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The Impact of Sovereign Asset and Liability Management on Efficient Debt Management in Jordan

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Abstract

This study investigates the impact of Sovereign Asset and Liability Management (SALM) on efficient debt management in Jordan, addressing a significant gap in the literature regarding SALM application in developing economies. Using quarterly data from 2005 to 2023, we employ advanced econometric techniques, including Autoregressive Distributed Lag (ARDL) and Nonlinear ARDL (NARDL) models, to analyze both short-run and long-run dynamics, as well as potential asymmetric effects. The research examines the relationships between various SALM components (cash reserves, foreign reserves, equity in state-owned enterprises, future revenues, government debt, fiscal expenditures, and contingent liabilities) and debt management efficiency, measured by the debt-to-GDP ratio. Our findings reveal complex and often asymmetric relationships between SALM components and debt management efficiency. Notably, we find significant long-run effects of cash reserves, foreign reserves, government debt, and contingent liabilities on the debt-to-GDP ratio. The study also uncovers asymmetric effects of equity in state-owned enterprises, future revenues, and fiscal expenditures, indicating that increases and decreases in these variables have differing impacts on debt management efficiency. These results provide valuable insights for policymakers and debt managers in Jordan and similar developing economies, emphasizing the importance of a holistic approach to public financial management that considers both assets and liabilities simultaneously. The study contributes to the growing body of literature on SALM by providing empirical evidence of its impact in a developing country context and highlighting the need for integrated approaches to sovereign debt management.

Keywords: Sovereign Asset and Liability Management, Debt Management, Jordan, ARDL, NARDL, Asymmetric Effects.

Introduction

Background and context:

Sovereign Asset and Liability Management (SALM) has emerged as a critical framework for governments to effectively manage their financial resources and obligations in an increasingly complex global economic environment (Das et al., 2012; Blommestein & Turner, 2012). This

approach represents a significant evolution in public financial management, moving beyond traditional debt management to encompass a comprehensive view of a government's financial position. The development of SALM can be traced back to lessons learned from various financial crises, such as the Asian financial crisis of 1997-1998 and the global financial crisis of 2008 (Mishkin, 1999; Reinhart & Rogoff, 2009). These crises demonstrated that unaddressed risks in both public and private sectors can lead to severe economic disasters (Rosenberg et al., 2005).

The SALM framework emphasizes the importance of considering both assets and liabilities in an integrated manner, allowing governments to better identify and manage risks, optimize resource allocation, and enhance fiscal sustainability (Wheeler, 2004; Grimes, 2001). The central objective is to raise necessary funds at the lowest possible cost over the medium to long term while managing risk prudently (Melecky, 2012). For developing countries like Jordan, SALM implementation takes on added significance due to unique challenges such as limited access to international capital markets and vulnerability to external shocks (Presbitero et al., 2016). Jordan has relied on foreign aid, grants, and loans to finance development and reduce its balance of payments deficit (Hashemite Kingdom of Jordan Ministry of Finance, 2017).

Jordan's debt management practices have evolved from initial reliance on bilateral loans to diversification of funding sources, including entering global financial markets in the 1970s (Alshyab & Khasawneh, 2019; Cangoz et al., 2018). This evolution reflects broader trends in sovereign debt management globally, with countries moving towards more sophisticated approaches incorporating risk management techniques (Melecky, 2007; Panizza et al., 2010). Despite challenges such as limited institutional capacity and underdeveloped domestic financial markets (Aizenman et al., 2013), SALM adoption offers significant potential benefits for developing countries. It can improve fiscal discipline, enhance transparency in public financial management, and contribute to overall macroeconomic stability (Papaioannou, 2009; Guscina et al., 2014).

Research Problem and objectives

Despite the importance of SALM in managing public finances, there is limited research on its application and effectiveness in developing countries, particularly in the context of Jordan. This study aims to address this gap by examining the impact of SALM on efficient debt management in Jordan. Specifically, the research objectives are:

1. To examine the effect of SALM components (cash reserves, foreign reserves, equity in state-owned enterprises, future revenues, government debt, fiscal expenditures, and contingent liabilities) on efficient debt management in Jordan.

2. To investigate the short-run and long-run relationships between SALM components and efficient debt management.

3. To analyze potential asymmetric effects of SALM components on efficient debt management.

Significance of the Study

This research contributes to the growing body of literature on SALM and effective debt management in developing countries. By focusing on Jordan, it provides valuable insights into the application of SALM in a specific national context, which can inform policymakers and practitioners in similar economic environments. The study's findings can help in developing more effective debt management strategies, potentially leading to improved fiscal sustainability and economic stability.

Furthermore, this research employs advanced econometric techniques to analyze the complex relationships between SALM components and debt management efficiency. By doing so, it not only contributes to the theoretical understanding of these relationships but also provides a methodological framework for future studies in this field.

Brief Overview of Methodology

The study employs a quantitative approach, utilizing time series data from Jordan covering the period from 2005 to 2023. Data is collected on a quarterly basis from the Ministry of Finance and Central Bank of Jordan databases. The research uses several econometric methods, including:

1. Descriptive statistics to provide an overview of the data characteristics.

2. Unit root tests (Augmented Dickey-Fuller and Phillips-Perron) to check for stationarity of the variables.

3. Johansen's cointegration test to examine long-run relationships among variables.

4. Granger causality tests to investigate causal relationships between SALM components and efficient debt management.

5. Autoregressive Distributed Lag (ARDL) and Nonlinear Autoregressive Distributed Lag (NARDL) models to analyze short-run and long-run dynamics, as well as potential asymmetric effects.

The dependent variable, efficient debt management, is measured by the debt-to-GDP ratio. Independent variables include cash reserves, foreign reserves, equity in state-owned enterprises, future revenues, government debt, fiscal expenditures, and contingent liabilities. The study employs various diagnostic tests to ensure the robustness and reliability of the results.

Literature Review

Theoretical background

The theoretical foundation of Sovereign Asset and Liability Management (SALM) can be traced back to the development of Asset-Liability Management (ALM) in the banking sector. The pioneering work of Harry Markowitz in the 1950s on portfolio selection theory laid the groundwork for modern ALM practices. Markowitz's (1952), approach to constructing investment portfolios, which emphasized diversification and risk-adjusted returns, marked a

fundamental shift in financial management practices. This seminal work introduced the concept of efficient frontiers, demonstrating how investors could optimize their portfolios by balancing risk and return.

Building on Markowitz's work, Tobin (1958), introduced the concept of the "separation theorem," which further refined portfolio theory by separating the decision of optimal risk-return trade-off from the decision of how much risk to bear. These foundational theories in finance provided the theoretical underpinnings for ALM practices that would later be adapted for sovereign finance management.

In the public sector, the concept of SALM evolved as an extension of ALM principles to government finances. Barro (1979), was among the early contributors to the theoretical discussions on comprehensive sovereign asset and liability management. His tax-smoothing theory proposed that governments should use debt to minimize the distortionary effects of taxation over time, effectively treating debt as a shock absorber for fiscal policy. This perspective laid the foundation for considering both assets and liabilities in government financial management.

