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FOREWORD

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Modelling Core Inflation in Eswatini

By Bongani Hlophe¹

Abstract

Eswatini has recently started developing core inflation forecasts, albeit without any underpinning empirical work. This study explores the robustness of Ordinary Least Squares (OLS), Bayesian Vector Autoregression (BVAR), and univariate generalized regression neural networks (GRNN) models in forecasting core inflation. The results indicate that the OLS outperforms both of the other models with robust MAPE, RMSE, and MAE statistics. The paper concludes that the OLS model is the optimal model and recommends that other machine learning methods be explored in a multivariate framework.

Keywords: Core inflation, OLS, BVAR, GRNN, forecast

1. Introduction

One of the primary functions of central banks is to ensure low and stable inflation (price stability). Monetary policy is the main toolkit with which central banks aim to deliver low and stable prices. In order to do this, central banks often aim to control headline inflation. However, headline inflation has demand and supply drivers making it challenging to distinguish fundamental price changes from transient shocks (Ruch et al., 2015). In recent years, major shocks like the COVID-19 pandemic and the Russia-Ukraine war have compounded this problem elevating the challenge of reducing inflation (Clark et al., 2023). Consequently, distilling “true” inflation from transient price shocks becomes critical.

For central banks operating in economies with robust financial markets, anchoring inflation expectations is a fundamental function of monetary policy as stable inflation expectations indicate sound monetary policy (Grønlund et al., 2024). Investors rely heavily on monetary authorities to demonstrate that they not only understand but also can influence

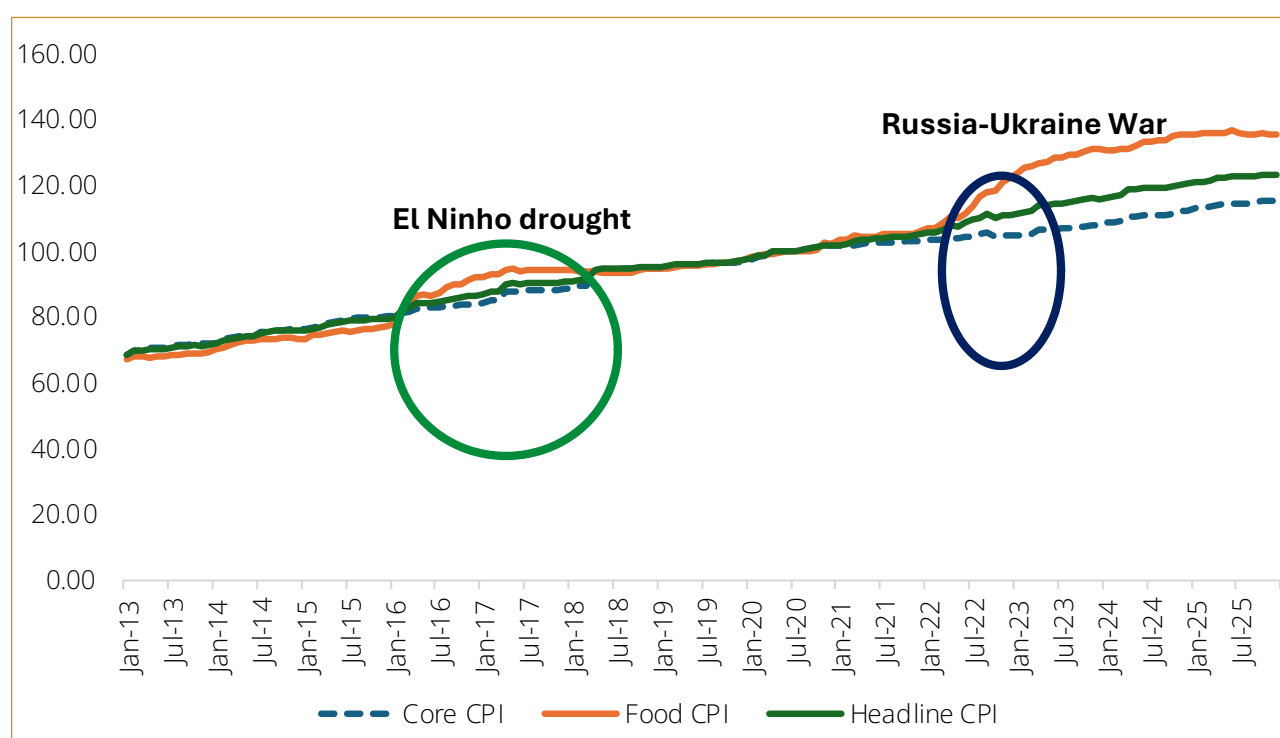
the fundamental path of price movements in the economy. Consequently, elements of the inflation basket that are stable in the long term (core) provide key cues for the future path of inflation.

