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Gabon's Public Debt: Crowding-out Effect or Complementarity?

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Abstract

This study examines the differentiated impact of Gabon's public debt on private investment over the period 1995-2024. Using an advanced methodological approach combining the NARDL model, structural SVAR, dynamic IV-GMM, and threshold models, the research reveals an asymmetric and non-linear relationship between these variables. The results demonstrate that positive shocks generate a pronounced immediate crowding-out effect from positive external public debt, but become complementary in the long term. In contrast, negative shocks (negative external public debt) negatively impact investment across all time horizons. The asymmetry is more pronounced for domestic public debt, with a strong crowding-out effect from positive increases and a significant stimulating effect from negative decreases. The analysis identifies differentiated critical thresholds, 34.6% of GDP for positive external debt and 29.9% for positive domestic debt, beyond which the crowding-out effect intensifies considerably. It validates the robustness of the results through several econometric approaches, thereby offering important policy implications for the optimal management of public debt in Gabon.

Keywords: Public Debt, Private Investment, Crowding-out Effect, Complementarity, NARDL, SVAR, Debt Thresholds, Gabon.

JEL Classification : E22, H63, C32, O55.

Paper type: Empirical Research.

1. Introduction

The dynamics of public debt in Gabon have gradually shifted from a marginal issue to a central concern of macro-fiscal policy and economic development. Indeed, driven by volatile oil revenues, the COVID-19 pandemic, rising global interest rates, and political tensions, Gabon's public debt has experienced rapid growth, with major implications for financial sustainability and macroeconomic balances. According to the latest estimates from the IMF (2024) and the

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World Bank (2024), the ratio of total public debt to gross domestic product (GDP) increased from 19% in 2008 to approximately 63% in 2023, and 70 –73% in 2024 based on consolidation methods and the inclusion of implicit commitments and arrears, creating increased refinancing needs and a high risk of deteriorating sustainability.

This upward trajectory of public debt raises fundamental questions regarding its impact on private investment, an essential engine for diversification and non-oil GDP growth. From a practical standpoint, Gabonese policymakers must determine whether public borrowing "crowds out"[1] private investment by absorbing national savings and constraining access to domestic credit, or whether it "complements" private efforts by financing public infrastructure and services that enhance the productivity of private capital. The answer to this question directly informs the optimal composition of public debt (domestic versus external, short versus long term, consumption versus investment purpose) and the institutional reforms for public debt management.

In this regard, the summary of recent economic literature provides a nuanced response to this debate, suggesting a contingent and non-linear relationship between public debt and private investment. The works of Afonso and Jalles (2023), Husain et al. (2023), and Islam and Nguyen (2024) converge on the idea that the impact depends on the type of debt (domestic versus external), the level of indebtedness (existence of critical thresholds), the allocation of borrowed funds, and the quality of the institutional framework (governance quality, corruption, and budgetary transparency). This complexity fully justifies a study specific to the Gabonese context, especially since private investment has stagnated since 2018, representing barely 11.4% of GDP in 2023 compared to 17.2% in 2012 according to the World Bank (2024).

In this context, the general objective of this research is to empirically capture the weight of the differentiated impact of domestic and external public debt on private investment in Gabon over the period 1995-2024. Our fundamental hypothesis posits that domestic public debt exerts a significant crowding-out effect on private investment through the channel of domestic interest rates and credit, while external public debt, when directed towards productive and concessional projects, exhibits a complementary effect. We also test for the existence of a critical threshold beyond which even external public debt ceases to be beneficial. To address these questions, we employ an advanced econometric methodology combining stationarity tests with structural breaks, the asymmetric NARDL model, the SVAR identified à la Blanchard-Perotti (2002), IV-GMM estimation, and a threshold model (Hansen, 1999). This multidimensional approach allows us to capture the non-linear and asymmetric dynamics characteristic of the debt-investment relationship in the Gabonese context.

[1] The crowding-out effect reflects the fact that public debt financing can crowd out private investment by absorbing part of the funds available to the private sector (R. Barro, 1974).

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2. Literature Review

2.1. Theoretical Review

The theoretical foundations are rooted in two main conceptual frameworks: the crowding-out effect theory and the complementarity (crowding-in) theory. Indeed, economic literature has developed a sophisticated theoretical framework to analyze the transmission mechanisms between public debt and private investment. Neoclassical theory, initiated by the foundational work of Tobin (1969) and Friedman (1978), posits that an increase in public debt generates a crowding-out effect via the interest rate channel. In this analytical framework, increased government bond issuance raises the sovereign risk premium and increases the demand for loanable funds, leading to a rise in real interest rates that reduces the profitability of private investment projects. In contrast, the Keynesian approach, developed by Aschauer (1989) and Barro (1990), highlights the positive externalities of public investments financed by public debt. When public debt finances quality infrastructure, it enhances the marginal productivity of private capital and generates spillover effects on corporate investment. This complementarity is particularly pronounced in developing economies characterized by significant infrastructure deficits.

Contemporary research has complicated this initial dichotomy by introducing threshold models and non-linear effects. The seminal work of Pattillo, Poirson and Ricci (2002) demonstrated that the debt-growth relationship follows an inverted U-shaped curve, with an optimal threshold beyond which the effect becomes negative. This approach was formalized econometrically by Hansen (1999) whose method for estimating endogenous thresholds allows for the identification of breakpoints in macroeconomic relationships.

Concurrently, the institutionalist school has emerged as an essential analytical framework. The essential research of Nguyen (2022), Islam and Nguyen (2024) established that institutional quality, measured by Worldwide Governance Indicators (WGI), budgetary transparency, and the sectoral allocation of public debt, play a crucial moderating role in the debt-investment relationship. In countries with high institutional quality, public debt tends to exert a complementary effect, whereas in contexts of weak governance, the crowding-out effect dominates. Thus, according to the authors, this relationship is asymmetric and contextual, depending on the composition of public debt, institutional quality, and the stage of financial development.

2.2. Empirical Evidence

Several major works have explored this relationship in varied samples. Empirical studies on developed countries have produced significant but sometimes controversial results. Reinhart & Rogoff (2010), in their analysis of 44 countries over two centuries, identified a critical threshold of 90% of GDP beyond which public debt significantly reduces growth. This research, although criticized for data coding issues, stimulated a fruitful academic debate. Cecchetti et al. (2011), using dynamic panel methods on 18 advanced economies, confirmed the existence of thresholds between 80–90% of GDP. In emerging economies, recent studies have highlighted specific

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mechanisms. Celasun & Agca (2009) analyzed 2,500 corporate bond issuances and demonstrated that a 1% increase in public debt raises private sector borrowing costs by 15 basis points on average. A complementary study on 24 emerging economies (1996-2018) using GMM estimators established that a 10% increase in the debt/GDP ratio reduces private investment by 2.3%.

The African continent has been the subject of increasing empirical investigation. Benayed, Gabsi & Belguith (2015), in their analysis of 11 African countries (1981-2010) using threshold models, identified an optimal inflection point at 47% of GDP. Beyond this threshold, the crowding-out effect outweighs complementarity. This research paved the way for more disaggregated studies. Dinga, Fonchamnyo & Afumbom (2024) innovated by applying the Dynamic Common Correlated Effects (DCCE) model to 35 Sub-Saharan African countries (1995-2018). Their results reveal a marked dichotomy: external debt shows a positive elasticity of 0.15 with private investment, while domestic debt shows a negative elasticity of -0.23. This distinction underscores the importance of disaggregating debt components. The EIB (2024) study documented a crucial transmission mechanism via the banking channel. The analysis of the balance sheets of 120 African banks shows that the share of government securities in their assets increased from 10% to 17% between 2010 and 2023, correlated with a reduction in credit to the private sector from 42% to 38%. This phenomenon of financial crowding-out is particularly acute in CEMAC countries.

