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TIME SERIES ANALYSIS AND STRUCTURAL CHANGE IN ARMENIAN PUBLIC DEBT (2016-2025)

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Abstract: Using monthly data and econometric methods, we analyze stationarity properties, optimal forecasting models, and regime changes in debt dynamics. Results show that all debt series are integrated of order one and require differencing for stationarity. ARIMA models indicate that total debt needs second differencing due to post-2022 acceleration, while external debt follows a random walk with drift. Structural break tests identify five significant breaks corresponding to April 2018, August 2019, January 2021, May 2022, and May 2024. These breaks delineate three fiscal regimes: Pre-Crisis (2016-2019) with stable external dominance, Crisis (2020-2021) with shock-driven accumulation, and Post-Crisis (2022-2025) with rapid domestic debt expansion. The compositional transformation from 79% external debt in 2016 to 52% domestic debt by 2024 represents a substantial shift in Armenia's debt financing approach.

Keywords: public debt, Armenia, ARIMA, time series analysis, debt composition, emerging markets, fiscal policy.

JEL codes: H63, E62, C22, C53

Research aims: To characterize the time series properties of Armenian public debt components, identify structural regime changes, and generate forecasts that inform debt sustainability assessment.

Research novelty: Identification of five structural breaks marking distinct fiscal regimes; documentation of the compositional transformation from 79% external to 52% domestic debt using formal statistical tests.

Introduction

Public debt management presents challenges for emerging market economies, particularly small open economies vulnerable to external shocks (Reinhart and Rogoff 2009). For Armenia, a landlocked country of approximately 3 million people in the South Caucasus, debt management became more complex following the COVID-19 pandemic and the 2020 Nagorno-Karabakh War (Charaia and Papava 2021). Between December 2016 and October 2025, Armenia's public debt increased from $5.9 billion to $14.2 billion. This growth was accompanied by a compositional shift from 79% external debt in 2016 to 52% domestic debt by 2024.

Existing research on Armenian public debt focuses on institutional frameworks and policy recommendations (Matevosyan et al. 2025; Grigoryan 2025). Babajanyan et al. (2022) developed the Ararat Fiscal Strategy Model for fiscal policy analysis, while Karapetyan (2021) examined domestic debt effects on the banking sector. However, no studies have applied time series econometrics to characterize the stochastic properties, identify structural breaks, and generate forecasts of Armenian debt dynamics.

Recent literature on public debt in emerging markets addresses several relevant dimensions. Panizza (2008) examine debt composition choices and their implications for fiscal sustainability. Greiner, Fincke, et al. (2016) analyze the relationship between public debt, sustainability, and economic growth. Elkhishin and Mohieldin (2021) assess external debt vulnerability during the COVID-19 shock across emerging markets. Studies on post-conflict debt dynamics (Addison and Murshed 2005; Mlambo, Kamara, and Nyende 2009) provide context for understanding debt accumulation following conflict periods.

This study addresses the research gap by characterizing the time series properties of Armenian debt components and identifying structural regime changes. We employ Augmented Dickey-Fuller tests to determine stationarity properties, ARIMA models to generate forecasts, and multiple structural break tests to identify regime transitions. Our analysis uses monthly data from December 2016 to October 2025, covering 107 observations.

We find that all debt series are non-stationary in levels but stationary after first differencing, indicating integrated processes of order one. The optimal ARIMA specifications differ across debt components, with total debt requiring second differencing and seasonal adjustment. Structural break tests identify five breaks that delineate three distinct fiscal regimes with different debt growth rates and compositional patterns. The May 2024 break corresponds to the compositional crossover when domestic debt exceeded external debt for the first time in Armenia's post-Soviet history.

Literature Review

The literature on public debt in emerging markets examines several dimensions relevant to our analysis. Reinhart and Rogoff (2009) document historical patterns of sovereign debt crises and identify common precursors to fiscal distress. Their work emphasizes the importance of understanding debt dynamics and compositional changes as early warning indicators. Panizza (2008) analyze the choice between external and domestic debt, showing that debt composition has implications for macroeconomic stability and exchange rate risk.

For small open economies and sustainability issues, Greiner, Fincke, et al. (2016) provide a theoretical framework linking public debt dynamics to economic growth, showing how debt sustainability depends on the relationship between interest rates and growth rates. Gill and Pinto (2024) discuss debt sustainability frameworks for market access countries, noting the challenges of applying standard frameworks to emerging markets.

