

Public Debt and Infrastructure-Oriented Capital Formation in Kenya: NARDL and Robustness Evidence, 1995–2024

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ABSTRACT

Kenya has relied heavily on public borrowing to finance long-lived capital projects, yet rising debt stocks and repayment obligations raise concern that debt may increasingly constrain rather than support capital formation. This study examines the dynamic relationship between domestic debt, external debt, debt servicing and gross fixed capital formation (GFCF) in Kenya over 1995–2024 using a Nonlinear Autoregressive Distributed Lag (NARDL) framework. The bounds test confirms a long-run relationship ($F = 3.3756 > 3.04$), while the error-correction coefficient is negative and significant ($B = -1.9660$, $p = .0049$), indicating rapid overshooting adjustment toward equilibrium. Debt servicing has a strong negative short-run effect ($B = -1.6321$, $p = .0053$). Formal Wald tests do not reject short- or long-run symmetry at the 5% level, although the NARDL specification provides better adjusted fit and information criteria than a comparable linear ARDL model. Dynamic multiplier paths differ in magnitude and timing, but their uncertainty bands overlap substantially. The findings therefore support a dynamic and composition-sensitive debt-investment relationship while requiring caution in claims of statistical asymmetry and causality.

Keywords: public debt; capital formation; debt servicing; NARDL; Kenya

INTRODUCTION

Transport networks, power grids, water systems and telecommunications lower the cost of doing business and raise the productive capacity of an economy. In Sub-Saharan Africa, where structural change is still incomplete and logistics costs remain high, physical infrastructure is considered a precondition for structural change (Gachunga Muhia & Kuso, 2019; Mutiiria et al., 2020). Kenya has dedicated a lot of resources into roads, the Standard Gauge Railway, electricity generation and transmission, expanding the ports, urban infrastructure and water. These projects were supported by the public borrowing, and the debt load created in the context of successive long-term development blueprints of the country has become an important determinant of fiscal policy choices.

Borrowing is economically efficient when it enables the government to distribute the costs of assets that have a long life over many generations that will use them, especially where current tax revenue cannot cover the upfront outlay. Meanwhile, principal and interest payments are scheduled on each loan; those payments will need to be funded from future budgets. Even when the borrowing is being used to pay for productive capital expenditures, the fiscal “space” for new capital expenditures may become smaller, if those expenditures increase at a rate greater than the increase in revenues. Heller's (2005) fiscal-space framework draws attention to exactly this tension: it is not enough to ask whether debt finances good projects; one must also ask whether the resulting repayment stream leaves the government able to keep spending productively without putting macroeconomic stability at risk.

This tension is well demonstrated by Kenya. The largest source of funding for the government is borrowing from the domestic securities market and external borrowing encompasses anything from concessional to bilateral and multilateral and Eurobonds. The domestic public debt level was about one-third of GDP at end-2023, with government-security yields elevated and gross financing requirements heavy going into 2024 (IMF, 2024). The National Treasury and Economic Planning (2024) has also recognised the increased importance of debt-management considerations in the process of fiscal planning. Budget analysis for Kenya also reveals that there are non-linear relationships between recurrent commitments and supplementary allocations and debt servicing which can squeeze the fiscal space for development priorities (Christine & Kuso, 2026). Under these circumstances, the relevant policy question is no longer simply whether borrowing pays for infrastructure, but whether different types and movements of debt have distinct short-run and long-run effects on capital formation.

In Kenya, most studies have been conducted on the impact of public debt on economic growth, fiscal sustainability or aggregate capital formation. Their findings are typically a single aggregate of public debt or symmetric effects. Kamau (2021) used data from 1980 to 2019 to show that the public debt-gross capital formation linkage was more complex and had multiple lags. Kararach et al. (2022) highlight that debt sustainability is partly related to the efficiency of the use of the borrowed money, and Ndikumana et al. (2020) report that public debt in Sub-Saharan Africa (SSA) is growing quickly and that debtor governments are now using non-concessional and shorter maturity instruments. These studies leave room for a Kenya-specific analysis that separates domestic from external debt, includes debt servicing as a direct fiscal constraint and tests whether increases and decreases in debt follow different dynamic paths.

This study fills that gap using annual data for 1995-2024 and a Nonlinear Autoregressive Distributed Lag (NARDL) framework. The advantage of NARDL is that it allows changes in selected regressors to be decomposed into partial positive and negative changes, which enables the investment response to an increase in debt to be different from the investment response to a decrease in debt (Shin et al., 2014). The dependent variable is gross fixed capital formation (GFCF) as a share of GDP, used with caution as a measure of capital formation across the economy, which is likely to include infrastructure investment, but not necessarily limited to government investment (World Bank, n.d.). The core explanatory variables are domestic debt, external debt and debt servicing while the macroeconomic variables are inflation, exchange rate and interest rate.

The study contributes in three ways. First, it separates domestic and foreign debt, not putting them together as an overall figure. Secondly, it brings in the debt servicing aspect directly, and ties the repayment element with the financing need of the borrowing. Third, it employs NARDL to let positive and negative movements in the debt level take different dynamic courses, and makes a formal statistical test of whether these paths are statistically distinct. The contribution is therefore a more policy-relevant analysis of debt composition, timing, repayment pressure and the robustness of the capital-formation relationship.

