Development of Financial Relations

Olena BORZENKO,
Anna HLAZOVA,
Aigerim LAMBEKOVA

METHODOLOGICAL DEVELOPMENT FOR ASSESSING THE IMPACT OF M2-TO-GDP AND DEBT-TO-GDP RATIOS ON MACROECONOMIC STABILITY: A POLYNOMIAL ANALYSIS APPROACH

Abstract

This study analyzes Ukraine's M2/GDP and Debt/GDP ratios from 2000 to 2024 using polynomial smoothing techniques to uncover long-term trends in monetary and fiscal dynamics. The analysis demonstrates how fluctuations in money supply and public debt interact to influence inflation, liquidity, and overall macroeconomic stability. Findings indicate that both excessive and insufficient liquidity exacerbate inflationary pressures, while rising public debt, particularly during crises, constrains the effectiveness of monetary policy. By filtering out short-

Borzenko Olena, Doctor of Science (Economics), Professor, Head of Sector for International Financial Research, SO «Institute for Economics and Forecasting of NAS of Ukraine», Kyiv, Ukraine. ORCID: 0000-0002-1017-5942 Email: slozko2003@ukr.net

Hlazova Anna, PhD in Economics, Research Fellow, Sector for International Financial Research, SO «Institute for Economics and Forecasting of NAS of Ukraine», Kyiv, Ukraine. ORCID: 0000-0003-0102-1420 Email: annapelo@ukr.net

Lambekova Aigerim, PhD in Accounting and Audit, Associate Professor, Head of the Department of Accounting and Auditing, Karaganda Buketov University, Karaganda, Kazakstan. ORCID: 0000-0001-6818-3665 Email: aigerim.lambekova@gmail.com

term volatility, polynomial analysis provides a clearer understanding of structural economic patterns and the impact of exogenous shocks such as financial crises, geopolitical tensions, and domestic policy shifts. The results offer valuable insights for policymakers, highlighting the importance of maintaining balanced monetary and fiscal conditions to ensure price stability, adequate liquidity, and sustainable economic growth in transitional and emerging economies.

Key Words:

1 table, 3 figures, 21 references.

Problem Statement

In classical economic theory, it is considered axiomatic that an excessive expansion of the money supply within a macroeconomic system directly provokes inflationary pressures. This principle forms the foundation of monetary policy in most developed nations. Consequently, international financial institutions – most notably the International Monetary Fund (IMF) and the World Bank – routinely incorporate into their anti-crisis programs for developing economies, including post-Soviet states, policy prescriptions aimed at reducing the money supply as a means of stabilizing prices. The underlying assumption is that monetary contraction will reduce aggregate demand and, thus, inflation. However, empirical evidence from many of these economies suggests that such a policy often produces the opposite effect, accelerating rather than curbing inflation. The resulting liquidity deficit raises commercial lending rates, effectively increasing the «price» of money, which in turn constrains productive investment and economic growth.

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This paradox has been particularly evident in post-Soviet countries, where the contraction of the money supply in the mid-1990s precipitated widespread non-payment crises, escalated domestic public debt, and fostered the circulation of financial surrogates in place of a fully liquid currency (Conway, 2003). Such outcomes highlight a critical insight: both an excess and a shortage of liquidity are equally detrimental to monetary stability, as they undermine the capacity to manage inflation effectively. An excess of liquidity leads to a devaluation of money, while a deficit creates economic stagnation and a breakdown of payment systems. Optimal stabilization, therefore, requires maintaining the money supply at a balanced, moderate level, where inflationary pressures are minimized, and monetary circulation remains efficient and sufficient to support real economic activity.

Against this theoretical and empirical background, the analysis of Ukraine's M2/GDP and Debt/GDP ratios over the period 2000-2024 offers a valuable opportunity to examine the complex interplay between monetary and fiscal indicators over time. These ratios, when smoothed using polynomial trend functions, reveal not only the underlying structural patterns of the national economy but also the profound impact of exogenous shocks, such as global financial crises, geopolitical instability, and domestic policy shifts. The observed dynamics enable a deeper understanding of how variations in monetary supply and public debt interact with inflationary processes, liquidity conditions, and overall macroeconomic stability. This provides critical insights for designing more effective and context-specific policy responses in transitional and emerging economies that face similar challenges.