Time series methods for analyzing debt dynamics are well established in the literature. Hamilton (2020) provides the foundational framework for testing stationarity and modeling integrated processes. Lütkepohl (2013) offers comprehensive treatment of vector autoregressive models and their applications to economic time series. For structural break identification, Zivot and Andrews (2002) develop tests for unit roots with structural breaks, while Bai and Perron (2003) provide methods for estimating multiple structural breaks when break dates are unknown.

Recent work on debt dynamics during crisis periods is particularly relevant. Elkhishin and Mohieldin (2021) examine how

the COVID-19 shock affected external debt vulnerability across emerging markets and developing economies. They find that countries with higher pre-crisis debt levels and limited fiscal space experienced greater vulnerability. Charaia and Papava (2021) analyze public debt increases under the COVID-19 pandemic in Caucasus countries, including Armenia, documenting the fiscal pressures created by simultaneous health and economic crises.

For post-conflict contexts, Addison and Murshed (2005) and Mlambo, Kamara, and Nyende (2009) examine the challenges of financing reconstruction in Africa. Their work shows that post-conflict periods typically involve rapid debt accumulation as governments finance reconstruction while rebuilding institutional capacity. This literature provides relevant comparisons for understanding Armenia's debt dynamics following the 2020 war.

Studies comparing debt composition shifts across regions offer additional context. Makoto et al. (2021) analyze public debt composition in Southern African Development Community countries, documenting shifts from external to domestic debt following adoption of debt relief programs. They note that countries shifting toward domestic debt experienced stable growth rates but faced higher debt service costs.

Institutional Context

Armenia's public debt management operates within a legal framework defined by the Law on State Debt and annual State Budget Laws (Grigoryan 2025). The legislation establishes two fiscal rules: total public debt cannot exceed 60% of GDP, and when debt exceeds 50% of GDP, the budget deficit cannot exceed 3% of the

average GDP from the preceding three years. These rules create a "warning zone" between 50% and 60% debt-to-GDP where fiscal policy must tighten.

The debt ceiling was breached in 2020 and 2021, when debt-to-GDP reached 63.5% and 60.2% respectively, triggering emergency fiscal consolidation measures (Charaia and Papava 2021). As of 2023, the ratio declined to 48.1%, returning below the warning threshold. Armenia's fiscal policy during 2019-2024 was shaped by a Stand-By Arrangement with the IMF, which emphasized domestic capital market development (Babajanyan et al. 2022).

Between 2016 and 2025, Armenia's fiscal trajectory exhibited three phases. The Pre-Crisis period (2016-2019) maintained relatively stable public finances with moderate debt accumulation from $5.9 billion to $7.3 billion. The Crisis period (2020-2021) brought unprecedented shocks from COVID-19 and the Nagorno-Karabakh War, with debt increasing to $9.2 billion. The Post-Crisis period (2022-2025) saw the most substantial transformation, with total debt reaching $14.2 billion driven almost entirely by domestic debt expansion from $2.7 billion to $7.3 billion, while external debt remained relatively stable.

Data and Methods

Our analysis uses monthly public debt statistics from the Ministry of Finance of Armenia covering December 2016 to October 2025 (107 observations). The dataset includes total public debt and its components (external and domestic) reported in both Armenian Drams and US Dollars. We conduct analysis using USD denominations to eliminate exchange rate effects. We supplement

the monthly debt data with annual debt-to-GDP ratios from 1998 to 2023 for sustainability assessment.

We employ three econometric approaches. First, we apply Augmented Dickey-Fuller (ADF) tests (Hamilton 2020; Lütkepohl 2013) to test for unit roots. For a series y_t, the ADF test estimates:

$$\Delta y_t = \alpha + \beta t + \gamma y_{t-1} + \sum_{i=1}^{p} \delta_i \Delta y_{t-i} + \varepsilon_t$$

where Δ denotes first differencing. The test examines whether γ=0 (unit root) or γ<0 (stationarity). We select lag length using the Akaike Information Criterion. If series are non-stationary in levels, we test first differences to determine the order of integration.