LITERATURE REVIEW AND THEORETICAL FRAMEWORK

2.1 Debt overhang, fiscal space and crowding-out mechanisms

The study is anchored in debt-overhang theory. Krugman (1988) contended that, when future claims of creditors are sufficiently large, the returns to new investment are effectively "taxed" by expected claims of the creditors. The original argument was about external sovereign debt; the reasoning applies to public infrastructure: When a government is spending a high proportion of its revenues on interest and principal payments on its debts, it could delay or reduce capital expenditures on projects that would have positive social returns. Debt overhang, therefore, anticipates that the relationship between borrowing and investment may vary after a certain level of debt.

A complementary channel is added in the fiscal-space theory. According to Heller (2005), fiscal space is the ability to raise the priority spending without compromising fiscal sustainability and macroeconomic stability. In the short run, borrowing releases capacity by allowing resources to be used for investment spending that is not funded by current revenues. However, over time amortisation, interest payments, and refinancing requirements can narrow that gap, especially in the case of large infrastructure programs that take many years to construct,

and have further years of economic benefits. When repayment starts before the assets financed bring in revenue, the debts could be greater than the revenue they are intended to produce.

The crowding-out mechanism is especially relevant to domestic debt. The issuance of Treasury bills and bonds by the government can lead to an increase in interest rates, a depletion of bank liquidity, and a direct bank competition for financing. Kulu et al. (2022) provide evidence how public financing pressures can have spillover effects into the broader investment environment, based on evidence from Sub-Saharan Africa. Although this study focuses on a capital-formation proxy rather than private investment alone, the same financial-market channel matters because higher domestic borrowing costs also feed into the government's own future interest bill.

External debt operates in a variety of ways. Foreign loans may provide funds for major capital investments and foreign exchange for the purchase of foreign machinery, but are also subject to exchange rate risk and external refinancing requirements. For Sub-Saharan African countries, Gachunga Muhia and Kuso (2018) identified a negative relationship between external debt and growth, particularly in middle income countries. Manasseh et al. (2022) come to a similar conclusion that governance quality is a moderating factor. These are just more evidence of how debt can be neither productive nor destructive, depending on the quality of the projects for which it is used, the terms and conditions of the loan, and the institutional capacity and the consequences of debt repayment.

Taken together, these theoretical channels suggest that a simple linear, symmetric model of debt and investment is likely to be too restrictive. A rise in debt may finance new projects, while a fall in debt during fiscal consolidation may also cut capital spending. Alternatively, debt reduction may eventually free fiscal space and lower borrowing costs. NARDL accommodates this asymmetry because it allows the adjustment path after a debt increase to differ from the path after a debt decrease, rather than forcing equal and opposite effects (Shin et al., 2014)

2.2 Empirical evidence and the research gap

The empirical record generally supports a conditional rather than universal link between public debt and investment. As public debt increases, investment in emerging markets will decrease, particularly during periods of fiscal contraction, as stated by de Mendonca and Brito (2021). A phenomenon known as a debt-overhang effect on private investment in European economies has been documented by Vanlaer et al. (2021), and shows that it is not limited to low-income economies. Both studies support the theoretical expectation that the investment consequences of debt are non-linear and depend on fiscal conditions.

Within Africa, public investment efficiency is a recurring theme. Kararach et al. (2022) reveal that investment efficiency issues can lead to debt sustainability issues and recommend improving the management of public investments if borrowed money is to provide sufficient economic return. A significant increase in public debt in Sub-Saharan Africa and the growing dependence on non-concessional debt with shorter maturities and increased rollover risk, explains Ndikumana et al. (2020), increases the vulnerability of these economies to interest-rate and rollover shocks. It suggests that the effects of the same amount of borrowing can be quite different with respect to maturity, interest costs, currency denomination, and the use of the borrowed funds.

Kenyan evidence points to significant lag dependence. Kamau (2021), using 1980-2019 data, found that domestic and external debt affected gross capital formation differently across successive lags. Other Kenya-specific time-series work reaches a similar methodological conclusion: Masibayi and Kuso (2026), for example, use an ARDL framework to identify a stable long-run relationship and a significant lagged renewable-energy effect on manufacturing output, confirming that annual macroeconomic transmission in Kenya can unfold with a delay. Different types of infrastructure investment typically do not reflect a funding decision immediately; instead, procurement, project preparation and disbursement can have lags, while interest costs and market reaction can be immediate. A dynamic specification is therefore preferable to a purely contemporaneous model.

The remaining gap is the joint treatment of debt composition, debt-service pressure and potentially asymmetric adjustment in a Kenya-specific capital-formation context. Much of the literature focuses on growth rather than investment, combines domestic and external debt, or does not distinguish increases from decreases in debt. Debt servicing is also frequently treated as an outcome of sustainability analysis rather than as an explanatory constraint on capital formation. This study addresses these gaps by estimating a NARDL/ECM specification for 1995–2024 with domestic debt, external debt and debt servicing alongside inflation, exchange-rate and interest-rate controls.