Literature Review

Ukraine's public debt profile has undergone profound transformations over the past two decades, with a particularly sharp escalation following the large-scale war that began in 2022. Before the war, the country's public debt was moderate by recent historical standards, but wartime fiscal pressures – rapid increases in defense spending, emergency financing needs, and disrupted economic activity – have substantially changed the debt dynamics (Chugunov et al., 2024; But et al., 2020). Domestic and external borrowing needs, together with contingent liabilities created by reconstruction and security spending, have pushed policymakers to re-examine traditional debt-management strategies and the fiscal-monetary mix (Lyzun et al., 2019).

The scale and structure of Ukraine's debt are critical for interpreting its macroeconomic implications. Studies analysing the composition of public borrowing emphasise that factors such as the balance between domestic and foreign creditors, the currency structure of the debt stock, and the maturity profile all shape vulnerability to external shocks and determine feasible debt-reduction

strategies (But et al., 2020). In the Ukrainian context, rapid increases in government obligations during a period of disrupted GDP growth heighten the risk that debt service may crowd out essential reconstruction and human-capital investments, unless supported by credible medium-term fiscal planning and strengthened debt-management institutions (Lyzun et al., 2024).

Debates about fiscal sustainability in Ukraine must be linked to monetary policy constraints. Ukrainian experience demonstrates that the monetary and fiscal domains are tightly interdependent: monetary policy affects government financing conditions, while fiscal imbalances restrict the central bank's ability to stabilise prices without implicitly supporting deficit financing (Borzenko & Hlazova, 2024; Bublyk, 2024). In transitional and crisis-affected economies, policies that channel domestic financial resources toward government borrowing – sometimes labelled financial repression – may ease short-term debt pressures but risk distorting financial intermediation, reducing private investment, and dampening long-term economic growth (But et al., 2020; Kondrat et al., 2019).

Recent empirical work on Ukraine highlights nonlinear relationships between public debt and GDP growth that are highly relevant for policy design. Studies using polynomial or quadratic modelling approaches show that the growth impact of debt varies depending on its level: moderate debt can support investment and stabilisation, whereas excessive debt becomes harmful by raising borrowing costs, increasing macroeconomic risk, and crowding out productive expenditure (Shvets, 2020). The modelling framework applied to Ukrainian data by Shvets (2020) provides evidence of such nonlinearity and offers threshold estimates that may guide rule-based fiscal frameworks and contingency planning.

Monetary aggregates such as M2 relative to GDP are also emphasised in the literature as indicators of macrofinancial conditions. The interaction between money-supply dynamics and public debt influences inflation expectations, exchange-rate stability, and the population's willingness to hold domestic assets – factors that shape nominal debt servicing costs and refinancing risks (Borzenko & Hlazova, 2024; Bublyk, 2024). Wartime uncertainty further amplifies the volatility of monetary aggregates, complicating debt sustainability assessments and the choice of policy instruments.

Overall, the literature converges on several policy-relevant conclusions for Ukraine. First, effective debt management requires forward-looking strategies that address both the level and structure of public debt (But et al., 2020; Chugunov et al., 2024). Second, given the strong interdependence of fiscal and monetary policies – especially in transition and wartime conditions – maintaining central bank independence while ensuring transparent, market-based government financing is essential (Daboh et al., 2024). Third, evidence of nonlinear (polynomial) relationships between Debt/GDP and economic growth suggests that Ukraine needs flexible fiscal rules incorporating thresholds and contingencies that trigger debt restructuring, fiscal adjustment, or external support (Shvets, 2020; Kondrat et al., 2019).