Bohn (1990), further developed these ideas by exploring how governments could use financial instruments to hedge against macroeconomic shocks. His work emphasized the importance of considering the entire balance sheet of the government when making fiscal policy decisions, a key principle of SALM.

The theoretical framework of SALM is built on several key principles:

1. Integrated risk management: SALM advocates for a holistic approach to managing government finances, considering both assets and liabilities simultaneously to optimize the overall risk-return profile. This principle is rooted in the work of Merton (1995), who proposed an integrated approach to financial system management. In the context of sovereign finance, this principle suggests that governments should consider the interrelationships between various financial risks and manage them collectively rather than in isolation.

2. Long-term sustainability: The framework emphasizes the importance of maintaining fiscal sustainability over the long term, balancing current needs with future obligations. This principle aligns with the work of Blanchard et al. (1990), who developed a framework for assessing fiscal sustainability. Their approach considers the long-term implications of current fiscal policies, emphasizing the need for governments to maintain a stable debt-to-GDP ratio over time.

3. Risk mitigation: SALM aims to identify and manage various financial risks, including interest rate risk, currency risk, and liquidity risk, across the government's entire balance sheet. This principle draws from the risk management literature in corporate finance, such as the work of Froot et al. (1993), who developed a framework for corporate risk management. In the sovereign context, this principle suggests that

governments should actively manage their financial risks to reduce vulnerability to economic shocks.

4. Optimization of resources: By considering the entire balance sheet, SALM seeks to optimize the use of government resources, potentially reducing borrowing costs and improving financial stability. This principle is grounded in the efficient market hypothesis proposed by Fama (1970), which suggests that financial markets are informationally efficient. In the context of SALM, this principle implies that governments should strive to make optimal use of available financial instruments and market mechanisms to manage their assets and liabilities.

The development of SALM as a comprehensive framework for sovereign financial management has been influenced by several strands of economic and financial theory. Missale (1999), provided a comprehensive review of the theoretical foundations of public debt management, highlighting the importance of considering both the cost and risk aspects of government debt. His work emphasized the role of debt management in achieving broader macroeconomic objectives, a key tenet of the SALM approach.

The global financial crisis of 2008 further underscored the importance of comprehensive financial risk management for sovereigns. Reinhart and Rogoff's (2009), influential work on the history of financial crises highlighted the potential for sovereign debt crises to have far-reaching economic consequences. This research reinforced the need for proactive management of sovereign balance sheets to mitigate systemic risks.

In recent years, the theoretical underpinnings of SALM have been further developed and refined. Das et al (2012), provided a comprehensive framework for conceptualizing sovereign risk and asset-liability management. Their work emphasized the interconnectedness of various risks facing sovereigns and the need for an integrated approach to managing these risks.

The application of SALM principles to developing countries has been a subject of particular interest in recent literature. Melecky (2007), explored the challenges and opportunities of implementing SALM in emerging market economies, highlighting the need to adapt the framework to the specific circumstances of these countries. His work emphasized the importance of considering factors such as limited financial market development and institutional capacity constraints when implementing SALM in developing country contexts.

The role of sovereign wealth funds (SWFs) in SALM has also been a focus of recent research. Clark and Monk (2011), examined the governance and investment strategies of SWFs, highlighting their potential role in managing sovereign assets and liabilities. Their work emphasized the importance of aligning SWF strategies with broader national economic objectives, a key principle of the SALM approach.

The theoretical foundations of SALM have also been influenced by developments in behavioral economics and finance. The work of Kahneman and Tversky (1979), on prospect theory has implications for understanding how policymakers may perceive and respond to financial risks in the context of sovereign asset and liability management. This perspective

suggests that psychological factors may play a role in shaping SALM strategies and decision-making processes.

Recent research has also explored the potential for applying advanced quantitative techniques to SALM. Blommestein and Koc (2008), proposed the use of stochastic simulation methods for sovereign debt and risk management, demonstrating how these techniques can be used to analyze the impact of different SALM strategies on key fiscal indicators.

The evolving nature of global financial markets and the increasing complexity of sovereign financial instruments have led to ongoing refinements in SALM theory and practice. Cangoz et al (2018), conducted a comprehensive survey of SALM practices across countries, providing insights into how theoretical principles are being applied in practice. Their work highlighted the diversity of approaches to SALM implementation and the need for continued research to identify best practices.

The COVID-19 pandemic has further underscored the importance of robust SALM frameworks. Benmelech and Tzur-Ilan (2020), examined the fiscal and monetary policy responses to the pandemic, highlighting the critical role of effective sovereign balance sheet management in navigating economic crises.

In conclusion, the theoretical foundations of SALM draw from a rich tapestry of economic and financial theories, ranging from portfolio optimization to fiscal sustainability and risk management. As governments face increasingly complex financial challenges, the SALM framework continues to evolve, incorporating new insights from both theoretical research and practical experience. The ongoing development of SALM theory and practice represents a critical area of research in public financial management, with important implications for fiscal policy, debt sustainability, and economic stability.

Review of Relevant Empirical Studies:

Empirical research on Sovereign Asset and Liability Management (SALM) and its impact on debt management has grown significantly in recent years. However, studies focusing specifically on developing countries remain limited, particularly in the Middle East region. This section provides a comprehensive review of relevant empirical studies, highlighting key findings and methodologies.

Conceptual Frameworks and Cross-Country Studies

Das et al (2012), conducted a seminal study on sovereign risk and asset-liability management, providing a conceptual framework for SALM implementation. Their research highlighted the potential benefits of SALM in identifying and managing critical financial exposures, contributing to macroeconomic and financial stability. The authors emphasized the importance of a comprehensive approach to sovereign balance sheet management, considering both assets and liabilities in an integrated manner.

Building on this framework, Blommestein and Koc (2008), examined the application of SALM in the context of Sovereign Wealth Funds (SWF) management. They demonstrated that considering both sovereign assets and liabilities in debt management strategies could lead to more efficient outcomes compared to standalone asset and liability strategies. Their study

provided empirical evidence supporting the integration of SWF management within the broader SALM framework.

In a comprehensive survey of sovereign balance sheet management practices, Cangoz et al (2018), analyzed data from 28 countries. Their findings revealed significant variation in SALM implementation across countries, with most respondents indicating that they regularly produce accounting balance sheets to monitor sovereign assets and liabilities, rather than determining mismatches between them. This study highlighted the practical challenges in implementing SALM and the diverse approaches adopted by different countries.

Melecky (2012), conducted a cross-country analysis of public debt management strategies, examining data from 205 countries over the period 1970-2008. The study found that countries with more sophisticated debt management strategies tended to have lower borrowing costs and were better able to weather financial crises. This research underscored the importance of strategic debt management in enhancing fiscal resilience.

Country-Specific Studies

Several studies have focused on SALM implementation in specific countries, providing valuable insights into the practical application of these principles. Amante et al (2019), studied the implementation of SALM in Uruguay, an emerging market economy. Their research showed that the SALM approach allowed authorities to identify and monitor sovereign exposure mismatches, increasing flexibility in dealing with foreign currencies and interest rates, and reducing risks. The study provided a detailed case analysis of how SALM principles can be adapted to the specific needs of an emerging economy.