Core inflation distinguishes between those items of the commodity basket that shift the long-run trend of inflation and those that are transient in nature (Kearns, 1998). The most common measures of core inflation are the so-called exclusion-based measures, specifically the excluding Food & Energy measures, constructed and reported by most statistical agencies (Wynne, 2001). Regardless of the criteria employed, the goal remains separating the noise from the signal in inflation data with a view of establishing a clearer picture of future trends in headline inflation (Almuzara & Sbordone, 2024). Maintaining this separation is critical because if transient shocks are persistent, they may filter through to consumer behavior, business, and market expectations (Almuzara & Sbordone, 2024). In such cases, these shocks will have an inherent ‘core’ effect on the aggregate picture.

Eswatini has recently started developing core inflation forecasts albeit without any underpinning empirical work to establish the determinants of core inflation. The criteria employed has primarily been the conventional exclusionary approach wherein food, auto fuel, and energy are excluded from the headline components. A similar approach was adopted by the South African Reserve Bank (SARB), which defined core inflation in terms of excluding prices for food, petrol, energy, and non-alcoholic beverages from headline inflation (Ruch et al., 2015).

Core inflation in Eswatini has generally moved in tandem with headline inflation, punctuated by periods of deviation underpinned by fundamental food price shocks. This is observable in figure 1 below, wherein the drought of 2016 and the Russia-Ukraine war in 2022 constitute watershed moments with major food price shocks. The movements over time appear to imply a substitution effect between food and other components of the consumption basket making up core inflation, during periods of shocks. That is to say, when food prices increase owing to supply shocks, demand for key features of core inflation, like services fall, as people prioritize subsistence.

¹ Bongani Hlophe is a Senior Economist, Modelling and Forecasting, in the Research Department. Email: bonganih@centralbank.org.sz

Figure 1: Food, Core and Headline CPI 2013-2025

An important aspect to consider for Eswatini is the issue of price regulation by the government for both items considered by the definition of core inflation as 'noisy', (i.e., bread price component of food inflation) and 'stable' (i.e., water and electricity tariffs aspect of utilities). The extent to which price regulation modifies the 'noise' in volatile items and 'stability' in the core items is not an area of focus for this paper. The goal of this paper is to provide the requisite underpinning empirical work on the optimal model for forecasting core inflation in Eswatini. Specifically, three methods are evaluated with a view of establishing the optimal for forecasting core inflation in Eswatini. Consequently, the paper seeks answer the question on which is the optimal method for forecasting core inflation in Eswatini between two multivariate methods (OLS and Bayesian VAR) and univariate method (generalized regression neural networks).

The next sections of this paper are organized as follows: literature review, methodology, results and discussion, and finally, the conclusion and recommendations.

2. Literature review

2.1 Measures of core inflation

Wayne (1999) noted the absence of a well-developed and largely approved theory on the measurement of core inflation, and that practitioners often are left with the measures that try to track better the trend inflation rate, which in many circumstances, may amount to the task of forecasting a future headline inflation rate. Drawing these thoughts, Bermingham (2009) described the two main techniques of core inflation assessment in the literature as assessing the ability of potential measures to track trend headline inflation in real time and forecasting future headline inflation.

Silver (2007) noted that measures of core inflation can be grouped into those that remove the noise to identify the signal, ideal for policy assessment, and those strictly formulated to predict headline inflation. Policy assessment measures feature exclusion-based methods, trend estimates, and limited influence estimators (median and trimmed means). Prediction measures, on the other hand, feature methods

that involve re-weighting the Consumer Price Index (CPI) and economic models. A trimmed mean is the weighted mean of the middle part of the ranked distribution of CPI component price movements, wherein each component is assigned its CPI weight (Holden, 2006). For example, a 14 percent trimmed mean would involve removing the highest and lowest 7 percent of the percentage price movements and then taking the weighted mean.