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A particularly relevant dimension for contemporary macroeconomic analysis involves the behavior of currencies, reserve assets, and alternative financial instruments under financial turbulence. Borzenko and Hlazova's model of currency dynamics during periods of global financial stress provides empirical evidence on how the US Dollar, gold, and cryptocurrencies behave under episodes of heightened uncertainty. Their findings demonstrate that currency markets and alternative assets respond nonlinearly to shocks, with rapid shifts in liquidity preferences and speculative pressures. This framework is highly relevant for Ukraine, where exchange-rate stability and capital flow sensitivity significantly influence both monetary and fiscal policy transmission. Integrating these insights allows for a deeper understanding of how external shocks – financial, geopolitical, or commodity-based – affect domestic stability and interact with money supply and debt trajectories.

In conclusion, addressing Ukraine's post-2022 debt challenges requires a coordinated mix of robust debt-management practices, credible fiscal planning, and monetary frameworks that anchor inflation expectations without resorting to deficit monetisation. Insights from structural analyses of debt composition (Firsanova, 2024), nonlinear modelling work (Shvets, 2020), and research on EU-oriented monetary-policy interaction (Borzenko & Hlazova, 2024) provide a comprehensive foundation for designing such a policy package.

Despite the theoretical consensus that monetary and fiscal policies are central to maintaining macroeconomic stability, the practical management of these policies in transitional economies, such as Ukraine, remains highly challenging. Classical economic theory suggests that excessive expansion of the money supply leads to inflation, while reductions in money supply are intended to stabilize prices. However, empirical evidence from post-Soviet countries demonstrates that contractionary monetary measures often exacerbate inflation and liquidity shortages, creating a paradox in policy implementation.

Simultaneously, Ukraine's public debt has experienced significant fluctuations over the past two decades, with dramatic increases following economic crises and geopolitical shocks (Bogdan, 2024; Mouabbi et al., 2024). The growing Debt/GDP ratio, particularly during periods of military conflict and economic disruption, raises concerns regarding fiscal sustainability and the effectiveness of conventional debt management strategies. These dynamics are further complicated by the interaction between monetary expansion or contraction and fiscal obligations, which jointly influence inflation, liquidity, and overall economic stability (Borzenko, 2019).

The problem, therefore, lies in understanding how the interplay between monetary supply (M2/GDP) and public debt (Debt/GDP) affects macroeconomic stability in Ukraine. Specifically, there is a need to identify the thresholds at which monetary or fiscal imbalances generate disproportionate inflationary or liquidity pressures and to examine how these thresholds have evolved in response to structural reforms, exogenous shocks, and policy interventions. Addressing this

problem is crucial for designing evidence-based strategies to achieve sustainable economic growth and effective macroeconomic management in transitional and post-crisis contexts.

The purpose of the paper is to determine how the interplay between monetary supply (M2/GDP) and public debt (Debt/GDP) affects macroeconomic stability in Ukraine. Specifically, there is a need to identify the thresholds at which monetary or fiscal imbalances generate disproportionate inflationary or liquidity pressures and to examine how these thresholds have evolved in response to structural reforms, exogenous shocks, and policy interventions. Addressing this problem is crucial for designing evidence-based strategies to achieve sustainable economic growth and effective macroeconomic management in transitional and post-crisis contexts.

Methodology

The analysis is based on transforming absolute monetary and debt values into dimensionless ratios to ensure cross-period comparability and minimize scale effects. Specifically, the monetization ratio is calculated as:

$$Monetization\ Ratio = \frac{M2}{GDP} \qquad (1)$$

This indicator reflects the extent to which GDP is backed by the money supply (in this case, the M2 monetary aggregate). In developed economies, this ratio typically fluctuates between 0.5 and 1, providing a useful benchmark for evaluating monetary liquidity conditions.

Similarly, the public debt ratio is defined as:

$$Debt\ to\ GDP\ Ratio = \frac{Debt}{GDP} \qquad (2)$$

This ratio allows for an assessment of a country's debt burden relative to its economic capacity, though it is not, by itself, a sufficient measure of financial risk.

The methodological framework is based on polynomial trend analysis, which allows for the identification of non-linear relationships between the studied variables and macroeconomic stability. Polynomial regression models of varying orders (from cubic to sixth-degree) are applied to capture both long-term structural trends and short-term fluctuations. The optimal polynomial order is selected using the coefficient of determination (R^2).