Second, we employ Box-Jenkins ARIMA (p, d, q) methodology to model debt dynamics and generate forecasts. Given monthly data, we extend to seasonal $ARIMA(p,d,q)(P,D,Q)_{12}$ to capture annual patterns. We use automated model selection across ARIMA specifications using AIC while ensuring invertibility and stationarity conditions. Model adequacy is assessed through residual diagnostics including the Ljung-Box test for serial correlation.

Third, we apply multiple structural break tests. For known break dates, we employ Chow tests (Andrews 1993) to test for breaks at March 2020 (COVID-19 onset) and September 2020 (44-day war). For unknown break dates, we use the supremum F-test (Andrews 1993) and the BIC-optimal multiple break procedure (Bai

and Perron 2003). The latter estimates the optimal number of breaks and their locations simultaneously.

Results

Total debt averaged $9,173 million over the sample period with high variability (SD = $2,480 million). Domestic debt exhibits higher relative variability (coefficient of variation = 0.64) compared to external debt (CV = 0.11), reflecting the explosive growth phase post-2022.

Table 1. Evolution of Debt Composition (Year-End %)

Source: *Author's own work.*

	2016	2017	2018	2019	2020	2021	2022	2023	2024
External	79.1	79.6	78.2	77.5	74.6	70.6	58.4	52.7	48.2
Domestic	20.9	20.4	21.8	22.5	25.4	29.4	41.6	47.3	51.8

Table 1 documents the compositional transformation. The external debt share declined monotonically from 79.1% in 2016 to 48.2% in 2024, a reduction of 30.9 percentage points. The crossover occurred in 2024, marking the first time domestic debt exceeded external debt.

Table 2. Augmented Dickey-Fuller Test Results

Source: *Author's own work.*

Series	ADF Statistic	P-value	Decision
Total Debt	-0.808	0.958	Non-stationary
External Debt	-2.096	0.537	Non-stationary
Domestic Debt	-1.443	0.808	Non-stationary
Total Debt (Δ)	-5.737	0.010	Stationary
External Debt (Δ)	-4.894	0.010	Stationary
Domestic Debt (Δ)	-4.296	0.010	Stationary

Table 2 presents ADF test results. All three debt series are non-stationary in levels with p-values exceeding 0.50, indicating unit roots. However, first differences are strongly stationary (all p-values < 0.01), confirming that each series is integrated of order one. This finding indicates that debt levels exhibit trending behavior and shocks have permanent effects, while changes in debt are mean-reverting.

Total debt requires second differencing (d=2) to achieve stationarity, likely due to acceleration in debt accumulation post-2022. The model includes a seasonal autoregressive term (SAR=1) capturing annual patterns and an MA(1) term indicating one-period carryover effects. External debt follows a simple random walk with positive drift (19.4 million USD per month, se=11.7), suggesting gradual upward trend but high month-to-month unpredictability. This aligns with institutional reality that external borrowing depends on lumpy loan disbursements from international institutions. Domestic debt also requires second differencing without seasonal components, with a large negative MA(1) coefficient (-0.908, se=0.037) consistent with erratic but persistent accumulation.

Table 3. Estimated Structural Break Points (BIC-Optimal)

Source: *Author's own work.*

Break Date	Observation	Interpretation
April 2018	17	Shift in external borrowing pattern
August 2019	33	Pre-crisis trajectory change
January 2021	50	Post-war adjustment phase
May 2022	66	Domestic debt acceleration begins
May 2024	90	Compositional crossover

Chow tests decisively reject parameter stability at both March 2020 ($F=348.2$, $p<0.001$) and September 2020 ($F=345.2$, $p<0.001$), confirming that the 2020 crisis events induced

fundamental regime changes (Zivot and Andrews 2002). The BIC-optimal procedure identifies five breaks as optimal (Table 3). These breaks define six regimes, with the May 2024 break corresponding to the compositional crossover when domestic debt exceeded external debt.

Table 4. Debt Dynamics by Fiscal Regime

Source: *Author's own work.*

Regime	Months	Mean Debt	Min	Max	Growth (%)
Crisis (2020-2021)	22	8,372	7,287	9,226	26.6
Post-Crisis (2022-2025)	46	11,662	9,283	14,196	52.7
Pre-Crisis (2016-2019)	39	6,690	5,942	7,351	23.7

Table 4 presents statistics for the three main regimes defined by policy-relevant periods. The Pre-Crisis regime (2016-2019) exhibited moderate debt growth of 23.7% over 39 months, with mean debt of $6,690 million. The Crisis regime (2020-2021) saw 26.6% growth compressed into 22 months. The Post-Crisis regime (2022-2025) experienced 52.7% growth over 46 months, with mean debt reaching $11,662 million and substantially increased volatility.