METHODOLOGY

3.1 Research design, data and measurement

The study adopted an explanatory quantitative time-series design. The annual data for the period 1995-2024 were compiled from Central Bank of Kenya (CBK), Kenya National Bureau of Statistics (KNBS) and World Development Indicators (WDI). The time frame represents Kenya's fiscal post-liberation phase, growth of large infrastructure projects, increased reliance on domestic securities and external commercial loans, the COVID-19 crisis and resulting fiscal and financing constraints.

Growth of the dependent variable, gross fixed capital formation (GFCF) as a proportion of GDP, is analyzed. GFCF accounts for acquisitions minus the disposals of fixed assets and includes public and private fixed capital. It is here used as a general measure of capital formation in infrastructure sectors and not as an indicator of government infrastructure spending. This distinction is kept all the way through the analysis and interpretation. Domestic debt and external debt capture the two main borrowing components, while debt servicing captures the fiscal burden of principal and interest obligations. Inflation controls domestic price and project-cost pressures; the exchange rate captures foreign-currency and imported-capital exposure; and the interest rate controls domestic financing conditions.

Table 1. Variables, measurement and analytical role

Variable	Operational measure / role	Primary source
GFCF	Gross fixed capital formation; dependent proxy for infrastructure-oriented capital formation	World Bank / KNBS
Domestic debt	Government borrowing from domestic sources; core debt variable	CBK
External debt	Government obligations to external creditors; core debt variable	CBK / World Bank
Debt servicing	Debt-repayment burden; captures fiscal pressure from interest and principal obligations	CBK / National Treasury
Inflation	Annual price change; control for real project-cost and budget-value effects	World Bank / KNBS
Exchange rate	Kenya shilling per US dollar; control for imported inputs and foreign-debt exposure	CBK / World Bank
Interest rate	Domestic financing-cost indicator; control for borrowing conditions	CBK

Note. Some debt series appear in transformed form in the econometric output. Coefficients are interpreted by sign, timing and statistical significance rather than as direct shilling-unit effects.

NARDL specification and estimation strategy

The analysis was done using the NARDL approach of Shin et al. (2014) which is an extension of the ARDL bounds-testing procedure by Pesaran et al. (2001). NARDL is appropriate when the variables are a mixture of $I(0)$ and $I(1)$, provided none is $I(2)$, and it enables positive and negative changes in selected regressors to enter separately. The baseline long-run relationship was:

$$\ln(\text{GFCF}_t) = B_0 + B_1 \ln(\text{DD}_t) + B_2 \ln(\text{ED}_t) + B_3 \text{DS}_t + B_4 \text{INF}_t + B_5 \text{EXR}_t + B_6 \text{IR}_t + \epsilon_t \quad (1)$$

To determine whether positive and negative debt increases affect the economy differently, domestic debt and external debt were split into positive and negative partial debt series similar to Shin et al. (2014):

$$DDt+ = \text{Sum of max(Change in DD, 0)}; DDt- = \text{Sum of min(Change in DD, 0)} \quad (2)$$

$$EDt+ = \text{Sum of max(Change in ED, 0)}; EDt- = \text{Sum of min(Change in ED, 0)} \quad (3)$$

DD+ and ED+ accumulate increases in domestic and external debt; DD- and ED- accumulate decreases. Debt servicing was retained symmetrically because the final estimated model does not decompose it into positive and negative partial sums. The NARDL error-correction representation is:

$$\text{Change in ln(GFCF)} = a_0 + L1*\ln(\text{GFCF})_{t-1} + L2*DD_{t-1} + L3*DD_{t-1} + L4*ED_{t-1} + L5*ED_{t-1} + L6*DS_{t-1} + L7*INF_{t-1} + L8*EXR_{t-1} + L9*IR_{t-1} + \text{Sum}(\phi_i * \text{Change in X})_{t-i} + \epsilon_t \quad (4)$$

The lagged-level terms capture the long-run relationship. The differenced terms capture short-run dynamics. The error-correction mechanism measures the speed at which deviations from long-run equilibrium are corrected. Long-run cointegration was assessed using the bounds test. Coefficient signs, lag structure and statistical significance were used to interpret the short-run dynamics. Differences between positive and negative coefficients were taken as suggestive of asymmetric adjustment, noting that a formal Wald test would be needed to confirm statistical asymmetry.

Estimation proceeded in stages. Augmented Dickey-Fuller (ADF) tests first established the order of integration and ruled out I(2) variables. The NARDL model was then estimated with lagged levels and short-run differences, followed by the bounds test for a long-run relationship. Where cointegration was supported, the error-correction representation was used to examine short-run adjustment and convergence. The dataset contains 30 annual observations for 1995–2024. Because the 2024 real interest-rate observation is unavailable, the robustness specifications use the common 1995–2023 sample, yielding 28 first-difference observations after one lag. This effective sample constraint is taken into account in the interpretation of the robustness results.