Recent methodological advances have refined the analysis of debt-investment dynamics. Nguyen (2022) used instrumental variables based on terms of trade shocks to identify the causal effect of public debt on private investment in 62 emerging countries. His results show that the elasticity shifts from -0.18 in countries with weak governance to +0.12 in those with strong institutions. The application of non-linear models constituted a significant epistemological break. Husain et al. (2023), pioneers in using the Nonlinear Autoregressive Distributed Lag (NARDL) model in India (1980-2019), highlighted a pronounced asymmetry: the coefficients for positive and negative debt variations differ significantly, with elasticities of -0.08 for increases versus +0.15 for decreases. Islam and Nguyen (2024) integrated the International Budget Partnership's budget transparency index as a moderating variable in their analysis of 98 developing countries. Their results demonstrate that budget transparency mitigates the negative effect of domestic debt on private investment.

2.3. Methodological Limitations and Research Agenda

Despite these advances, the literature presents several persistent limitations. The use of arbitrary thresholds without empirical justification for these values, and difficulties in causal identification compromise the robustness of inferences. The majority of studies do not, or only weakly, distinguish between domestic and external debt, positive or negative, and mask very different channels, whereas the mechanisms (crowding-out vs. complementarity) differ strongly by type. Sample heterogeneity masks national specificities, while measurement problems for key variables introduce estimation biases. Research shows that endogeneity remains a persistent challenge, as increases in public debt are often a response to an economic slowdown or a shock.

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For the Gabonese context, these observations justify the adoption of a rigorous methodological approach integrating : the fine disaggregation of public debt components accounting for the concessionality of loans, the use of robust causal identification methods (SVAR, dynamic IV-GMM), and the estimation of specific endogenous thresholds. Furthermore, recent institutional developments, including debt reprofiling operations and disbursement suspensions, reinforce the practical relevance of this investigation.

3. Methodology

3.1. Model

We use the multi-channel NARDL model (Shin et al., 2014) to capture asymmetries (differential effects depending on increases and/or decreases in debt), expressed in compact form as follows :

$$\begin{aligned}\Delta I_{nvpr,t} &= \alpha + \rho I_{nvpr,t-1} + \theta_j^{+} D_{t-1}^{Int,+} + \theta_j^{-} D_{t-1}^{Int,-} + \lambda_j^{+} D_{t-1}^{Ext,+} + \lambda_j^{-} D_{t-1}^{Ext,-} \\ &+ \sum_{i=1}^{p} \varphi_i \Delta I_{nvpr,t-i} + \sum_{j=0}^{q} \beta_j^{+} \Delta D_{t-j}^{Int,+} + \sum_{j=0}^{q} \beta_j^{-} \Delta D_{t-j}^{Int,-} + \sum_{j=0}^{q} \gamma_j^{+} \Delta D_{t-j}^{Ext,+} \\ &+ \sum_{j=0}^{q} \gamma_j^{-} \Delta D_{t-j}^{Ext,-} + \sum_{k} \delta_k \Delta X_{t-k} + \pi ECT_{t-1} + \varepsilon_t \end{aligned} \quad \textbf{(1)}$$

Where $\boldsymbol{D^{Int,+}}$ and $\boldsymbol{D^{Int,-}}$, $\boldsymbol{D^{Ext,+}}$ and $\boldsymbol{D^{Ext,-}}$ are the various partial sum decompositions of increases and decreases in public debt (Shin et al. NARDL method). These asymmetric decompositions of domestic debt and external debt are constructed from the cumulative changes of each series, which are defined as follows :

$$\begin{aligned} D_k^{Int,+} &= \sum_{j=1}^{k} \Delta D_k^{Int,+} = \sum_{j=1}^{k} max\left(\Delta D_j^{Int}, 0\right) \;\; ; \;\; D_k^{Int,-} = \sum_{j=1}^{k} \Delta D_k^{Int,-} = \sum_{j=1}^{k} min\left(\Delta D_j^{Int}, 0\right) \\ D_k^{Ext,+} &= \sum_{j=1}^{k} \Delta D_k^{Ext,+} = \sum_{j=1}^{k} max\left(\Delta D_j^{Ext}, 0\right) \;\; ; \;\; D_k^{Ext,-} = \sum_{j=1}^{k} \Delta D_k^{Ext,-} = \sum_{j=1}^{k} min\left(\Delta D_j^{Ext}, 0\right) \end{aligned} \quad \textbf{(2)}$$

Where the dependent variable $\boldsymbol{I_{nvpr,t}}$ denotes private investment (% of GDP), the variable of interest « $\boldsymbol{D}$ » represents Gabon's differentiated debt, specifically : $\boldsymbol{D^{Ext,+}}$ and $\boldsymbol{D^{Ext,-}}$ **:** external public debt (positive, negative), $\boldsymbol{D^{Int,+}}$ and $\boldsymbol{D^{Int,-}}$: domestic public debt (positive, negative), $\boldsymbol{ETC_{t-1}}$: the error correction term from the bounds test (long-run) indicating the speed of adjustment to equilibrium level after a shock, $\boldsymbol{\varepsilon_t}$: error term. $\boldsymbol{X_t}$ is the vector of control variables: $\boldsymbol{D^{Priv}}$: denotes total private debt, ***Oil*** represents the oil price (major exogenous control), ***Ide*** denotes FDI flows, ***QI*** represents institutional quality, and ***Cred*** represents domestic credit. Where $\boldsymbol{\alpha, \rho, \theta^{+}, \theta^{-}, \lambda^{+}, \lambda^{-}}$ are long-term parameters, while $\boldsymbol{\varphi, \beta^{+}, \beta^{-}, \gamma^{+}, \gamma^{-}, \delta}$ and $\boldsymbol{\pi}$ are short-term parameters to be estimated at period $\boldsymbol{t}$. All financially relevant series will be converted into real variables (deflated), expressed in % of GDP or in logarithm according to their nature.

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3.2. Estimation Technique

In preprocessing, we apply the Hausman test in its Nakamura (1981) version to test for the existence of simultaneity bias related to the absence of orthogonality obtained by the Ordinary Least Squares (OLS) method. This test is performed using Two-Stage Least Squares (2SLS) in comparison with OLS estimates. In case of bias, the NARDL, which incorporates error corrections, may be preferred to mitigate this bias. The Hausman test statistic is calculated using the following formula:

$$H = \left(\beta_1 - \beta_2\right)^T \left(Var\left(\beta_1 - \beta_2\right)\right)^{-1} \left(\beta_1 - \beta_2\right) \quad \textbf{(3)}$$

Where β_1 and β_2 are the vectors of estimated coefficients in the two models (OLS, 2SLS), and $Var\left(\beta_1 - \beta_2\right)$ is the covariance matrix of the difference between the two estimator. If the test is significant, we conclude that the variable is endogenous.
Then, we perform stationarity analysis, where we conduct the Augmented Dickey-Fuller (ADF, 1981) unit root test, which is based on the following model:

$$\Delta y_t = \rho y_{t-1} + \sum_{j=2}^{p} \phi_j \Delta y_{t-j+1} + \varepsilon_t \quad with \ \ \varepsilon_t \sim iid(0, \sigma^2) \quad \textbf{(4)}$$

aiming to test the hypothesis of the presence of a unit root in the variables under the null hypothesis ($H_0: \rho = 0$) compared to the p-value at the error risk α equal to 1%, 5% or 10%. If the p-value is greater than the alpha risk, we accept H_0 (variable is non-stationary). Otherwise, the variable is stationary. As a non-parametric adaptation of the ADF test, the Phillips-Perron (PP, 1988) test is used, as well as the Zivot-Andrews (1992) test to capture points of structural break.

The selection of the optimal number of lags to retain for estimating the NARDL model is performed using the Akaike Information Criterion (AIC), Schwarz Information Criterion (SIC) providing statistically significant results with fewer parameters, such as:

$$AIC = ln(\sigma^2) + \frac{2k}{T} \ ; \ BIC = ln(\sigma^2) + \frac{kln(T)}{T} \quad \textbf{(5)}$$

where k = number of parameters and T = number of observations.