Conclusion

This study characterizes the time series properties and structural breaks in Armenian public debt between 2016 and 2025. Our findings indicate that all debt series are integrated of order one, requiring differencing for proper statistical modeling. The optimal ARIMA specifications differ across debt components, with total debt requiring second differencing due to post-2022 acceleration. Structural break tests identify five breaks corresponding to April 2018, August 2019, January 2021, May

2022, and May 2024, delineating three fiscal regimes with distinct characteristics.

The compositional transformation from 79% external debt in 2016 to 52% domestic debt by 2024 represents a substantial shift in Armenia's debt financing approach. Forecasts project continued debt growth toward $16-17 billion by 2027, implying debt-to-GDP ratios approaching warning thresholds if GDP grows at projected rates. These findings provide empirical baselines for understanding Armenian fiscal policy and establish a foundation for future research examining the determinants of debt composition changes and their macroeconomic implications.

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ՀԱՅԱՍՏԱՆԻ ՊԵՏԱԿԱՆ ՊԱՐՏՔԻ ԺԱՄԱՆԱԿԱՅԻՆ ՇԱՐՔԵՐԻ ՎԵՐԼՈՒԾՈՒԹՅՈՒՆԸ ԵՒ ԿԱՌՈՒՑՎԱԾՔԱՅԻՆ ՓՈՓՈԽՈՒԹՅՈՒՆՆԵՐԸ (2016-2025 թթ.)

Եպրաքսյա Իսրաելյան
Հայաստանի պետական տնտեսագիտական համալսարան
դասախոս

Բանալի բառեր - պետական պարտք, Հայաստան, ARIMA, ժամանակային շարքերի վերլուծություն, պարտքի կառուցվածք, զարգացող շուկաներ, հարկաբյուջետային քաղաքականություն:

Սույն հետազոտությունում, հենվելով ՀՀ պետական պարտքի ամսական ցուցանիշների վրա և կիրառելով էկոնոմետրիկ վերլուծության գործիքակազմը, դիտարկվել են պարտքի դինամիկայի ստացիոնարությունը, կանխատեսման օպտիմալ մոդելները և ռեժիմային տեղաշարժերը: Վերլուծությունը ցույց է տալիս, որ դիտարկվող ժամանակային շարքերը բնութագրվում են առաջին կարգի ինտեգրվածությամբ՝ ստացիոնարության ապահովման նպատակով պահանջելով դիֆերենցում:

Համաձայն ARIMA մոդելների՝ 2022 թվականից արձանագրված աճի տեմպերի արագացմամբ պայմանավորված՝ պարտքի ընդհանուր ցուցանիշը ենթադրում է երկրորդ կարգի դիֆերենցում, մինչդեռ արտաքին պարտքը դրսևորում է «դրեյֆով պատահական քայլի» (random walk with drift) վարքագիծ: Կառուցվածքային խզումների թեստերը վեր են հանել հինգ առանցքային կետեր (2018 թ. ապրիլ, 2019 թ. օգոստոս, 2021 թ. հունվար, 2022 թ. մայիս և 2024 թ. մայիս), որոնք սահմանազատում են հարկաբյուջետային երեք ռեժիմ. նախաճգնաժամային (2016-2019թթ.)՝ արտաքին պարտքի կայուն գերակայությամբ, ճգնաժամային (2020-2021թթ.)՝ ցնցումներով պայմանավորված պարտքի կուտակմամբ, և հետճգնաժամային (2022-2025թթ.)՝ ներքին պարտքի ծավալների կտրուկ ընդլայնմամբ:

Կառուցվածքային նմանօրինակ փոխակերպումը՝ 2016 թ. արտաքին պարտքի 79% մասնաբաժնից անցումը 2024 թ. ներքին պարտքի 52%-ին, վկայում է ՀՀ պարտքի ֆինանսավորման քաղաքականության արմատական վերափոխման մասին:

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