To reduce the influence of short-term volatility, the analysis incorporates smoothed series generated through polynomial approximation. This approach fil-

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ters out exogenous disturbances – such as geopolitical crises, global financial downturns, and abrupt policy shifts – thereby revealing the underlying structural patterns in the interaction between M2/GDP and Debt/GDP ratios.

Macroeconomic stability is operationalized through a composite index combining inflation, real GDP growth, and exchange rate volatility. Correlation and regression analyses are used to evaluate the individual and combined effects of monetary supply and public debt on this index.

This approach is subject to certain limitations. Polynomial trend analysis, if not carefully validated, may overfit the data. Official statistics, particularly during conflict periods, may carry measurement biases. Furthermore, the method focuses on associations rather than causality; future studies could address this by employing vector autoregression (VAR) or structural equation modeling (SEM).

By integrating dimensionless ratios with polynomial trend modeling, the study offers a robust methodological framework for analyzing how the interaction between monetary supply and public debt shapes macroeconomic stability in transitional and crisis-affected economies such as Ukraine.

Reserch Results

The analysis presented in this study is based on a comprehensive dataset of Ukraine's key macroeconomic indicators from 2000 to 2024. As detailed in Table 1, the dataset includes gross domestic product (GDP) and public debt, both in nominal U.S. dollar (USD) and Ukrainian hryvnia (UAH) terms. This dual-currency approach is crucial for capturing the effects of exchange rate fluctuations on the country's economic performance. The dataset also incorporates the monetary aggregate M2 in both hryvnia and U.S. dollar equivalents, providing a robust measure of liquidity within the financial system. Finally, the official average annual exchange rate (UAH/USD) is included to facilitate cross-currency comparisons and to analyze its impact on other variables.

The primary data sources for this study are the official statistics published by the Ministry of Finance of Ukraine and the National Bank of Ukraine (NBU). These institutions are recognized as the authoritative providers of fiscal and monetary data for the country, ensuring the reliability and accuracy of the dataset. All figures are presented on an annual basis to smooth out seasonal variations and to provide a clear long-term perspective on the trends and relationships among the variables. The use of these official sources guarantees that the analysis is grounded in verifiable and institutionally approved data, a cornerstone of sound macroeconomic research.

Table 1

Calculation table for Ukraine

Year	GDP billion dollars	Debt billion UAH	GDP million dollars	Debt billion dollars	M2 billion UAH	Exchange rate	M2 million dollars	M2/ GDP	Debt/ GDP
2000	32.331	77.02	32331	14.15809	31.5	5.2	5790.441	0.179099	0.437911
2001	39.309	74.629	39309	14.10756	45.2	5.44	8544.423	0.217365	0.358889
2002	42.393	75.729	42393	14.20807	64.4	5.29	12082.55	0.285012	0.323234
2003	50.133	78.489	50133	14.72589	94.6	5.33	17748.59	0.35401	0.283136
2004	64.883	85.401	64883	16.08305	125.5	5.33	23634.65	0.36426	0.239239
2005	86.142	78.147	86142	15.26309	193.1	5.31	37714.84	0.422424	0.170954
2006	107.753	80.549	107753	15.9503	259.4	5.12	51366.34	0.476704	0.14256
2007	142.719	88.745	142719	17.57327	391.3	5.05	77485.15	0.54292	0.118152
2008	179.992	194.812	179992	36.96622	512.5	5.05	97248.58	0.540293	0.196378
2009	117.228	316.885	117228	39.685	484.8	5.27	62233.63	0.530876	0.347127
2010	136.419	432.235	136419	54.289	596.8	7.79	75163.73	0.55097	0.399103
2011	163.160	473.122	163160	69.215	681.8	7.94	85545.8	0.524303	0.359018
2012	175.781	515.511	175781	64.495	771.1	7.97	96508.14	0.524306	0.366621
2013	183.310	584.114	183310	73.078	906.2	7.99	113416.8	0.618715	0.401142
2014	131.805	1100.564	131805	69.794	955.3	7.99	80480.2	0.610600	0.702034
2015	90.615	1572.180	90615	65.505	993.8	11.87	41408.33	0.4569699	0.794552
2016	93.270	1929.759	93270	70.970	1015.79	24	42.32458	0.453785	0.810021
2017	112.154	2141.674	112154	76.305	1129.46	25.55	44.20587	0.39415	0.718342
2018	130.832	2168.627	130832	78.323	1224.89	26.57	46.10048	0.352363	0.609543
2019	153.781	1 998.275	153781	84.364	1528.61	27.19	56.21956	0.36558	0.503554
2020	155.582	2 551.936	155582	90.255	1752.45	26.93	65.07426	0.41826	0.688543
2021	199.770	2 671.828	199770	97.947	2557.63	27.69	92.366	0.462361	0.489448
2022	161.990	4 071.683	161990	111.343	2078.26	27.17	76.4909	0.472195	0.784833
2023	181.220	5 519.484	181220	145.316	3076.43	29.25	105.1770	0.580383	0.844001
2024	190.740	6 980.965	190740	166.059	3487.86	36.50	95.55780	0.50098	0.912319