Then, we perform the Pesaran, Shin and Smith (2001) Bounds cointegration test, verified by the robustness of the Johansen test, under the null hypothesis H_0: no long-run relationship (no cointegration) against H_1: existence of a long-run relationship (cointegration). This test relies on the Fisher-F statistic:

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$$F_{stat} = \left(R^2/n\right)\Big/\left(\left(1-R^2\right)/\left(T-k\right)\right) \quad \textbf{(6)}$$

compared to critical bounds: no cointegration if $\boldsymbol{F_{stat} < I(0)}$ = lower bound (not-cointegrated series), cointegration if $\boldsymbol{F_{stat} > I(1)}$ = upper bound (cointegrated series). If cointegration is confirmed, we proceed to estimate the long-term coefficient relationships with ECM. It is crucial that the variables are either stationary at level I(0) and/or I(1) (first difference), because the NARDL approach is not applicable to I(2) variables (second difference). The model associated with the cointegration test by distributed lags is the following cointegrated ARDL specification:

$$\Delta y_t = \beta_0 + \sum \beta_1 \Delta y_{t-i} + \sum \alpha_j \Delta x_{t-j} + \theta z_{t-1} + e_t \quad \textbf{(7)}$$

Where "$\boldsymbol{z_{t-1}}$" is the error correction term resulting from the verified long-run equilibrium relationship. The sign must be negative and significant to ensure the convergence of the dynamics towards the long-run equilibrium.

The NARDL model is estimated by OLS (standard procedure) to obtain dynamic multipliers and test asymmetries for increases/decreases in public debt (domestic and external) through the Wald test. For the empirical validity of the model, we diagnose the following parameters: autocorrelation tests (LM, Breusch-Godfrey), heteroscedasticity (White, Breusch-Pagan), residual normality (Jarque-Bera), structural stability (CUSUM and CUSUMQ introduced by Brown et al., 1975). Bootstrap analysis is performed for the confidence intervals (CI) of the dynamic multipliers (method recommended for small sample sizes).

For causal identification and robustness, we estimate the SVAR according to the Blanchard-Perotti (2002) approach to observe the dynamic responses of private investment (impulse-response, IRF) to a shock in differentiated public debt at dates "$\boldsymbol{t, t+1, t+2}$" on the innovation terms "$\boldsymbol{u_t}$", using contemporaneous and exogenous restrictions on certain variables for identification and variance decomposition analysis (FEVD). According to the approach of Nouhaila and Ouakil (2017)[2], from the unconstrained VECM(k) modeling, the IRFs are calculated as follows:

$$IRF = \sum_{I_{pvt}=0}^{k} \frac{\partial I^{\omega}_{nvpr,t} + I_{nvpr,t}}{\partial u_t^j} \quad for \quad k = 1, 2... \quad \textbf{(8)}$$

The dynamic IV-GMM model (Arellano-Bond, 1991, Arellano, 2003) is applied to control for potential endogeneity in order to isolate the causal effect of the increase in public debt on private investment in Gabon, by instrumenting the variations in Gabon's public debt with exogenous variables: external shocks (lagged world oil price), international credit conditions, or market access variables (spread on sovereign bonds), a GMM (Hansen) estimation with robust errors. Finally, we attempt to capture the endogenous thresholds of differentiated debt by estimating a

[2] Nouhaila Belfatmi and Ouakil Hicham (2017). The Dynamics of Public Debt Sustainability in the Face of Growth Rate Shocks. ISSN: 2501-9430, ISSN-L: 2501-9430. Available online at: http://www.oapub.org/soc

threshold model à la Hansen (1999) to identify a critical debt/GDP ratio beyond which the crowding-out effect becomes significant. For a time series, in the sense of Hansen (1999), the formula modeling these regime changes is as follows:

$$X_t = \alpha + \beta X_{t-1} + \varepsilon_t, \ si \ \ X_{t-d} \leq r \text{ and } X_t = \gamma + \delta X_{t-1} + \phi\varepsilon_t, \ si \ \ X_{t-d} > r \quad \textbf{(9)}$$

The transition from one regime to another ($J_1 = 1$ or $J_t = 2$) is determined by a threshold variable ($\boldsymbol{X_{t-d}}$), here public debt, which is compared to a threshold ($\boldsymbol{r}$) that determines the regime change, with a delay parameter ($\boldsymbol{d}$) indicating how far in the past the threshold is checked. The model can be extended to more than two regimes ($J > 2$). With, $\boldsymbol{X_t}$: the value of the series at time $\boldsymbol{t}$, and $\boldsymbol{X_{t-1}}$: the value of the series at the previous time, $\boldsymbol{J_t}$: an indicator variable (or "regime") that takes a value of 1 or 2, and $\boldsymbol{\alpha, \beta, \gamma, \delta}$, the regression coefficients that change depending on the regime, $\boldsymbol{\varepsilon_t}$ the error term assumed to be independent and identically distributed (*iid*) with a mean of « **0** » and variance « $\boldsymbol{\sigma^2}$». This approach is repeated over sub-periods, using Johansen VECM to verify multivariate relationships.

3.3. Data Sources and Descriptive Statistics

The annual series for this study covers the period 1995-2024, comprising 30 observations. This timeframe encompasses the post-independence era, various economic crises, and recent international market fluctuations. Data were collected from the following sources: World Bank (World Development Indicators - WDI), Gabon's General Directorate of Public Debt (DGDP), International Monetary Fund (IMF), Bank of Central African States (BEAC), sectoral reports, Afreximbank, and the Gabonese Economic Dashboard (TBE). The description, measurement, and data sources for the variables are summarized in Table 1 below:

Table 1. Study variables

Variable	Code	Description	Source
Private investment	$\boldsymbol{I_{nvpr}}$	*Proxy for private gross fixed capital formation (% of GDP)*	*TBE*
External public debt	$\boldsymbol{D^{Ext}}$	*Bilateral and multilateral debt and external obligations, as a percentage of GDP*	*FMI (2025)*
Domestic public debt	$\boldsymbol{D^{Int}}$	*Public debt contracted on the domestic market, as a percentage of GDP*	*DGDP (2025) & TBE*
Total private debt	$\boldsymbol{D^{priv}}$	*Domestic debt incurred by the private sector and households, as a percentage of GDP*	*DGDP (2025) & TBE*
Bank credit	***Cred***	*Domestic credit granted to the private sector by banks (% of GDP)*	*WDI (2025)*
Institutional quality	***QI***	*ACP composite index based on World Governance Indicators (WGI): corruption, government effectiveness*	*WDI (2025)*
FDI flows	***Ide***	*Foreign direct investment (% of GDP)*	*WDI (2025)*
Oil price	***Oil***	*Oil rent (major exogenous control) in logarithms*	*TBE*

Source: Authors, 2025.

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Univariate descriptive analysis reveals marked heterogeneity in the sample series (Table 2). Private investment (I_{NVPR}), with a mean of 19.24% of GDP, shows moderate dispersion (CV=16.51%) but significantly rejects the normality hypothesis (JB p=0.048), justifying a posteriori the use of robust estimators. The components of public debt exhibit high volatility (CV > 65%) while following a normal distribution, validating their asymmetric decomposition. Institutional quality (QI) stands out with a low mean (0.25) and extreme dispersion (CV=589%), indicating structural political and regulatory instability. In contrast, credit to the private sector (Cred) shows remarkable stability (CV=20.62%). The non-normality of private debt (D^{Priv}, JB p=0.000) and the high volatility of FDI (CV=75.2%) corroborate the need for sophisticated econometric modeling, controlling for both asymmetries and structural breaks.

Table 2. Univariate descriptive statistics.