In the context of New Zealand, Huijben et al (2019), examined the country's approach to sovereign balance sheet management. They found that New Zealand's integrated approach to fiscal policy and balance sheet management contributed to improved fiscal outcomes and enhanced resilience to economic shocks. This study highlighted the potential benefits of a comprehensive SALM approach in a developed economy context.

Koc (2014), provided an overview of SALM frameworks for Debt Management Offices (DMOs) based on country experiences. The study emphasized the importance of identifying and assessing priority balance sheet areas from a vulnerability and management perspective. This research contributed to the practical understanding of how SALM principles can be operationalized within government institutions.

Focusing on the United Kingdom, Beetsma et al (2018), analyzed the impact of debt management on fiscal stabilization. Their empirical analysis found that strategic debt management, particularly through the issuance of inflation-linked bonds, can enhance fiscal stability and reduce borrowing costs. This study provided evidence of the macroeconomic benefits of sophisticated debt management strategies.

Emerging Market and Developing Economy Studies

While research on SALM in developing countries remains limited, several studies have provided valuable insights into the challenges and opportunities in these contexts.

Adom et al (2020), examined the determinants of public debt in Sub-Saharan African countries, using panel data analysis. Their study found that factors such as GDP growth, inflation, and institutional quality significantly influenced public debt levels. This research highlighted the importance of considering macroeconomic and institutional factors in debt management strategies for developing economies.

In the context of Latin America, Clements et al (2019), analyzed the fiscal sustainability of several countries in the region. Their study employed various econometric techniques, including cointegration analysis and fiscal reaction functions, to assess the long-term sustainability of public finances. The research emphasized the importance of prudent fiscal management and debt sustainability in emerging market contexts.

Focusing on the Middle East and North Africa (MENA) region, Emara and El Said (2021), investigated the impact of governance on public debt. Using panel data analysis, they found a significant relationship between governance indicators and public debt levels. This study underscored the importance of institutional factors in debt management for countries in the MENA region.

Methodological Approaches in Empirical SALM Research

Empirical studies on SALM have employed a variety of methodological approaches, reflecting the complexity of the subject and the diverse contexts in which SALM is applied.

Time Series Analysis: Many studies have used time series techniques to analyze the long-term relationships between SALM components and debt management outcomes. For example, Bohn (1998), employed cointegration analysis to examine the sustainability of U.S. fiscal policy, providing a methodological framework that has been widely applied in subsequent research.

Panel Data Analysis: Cross-country studies often employ panel data techniques to capture both time and country-specific effects. Afonso and Jalles (2013), used panel data methods to analyze the determinants of sovereign debt yields across a large sample of countries, demonstrating the applicability of these techniques in SALM research.

Vector Autoregression (VAR) Models: VAR models have been used to analyze the dynamic interactions between SALM components and macroeconomic variables. For instance, Cherif and Hasanov (2018), employed a VAR approach to study the fiscal-monetary policy mix in oil-exporting countries, providing insights into the interdependencies between fiscal policy, debt management, and monetary policy.

Stochastic Simulation: Advanced quantitative techniques, such as stochastic simulation, have been used to model the complex dynamics of sovereign balance sheets. Consiglio and Staino (2012), developed a stochastic programming model for sovereign debt issuance, demonstrating the potential of these techniques in optimizing debt management strategies.

Emerging Themes in SALM Research

Recent empirical research has highlighted several emerging themes in the field of SALM:

Climate Risk and Sovereign Debt: A growing body of research is examining the implications of climate change for sovereign debt management. Kling et al (2018), analyzed the potential

impact of climate risks on sovereign bond yields, highlighting the need for governments to incorporate environmental considerations into their debt management strategies.

Digital Currencies and SALM: The emergence of central bank digital currencies (CBDCs) has raised new questions for SALM. Agur et al. (2021) explored the potential implications of CBDCs for monetary policy and financial stability, highlighting the need for further research on how these innovations might affect sovereign balance sheet management.

Pandemic Response and Fiscal Sustainability: The COVID-19 pandemic has sparked renewed interest in fiscal sustainability and debt management. Benmelech and Tzur-Ilan (2020) examined the fiscal and monetary policy responses to the pandemic across countries, providing insights into how SALM principles can be applied in crisis situations.

Research Gap and Hypotheses:

Despite the growing body of literature on SALM, several significant gaps remain in our understanding of its application and effectiveness, particularly in developing countries and the Middle East region.

1. Limited Focus on Developing Countries: Most existing studies focus on developed economies or larger emerging markets, leaving a gap in knowledge about how SALM principles can be effectively applied in smaller, more vulnerable economies like Jordan. There is a need for more research on the specific challenges and opportunities for SALM implementation in these contexts.
2. Lack of Comprehensive Analysis of SALM Components: While previous studies have examined the general impact of SALM on debt management, there is limited research on the specific components of SALM and their individual and collective effects on debt management efficiency. A more granular analysis of these components could provide valuable insights for policymakers.
3. Asymmetric Effects: The potential for asymmetric effects of SALM components on debt management has not been extensively explored in the existing literature. Understanding these asymmetries could be crucial for developing more nuanced and effective debt management strategies.
4. Long-term vs. Short-term Dynamics: There is a need for more research on the long-term and short-term dynamics of SALM effects on debt management efficiency. Most studies focus on either short-term or long-term effects, but a comprehensive analysis of both timeframes is lacking.
5. Institutional and Governance Factors: While some studies have touched on the role of institutional factors in debt management, there is a need for more in-depth research on how governance structures and institutional capacity affect the implementation and effectiveness of SALM strategies in developing countries.
6. Integration with Broader Economic Policy: Further research is needed on how SALM strategies interact with other areas of economic policy, such as monetary policy, fiscal policy, and financial sector development, particularly in the context of developing economies.

To address these gaps, this study proposes the following hypotheses:

H1: There is a statistically significant effect of SALM cash reserves on efficient debt management in Jordan.

H2: There is a statistically significant effect of SALM foreign reserves on efficient debt management in Jordan.

H3: There is a statistically significant effect of SALM equity in state-owned enterprises on efficient debt management in Jordan.

H4: There is a statistically significant effect of SALM future revenues on efficient debt management in Jordan.

H5: There is a statistically significant effect of SALM government debt on efficient debt management in Jordan.

H6: There is a statistically significant effect of SALM fiscal expenditures on efficient debt management in Jordan.

H7: There is a statistically significant effect of SALM contingent liabilities on efficient debt management in Jordan.

H8: The effects of SALM components on efficient debt management in Jordan are asymmetric in nature.

By testing these hypotheses, this study aims to provide a comprehensive understanding of how SALM components influence debt management efficiency in Jordan, considering both short-run and long-run dynamics, as well as potential asymmetric effects. The research will contribute to filling the identified gaps in the literature and provide valuable insights for policymakers in Jordan and similar developing economies.

Methodology

Research Design

This study employs a quantitative research design to investigate the impact of Sovereign Asset and Liability Management (SALM) on efficient debt management in Jordan. The research utilizes time series analysis, which is appropriate for examining the dynamic relationships between variables over time (Brooks, 2019). This approach allows for the exploration of both short-run and long-run effects, as well as potential asymmetric relationships between SALM components and debt management efficiency.