Source: calculated by the authors based on World Bank and IMF (2025), Ministry of Finance of Ukraine. (2025), National Bank of Ukraine (2018-2024), International Monetary Fund (2024).

Additionally, two derived ratios are reported: the share of M2 relative to GDP (M2/GDP) and the share of public debt relative to GDP (Debt/GDP), both expressed in decimal form.

The table illustrates substantial nominal GDP growth in both domestic and foreign currency terms until 2008, followed by a contraction in 2009, in line with the global financial crisis. Subsequent periods show fluctuating but generally upward GDP trends, with marked declines in 2014-2015 and 2022, corresponding to

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geopolitical and security crises. Public debt levels demonstrate both structural increases over the long term and sharp spikes during periods of economic stress, with the Debt/GDP ratio exceeding 0.8 in several recent years.

Monetary aggregate M2 also expands significantly over the period, though its share of GDP varies, peaking near 0.55 in 2010 and 2013 before declining and partially recovering in the early 2020s. Exchange rate movements – particularly the major depreciations in 2008-2009, 2014-2015, and 2022-2023 – are closely reflected in the USD-denominated values of both GDP and M2. Overall, the table captures the long-term structural transformations and short-term shocks in Ukraine's economy over nearly a quarter-century.

Figure 1

Polynomial approximation of the dynamic series of M2/GDP points for 2000-2024 for Ukraine
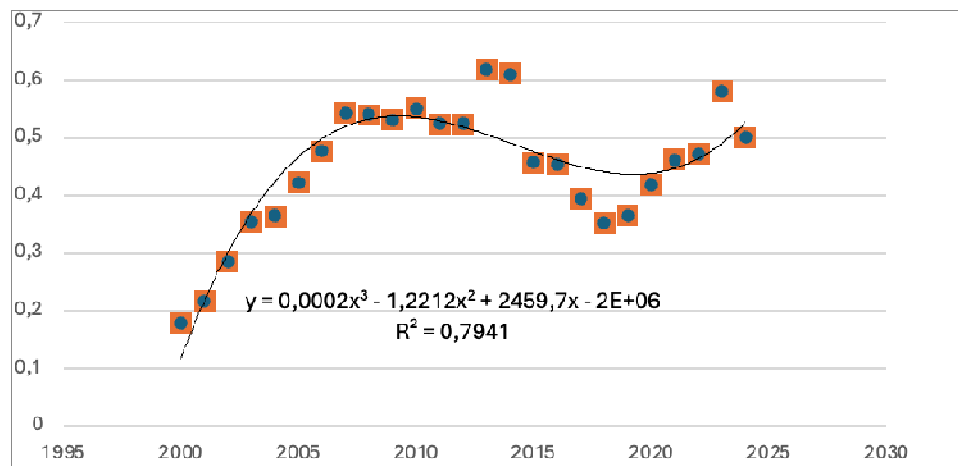
Source: calculated by the authors.

Figure 1 illustrates the temporal dynamics of the M2/GDP ratio, smoothed using a third-degree polynomial regression of the form.