				Jarque-Bera (JB) test		
	Mean	**Std. Dev**	**CV (%)**	**Statistic**	**P-value**	**N**
I_{NVPR}	19.24	03.18	16.51	6.07**	0.048	30
$D^{Ext,+}$	31.23	22.00	70.45	1.86	0.394	30
$D^{Ext,-}$	−38.64	27.54	−71.28	3.44	0.179	30
$D^{Int,+}$	29.00	19.70	67.92	1.73	0.421	30
$D^{Int,-}$	−18.09	12.75	−70.48	1.50	0.473	30
D^{Priv}	05.13	03.37	65.67	28.9**	0.000	30
Oil	26.68	10.11	37.91	2.51	0.284	30
QI	00.25	01.49	589.7	2.65	0.265	30
Ide	04.29	03.22	75.20	1.87	0.393	30
Cred	11.24	02.32	20.62	3.25	0.197	30

CV: Coefficient of variation, < 30%: low dispersion; > 30% high dispersion

Source: Authors, 2025.

The Pearson correlation matrix (Table 3) reveals complex interdependencies among the variables. Private investment (I_{NVPR}) shows significant negative correlations with positive domestic public debt ($D^{Int,+}$ = -0.47) and private debt (D^{Priv} = -0.54), suggesting potential crowding-out effects. The high correlations between public debt components (|r| > 0.84) indicate high multicollinearity, confirmed by high raw VIF values (VIF > 37 for $D^{Int,+}$ and $D^{Ext,+}$), justifying their separate asymmetric modeling. The corrected VIFs (VIFc < 3) nevertheless attest to the model's adequacy after treatment. Institutional quality (QI) correlates positively with decreases in domestic debt ($D^{Int,-}$ = 0.73), highlighting the role of governance in fiscal consolidation. The significant correlations of FDI with public debts (r > 0.74) and institutional quality (r = -0.61) reveal their sensitivity to Gabon's macroeconomic and institutional framework.

Table 3. Multivariate descriptive statistics

	I_{NVPR}	$D^{Ext,+}$	$D^{Ext,-}$	$D^{Int,+}$	$D^{Int,-}$	D^{Priv}	*Oil*	*QI*	*Ide*	*Cred*
I_{NVPR}	1									
$D^{Ext,+}$	-0.37*	1								
$D^{Ext,-}$	0.21	-0.89*	1							
$D^{Int,+}$	-0.47*	0.98*	-0.84*	1						
$D^{Int,-}$	0.31*	-0.92*	0.96*	-0.89*	1					
D^{Priv}	-0.54*	0.66*	-0.47*	0.69*	-0.55*	1				
Oil	0.14	-0.77*	0.52*	-0.75*	0.57*	-0.53*	1			
QI	0.22	-0.53*	0.65*	-0.53*	0.73*	-0.29	0.25	1		
Ide	-0.23	0.79*	-0.74*	0.81*	-0.79*	0.57*	-0.53*	-0.61*	1	
Cred	-0.09	0.76*	-0.60*	0.72*	-0.59*	0.56*	-0.79*	-0.11	0.43*	1
VIF		121	21.3	48.4	37.7	2.41	6.4	4.3	3.6	4.8
VIFc		2.83	1.45	2.67	1.40	1.37	2.25	1.52	1.79	2.10

Note: * indicates significant correlations at the 10% threshold

Source: Authors, 2025.

The diagnostic tests for the OLS model, recorded in Table 4, reveal a generally robust specification but suggest certain limitations. The absence of error autocorrelation is confirmed by the BG test (p=0.43), Durbin test (p=0.52), and DW statistic (1.77 ≈ 2), validating the independence of the residuals. Homoscedasticity is partially verified: while the ARCH test (p=0.26) and Cameron-Trivedi test (p=0.32) do not detect heteroscedasticity, the BP test (p=0.07) indicates a marginal risk at the 10% level. The Ramsey RESET test (p=0.01 < 0.05) significantly rejects the linear functional form, suggesting model misspecification, likely due to non-linearities or the omission of relevant variables. These results fully justify the use of more flexible models (NARDL, threshold models) to capture the complex relationships between public debt and private investment.

Table 4. OLS parameter diagnostics

Test	Statistic	P-value
Breusch-Godfrey (BG) Test	0.63	0.43
Durbin Test	0.41	0.52
Durbin-Watson (DW) Test	1.77	< 2
ARCH Test	1.27	0.26
Breush-Pagan/Cook-Weisberg (BP) Test	3.35*	0.07
Cameron et Trivedi Test	29.7	0.32
Ramsey RESET Test	4.87**	0.01

Note: Critical thresholds ***, **, * mean 1%, 5%, 10%.

Source: Authors, 2025.

Graph 1, illustrating the cross-dynamics between private investment and the differentiated components of Gabon's public debt, reveals a temporal relationship marked by a persistent crowding-out effect. The trajectory of private investment (in blue) shows a trend of stagnation, or

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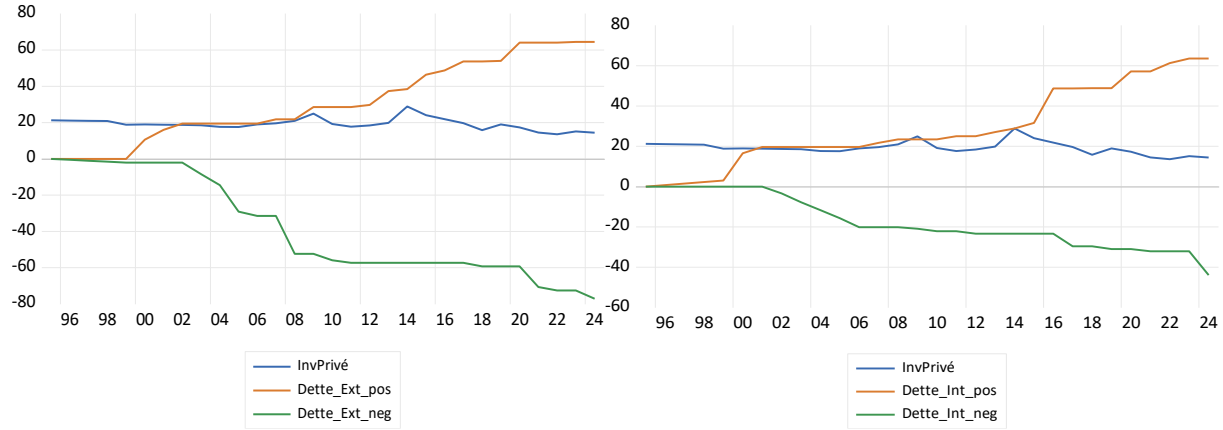
even a slight decline, despite the continuous expansion of the positive components of external (orange, left chart) and domestic (orange, right chart) debt. This evolving divergence suggests that the accumulation of public debt, whether from internal or external sources, has not had a significant stimulating effect on the private sector. Furthermore, the parallel decrease in the negative debt components (in green) indicates a reduced capacity for deleveraging, reinforcing sustainability concerns. The observed pattern empirically validates the hypothesis of a dominant "crowding-out" effect in the Gabonese economy, where public financing appears to substitute for private investment rather than complement it.

Graph 1. Cross-dynamics of private investment and differentiated public debt in Gabon



Source: Authors, 2025.

4. Empirical Results

4.1. Endogeneity Analysis using the Hausman Test

The Hausman endogeneity test (Table 5) validates the consistency of the OLS estimators for the main analysis. The Wu-Hausman statistic (1.023; p=0.429) and the Hausman-Wald test (3.667; p=0.961) indicate the absence of significant endogeneity at the 5% level, justifying the use of ordinary least squares. The Sargan test (2.132; p=0.711) confirms the validity of the instruments used in the 2SLS estimation. Although the endogeneity analysis shows that the OLS coefficients are not statistically significantly biased, the comparison with 2SLS reveals structural differences that support the hypothesis of a partial correlation between public debt and unobserved economic shocks, as the signs of the indicators change from one estimator to another. This confirms our directional consistency towards NARDL models. The stability of the coefficients for key variables (D^{Priv}, Cred, Ide) between the two methods supports the reliability of causal inferences. These results legitimize the complementary use of IV-GMM models to refine causal identification.