The choice of a quantitative approach is grounded in the positivist research paradigm, which emphasizes the use of empirical evidence and statistical techniques to test hypotheses and draw conclusions (Creswell & Creswell, 2017). This approach is particularly suitable for studying economic phenomena and has been widely used in similar studies on sovereign debt management (Melecky, 2012; Reinhart & Rogoff, 2011).

The study covers the period from 2005 to 2023, using quarterly data. This timeframe is chosen to capture recent developments in Jordan's economic and financial landscape, including the effects of global financial crises and regional economic challenges. The use of quarterly data allows for a more granular analysis of the relationships between variables and provides a sufficient number of observations for robust statistical analysis (Wooldridge, 2016).

Data Collection

Data for this study is collected from secondary sources, primarily the Ministry of Finance (MoF) and Central Bank of Jordan (CBJ) databases. These sources are chosen for their reliability and comprehensive coverage of the required financial and economic indicators. The use of official government sources enhances the credibility and accuracy of the data, a crucial factor in ensuring the validity of the research findings (Saunders et al., 2019).

The data collected includes:

1. Debt-to-GDP ratio (as a measure of efficient debt management)
2. Cash reserves
3. Foreign/international reserves
4. Equity in state-owned enterprises
5. Future revenues
6. Government debt
7. Fiscal expenditures
8. Contingent liabilities

All financial data is collected in Jordanian Dinars (JOD) to ensure consistency and avoid potential issues related to currency conversion. This approach aligns with best practices in international finance research, which emphasize the importance of using a consistent currency base when analyzing cross-border financial data (Bekaert & Hodrick, 2017).
The selection of these specific variables is informed by previous research on SALM and debt management. For instance, the inclusion of cash reserves and foreign reserves is supported by studies such as Aizenman and Marion (2004), who highlighted the importance of these variables in managing external shocks. The consideration of equity in state-owned enterprises is based on research by Bova et al. (2019), which emphasized the role of state-owned enterprises in fiscal risk management.

Variables and Measures

Dependent Variable:

- Efficient Debt Management (EDM): Measured by the debt-to-GDP ratio, calculated as the total outstanding debt divided by the Gross Domestic Product (GDP). This measure is widely used in the literature as an indicator of debt sustainability and management efficiency (Reinhart et al., 2012).

Independent Variables:

1. Cash Reserves (CRES): The worth of money that the government keeps for use in case of emergency. This variable is included based on research by Obstfeld et al. (2010), who highlighted the importance of reserve adequacy in managing financial crises.
2. Foreign/International Reserves (FORR): The amount of foreign currency assets held by the central bank. The inclusion of this variable is supported by studies such as

Aizenman and Lee (2007), who examined the motives for holding international reserves.

3. Equity in State-Owned Enterprises (SOES): The total assets or worth owned by state-owned enterprises. This variable is included based on research by Bova et al. (2016), who analyzed the fiscal costs of contingent liabilities arising from state-owned enterprises.
4. Future Revenues (FUR): Projected income the country will generate from selling goods and services. The inclusion of this variable is supported by studies on fiscal forecasting and its role in debt management (Leal et al., 2008).
5. Government Debt (GDEBT): The total amount of debt owed by the government at a specific time. This variable is a key component of SALM and is included based on extensive literature on public debt management (Missale, 2012).
6. Fiscal Expenditures (FEXP): Government spending on various programs and services. The inclusion of this variable is based on research linking fiscal policy to debt sustainability (Alesina & Passalacqua, 2016).
7. Contingent Liabilities (CL): Potential financial obligations that may arise in the future, depending on certain events or conditions. This variable is included based on research highlighting the importance of managing implicit government liabilities (Irwin & Mokdad, 2010).

To account for different scales and to facilitate interpretation, the natural logarithm of these variables is used in the analysis, denoted as LNCRES, LNFORR, LNSOES, LNFUR, LNGDEBT, LNFEXP, and LNCL respectively. This logarithmic transformation is a common practice in econometric analysis, as it helps to linearize relationships and reduce the impact of outliers (Wooldridge, 2016).

The selection and measurement of these variables align with the conceptual framework of SALM, which emphasizes the importance of considering both assets and liabilities in sovereign financial management (Das et al., 2012). By including a comprehensive set of variables representing different aspects of the sovereign balance sheet, this study aims to provide a holistic analysis of the factors influencing efficient debt management in Jordan.

Analytical Approach

The study employs a comprehensive analytical approach using several econometric techniques:

1. Descriptive Statistics: To provide an overview of the data characteristics, including measures of central tendency and dispersion.
2. Unit Root Tests: The Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests are used to check for stationarity in the time series data. This step is crucial to avoid spurious regression results.
3. Cointegration Test: Johansen's cointegration test is employed to examine the long-run relationships among the variables. This test helps determine whether the variables share a common stochastic trend.
4. Granger Causality Test: This test is used to investigate the causal relationships between the SALM components and efficient debt management.

5. Autoregressive Distributed Lag (ARDL) Model: The ARDL approach is used to analyze both short-run and long-run dynamics between the variables. This method is chosen for its ability to handle variables with different orders of integration and its efficiency in small samples.
6. Nonlinear Autoregressive Distributed Lag (NARDL) Model: The NARDL model is employed to capture potential asymmetric effects of the explanatory variables on the dependent variable. This approach allows for the decomposition of the explanatory variables into positive and negative partial sums, enabling the analysis of asymmetric short-run and long-run impacts.
7. Diagnostic Tests: Several diagnostic checks are performed to ensure the validity and reliability of the models:

- Normality test (Jarque-Bera test)
- Multicollinearity test (Variance Inflation Factor)
- Autocorrelation test (Breusch-Godfrey LM test)
- Heteroskedasticity test (ARCH test)
- Model specification test (Ramsey RESET test)
- Stability tests (CUSUM and CUSUMSQ)

The analysis is conducted using EViews 13 econometric software, which is well-suited for time series analysis and provides a comprehensive set of tools for the required tests and models.
This methodological approach allows for a thorough examination of the relationships between SALM components and efficient debt management in Jordan. By employing both ARDL and NARDL models, the study can capture linear and nonlinear relationships, providing a more nuanced understanding of the dynamics at play. The inclusion of various diagnostic tests ensures the robustness and reliability of the results, enhancing the validity of the study's findings and subsequent policy implications.

Results

Descriptive Statistics

The descriptive statistics provide an overview of the characteristics and trends of the variables used in this study. Table 1 presents the mean, median, maximum, minimum, and standard deviation of the variables employed in the analysis.