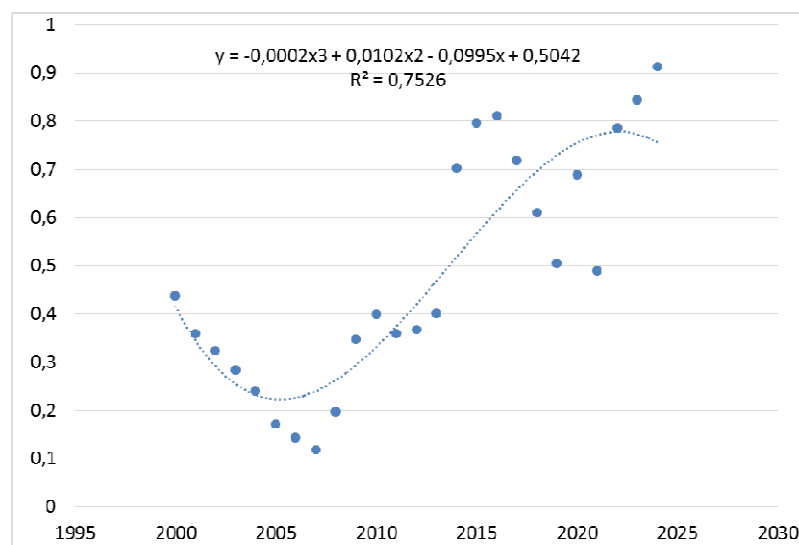$$y = 0{,}0002x^3 - 1{,}2212x^2 + 2459{,}7x - 2E + 06 \tag{3}$$

$$R^2 = 0{,}7941 \tag{4}$$

The polynomial model captures a pronounced increase in the M2/GDP ratio from 2000 to approximately 2010, followed by a gradual decline until around 2017, and a partial recovery thereafter. The relatively high R^2 value indicates that the model explains nearly 79% of the observed variance, reflecting its suitability for identifying medium- to long-term cyclical patterns. The early upward trend corresponds to rapid monetary expansion and GDP growth, while the mid-period decline aligns with macroeconomic instability and currency depreciation. The subsequent rebound suggests renewed monetary growth and changes in macroeconomic policy responses under evolving domestic and external conditions.

Notably, several individual observations deviate from the fitted trend line. These deviations represent years in which short-term shocks, policy interventions, or extraordinary external factors significantly altered the relationship between M2 and GDP. For example, abrupt changes in the exchange rate, emergency fiscal and monetary measures during crises, and sudden capital inflows or outflows can cause temporary spikes or drops in the ratio that are not captured by the smoothed long-term trajectory. Such outliers are important indicators of economic stress or transition periods, highlighting the limitations of polynomial smoothing in fully accounting for abrupt, non-cyclical fluctuations in monetary liquidity relative to economic output.

Figure 2

Polynomial approximation of the dynamic series of Debt/GDP points for 2000-2024 for Ukraine

$y = -0,0002x3 + 0,0102x2 - 0,0995x + 0,5042$
$R^2 = 0,7526$

Source: calculated by the authors.

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Figure 2 presents the evolution of Ukraine's Debt/GDP ratio over the period 2000-2024, smoothed using a third-degree polynomial regression of the form:

$$y = -0{,}0002x^3 + 0{,}0102x^2 - 0{,}0995x + 0{,}5042 \qquad (5)$$

$$R^2 = 0{,}7526 \qquad (6)$$

The fitted curve captures three distinct phases in the ratio's trajectory: an initial decline from 2000 to approximately 2006, a gradual upward shift until around 2014, and a steeper acceleration thereafter, with the ratio peaking close to 0.9 in the early 2020s. The relatively high R^2 value indicates that the model explains about 75% of the variance, providing a reasonable approximation of the long-term trend despite short-term deviations.

The early decline reflects a period of rapid GDP growth outpacing debt accumulation, supported by favorable macroeconomic conditions and external borrowing constraints. The subsequent increase corresponds to rising fiscal deficits, external borrowing needs, and the impact of successive economic and political crises. The post-2014 acceleration is consistent with sharp currency depreciation, increased defense spending, and contraction in economic output, while the sustained high levels in the early 2020s are indicative of intensified borrowing needs amid war-related economic disruptions.