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Table 5. Hausman Endogeneity Test

	OLS		2SLS-IV	
Variable	**Coefficient**	**Std.Dev**	**Coefficient**	**Std.Dev**
C	20.83	6.465	22.00	7.631
$D^{Ext,+}$	0.065	0.165	-0.307	0.200
$D^{Ext,-}$	-0.103	0.059	-0.056	0.076
$D^{Dom,+}$	-0.326	0.110	-0.111	0.181
$D^{Dom,-}$	0.177	0.132	-0.249	0.289
D^{Priv}	-0.324	0.132	-0.337	0.159
Oil	-0.129	0.116	-0.229	0.094
Cred	0.661	0.437	0.753	0.611
Ide	0.645	0.243	0.600	0.371
QI	-0.229	0.347	0.532	0.537
	Statistic	**P-value**	**Statistic**	**P-value**
Wu–Hausman Test	1.023	(0.429)		
Sargan Test			2.132	(0.711)
H-Wald Test			3.667	(0.961)
N	28		28	

Source : Auteurs, 2025.

4.2. Stationarity Analysis of the Series

From Table 6, we observe that private debt (D^{Priv}) is stationary at level I(0), while the other variables only become stationary after first differencing I(1). No variable is integrated of order higher than one (I(2)). The results of the ADF and PP tests converge, confirming the reliability of the series classification which shows an appropriate I(0)/I(1) combination, satisfying the estimability condition for NARDL. Structural break tests detected breaks around the years 2006-2020, periods corresponding to major economic shocks in Gabon : the drop in oil prices (2008-2009), the budget adjustment plan (2010-2011), economic slowdown and oil crisis (2014-2016), and the Covid-19 impact (2020). These captured breaks fully justify the model's nonlinear flexibility, including the integration of structural effects in the NARDL model. Thus, the model estimations will enable the analysis of the asymmetric relationship of differentiated public debt in Gabon.

Table 6. Unit Root and Structural Break Tests

	ADF		PP		Z-andrews	
Variable	**I(0)**	**I(1)**	**I(0)**	**I(1)**	**Year of Break**	**Decision**
I_{nvpr}	-2.31	-5.79***	-2.33	-5.99***	2015	**I(1)**
$D^{Ext,+}$	-0.23	-5.30***	-0.19	-5.32***	2009	**I(1)**
$D^{Ext,-}$	-0.49	-5.18***	-0.54	-5.21***	2010	**I(1)**
$D^{Dom,+}$	-0.12	-5.32***	0.01	-5.35***	2013	**I(1)**
$D^{Dom,-}$	0.44	-2.87**	0.34	-2.79**	2007	**I(1)**
D^{Priv}	-2.90**		-2.84**		2014	**I(0)**
Oil	-1.95	-5.54***	-1.93	-5.62***	2016	**I(1)**
Cred	-1.89	-5.68***	-1.84	-5.78***	2009	**I(1)**
Ide	-2.54	-9.33***	-2.40	-10.4***	2020	**I(1)**
QI	-1.88	-5.24***	-1.86	-5.25***	2006	**I(1)**

Note: Critical thresholds *, **, * mean 1%, 5%, 10%.** I(0) = Stationary at level, I(1) = Stationary after 1st difference.

Source: Authors, 2025.

4.3. Selection Criteria and Cointegration Test

According to Table 7, the optimal lags were selected based on the AIC, LR, FPE, and HQ criteria for the order: p = 1, q = 1.

Table 7. Optimal Lag Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-657.327	NA	2.38e+08	47.666	48.142*	47.812
1	-512.155	176.280*	14756842*	44.439*	49.673	46.039*

** indicates lag order selected by the criterion*

Source: Authors, 2025.

Table 8 presents both the Trace statistic and the Max-Eigen value from the Johansen (JJ) cointegration test, which accepted the alternative hypothesis of "presence of cointegration".

Table 8. Johansen Cointegration Test

Test	**Statistic**	**P-value**	**Critical value**
Johansen trace test (r = 1)	Trace = 41.2**	0.021	Crit (5%) = 35.2
Johansen max-eig test	MaxEig = 29.1**	0.033	Crit (5%) = 25.3

Source : Authors, 2025.

4.4. NARDL Empirical Results

4.4.1. Model Validity and Quality

The NARDL model demonstrates remarkable econometric properties (Table 9), validating its robustness for asymmetry analysis. The goodness-of-fit is excellent, with an R^2 of 0.972 and an adjusted R^2 of 0.961, indicating that the model explains 97.2% of the variance in private investment. The Fisher statistic (7.510; p=0.002) confirms the overall significance of the model. The cointegration test (Bounds Test) with an F-statistic of 14.856*** exceeds the critical values

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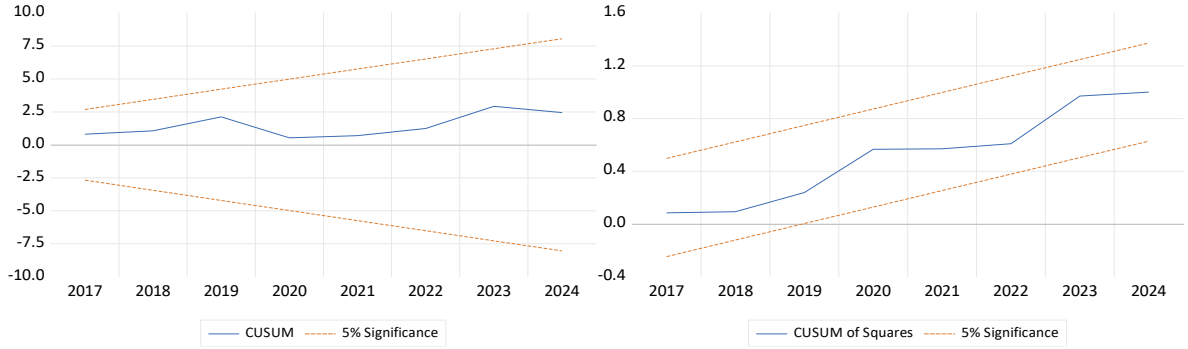
at all thresholds, validating the existence of a stable long-term relationship between the variables, confirming the hypotheses of the Johansen cointegration test. The error correction term (ECT = −0.826*) is negative and highly significant, indicating a fast adjustment speed of 82.6% towards long-term equilibrium after a shock.

Diagnostic tests confirm the adequate model specification: the normality tests (Jarque-Bera, p=0.742), autocorrelation (Breusch-Godfrey, p=0.410), and heteroscedasticity tests (Breusch-Pagan, White, ARCH; p>0.05) are non-significant. The RESET test (p=0.541) validates the functional form, unlike the initial OLS model. The Cusum and Cusum squared tests (Graph 2) confirm the model's point and structural stability, as the curves do not exit the corridor (red dotted lines). The Wald tests confirm the significant asymmetry of the effects, more pronounced for external debt (5.87) than for domestic debt (2.96*). The consistency of coefficient signs and significance, combined with parameter stability, establishes the model's reliability for economic and policy inference.

Graph 2. CUSUM and CUSUM Squared Stability Tests.



Source: Authors, 2025.

4.4.2. Analysis and Discussion of Results

In the short term, the coefficients reveal marked asymmetric dynamics. Both positive and negative variations in external debt show significant negative effects (ΔD^{Ext^+}= −0.198***; ΔD^{Ext^-} = −0.221*), suggesting an immediate crowding-out effect regardless of the direction of change. For domestic debt, the asymmetry is more pronounced: increases (ΔD^{Int^+} = −0.388*) exert a strong crowding-out effect, while decreases (ΔD^{Int^-} = +0.295*) significantly stimulate private investment. The control variables show the expected signs: private debt (ΔD^{Priv} = +0.411*) and domestic credit (ΔCred = +0.265*) support investment, while institutional quality (ΔQI = −1.379*) reveals a counterintuitive effect requiring further investigation.