The following diagnostic checks were performed: residual normality (Jarque-Bera), serial correlation (Breusch-Godfrey LM test), heteroskedasticity (Breusch-Pagan-Godfrey) and multicollinearity (variance inflation factors). A 5 per cent level of statistical significance was used. No humans took part in this study which was conducted using publicly available secondary macroeconomic data, and the integrity of the study was based on the accuracy of sourcing, reporting and faithful interpretation of the econometric output.

RESULTS

4.1 Stationarity and the long-run relationship

The ADF results showed that inflation was stationary at levels, while GFCF, domestic debt, external debt, debt servicing, the exchange rate and the interest rate were non-stationary at levels at the 5 per cent threshold. After first differencing, all variables became stationary. The mixture of I(0) and I(1), with no I(2) series, satisfies the integration-order requirement for ARDL/NARDL estimation (Pesaran et al., 2001; Shin et al., 2014).

Table 2. ADF unit-root and bounds-test evidence

Variable	ADF p at level	ADF p at first diff.	Conclusion
GFCF	.1816	.0001	I(1)
Domestic debt	1.0000	.0167	I(1)
External debt	.9961	.0215	I(1)
Debt service	.1491	.0004	I(1)
Inflation	.0005	.0009	I(0)
Exchange rate	.8671	.0028	I(1)
Interest rate	.0803	.0004	I(1)

Note. ADF decisions at 5%. Bounds F-statistic = 3.3756; 5% lower/upper bounds = 1.98/3.04. Because 3.3756 > 3.04, the null of no levels relationship was rejected.

The bounds test is the central piece of evidence for a long-run relationship. The calculated F-statistic of 3.3756 exceeded the 5 per cent upper critical bound of 3.04, so the null hypothesis of no levels relationship was rejected. GFCF, the debt variables and the macroeconomic controls therefore move together over the long run, even though their individual short-run effects differ in sign and timing. This result matters because it means the analysis can move beyond isolated annual correlations and look at the system as one in which short-run disequilibria are corrected over time.

Error-correction dynamics

Table 3. Selected error-correction estimates

Term	B	SE	t	p
D(GFCF(-1))	-.366685	.056993	-6.4338	.0233
D(DD+)	-1.99E-05	1.50E-06	-13.2408	.0057
D(DD+(-1))	-1.72E-05	2.41E-06	-7.1197	.0192
D(DD-)	3.04E-05	6.85E-05	.4431	.7010
D(DD-(-1))	.000566	.000102	5.5470	.0310
D(ED)	-4.72E-06	6.36E-07	-7.4247	.0177
D(ED(-1))	8.77E-06	1.17E-06	7.4665	.0175
D(INF)	-.514170	.032173	-15.9814	.0039
D(INF(-1))	.231004	.022892	10.0911	.0097
D(EXR)	.092223	.019820	4.6529	.0432
D(EXR(-1))	.109379	.017158	6.3749	.0237
D(IR)	.259140	.017572	14.7471	.0046
D(IR(-1))	-.074092	.013630	-5.4361	.0322
D(DS)	-1.632053	.119451	-13.6629	.0053
CointEq(-1)	-1.965973	.137525	-14.2954	.0049

Note. Dependent variable: change in the infrastructure-investment proxy. DD+ and DD- are positive and negative domestic-debt partial sums.

Domestic debt showed a clear time-dependent pattern. When domestic debt increased, the effect on investment was negative and significant in the current period ($B = -1.99 \times 10^{-5}$, $p = .0057$) and after one lag ($B = -1.72 \times 10^{-5}$, $p = .0192$). In contrast, the contemporaneous term for a fall in domestic debt was not significant, while the one-period lag was positive and significant ($B = .000566$, $p = .0310$). Read together, these coefficients suggest different dynamic responses to increases and decreases in domestic debt. However, the formal Wald tests reported in Section 4.4 do not reject equality of the positive and negative coefficients at conventional significance levels. The evidence is therefore described as a dynamic difference in point estimates rather than as statistically proven asymmetry.

External debt also showed a timing effect. The contemporaneous change was negative and significant ($B = -4.72 \times 10^{-6}$, $p = .0177$), but the lagged change was positive and significant ($B = 8.77 \times 10^{-6}$, $p = .0175$). A possible interpretation is that the occurrence of external borrowing is initially tied to the repayment pressure, exchange-rate exposure or delays between the drawing of the loan and the start of project execution, while the investment payoff shows up later as externally financed projects move through procurement and construction. This interpretation is consistent with the African evidence which shows that the external debt outcome is influenced by the terms of borrowing and the governance of borrowed funds and their productive application (Manasseh et al., 2022).

The most noticeable result was the debt servicing. The coefficient was negative and significant at the .0053 level ($B = -1.632053$), suggesting that an increase in repayment obligations would be related to a decrease in short-run investment. Though the money may come from borrowing funds, as interest and principal payments increase over time, resources may be diverted from new capital projects. This is consistent with the findings by the IMF (2024) and the National Treasury and Economic Planning (2024) who highlight the high financing cost in Kenya, maturity profile of debt and the high level of gross financing needs.