Brischetto and Richards (2006) assessed the comparative gains of headline inflation, exclusion measures, and trimmed mean measures as indicators of true inflation. They found that trimmed mean measures offer substantial advantages over headline inflation in terms of providing measures of inflation that have a higher signal-to-noise ratio. Earlier work by Bryn and Cocchetti (1994) provided the empirical base for the use of trimmed means wherein growth in money supply was used to forecast core inflation as measured by a weighted median and the 15 percent trimmed mean.

Quah and Vahey (1995) employed a vector autoregressive framework to measure the core inflation terms of the exogenous disturbances to headline inflation, which do not have a long-run impact on output. In this framework, core inflation is identified as being output-neutral in the medium to long run. They let Y and π denote output and measured inflation, and the two disturbances η_1 and η_2 . Additionally, output and inflation were assumed to have stochastic trends but are not cointegrated. Denote $X = (\Delta Y, \Delta \pi)'$ and $\eta = (\eta_1, \eta_2)'$ such that:

$$X_t = \sum_{j=0}^{\infty} D_j \eta_{t-j}$$

where $\text{Var}(\eta) = I$ Where the long run neutrality condition is given by $\sum_{j=0}^{\infty} d_{11}(j) = 0$

Johansson and Tysklind (2024) underscore the need for robust core inflation measures to not only indicate the typical and persistent components of inflation but also show how high inflation is when transient effects dissipate. To this end, they suggest that measures of core inflation should be forward-looking and have information on future inflation nested within them.

Their analysis found that core inflation forecasts based on monthly CPI changes as opposed to the conventional annualized changes performed were much more robust.

2.2 Empirical review

Bermingham (2009) evaluated the robustness of the Hodrick-Prescott filter, trimmed mean, structural VAR (SVAR), band-pass filter, a factor model, and exponential smoothing as measures of core inflation. He used the ability to track and forecast headline inflation as the two principal benchmarks for performance for each measure. He concluded that the systematic failure of core inflation regressions to beat a naive benchmark indicates that core inflation rates are not a useful tool in terms of forecasting inflation.

Cristadoro et al. (2008) employed the Generalized Dynamic Factor Model (GDFM) to assess measures of forecasting core inflation for the European Union. Their reparametrized model within a static factor set up took the following form;

$$y_{i,t} = \chi_{i,t} + \xi_{i,t} = \lambda_i F_t + \xi_{i,t} = \sum_{h=1}^r \lambda_{i,h} F_{t,h} + \xi_{i,t}$$

Where r represents a function of variable dynamic specific shocks, $\chi_{i,t}$ is a component that stores common shocks across the panel while being free from measurement errors and sector-specific sources of capriciousness estimated through cross-sectional smoothing. They found that the robustness of the GDFM in forecasting core inflation was conditional sector and economy dynamics, performing relatively well in the Italy and France cross-sections and struggling in the Germany cross-section.

Clark et al. (2025) examined the forecasting efficacy and implications of three measures of core inflation: goods excluding food and energy, services excluding energy and housing, and housing. After conducting a comprehensive historical appraisal of the accuracy of point and density forecasts from a range of models and approaches, the results showed that a Bayesian VAR with stochastic volatility in aggregate core inflation was an effective tool for forecasting inflation's components as well as overall core inflation.

Libonatti (2018) explored different expressions of the Mixed Data Sampling (MIDAS) regression method to

forecast core inflation in Argentina using a daily price index. He found that for some MIDAS specifications, there is a slight improvement compared to the low frequency benchmark autoregression and the unconditional mean. In principle, this would imply that high-frequency online price indices have good potential to forecast future behavior of consumer inflation for immediate horizons in Argentina. A similar approach was employed by Ribon and Suhoy (2011), and Beck et al. (2023) for Israel and Germany, respectively.

Stock and Watson (2016) developed a univariate unobserved components/stochastic volatility outlier-adjustment (UCSVO) method, along with a multivariate version, to empirically assess whether the measurement of trend inflation can be enhanced by using disaggregated data on sectoral inflation to construct indexes analogous to core inflation. Their model expressed the inflation rate as the sum of a permanent and transitory component, where the innovations to both components have variances that evolve over time according to independent stochastic volatility processes, and where the innovation to the temporary component can have heavy tails. They found that there are substantial gains from using sectoral inflation over using headline inflation and that improved accuracy can be achieved from univariate estimates constructed from traditional measures of core inflation.