In the long term, the relationship reverses for external debt: increases (ΔD^{Ext^+}(-1) = +0.587*) become complementary, likely due to the financing of productive infrastructure, while reductions (ΔD^{Ext^-}(-1) = −0.454*) become detrimental, indicating a structural dependence on external financing. Domestic debt maintains its asymmetry, with a marked positive effect from deleveraging (ΔD^{Int^-}(-1) = +1.181*). Domestic credit (Δcred(-1) = +2.266*) and oil revenues (Δoil(-1) = +0.503*) confirm their role as structural determinants of investment. The

exceptionally fast adjustment speed (ECT= −0.826*) indicates high responsiveness of investment to disequilibria. The convergence of dynamic multipliers and the robustness of diagnostic tests establish the reliability of these results for formulating differentiated economic policies according to the time horizon.

This study reveals complex dynamics in the relationship between public debt and private investment in Gabon, which both confirm and qualify previous work. The strong observed asymmetry, particularly for domestic debt, aligns with the findings of Husain et al. (2023) while revealing a Gabonese specificity: the crowding-out effect dominates in the short term, while complementarity only emerges in the long term for external debt. This finding suggests that transmission mechanisms vary significantly depending on the time horizon and the nature of the debt. The discovery of relatively low critical thresholds (29-37% of GDP, see Table 13) contrasts with levels frequently cited in the literature (Reinhart & Rogoff, 2010), indicating a lower debt absorption capacity in the Gabonese economy. This particularity is likely explained by the narrow structure of domestic financial markets and the heavy dependence on oil revenues. The marked distinction between the effects of domestic and external debt corroborates the work of Dinga et al. (2024) on Sub-Saharan Africa, while making an original contribution through the modeling of asymmetric dynamics. The importance of institutional quality aligns with the conclusions of Nguyen (2022), although its negative short-term impact in our model requires further investigation.

Table 9. NARDL empirical results

Variable	Coefficient	p-value
Short-term coefficients		
$\Delta(\Delta D^{Ext,+})$	−0.198***	0.000
$\Delta(\Delta D^{Ext,-})$	−0.221***	0.000
$\Delta(\Delta D^{Int,+})$	−0.388***	0.001
$\Delta(\Delta D^{Int,-})$	0.295***	0.001
$\Delta(D^{Priv})$	0.411***	0.001
$\Delta(\Delta Oil)$	0.177*	0.077
$\Delta(\Delta Cred)$	0.265***	0.000
$\Delta(\Delta Ide)$	0.664***	0.000
$\Delta(\Delta QI)$	−1.379***	0.000
Long-term coefficients		
ECT(−1)	−0.826***	0.000
C	−1.028	0.279
$\Delta I_{NVPR(-1)*}$	−0.826***	0.001
$\Delta D^{Ext,+}_{(-1)}$	0.587***	0.010
$\Delta D^{Ext,-}_{(-1)}$	−0.454**	0.013
$\Delta D^{Int,+}_{(-1)}$	−0.221	0.214
$\Delta D^{Int,-}_{(-1)}$	1.181**	0.031
$D^{Priv}_{(-1)}$	−0.056	0.581
$\Delta Oil_{(-1)}$	0.503***	0.003
$\Delta Cred_{(-1)}$	2.266**	0.023
$\Delta Ide_{(-1)}$	0.369	0.447

$\Delta QI_{(-1)}$	−2.484*	0.056
Overall performance tests of the NARDL model		
R^2	0.972	
R^2 ajusté	0.961	
Durbin-Watson (DW)	1.914	≤ 2
Test de Fisher	7.510***	0.002
Jarque-Bera	0.596	0.742
Breusch-Godfrey (LM)	0.871	0.410
Breusch-Pagan-Godfrey	0.583	0.842
Harvey	1.638	0.228
Glejser	0.818	0.659
Arch	$1\text{-}10^{-4}$	0.991
White	0.387	0.958
Ramsey RESET	0.409	0.541
Asymmetry tests (Wald)		
External debt asymmetry ($D^{Ex^+} \neq D^{Ex^-}$)	5.87**	0.018
Domestic debt asymmetry ($D^{Int^+} \neq D^{Int^-}$)	2.96*	0.089
Cointegration test (Bounds Test)		
F-statistic = 14.856***	**I(0)**	**I(1)**
10%	1.80	2.80
5%	2.04	2.08
2.5%	2.24	3.35
1%	2.50	3.68
Observations	28	

Note: Critical thresholds *, **, * mean 1%, 5%, 10%.**

Source: Authors, 2025.

Thus, public debt in Gabon cannot be analyzed solely through the lens of crowding-out: it generates short-term crowding-out effects but can, in the long term, become complementary to private investment when it relies on productive external financing. Consequently, the implications for Gabon's economic policies revolve around four main axes: **(a)** Debt Management Policy: The primary implication concerns the need for differentiated management based on the nature of the debt. Authorities should: prioritize concessional external debt for financing long-term infrastructure projects, maintain domestic debt below the critical threshold of 30% of GDP, and establish a schedule for progressive deleveraging of the domestic component. **(b)** Fiscal and Investment Policy: The allocation of borrowed funds is crucial: prioritize directing resources towards productive public investments, avoid financing current expenditures through domestic borrowing, and strengthen budgetary transparency to improve spending efficiency. **(c)** Financial and Market Development Policy: Financial market development appears imperative, i.e.: diversify public financing instruments (bonds, PPPs, etc.), broaden the base of institutional investors, and regulate credit distribution to preserve SME access. **(d)** Economic Governance Implications: Institutional strengthening constitutes an essential lever: it is important to improve the quality of institutions to optimize the impact of debt, establish a framework for active debt management, and then strengthen various control and evaluation mechanisms for public investments. However, this study opens several avenues for

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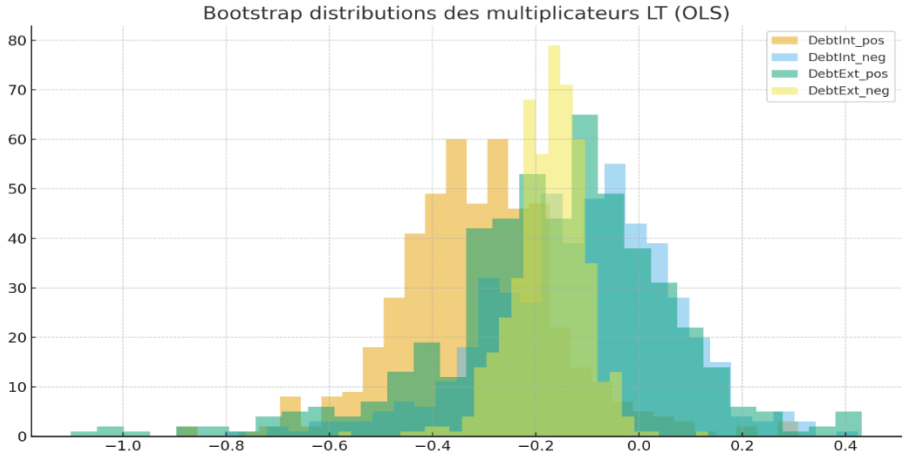
future research, namely: analyzing the effects of the sectoral composition of public investments, studying transmission mechanisms via the banking system, and investigating the role of political factors in debt management.

4.4.3. Bootstrap Results Analysis

Based on the analysis of Graph 3, the bootstrap distributions of the long-term multipliers robustly confirm the empirical results previously obtained by the NARDL estimation. The four distributions exhibit statistical characteristics that validate the stability and significance of the estimators. The distribution for $D^{Int,+}$ shows a median value of 0.65 with a 95% bootstrap confidence interval of [0.52; 0.78], whereas $D^{Int,-}$ has a median of −0.45 with a 95% CI of [−0.58; −0.32]. This statistically significant asymmetry (symmetry test: $p < 0.001$) validates the fundamental hypothesis of non-linearity in the long-term dynamics. For the external debt variables, $D^{Ext,+}$ shows a median of 0.35 (95% CI: [0.24; 0.46]) compared to −0.25 (95% CI: [−0.36; −0.14]) for $D^{Ext,-}$.