Table 1
Descriptive Statistics

Variable	Mean	Median	Maximum	Minimum	Std. Dev.
DEBTEX	0.77	0.775	0.964	0.384	0.134
LNCRES	6.841	6.975	7.89	5.31	0.535
LNFORR	8.867	8.989	9.28	8.115	0.332
LNSOES	8.147	8.262	8.697	5.981	0.381
LNFUR	8.058	8.145	9.095	6.74	0.607
LNGDEBT	9.84	10.008	10.614	8.883	0.529
LNFEXP	8.305	8.334	9.256	7.102	0.585
LNCL	9.302	9.365	9.932	8.44	0.283

The mean value of the debt-to-GDP ratio (DEBTEX) is 0.770, indicating that, on average, Jordan's public debt constitutes 77% of its GDP during the sample period. The median value of 0.775 is close to the mean, suggesting a relatively symmetric distribution. The maximum and minimum values of 0.964 and 0.384, respectively, show that the debt-to-GDP ratio has fluctuated considerably over time, with a standard deviation of 0.134. The natural logarithm of cash reserves (LNCRES) has a mean of 6.841 and a standard deviation of 0.535, indicating significant variability in cash reserves over the sample period. Foreign reserves (LNFORR) show less variability with a standard deviation of 0.332 around a mean of 8.867. Equity in state-owned enterprises (LNSOES) has a mean of 8.147 and a standard deviation of 0.381, while future revenues (LNFUR) show higher variability with a mean of 8.058 and a standard deviation of 0.607. Government debt (LNGDEBT) exhibits the highest mean value of 9.840 with a standard deviation of 0.529, reflecting the substantial growth and fluctuations in government debt levels over the sample period. Fiscal expenditures (LNFEXP) have a mean of 8.305 and a standard deviation of 0.585, suggesting significant variability in government spending. Contingent liabilities (LNCL) show the lowest variability among the independent variables, with a mean of 9.302 and a standard deviation of 0.283.

Main Empirical Findings

Unit Root Test Results

To ensure the stationarity of the variables and avoid spurious regression results, both the Phillips-Perron (PP) and Augmented Dickey-Fuller (ADF) tests were conducted. The results are presented in Table 2.

Table 2
Unit Root Test Results

Variable	PP Test	ADF Test	Order of Integration
DEBTEX	I(0)	I(1)	I(0)/I(1)
LNCRES	I(1)	I(1)	I(1)
LNFORR	I(1)	I(1)	I(1)
LNSOES	I(0)	I(0)	I(0)
LNFUR	I(0)	I(1)	I(0)/I(1)
LNGDEBT	I(1)	I(0)	I(0)/I(1)
LNFEXP	I(0)	I(1)	I(0)/I(1)
LNCL	I(0)	I(0)	I(0)

The results indicate that the variables are a mix of I(0) and I(1), justifying the use of the ARDL approach, which can handle variables with different orders of integration.

Cointegration Test Results

The Johansen cointegration test was employed to examine the long-run relationships among the variables. The results are presented in Table 3.

Table 3
Johansen Cointegration Test Results

Test	Number of CE(s)	Test Statistic	Critical Value (0.05)	Prob.
Trace	None *	302.3151	159.5297	0.0000
	At most 1*	136.2222	125.6154	0.0096
	At most 2	94.8322	95.7537	0.0578
Max-Eigen	None *	166.0929	52.3626	0.0000
	At most 1	41.3900	46.2314	0.1509
	At most 2	30.2127	40.0776	0.4100

The trace test indicates two cointegrating equations and the Max-Eigen test indicate one cointegrating equation at the 0.05 level, confirming the existence of long-run relationships among the variables.

Granger Causality Test Results

The Granger causality test was conducted to investigate the causal relationships between the SALM components and efficient debt management. The key findings (Appendix 1) are summarized below:

1. Bidirectional causality was found between DEBTEX and LNSOES, LNFUR, and LNFEXP.
2. Unidirectional causality was observed from LNFUR to LNFORR, and from LNFEXP to LNFORR.
3. Bidirectional causality was also found between LNGDEBT and LNFUR, as well as between LNGDEBT and LNFEXP.

These results suggest complex interrelationships between the SALM components and debt management efficiency.

ARDL Model Results

The ARDL model was employed to analyze both short-run and long-run dynamics between the variables. The optimal lag structure was determined using the Akaike Information Criterion (AIC). The selected model is ARDL(4,5,1,5,0,0,4,5). The short-run coefficients (Appendix 2) reveal significant effects of lagged values of DEBTEX, LNCRES, LNFORR, LNSOES, LNGDEBT, LNFEXP, and LNCL on the current value of DEBTEX. This indicates that changes in these variables have immediate effects on the debt-to-GDP ratio. The long-run coefficients are presented in Table 4.

Table 4
ARDL Long-run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNCRES	0.4989	0.1878	2.656	0.01
LNFORR	-0.3414	0.14	-2.4379	0.0177
LNSOES	0.1238	0.1318	0.9393	0.3512
LNFUR	-0.1117	0.1739	-0.6423	0.523
LNGDEBT	0.543	0.1478	3.6743	0.0005
LNFEXP	0.158	0.2733	0.5782	0.5652
LNCL	-1.3732	0.5553	-2.4728	0.0162

The results indicate that LNCRES, LNFORR, LNGDEBT, and LNCL have significant long-run effects on DEBTEX. Notably, LNCRES and LNGDEBT have positive effects, while LNCL and LNFORR has a negative effect on the debt-to-GDP ratio in the long run. The error correction term coefficient is -0.4764 and statistically significant, indicating that about 47.64% of any disequilibrium is corrected within one quarter.

NARDL Model Results

The NARDL model was employed to capture potential asymmetric effects of the explanatory variables on the debt-to-GDP ratio. The selected model is NARDL(4,4,4,0,2,3,1,4). The results reveal asymmetric short-run effects of LNSOES, LNFUR, and LNFEXP on DEBTEX (Appendix 3). The coefficients for positive and negative changes in these variables differ in magnitude and significance, indicating that increases and decreases in these variables have different immediate effects on the debt-to-GDP ratio. Table 5 presents the long-run coefficients from the NARDL model.

Table 5
NARDL Long-run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNCRES	-0.0982	0.0727	-1.3495	0.1823
LNFORR	-0.0698	0.0866	-0.8053	0.4239
LNGDEBT	0.7720	0.1203	6.4191	0.0000
LNCL	-0.1129	0.1144	-0.9875	0.3274
LNSOES+	0.2775	0.1029	2.6971	0.0091
LNSOES-	0.2891	0.0953	3.0330	0.0036
LNFUR+	0.1703	0.0828	2.0564	0.0442
LNFUR-	0.2877	0.0914	3.1482	0.0026
LNFEXP+	-0.5848	0.1425	-4.1026	0.0001
LNFEXP-	-0.6797	0.1374	-4.9462	0.0000

The results show asymmetric long-run effects of LNSOES, LNFUR, and LNFEXP on DEBTEX. Both positive and negative changes in these variables have significant but different impacts on the debt-to-GDP ratio in the long run.

Hypothesis Testing Results

Based on the empirical findings, we can evaluate the research hypotheses:

H1: There is a statistically significant effect of SALM cash reserves on efficient debt management in Jordan. Result: Supported. The ARDL model shows a significant positive long-run effect of cash reserves on the debt-to-GDP ratio.

H2: There is a statistically significant effect of SALM foreign reserves on efficient debt management in Jordan. Result: Partially supported. The ARDL model shows a significant negative long-run effect, but the NARDL model does not confirm this finding.

H3: There is a statistically significant effect of SALM equity in state-owned enterprises on efficient debt management in Jordan. Result: Supported. The NARDL model reveals significant asymmetric effects of equity in state-owned enterprises on the debt-to-GDP ratio in both the short and long run.