Among the macroeconomic controls, inflation showed a negative impact but it was positive after one lag ($B = -.514170$, $p = .0039$). The negative sign is economically sensible as higher inflation will increase construction costs and reduce the purchasing power of nominal capital budgets. The ARDL evidence is also Kenya specific and confirms that inflation is driven by structural factors and pass-through effects rather than a one-off shock (Owuor & Kuso, 2024). The exchange rate was positive in both current and lagged differences, while the interest rate was positive on impact and negative after one lag. The mixed signs on these controls suggest that macroeconomic conditions feed into infrastructure financing through several channels at once.

Speed of adjustment and diagnostic adequacy

The error-correction coefficient was -1.965973 and significant at the 5 per cent level ($p = .0049$). The negative sign indicates convergence to the long run relationship suggested by the bounds test. Since the magnitude is above $+1$ in absolute value, the adjustment process is best characterized by overshooting: following a disturbance, the system makes a strong adjustment, possibly overshooting the equilibrium path and then converging. This does not mean that every year 196.6 per cent of a disequilibrium is eliminated forever, but rather that the disequilibrium is adjusted rapidly and oscillates around the long-run path every year.

The model diagnostics were broadly acceptable: the Jarque-Bera probability was .4055; the Breusch-Godfrey LM test reported $p = .2266$; and the Breusch-Pagan-Godfrey test reported $p = .9949$. Most centred VIFs were below 10, although the exchange-rate VIF was 10.054 and therefore borderline. These diagnostics support cautious inference but do not remove the small-sample constraint. The high ECM R^2 is treated strictly as in-sample explanatory fit and not as evidence of causality.

Table 4. Selected diagnostic indicators

Diagnostic	Statistic	p / threshold	Interpretation
Jarque-Bera	1.8051	.4055	No evidence against normality
Breusch-Godfrey LM	$F = 1.6598$	.2266	No serial correlation at one lag
Breusch-Pagan-Godfrey	$F = .2009$	.9949	No heteroskedasticity
Max centred VIF	10.054	~10	Exchange rate borderline; others lower
ECM R-squared	.9828	Adj = .9571	High fit; interpret cautiously

Note. High R-squared in a dynamic time-series model does not establish causal validity.

Symmetry Tests, Dynamic Multipliers and Robustness Checks

For robustness, the model was re-estimated using a common one-lag specification over the 1995–2023 sample. Positive and negative partial sums were constructed from log changes in domestic and external debt, and formal Wald tests were used to test equality of the corresponding positive and negative coefficients. The resulting estimates provide an additional check on the stability of the main NARDL findings under a comparable specification.

Table 5. Formal Wald tests of short-run and long-run symmetry

Restriction tested	F	p	Decision at 5%
Long-run domestic debt: $DD^+ = DD^-$	3.018	.113	Fail to reject symmetry
Long-run external debt: $ED^+ = ED^-$	.798	.393	Fail to reject symmetry
Short-run domestic debt: $\Delta DD^+ = \Delta DD^-$	.023	.883	Fail to reject symmetry

Restriction tested	F	p	Decision at 5%
Short-run external debt: $\Delta ED^+ = \Delta ED^-$	.126	.730	Fail to reject symmetry

The formal tests materially refine the interpretation of the article. None of the four conventional Wald tests rejects equality of positive and negative debt coefficients at the 5% level. The domestic-debt long-run test is the closest to significance ($F = 3.018$, $p = .113$), but it remains above conventional thresholds. The study therefore reports dynamic differences in sign, timing and magnitude without claiming that statistical asymmetry has been conclusively established.