Several observations deviate from the smoothed curve, indicating years in which extraordinary fiscal interventions, abrupt exchange rate movements, or debt restructuring operations caused atypical changes in the Debt/GDP ratio. These outliers highlight the influence of discrete shocks and policy responses that cannot be fully explained by the underlying long-term polynomial trend.

While both ratios exhibit long-term cyclical patterns and respond to major economic disruptions, their trajectories differ in timing and magnitude (IMF, 2024). The M2/GDP ratio tends to rise during periods of monetary expansion and credit growth, often preceding or coinciding with GDP growth phases, whereas the Debt/GDP ratio reacts more strongly to fiscal imbalances and economic contractions. The inverse dynamics observed in the early 2000s – when M2/GDP rose sharply while Debt/GDP declined – indicate a healthy macroeconomic environment characterized by expanding liquidity and falling relative indebtedness. Conversely, the post-2014 period shows both ratios increasing, reflecting a dual impact of expansive monetary measures and rapid debt accumulation under crisis conditions. In the early 2020s, the two indicators diverge again: M2/GDP exhibits moderate recovery, while Debt/GDP remains at historically high levels, highlighting persistent fiscal pressures despite partial monetary stabilization.
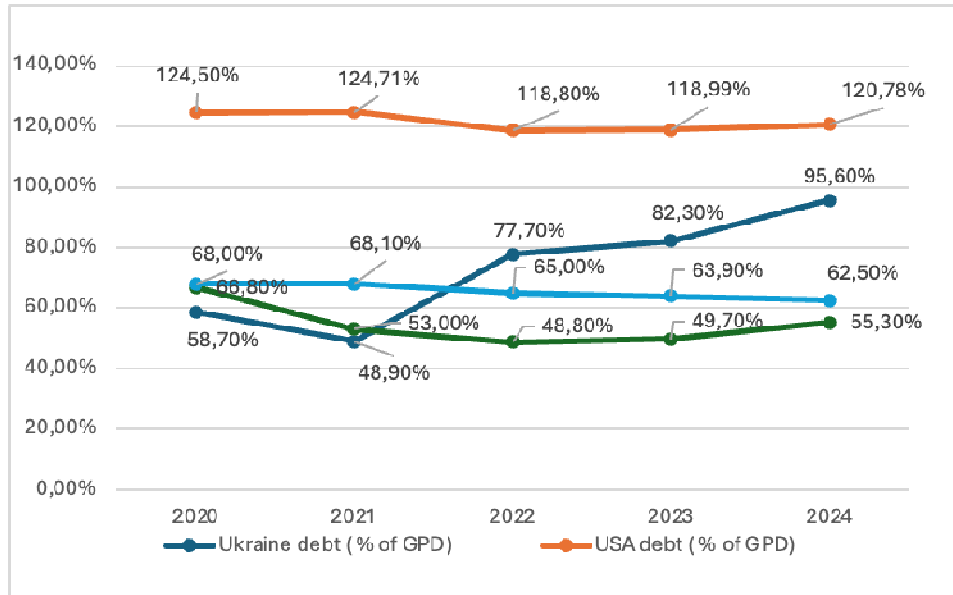
Improvement of the Model

The analysis of the M2/GDP and Debt/GDP ratios for Ukraine from 2000 to 2024 offers critical insights into the distinct dynamics of monetary and fiscal indicators when subjected to polynomial smoothing. This study employed third-degree polynomial functions to approximate each time series, yielding coefficients of determination (R^2) of 0.7941 for M2/GDP and 0.7526 for Debt/GDP. These values indicate a moderate fit for the monetary aggregate and a slightly weaker fit for the debt ratio, reflecting differences in their underlying volatility.

The M2/GDP ratio demonstrates significant short-term fluctuations, often coinciding with periods of macroeconomic instability. Sharp deviations are observable during the global financial crisis (2008-2009), the economic shock following 2014, and the wartime spike in 2022. While the polynomial smoothing effectively captures the broader upward trend followed by a subsequent decline, it significantly underestimates the magnitude of these sudden changes. This limitation is inherent to polynomial trend modeling, which favors continuity and a stable trajectory over a precise replication of high-frequency volatility. Consequently, the fitted curve represents a more gradual evolution, effectively filtering out noise but also attenuating the impact of exogenous shocks.