H4: There is a statistically significant effect of SALM future revenues on efficient debt management in Jordan. Result: Supported. The NARDL model shows significant asymmetric effects of future revenues on the debt-to-GDP ratio in both the short and long run.

H5: There is a statistically significant effect of SALM government debt on efficient debt management in Jordan. Result: Strongly supported. Both ARDL and NARDL models show a significant positive long-run effect of government debt on the debt-to-GDP ratio.

H6: There is a statistically significant effect of SALM fiscal expenditures on efficient debt management in Jordan. Result: Supported. The NARDL model reveals significant asymmetric effects of fiscal expenditures on the debt-to-GDP ratio in both the short and long run.

H7: There is a statistically significant effect of SALM contingent liabilities on efficient debt management in Jordan. Result: Partially supported. The ARDL model shows a significant negative long-run effect, but the NARDL model does not confirm this finding.

H8: The effects of SALM components on efficient debt management in Jordan are asymmetric in nature. Result: Supported. The NARDL model reveals asymmetric effects for equity in state-owned enterprises, future revenues, and fiscal expenditures on the debt-to-GDP ratio.

In summary, the empirical findings largely support the hypothesized relationships between SALM components and efficient debt management in Jordan. The results highlight the complex and often asymmetric nature of these relationships, emphasizing the importance of considering both positive and negative changes in SALM components when formulating debt management strategies.

Discussion

Interpretation of key findings

The empirical analysis conducted in this study provides valuable insights into the relationship between Sovereign Asset and Liability Management (SALM) and efficient debt management in Jordan. The findings reveal a complex interplay between various SALM components and the debt-to-GDP ratio, with both short-run and long-run effects, as well as asymmetric dynamics.

One of the most striking findings is the positive long-run effect of cash reserves on the debt-to-GDP ratio. This result, while counterintuitive at first glance, may be explained by the precautionary motive for holding cash reserves in uncertain economic environments. It suggests that as Jordan accumulates more cash reserves, it may also be incurring more debt, possibly as a buffer against potential economic shocks. This finding aligns with the research of Aizenman and Marion (2003), who noted that emerging economies often accumulate reserves for reasons beyond mere debt management.

The negative long-run effect of foreign reserves on the debt-to-GDP ratio, as revealed by the ARDL model, is consistent with conventional wisdom and previous studies (e.g., Bussière & Mulder, 1999). It suggests that higher levels of foreign reserves are associated with lower debt burdens, possibly due to reduced need for external borrowing and improved creditworthiness.

The asymmetric effects of equity in state-owned enterprises, future revenues, and fiscal expenditures on the debt-to-GDP ratio, as shown by the NARDL model, are particularly noteworthy. These findings indicate that increases and decreases in these variables have different impacts on debt management efficiency. For instance, the positive effect of both increases and decreases in state-owned enterprise equity on the debt-to-GDP ratio suggests that changes in this sector, regardless of direction, may lead to increased debt burdens. This could be due to the complex nature of state-owned enterprises and their potential to generate both assets and liabilities for the government.

The strong positive effect of government debt on the debt-to-GDP ratio, confirmed by both ARDL and NARDL models, underscores the self-reinforcing nature of debt accumulation. This finding aligns with the debt overhang theory proposed by Krugman (1988) and emphasizes the importance of prudent debt management to avoid unsustainable debt levels.

The asymmetric effects of fiscal expenditures, where both increases and decreases are associated with a lower debt-to-GDP ratio in the long run, present an intriguing finding. This could suggest that changes in fiscal policy, regardless of direction, may lead to improved debt management efficiency, possibly through increased focus on fiscal discipline or structural reforms accompanying policy changes.

Theoretical and Practical Implications

From a theoretical perspective, this study contributes to the growing body of literature on SALM by providing empirical evidence of its impact on debt management efficiency in a developing country context. The findings support the notion that SALM components have significant and often complex effects on debt management, extending beyond simple linear relationships. The asymmetric effects revealed by the NARDL model highlight the importance of considering non-linear dynamics in theoretical models of sovereign debt management.

The study also bridges the gap between traditional debt management theories and the more comprehensive SALM framework. By demonstrating the interconnectedness of various financial components in affecting debt efficiency, it underscores the need for integrated approaches to public financial management, as advocated by Blommestein and Koc (2008).

Practically, the findings have several implications for policymakers and debt managers in Jordan and similar developing economies:

1. The positive relationship between cash reserves and debt-to-GDP ratio suggests that policymakers should carefully balance the benefits of precautionary cash holdings against the costs of additional debt.
2. The asymmetric effects of several SALM components indicate that policymakers should consider the direction of changes in these variables when formulating debt management strategies. For instance, the different impacts of increases and decreases in fiscal expenditures suggest that both expansionary and contractionary fiscal policies may have unique implications for debt management.
3. The strong positive effect of government debt on the debt-to-GDP ratio emphasizes the need for stringent debt management practices to prevent unsustainable debt accumulation.
4. The complex interrelationships between SALM components and debt efficiency highlight the importance of a holistic approach to public financial management, considering assets and liabilities simultaneously.

Limitations

While this study provides valuable insights, it is important to acknowledge its limitations:
1. The study focuses solely on Jordan, which may limit the generalizability of findings to other developing countries with different economic structures or institutional frameworks.
2. The time period covered (2005-2023) includes several global economic events, such as the 2008 financial crisis and the COVID-19 pandemic, which may have influenced the relationships observed.
3. The study relies on aggregate measures of SALM components, which may mask important details or sub-component effects.
4. While the NARDL model captures some non-linear relationships, it may not fully account for all potential non-linearities or threshold effects in the relationships between SALM components and debt efficiency.
5. The study does not directly account for external factors such as global economic conditions or geopolitical events that may influence both SALM components and debt management efficiency.

Conclusion

Summary of main findings

This study investigated the impact of Sovereign Asset and Liability Management (SALM) on efficient debt management in Jordan using quarterly data from 2005 to 2023. The research employed advanced econometric techniques, including ARDL and NARDL models, to analyze both short-run and long-run dynamics, as well as potential asymmetric effects.
Key findings include:

1. The existence of long-run relationships between SALM components and the debt-to-GDP ratio.
2. Significant short-run and long-run effects of cash reserves, foreign reserves, government debt, and contingent liabilities on debt management efficiency.

3. Asymmetric effects of equity in state-owned enterprises, future revenues, and fiscal expenditures on the debt-to-GDP ratio, indicating that increases and decreases in these variables have different impacts on debt management efficiency.
4. A strong positive relationship between government debt and the debt-to-GDP ratio, emphasizing the self-reinforcing nature of debt accumulation.
5. Complex interrelationships between SALM components, as revealed by Granger causality tests, suggesting the need for an integrated approach to public financial management.

Contributions

This study makes several important contributions to the field of public financial management and debt studies:
1. It provides empirical evidence on the effectiveness of SALM in a developing country context, addressing a gap in the literature which has predominantly focused on developed economies.
2. The research demonstrates the importance of considering asymmetric effects in analyzing the relationship between SALM components and debt management efficiency.
3. It offers a comprehensive methodological approach for studying SALM impacts, combining traditional econometric techniques with more advanced models like NARDL.
4. The findings provide valuable insights for policymakers and debt managers in Jordan and similar economies, offering a basis for more informed decision-making in public financial management.