Figure 1. Dynamic multiplier response to a 1% domestic-debt shock

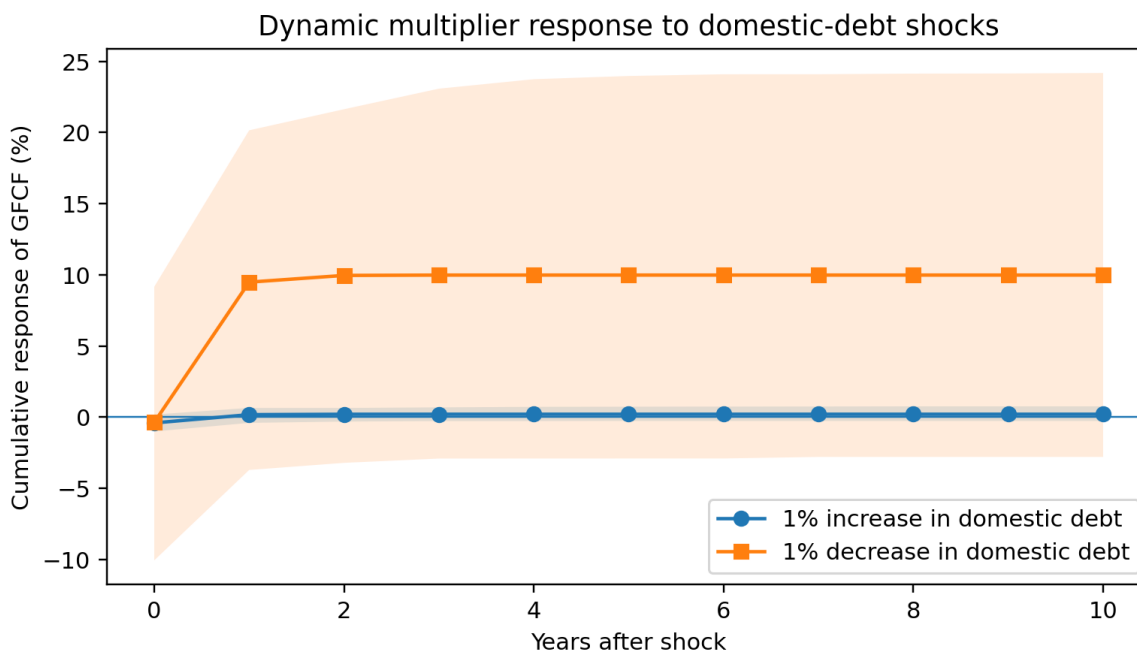
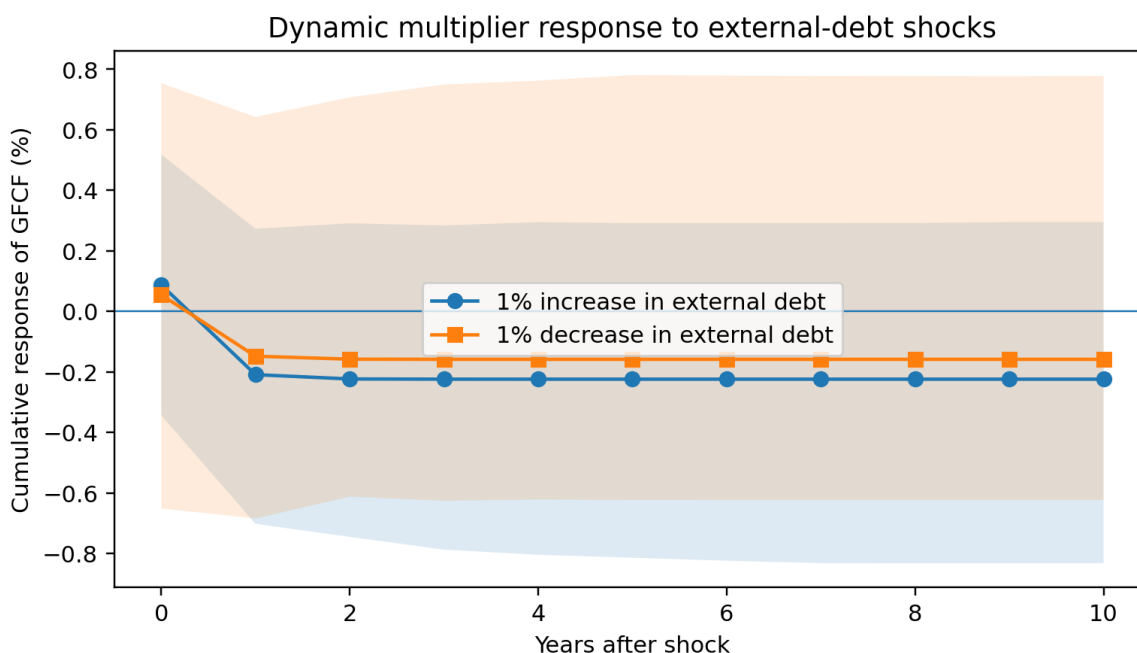


Figure 2. Dynamic multiplier response to a 1% external-debt shock



The multiplier plots further illustrate the point that positive and negative shocks can take differing point paths – and help explain the need for formal testing. The numerical magnitude of the estimated response to a debt

reduction for domestic debt is large but the 95% parameter-uncertainty band is very wide and overlaps zero. The external-debt paths are much closer together and their uncertainty bands overlap substantially. The figures therefore support a cautious conclusion: dynamic adjustment differs descriptively, but the available annual sample does not provide precise evidence that the positive and negative paths are statistically distinct.

Table 6. Linear ARDL and NARDL robustness comparison

Indicator	Linear ARDL	NARDL
Effective observations	28	28
R ²	.772	.870
Adjusted R ²	.560	.650
AIC	-71.55	-79.33
BIC	-52.90	-55.35
Durbin-Watson	2.179	2.637

On the common effective sample, the NARDL specification provides better in-sample fit than the linear ARDL: adjusted R² rises from .560 to .650 and both AIC and BIC are lower despite the NARDL's larger parameter set. This supports retaining the nonlinear framework as a flexible dynamic specification. It does not, however, override the Wald evidence: better fit is not equivalent to proof of statistically significant asymmetry.

A residual CUSUM stability check on the NARDL robustness specification did not reject parameter constancy (statistic = .229, $p > .99$). Nevertheless, this result is interpreted cautiously because the effective sample is small and formal break tests have limited power. The 2008–2009 global financial crisis, Kenya's 2014 entry into Eurobond financing, the 2020 COVID-19 shock and the 2022–2023 exchange-rate adjustment remain economically plausible regime shifts. Rather than saturating a 28-observation model with multiple break dummies, these episodes are recognised explicitly in the interpretation and are appropriate priorities for future testing with higher-frequency data.