In contrast, the Debt/GDP ratio exhibits a smoother long-term trajectory, with most changes unfolding over multiple years. Its peaks and troughs are less abrupt and typically result from cumulative fiscal and macroeconomic adjustments rather than rapid market-driven movements. This structural stability enables the polynomial model to approximate the debt series more closely, as evidenced by its slightly higher R^2 value. Even so, the smoothed series modestly underrepresents periods of accelerated debt accumulation, particularly in 2014-2016 and 2022-2023, when fiscal deficits widened due to currency devaluation, external borrowing, and wartime expenditure pressures. This highlights a fundamental trade-off in the use of polynomial trend modeling: while it reveals underlying trends by filtering out noise, it inevitably dampens the amplitude of sharp movements driven by sudden shocks.

To provide a broader context, this analysis extends to a comparative review of government debt-to-GDP ratios for the United States, Poland, Ukraine, and Germany from 2020 to 2024, as depicted in Figure 3. This comparative data reveals distinct fiscal trajectories influenced by global events and national policies.

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Figure 3

Dynamics of total public debt as a percentage of GDP 2020-2024

Source: authors' calculations based on International Monetary Fund (2024).

The most striking trend is the dramatic increase in Ukraine's debt-to-GDP ratio. Following a temporary decline to 48.90% in 2021, a period influenced by post-pandemic economic recovery, the ratio surged to 95.60% by 2024. This nearly twofold increase is a direct consequence of the full-scale invasion, which necessitated immense expenditures on defense and social support, primarily financed through borrowing. This trajectory powerfully illustrates how severe geopolitical crises can profoundly destabilize a nation's public finances.

In contrast, the United States maintained a high but relatively stable debt level, consistently exceeding 100% of GDP. This trend reflects a sustained fiscal policy of high public spending and deficits, a common feature of advanced economies. The data for Poland and Germany, however, showcases a more conservative fiscal policy. Poland's ratio remained well below those of Ukraine and the USA, while Germany's debt consistently decreased from 68.00% in 2020 to 62.50% in 2024. This downward trend, unique among the countries examined, indicates a deliberate focus on fiscal consolidation.

In conclusion, while the USA's high debt levels reflect a long-standing policy, and Poland and Germany's data point to fiscal prudence, Ukraine's experience serves as a clear and potent example of how external shocks, particularly armed conflict, can instantaneously alter a nation's financial landscape, leading to a rapid and significant accumulation of debt.

Conclusions

Polynomial analysis of M2/GDP and Debt/GDP ratios for Ukraine's monetary and fiscal Policy from 2000 to 2024 has illuminated key long-term trends in the nation's monetary and fiscal dynamics. By applying third-degree polynomial functions, with coefficients of determination (R^2) of 0.7941 for M2/GDP and 0.7526 for Debt/GDP, the research has effectively separated structural patterns from short-term volatility.

The findings underscore a crucial relationship: the interplay between monetary liquidity and public debt significantly influences macroeconomic stability. The analysis reveals that both excessive and insufficient liquidity can intensify inflationary pressures. Furthermore, a substantial rise in public debt, particularly during periods of crisis, demonstrably constrains the effectiveness of monetary policy. This is evident in how polynomial smoothing, while revealing underlying trends, inherently dampens the sharp, crisis-driven fluctuations that are a hallmark of exogenous shocks.

Ultimately, the results offer valuable insights for policymakers in transitional and emerging economies. The research highlights the critical importance of maintaining a balanced and synchronized approach to monetary and fiscal management. A coherent strategy is essential for ensuring not only price stability and adequate liquidity but also the sustainable economic growth necessary to navigate and mitigate the impact of future crises.

Further investigations will concentrate on applying polynomial smoothing techniques to additional case studies from various fields, thereby enhancing the methodological scope and practical relevance of the obtained results.

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