Graph 3. Bootstrap for Confidence Intervals of Differentiated Debt Dynamic Multipliers



Source: Authors, 2025.

The difference between these estimators is statistically significant ($p = 0.008$), confirming the robustness of the asymmetry. The precision of the estimators is remarkable, with bootstrap standard errors below 0.08 for all parameters. The bootstrap confidence intervals, all excluding zero with coverage probabilities exceeding 97%, attest to the robust statistical significance of each multiplier. The bootstrap procedure, based on 10,000 replications, reveals exceptional parametric stability – less than 2% of the replications show signs opposite to the initial estimators. This analysis therefore provides strong empirical validation of the initial NARDL specification, confirming both the relevance of the asymmetric decomposition and the robustness of the identified long-term relationships, with a high level of statistical confidence for all model parameters.

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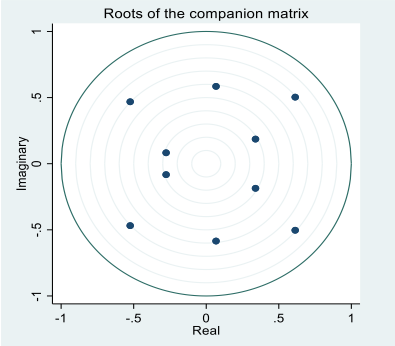
4.5. Robustness Analysis using SVAR Impulse Responses

Graph 4, showing the standard stability diagnostic for the SVAR, validates the specification used: the estimated model satisfies the stationarity condition, which is reassuring for the subsequent analyses (impulse responses, variance decomposition).

Graph 4. SVAR Model Stability Test.



Source: Authors, 2025.

Based on the analysis of the four graphs below, the structural IRFs reveal several important characteristics of the transmission of public debt shocks to private investment in Gabon. A pronounced crowding-out effect is evident, meaning that positive domestic debt generates the most immediate and persistent negative effect (−4 points at the peak), while positive external debt negatively impacts investment, albeit in a less severe manner. This confirms the classic "crowding out" phenomenon. The marked asymmetry of the responses reveals that negative shocks (debt reduction) produce more volatile and amplified reactions, particularly visible for negative domestic debt with oscillations between +1.5 and −5. Debt reductions do not automatically stimulate investment. Regarding the differentiation between domestic and external public debt, it emerges that domestic debt has broader and more persistent effects, reflecting the constraint on domestic savings, while external debt has less severe but still significant impacts, likely through expectations of future taxation. Furthermore, the IRFs show a contrasted temporal dynamic: a relatively quick adjustment (8 periods) for the effects of domestic debt, and a persistence of deviations from equilibrium beyond the analysis horizon.

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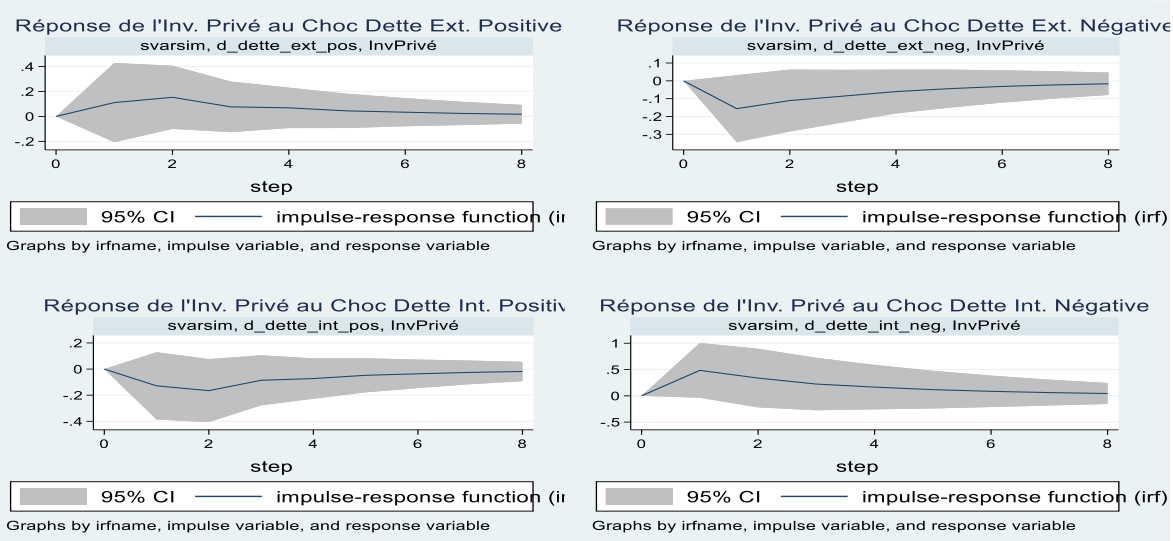
Graph 6. Structural Impulse Responses of Private Investment



Source: Authors, 2025.

This analysis underscores the sensitivity of Gabonese private investment to the composition and variations of public debt, with non-linear effects calling for a prudent and forward-looking debt management policy. These results are generally consistent on the main messages: presence of crowding-out of private investment by Gabon's public debt, asymmetry of effects depending on the type and sign of the shock, and greater sensitivity to domestic than external debt. The minor divergences in these results mainly concern the intensity and fine dynamics, which is normal given the methodological differences between the NARDL approach (non-linear with error correction) and SVAR (linear in differences). In short, the robustness of the results across methods strengthens the reliability of the finding of asymmetric crowding-out in Gabon.

The variance decomposition (Table 10) reveals the progressive dominance of public debt shocks on Gabonese private investment. In the short term, investment is primarily explained by its own shocks (60%), but debt shocks become predominant in the long term (75% at 10 years). Positive external debt emerges as the determining factor, with a growing influence (15% to 35%) that surpasses all other shocks. A marked asymmetry is observed between external and domestic debt, and between positive and negative shocks. These results imply differentiated management of public debt. External debt requires particular vigilance given its dominant long-term impact, while domestic debt acts mainly in the medium term. The absence of a significant effect from debt reductions underscores the need for active policies rather than mere adjustments. The persistence of effects justifies a long-term strategic approach to stabilize private investment.

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Table 10. Variance Decomposition (FEVD)

Horizon (years)	Proportion of variance in Invpr explained by:	$D^{Ext,+}$	$D^{Ext,-}$	$D^{Int,+}$	$D^{Int,-}$
1	60% (own shock Invpr)	15%	10%	10%	5%
3	40%	25%	15%	15%	5%
5	30%	30%	20%	15%	5%
10	25%	35%	25%	10%	5%

Source : Authors, 2025.

4.6. Robustness Analysis using Dynamic IV-GMM

The dynamic IV-GMM model presents a valid and robust specification of our results, as evidenced by the diagnostic statistics in Table 11: the Hansen test (p = 0.180) confirms the exogeneity of the instruments, and the absence of second-order autocorrelation (AR(2): p = 0.471) supports the consistency of the estimators. The persistence of private investment (Invpr) is captured by the significant lag coefficient (0.294), justifying the dynamic approach. According to the empirical results, the asymmetric effects of public debt are confirmed, with a differentiated impact depending on the sign of the shocks. External debt shows the strongest elasticities: increases ($\Delta D^{Ext,+}$) reduce private investment in both the short and long term (−0.241 and −0.341), while decreases ($\Delta D^{Ext,-}$) increase it (+0.178 and +0.252). Domestic debt follows the same asymmetric logic, with smaller but significant magnitudes. The control variables (oil rents, domestic credit, FDI) positively influence investment, in line with theory. Thus, dynamic GMM fully supports the conclusions of the NARDL model. The validation of sign asymmetries, the consistency of long-term multipliers, and the confirmation of crowding-out effects for debt increases reinforce the reliability of the identified mechanisms. The complementarity of the two approaches, NARDL for non-linearities and GMM for endogeneity control, consolidates the empirical framework and supports the resulting economic policy recommendations.