Future Research Directions

Based on the findings and limitations of this study, several avenues for future research are proposed:
1. Extend the analysis to other developing countries to test the generalizability of the findings and identify potential country-specific factors influencing SALM effectiveness.
2. Investigate the impact of external factors, such as global economic conditions or geopolitical events, on the relationship between SALM and debt management efficiency.
3. Conduct a more granular analysis of SALM components, examining sub-components and their individual effects on debt management.
4. Explore potential threshold effects or non-linear relationships that may exist beyond those captured by the NARDL model.
5. Investigate the institutional and governance factors that may influence the effectiveness of SALM implementation in developing countries.
6. Conduct comparative studies between developing and developed economies to identify best practices in SALM implementation and their applicability across different economic contexts.

By addressing these research directions, future studies can further enhance our understanding of SALM and its role in promoting efficient debt management, ultimately contributing to improved fiscal sustainability and economic stability in developing countries.

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Appendices

Appendix 1 Granger Causality Test

Pairwise Granger Causality Tests

Sample: 2005Q1 2023Q4
Lags: 2

Null Hypothesis:	Obs.	F-Statistic	Prob.
D(LNCRES) does not Granger Cause D(DEBTEX)	72	1.3752	0.2598
D(DEBTEX) does not Granger Cause D(LNCRES)		1.3621	0.2631
D(LNFORR) does not Granger Cause D(DEBTEX)	72	1.0866	0.3432
D(DEBTEX) does not Granger Cause D(LNFORR)		0.1021	0.9031
LNSOES does not Granger Cause D(DEBTEX)	72	5.4101	0.0066
D(DEBTEX) does not Granger Cause LNSOES		3.1926	0.0474
D(LNFUR) does not Granger Cause D(DEBTEX)	72	8.5230	0.0005
D(DEBTEX) does not Granger Cause D(LNFUR)		13.1553	0.0000
D(LNGDEBT) does not Granger Cause D(DEBTEX)	72	0.3970	0.6739
D(DEBTEX) does not Granger Cause D(LNGDEBT)		0.1520	0.8593
D(LNFEXP) does not Granger Cause D(DEBTEX)	72	7.6651	0.0010
D(DEBTEX) does not Granger Cause D(LNFEXP)		11.2048	0.0001
LNCL does not Granger Cause D(DEBTEX)	72	0.5402	0.5852
D(DEBTEX) does not Granger Cause LNCL		0.0303	0.9701
D(LNFORR) does not Granger Cause D(LNCRES)	72	0.0200	0.9802
D(LNCRES) does not Granger Cause D(LNFORR)		0.8889	0.4159
LNSOES does not Granger Cause D(LNCRES)	72	0.5845	0.5602
D(LNCRES) does not Granger Cause LNSOES		0.0739	0.9288
D(LNFUR) does not Granger Cause D(LNCRES)	72	0.9569	0.3893
D(LNCRES) does not Granger Cause D(LNFUR)		2.4620	0.0930
D(LNGDEBT) does not Granger Cause D(LNCRES)	72	0.0970	0.9077
D(LNCRES) does not Granger Cause D(LNGDEBT)		1.0346	0.3610
D(LNFEXP) does not Granger Cause D(LNCRES)	72	0.7912	0.4575
D(LNCRES) does not Granger Cause D(LNFEXP)		2.2093	0.1177
LNCL does not Granger Cause D(LNCRES)	72	0.8904	0.4153
D(LNCRES) does not Granger Cause LNCL		2.6135	0.0807
LNSOES does not Granger Cause D(LNFORR)	72	2.0980	0.1307
D(LNFORR) does not Granger Cause LNSOES		1.1049	0.3372
D(LNFUR) does not Granger Cause D(LNFORR)	72	2.6513	0.0780
D(LNFORR) does not Granger Cause D(LNFUR)		4.4941	0.0147
D(LNGDEBT) does not Granger Cause D(LNFORR)	72	1.2196	0.3018
D(LNFORR) does not Granger Cause D(LNGDEBT)		1.5856	0.2124
D(LNFEXP) does not Granger Cause D(LNFORR)	72	2.5846	0.0829
D(LNFORR) does not Granger Cause D(LNFEXP)		4.3066	0.0174
LNCL does not Granger Cause D(LNFORR)	72	0.8201	0.4448
D(LNFORR) does not Granger Cause LNCL		0.1930	0.8250
D(LNFUR) does not Granger Cause LNSOES	72	2.7676	0.0700
LNSOES does not Granger Cause D(LNFUR)		0.6787	0.5107
D(LNGDEBT) does not Granger Cause LNSOES	72	0.2116	0.8098
LNSOES does not Granger Cause D(LNGDEBT)		0.5532	0.5777
D(LNFEXP) does not Granger Cause LNSOES	72	2.8207	0.0667

LNSOES does not Granger Cause D(LNFEXP)	73	0.8037	0.4519
LNCL does not Granger Cause LNSOES		3.3883	0.0396
LNSOES does not Granger Cause LNCL		1.9448	0.1509
D(LNGDEBT) does not Granger Cause D(LNFUR)	72	5.6519	0.0054
D(LNFUR) does not Granger Cause D(LNGDEBT)		5.3900	0.0068
D(LNFEXP) does not Granger Cause D(LNFUR)	72	0.9785	0.3812
D(LNFUR) does not Granger Cause D(LNFEXP)		0.4526	0.6379
LNCL does not Granger Cause D(LNFUR)	72	0.0280	0.9724
D(LNFUR) does not Granger Cause LNCL		0.0633	0.9387
D(LNFEXP) does not Granger Cause D(LNGDEBT)	72	4.0819	0.0212
D(LNGDEBT) does not Granger Cause D(LNFEXP)		3.9483	0.0239
LNCL does not Granger Cause D(LNGDEBT)	72	0.1310	0.8775
D(LNGDEBT) does not Granger Cause LNCL		1.0867	0.3432
LNCL does not Granger Cause D(LNFEXP)	72	0.0504	0.9508
D(LNFEXP) does not Granger Cause LNCL		0.0619	0.9401

Appendix 2 ARDL Model Estimation for Short-Run Dynamics

Dependent Variable: DEBTEX
Method: ARDL
Sample: 2006Q2 2023Q3
Included observations: 70
Dependent lags: 5 (Automatic)
Automatic-lag linear regressors (5 max. lags): LNCRES LNFORR LNSOES LNFUR LNGDEBT LNFEXP LNCL
Deterministics: Restricted constant and no trend (Case 2)
Model selection method: Akaike info criterion (AIC)
Number of models evaluated: 1399680
Selected model: ARDL(4,5,1,5,0,0,4,5)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
DEBTEX(-1)	0.2955	0.1185	2.4937	0.0171
DEBTEX(-2)	-0.2788	0.1324	-2.1058	0.0419
DEBTEX(-3)	0.1457	0.1416	1.0292	0.3099
DEBTEX(-4)	0.3612	0.1139	3.1719	0.0030
LNCRES	-0.0223	0.0388	-0.5747	0.5689
LNCRES(-1)	0.0292	0.0405	0.7208	0.4755
LNCRES(-2)	0.1160	0.0417	2.7831	0.0083
LNCRES(-3)	0.0413	0.0376	1.0975	0.2793
LNCRES(-4)	-0.0101	0.0321	-0.3148	0.7546
LNCRES(-5)	0.0836	0.0307	2.7186	0.0098
LNFORR	0.0467	0.0797	0.5857	0.5616
LNFORR(-1)	-0.2093	0.0830	-2.5222	0.0160
LNSOES	0.0489	0.0230	2.1266	0.0400
LNSOES(-1)	0.0158	0.0232	0.6826	0.4990
LNSOES(-2)	0.0631	0.0227	2.7809	0.0084
LNSOES(-3)	-0.0489	0.0234	-2.0891	0.0434
LNSOES(-4)	0.0141	0.0240	0.5871	0.5606
LNSOES(-5)	-0.0340	0.0232	-1.4678	0.1504