DISCUSSION

5.1 Domestic debt and infrastructure investment

The finding that increases in domestic debt were associated with lower short-run investment is not surprising when considered against Kenya's recent borrowing experience. The government issued a lot of Treasury bills and bonds during the 2020–24 period, to finance increasingly larger budget deficits, which increased the government's interest costs on its debt. Despite high gross financing needs, the government's security yields remained high in 2024, according to the IMF (2024). When a growing share of tax revenue goes to service domestic debt, less is left for capital allocations, even when the original intention of borrowing was to finance development.

What the data also show is that the fiscal benefit of lower domestic borrowing takes time to materialise. The lagged positive effect of domestic debt reduction on capital formation is consistent with Kamau (2021), who found that the debt-capital formation relationship in Kenya changed across lags. From a practical standpoint, it means that a government which has cut borrowing from the domestic market this year would not benefit from this in its capital budget until following year, when rollover needs would have eased and interest savings would have been incorporated into the budgeting process.

None of this implies that domestic borrowing should be abandoned. Domestic market offers currency-matched financing and is instrumental in protecting the government against external shocks. It isn't a question of whether to borrow locally, but how. The focus on a longer-term instrument against a project that has a clear economic return is more conducive to capital formation than to the issuance of a short-term instrument repeatedly filling a structural revenue gap. Kararach et al. (2022) make the same point at the continental level when they argue that

what matters for debt sustainability is not the volume borrowed but the efficiency with which borrowed funds are invested.

All of this does not mean that households should not take loans. Domestic market is the source of currency matched financing and is crucial for safeguarding the government against external shocks. It isn't a question of whether to borrow locally, but how. The focus on a longer-term instrument against a project that has a clear economic return is more conducive to capital formation than to the issuance of a short-term instrument repeatedly filling a structural revenue gap. At the continental level, Kararach et al. (2022) have stated that it is not the amount borrowed that is the issue of concern for debt sustainability but the efficiency of the allocation of borrowed funds.

5.2 External debt and the timing of investment effects

The opposite signs of the contemporaneous and lagged external-debt coefficients illustrate why a single-period regression can give a misleading picture. New external loans often come with new repayment and foreign exchange risks. Disbursement, procurement and construction of an externally-financed project all take time, so the capital-formation payoff of an externally financed project may not appear in the GFCF data until a later year.

This reading is broadly in line with debt-overhang theory (Krugman, 1988) but does not support a blanket conclusion that external debt is harmful. The type of external borrowing is the important aspect. The fiscal burden of commercial Eurobonds with the same short term as the multilateral institutions, but with market interest rates, is a less burdensome one than that of the multilateral institutions, which has a very long term. Manasseh et al. (2022) reveal that the external debt-growth nexus in Sub-Saharan Africa is further influenced by governance quality. The lesson for Kenya is that external borrowing needs to be evaluated on a project-by-project basis, paying close attention to the terms and costs of each borrow, and the government's ability to handle exchange-rate risk.

Exchange-rate risk deserves separate emphasis. External debt service is paid in foreign currency, many infrastructure projects are dependent on imported machinery, fuel and construction material. With a devaluing of the Kenya shilling, the cost of the debt repayment as well as the cost of project inputs in Kenya also increases. The ECM exchange-rate coefficients in this study are positive, but they should be interpreted carefully because exchange-rate movements can coincide with policy responses, shifts in external inflows and changes in nominal investment values. External-debt management and exchange-rate risk management go hand in hand.

5.3 Debt servicing, fiscal space and macroeconomic conditions

The debt-servicing coefficient is one of the results that is the most straightforward. The negative coefficient ($B = -1.632053$, $p = .0053$) shows that the more government debt rises, the less money is put toward capital formation. This is in line with the fiscal-space framework set out by Heller (2005): mandatory debt payments can squeeze discretionary development spending. The discovery is also in line with recent budget analysis in Kenya, which indicates that debt service and recurrent obligations can have a negative impact on development spending, affecting final allocations even after budgets have been passed (Christine & Kuso, 2026). The National Treasury and Economic Planning (2024) also echoes the issue of a debt-service pathway for Kenya.

The practical message is that two countries with the same debt-GDP ratio can have vastly different constraints on investment if one has long maturities, low interest rates and more generous terms. The debt strategy for Kenya should instead be a consideration of the total flow of debt payments to come, and how much debt is provided along the way. Refinancing, maturity extension and concessional financing can help reduce short-term pressure on payments, but shouldn't simply be a way to postpone unsustainable liabilities.

Inflation and interest-rate dynamics reinforce this interpretation. Inflation can increase project costs more rapidly than the increase in nominal budget allocations, thereby decreasing the amount of infrastructure that can be acquired for a given amount of budget. Higher interest rates lead to the increased cost of taking fresh loans and higher future debt-service requirements. The significant lagged interest-rate effect in the ECM therefore supports

stronger coordination between debt management, fiscal policy and monetary conditions. Infrastructure investment cannot be planned independently of macroeconomic stability.

