d2_EXR", "d2_UNEMP")
gc_results <- lapply(response_vars, function(resp) {
  subset_data <- model2_data[, c("d_EBF", resp)]
  var_model <- VAR(subset_data, p = 2, type = "const")
  gc_test <- causality(var_model, cause = "d_EBF")$Granger
  data.frame(Response = resp, F_stat = gc_test$statistic, p_value = gc_test$p.value)
})
gc_df <- bind_rows(gc_results)
gc_df$Significance <- cut(gc_df$p_value, c(-Inf, 0.01, 0.05, 0.1, Inf), labels = c("***", "**", "*", ""))
print(gc_df)
```

Appendix 12. Data

Thesis Data