LNFUR	-0.0532	0.0720	-0.7392	0.4643
LNGDEBT	0.2587	0.0753	3.4361	0.0014
LNFEXP	-0.2521	0.0884	-2.8506	0.0070
LNFEXP(-1)	0.0195	0.0314	0.6212	0.5382
LNFEXP(-2)	-0.0037	0.0316	-0.1183	0.9064
LNFEXP(-3)	0.0199	0.0314	0.6354	0.5290
LNFEXP(-4)	0.2916	0.0681	4.2846	0.0001
LNCL	-0.0704	0.0741	-0.9500	0.3481
LNCL(-1)	-0.2110	0.0779	-2.7073	0.0101
LNCL(-2)	0.0036	0.0784	0.0456	0.9639
LNCL(-3)	-0.1082	0.0711	-1.5223	0.1362
LNCL(-4)	-0.0201	0.0738	-0.2721	0.7870
LNCL(-5)	-0.2481	0.0643	-3.8592	0.0004
C	3.0526	0.6870	4.4436	0.0001
R-squared	0.9416	Mean dependent var	0.7729	
Adjusted R-squared	0.8940	S.D. dependent var	0.1380	
S.E. of regression	0.0449	Akaike info criterion	-3.0649	
Sum squared resid	0.0766	Schwarz criterion	-2.0370	
Log likelihood	139.2698	Hannan-Quinn criter.	-2.6566	
F-statistic	19.7773	Durbin-Watson stat	2.0025	
Prob(F-statistic)		0.0000		

*Note: p-values and any subsequent test results do not account for model selection.

Appendix 3 NARDL Model Estimation for Short-Run Dynamics

Dependent Variable: D(DEBTEX)
Method: ARDL
Sample: 2006Q2 2023Q3
Included observations: 70
Dependent lags: 5 (Automatic)
Automatic-lag linear regressors (5 max. lags): LNCRES LNFORR LNGDEBT LNCL
Automatic-lag dual non-linear regressors (4 max. lags): LNSOES LNFUR LNFEXP
Deterministics: Restricted constant and no trend (Case 2)
Model selection method: Akaike info criterion (AIC)
Number of models evaluated: 312500
Selected model: ARDL(4,4,4,0,2,3,1,4)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
DEBTEX(-1)	-1.3540	0.3308	-4.0931	0.0003
LNCRES(-1)	-0.1329	0.0959	-1.3857	0.1764
LNFORR(-1)	-0.0945	0.1275	-0.7409	0.4647
LNGDEBT	1.0452	0.2867	3.6458	0.0010
LNCL(-1)	-0.1529	0.1617	-0.9454	0.3523
@CUMDP(LNSOES(-1))	0.3758	0.1644	2.2857	0.0298
@CUMDN(LNSOES(-1))	0.3914	0.1500	2.6086	0.0142
@CUMDP(LNFUR(-1))	0.2305	0.1502	1.5347	0.1357
@CUMDN(LNFUR(-1))	0.3895	0.1815	2.1465	0.0403
@CUMDP(LNFEXP(-1))	-0.7918	0.2906	-2.7251	0.0108

@CUMDN(LNFEXP(-1))	-0.9203	0.2973	-3.0952	0.0043
C	-5.1789	1.9852	-2.6088	0.0142
D(DEBTEX(-1))	0.3340	0.2691	1.2411	0.2245
D(DEBTEX(-2))	-0.0961	0.1872	-0.5132	0.6117
D(DEBTEX(-3))	-0.5015	0.1416	-3.5408	0.0014
D(LNCRES)	-0.1490	0.0455	-3.2768	0.0027
D(LNCRES(-1))	-0.1218	0.0649	-1.8759	0.0708
D(LNCRES(-2))	-0.0990	0.0562	-1.7611	0.0888
D(LNCRES(-3))	0.0484	0.0393	1.2306	0.2284
D(LNFORR)	0.0592	0.1150	0.5151	0.6104
D(LNFORR(-1))	0.0011	0.0965	0.0117	0.9908
D(LNFORR(-2))	0.1288	0.0992	1.2994	0.2040
D(LNFORR(-3))	-0.2087	0.0953	-2.1915	0.0366
D(LNCL)	0.0812	0.0906	0.8969	0.3772
D(LNCL(-1))	0.1081	0.0948	1.1406	0.2634
@DCUMDP(LNSOES)	0.1687	0.1411	1.1956	0.2415
@DCUMDN(LNSOES)	0.0410	0.0256	1.6047	0.1194
@DCUMDP(LNSOES(-1))	-0.2275	0.1427	-1.5942	0.1217
@DCUMDN(LNSOES(-1))	-0.2048	0.1619	-1.2651	0.2159
@DCUMDP(LNSOES(-2))	0.0592	0.0277	2.1413	0.0408
@DCUMDN(LNSOES(-2))	-0.1701	0.1365	-1.2457	0.2228
@DCUMDP(LNFUR)	0.5673	0.2053	2.7634	0.0098
@DCUMDN(LNFUR)	0.0817	0.1438	0.5679	0.5745
@DCUMDP(LNFEXP)	-0.5165	0.2308	-2.2380	0.0331
@DCUMDN(LNFEXP)	-0.5103	0.1749	-2.9180	0.0067
@DCUMDP(LNFEXP(-1))	0.3909	0.3243	1.2053	0.2378
@DCUMDN(LNFEXP(-1))	0.1425	0.1540	0.9252	0.3625
@DCUMDP(LNFEXP(-2))	-0.2529	0.2608	-0.9697	0.3402
@DCUMDN(LNFEXP(-2))	0.1510	0.1301	1.1611	0.2551
@DCUMDP(LNFEXP(-3))	-0.3068	0.2114	-1.4513	0.1574
@DCUMDN(LNFEXP(-3))	-0.1824	0.1165	-1.5655	0.1283
R-squared	0.8941	Mean dependent var		0.0023
Adjusted R-squared	0.7479	S.D. dependent var		0.0869
S.E. of regression	0.0436	Akaike info criterion		-3.1363
Sum squared resid	0.0552	Schwarz criterion		-1.8193
Log likelihood	150.7704	Hannan-Quinn criter.		-2.6132
F-statistic	6.1181	Durbin-Watson stat		1.8445
Prob(F-statistic)		0.0000		

*Note: p-values and any subsequent test results do not account for model selection.