5.4 Methodological observations

One of the important methodological lessons from this study is that the relationship between debt and investment in Kenya is dynamic in nature and not adequately described by a single contemporaneous coefficient. The static regression would not have detected that a rise in external debt was negative at impact but positive one lag later; or that a decline in domestic debt only became positive with a lag. The NARDL/ECM framework can address just this type of complexity (Shin et al., 2014). The significance of lag structure has been confirmed in other Kenya-specific ARDL applications such as those by Masibayi & Kuso (2026) and Owuor & Kuso (2024).

The robustness analysis sharpens the methodological conclusion. Positive and negative debt movements have different point estimates and the different multiplier paths, but the short- and long-run symmetry tests using the conventional Wald tests are not rejected at the 5% level. The article therefore does not conceptualise differences in the visual or in the coefficients as evidence of a statistical asymmetry. The NARDL specification, on the other hand, performs better than the linear ARDL model on the adjusted R^2 , AIC and BIC, thus favoring the application of NARDL as a flexible dynamic model. Neither outcome proves causality: Fiscal policy and debt could be affected by common shocks, as could be the interest rate, inflation and investment. Findings are best understood as dynamic econometric relationships that are policy-relevant.

The choice of GFCF remains an important qualification. The level of GFCF does not represent a shilling for shilling measure of government infrastructure expenditure because it includes private fixed capital. The term 'infrastructure-oriented capital formation' is then used in the analysis, and the term 'GFCF' is used as a broad proxy. The CUSUM stability check does not indicate an identified parameter break, but the limited annual sample makes that test low-powered. Major fiscal and financing episodes are therefore acknowledged explicitly rather than ignored.

6. Conclusion and Policy Implications

This study used a NARDL error-correction framework to examine how domestic debt, external debt and debt servicing relate to infrastructure-oriented capital formation in Kenya over 1995–2024. The bounds test supports a long-run relationship and the error-correction term indicates rapid overshooting adjustment. Debt servicing remains the clearest adverse short-run association. Formal Wald tests do not establish statistically significant short- or long-run asymmetry at the 5% level, even though positive and negative debt movements display different point paths. The NARDL nevertheless fits the common effective sample better than a linear ARDL benchmark. The appropriate conclusion is therefore not that debt effects are proven to be asymmetric, but that they are dynamic, composition-sensitive and strongly conditioned by repayment pressure and macroeconomic circumstances.

Two oversimplified policy positions are rejected by these results. First, there is no evidence in the data that more borrowing automatically equals more infrastructure. Second, the results do not justify a blanket policy of debt minimisation irrespective of the reason for the borrowing: The impact of borrowing on investment depends on the nature of the borrowing, loan terms and maturities, the quality of the investment projects and the effectiveness of project execution and repayment profile. The policy objective should be productive and sustainable borrowing, not debt expansion or debt reduction as goals in themselves.

On domestic debt, the National Treasury must focus on extending maturities, actively manage refinancing risk and tie new debt to specific capital projects. In terms of external debt, concessional and long-maturity financing should be preferred, with explicit assessment of exchange-rate and refinancing risks before each commitment. Fundamental to capital-budget planning should be a debt-service projection to ensure realistic commitments for new infrastructure under plausible debt-service projections. The recommendations are corroborated by the African evidence that investment efficiency plays a key role in debt sustainability (Kararach et al., 2022).

Public investment management matters just as much as the financing decision. Borrowed resources should be directed towards projects that have been suitably appraised, procured and supervised and that have proven to have economic and social returns. The government bears the debt when the project is delayed, costs are over budget, or it is not managed well enough to generate the maximum return. Better project selection, tracking and completion can achieve more infrastructure with less borrowing.

Lastly, macroeconomic stability should be viewed as a component of the infrastructure financing plan. Capital budgets are subject to the effects of inflation. High interest rates make domestic borrowing more expensive. The cost of external debt and imported project inputs in local currency is higher when the exchange rate is volatile. Coordinating debt management, fiscal policy and monetary policy within a medium-term framework is essential if Kenya is to preserve the fiscal space needed for productive investment

7. Limitations and Further Research

Five limitations should be recognised. First, GFCF is a broad capital-formation measure containing private as well as public fixed assets; a consistent government-specific capital-expenditure or public-GFCF series would improve construct validity. Second, 30 annual observations are available and the effective robustness sample falls to 28 first-difference observations after the missing 2024 interest-rate value and one lag are accounted for. Third, the formal Wald tests do not reject symmetry at conventional levels, so the study does not claim statistically proven asymmetry. Fourth, the dynamic multiplier confidence bands are wide, especially for domestic-debt reductions, showing that some point estimates are imprecise. Fifth, the CUSUM stability test does not reject parameter constancy, but its power is limited in such a small sample and major events may still have altered the transmission mechanism.

Future research should use quarterly or fiscal-quarter data where a reliable series can be constructed, distinguish government from private fixed capital more precisely, separate concessional from commercial external debt, and incorporate institutional quality and project-execution efficiency. With a larger sample, researchers should test identified structural breaks around major financing and macroeconomic episodes and compare NARDL with threshold models, structural VARs and Bayesian time-series approaches. These extensions would improve causal interpretation and the precision of dynamic multipliers.

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