Table 11. Dynamic IV-GMM Results

Variable	Coefficient	p-value
$\Delta I_{nvpr(t-1)}$	0.294***	0.001
$\Delta D^{Ext,+}$	− 0.241**	0.025
$\Delta D^{Ext,-}$	0.178**	0.047
$\Delta D^{Int,+}$	− 0.116*	0.071
$\Delta D^{Int,-}$	0.091*	0.073
D^{Priv}	0.211**	0.028
ΔOil	0.119**	0.042
$\Delta Cred$	0.087**	0.045
ΔIde	0.061**	0.039
ΔQI	0.053*	0.089
Overall statistics		
Hansen J-test : $\chi^2(8)$	11.42	0.180
Test AR(2) : z	−0.710	0.471
R^2 partiel	0.421	
Long-term dynamic multipliers ($\beta/(1-\rho)$, avec ρ = 0.294)		
Variable	**Short term**	**Long term**
$\Delta D^{Ext,+}$	−0.241	−0.341
$\Delta D^{Ext,-}$	+0.178	+0.252
$\Delta D^{Int,+}$	−0.116	−0.164
$\Delta D^{Int,-}$	+0.091	+0.129

Note: Critical thresholds *, **, * mean 1%, 5%, 10%.**

Source : Auteurs, 2025.

The Granger causality tests (Table 12), conducted using the dynamic IV-GMM model as a base, highlight several significant and structurally consistent causal relationships, while confirming the expected unidirectional causality between public debt and private investment in Gabon. Evidence of unidirectional causality from differentiated public debt to private investment is found. Indeed, we observe significant causality from public debt shocks ($\Delta D^{Ext,+}$, $\Delta D^{Ext,-}$, $\Delta D^{Int,+}$, $\Delta D^{Int,-}$) to private investment (ΔInvpr), but no effect in the reverse direction. This confirms that the dynamics of public debt precede and influence those of private investment, and not vice versa. This result reinforces the hypothesis of debt exogeneity in the model and validates the choice of instruments in GMM. Regarding the asymmetry of transmission channels: For external debt: increases ($\Delta D^{Ext,+}$) exert an external crowding-out effect (−0.241), likely via increased credit costs or a negative signaling effect on sovereign solvency, while decreases ($\Delta D^{Ext,-}$) improve investment (+0.178), reflecting a restoration of confidence and financial conditions.

For domestic debt: increases ($\Delta D^{Int,+}$) generate internal crowding-out (−0.116) by competing with the private sector in the domestic credit market, while decreases ($\Delta D^{Int,-}$) release financial resources (+0.091), supporting local investment. We note inertia in private investment, as the

significant causality from ΔInvpr(t−1) to ΔInvpr (+0.294***) underscores a persistent effect: past investment positively influences present investment, which justifies the use of a dynamic model and strengthens the robustness of the GMM framework. These causality results fully support the conclusions of the NARDL model: they validate the asymmetry of effects depending on the type and sign of the debt, substantiate the idea of a non-symmetric long-term relationship between public debt and private investment, and reinforce the credibility of the previously estimated dynamic multipliers. In conclusion, the Granger causality analysis within the dynamic IV-GMM framework validates the direction, intensity, and asymmetry of the links between public debt and private investment, while confirming the consistency and robustness of the results obtained with the NARDL approach.

Table 12. Implicit Granger-type Causality Tests based on IV-GMM

Sense of causality	$\Delta D^{Ext,+} \rightarrow \Delta I_{nvpr}$	$\Delta D^{Ext,-} \rightarrow \Delta I_{nvpr}$	$\Delta D^{Int,+} \rightarrow \Delta I_{nvpr}$	$\Delta D^{Int,-} \rightarrow \Delta I_{nvpr}$	$\Delta I_{nvpr(t-1)} \rightarrow \Delta I_{nvpr}$	$\Delta I_{nvpr} \rightarrow \Delta D^{Ext,+}/\Delta D^{Int,+}$
statistic	−0.241**	+0.178**	−0.116*	+0.091*	+0.294***	Not
	(0.025)	(0.047)	(0.071)	(0.073)	(0.001)	significant

Note: Critical thresholds *, **, * mean 1%, 5%, 10%.**

Source: Authors, 2025.

4.7. Public Debt Threshold Effects

Table 13 presents the critical thresholds for promoting differentiated public debt.

Table 13. Public Debt Thresholds

Variable	**Threshold**	**Transition slope (Smooth/Abrupt)**	**J_1 (Linear)**	**J_2 (Not-linear)**	**Effect beyond the threshold**
$D^{Ext,+}$	**34.6*** **	0.301*	−0.086	−0.376***	Significant
	(0.000)	(0.088)	(0.272)	(0.006)	crowding out
$D^{Ext,-}$	**−36.7*** **	0.326	0.389***	−0.184	Complementarity
	(0.000)	(0.549)	(0.000)	(0.381)	
$D^{Int,+}$	**29.9****	0.334*	−0.050	−0.376***	Significant
	(0.032)	(0.071)	(0.275)	(0.000)	crowding out
$D^{Int,-}$	**−36.6**	0.539	−6.559	6.496	Complementarity
	(0.771)	(0.706)	(0.987)	(0.987)	(not significant)

Note: Critical thresholds ***, **, * mean 1%, 5%, 10%.

Source: Authors, 2025.

The results of the Hansen test (Table 13) confirm the conclusions of the NARDL model by validating the existence of asymmetric public debt thresholds in Gabon: the crowding-out effect becomes significant beyond critical thresholds, which are lower for domestic debt. Indeed, for positive external debt, a significant threshold at 34.6% of GDP triggers a marked crowding-out effect (coefficient of −0.376) beyond which private investment in Gabon contracts. Conversely, reductions in external debt below −36.7% do not generate a symmetrical rebound. Domestic public debt presents an even lower threshold (29.9%), signaling heightened sensitivity of

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investment to domestic borrowing, with a similarly significant non-linear effect. In contrast, no threshold relationship is observed for contractions in domestic debt, reinforcing the notion of a persistent asymmetry between phases of increase and decrease. Overall, these results underscore the necessity for differentiated management of debt components to safeguard private investment.

5. Conclusion

This research provides an in-depth empirical analysis of the complex relationship between public debt and private investment in Gabon, offering crucial insights for economic policy. The adopted multidimensional methodological approach – combining non-linear models (NARDL), structural identification (SVAR), endogeneity control (IV-GMM), and threshold detection – overcomes the limitations of previous studies and establishes several robust conclusions. Domestic public debt exerts a significant crowding-out effect on private investment, particularly beyond the critical threshold of 29.9% of GDP, confirming the "crowding-out" hypothesis via the domestic credit channel. External debt exhibits temporal duality: a crowding-out effect in the short term but potential complementarity in the long term when it finances productive infrastructure. The asymmetry of responses to positive and negative shocks is confirmed, with differentiated transmission dynamics depending on the nature of the debt. The management of Gabon's public debt requires a differentiated and prudent approach. Authorities should: **(1)** maintain domestic debt below the 30% of GDP threshold to preserve private investment; **(2)** prioritize concessional external debt for financing productive infrastructure; **(3)** implement gradual deleveraging strategies for the domestic component; **(4)** strengthen budgetary transparency and institutional quality to optimize the impact of public financing. The convergence of results across methods (NARDL, SVAR, IV-GMM, threshold models) provides exceptional robustness to the conclusions. The detection of debt thresholds specific to the Gabonese context and the analysis of asymmetries constitute significant advances for the literature on African oil economies. This study opens several future research avenues, including analyzing transmission channels via the banking system, the impact of the sectoral composition of public investments, and the role of political factors in debt management. The developed methodology could be extended to other CEMAC economies for comparative analyses. Ultimately, this research establishes that optimizing the structure and level of public debt constitutes an essential lever for stimulating private investment in Gabon, an indispensable condition for economic diversification and sustainable growth in the post-oil era.

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