Ruch et al. (2015) explored small- and large-time varying parameter vector autoregressive (TVP-VARs) models to forecast core inflation in South Africa. They found that most VAR models (specifically the small TVP-VARs) perform better than the random walk model and other benchmark models for both forecast evaluation methods and for all horizons. Additionally, heteroscedastic models outperformed models with constant variance over time. Employing machine learning and big data approaches, Botha et al. (2022) found that these models were generally more robust when the course of South Africa's inflation deviated from the steady state due to major shocks.

Building from simple Ordinary Least Squares (OLS)

techniques, Verona (2026) developed the Sum of the Cycles (SOC) to forecast different components of inflation through varying decomposition techniques. SOC decomposes headline inflation into recurrent components, applies forecasting models appropriate to their persistence, and recombines them into an aggregate forecast. He found that the SOC method delivers substantial and economically meaningful forecasting gains. Using US inflation data, he showed that for different measures and horizons, SOC consistently outperforms leading time-series 2 benchmarks, with improvements particularly marked at medium and long horizons, wherein forecast errors fall by almost 50 percent.

Choudhary et al. (2023) considered a univariate approach like the Autoregressive Integrated Moving Average (ARIMA) model to forecast core inflation in India. They augmented this with consideration of other covariates such as global oil prices, food cpi and the real effective exchange rate, within an ARIMAX framework. Their results showed that separately forecasting the core CPI components and then combining them produces improved forecasting efficacy. They argued this approach permits a more precise understanding of the underlying dynamics within each component, thereby capturing short-term fluctuations more precisely.

3. Data and Methodology

3.1 Data

This paper employs monthly data from January 2013 to February 2026, consisting of Eswatini Core CPI (as measured by the exclusion approach), Food CPI, Services CPI, USD exchange rate (EXCH), crude oil prices, fuel CPI, and South African headline CPI (RSA_CPI). Data are sourced from the Central Bank of Eswatini (CBE), Central Statistical Office of Eswatini (CSO), Statistics South Africa, and the South African Reserve Bank. Table 1 presents the summary statistics for the data.

Table 1 Summary statistics

	CORE_CPI	EXCH	FOOD_CPI	FUEL_CPI	HOUSING_CPI	OIL	RSA_CPI	SERVICES_CPI	ELECTRICITY_CPI
Mean	94.20739	14.72421	100.5004	123.0193	91.45996	70.27796	79.01951	91.77588	93.50707
Median	96.03000	14.66000	96.00000	105.8000	93.80000	68.58000	78.20000	95.25000	100.0000
Maximum	115.9000	19.07000	136.7300	197.7000	117.8110	116.8000	103.8447	110.7875	142.1200
Minimum	68.70000	8.790000	67.10000	85.30000	67.30000	21.04000	55.80000	66.71000	49.70000
Std. Dev.	13.70940	2.759640	21.76306	36.68701	15.43016	21.29692	14.28103	13.10739	27.18311
Skewness	-0.242852	-0.203725	0.257440	0.721632	-0.029763	0.214964	0.186397	-0.379896	-0.000616
Kurtosis	1.819092	2.129363	1.954862	1.818817	1.673618	2.296618	1.852165	1.741992	2.036096
Jarque-Bera	10.66587	6.044663	8.879754	22.75326	11.53186	4.445615	9.527938	14.12913	6.077948
Probability	0.004830	0.048688	0.011797	0.000011	0.003132	0.108305	0.008532	0.000855	0.047884
Sum	14790.56	2311.701	15778.57	19314.02	14359.21	11033.64	12406.06	14408.81	14680.61
Sum Sq.	1422700.	35226.01	1659640.	2585963.	1350435.	846176.9	1012137.	1349183.	1488013.
Sum Sq. Dev.	29319.83	1188.035	73886.41	209966.1	37142.01	70755.19	31815.85	26801.38	115271.7
Observations	157	157	157	157	157	157	157	157	157

3.2 Data generating process

As part of the descriptive process, the paper considered the probability distribution descriptive of the data generating process of core inflation. Petrou et al. (2021) underscore the importance of model input distributions to be defined pursuant to ensuring modelling robustness, uncertainty, and sensitivity analysis are covered. The lack of detailed uncertainty propagation can lead to overly confident and unreliable models, while sensitivity analysis can quickly identify model inputs that can greatly influence outputs (Tian et al., 2021).

The Cullen-Frey plot was used to identify the candidate distribution of core inflation. The Cullen-Frey graph plots the kurtosis against the square of skewness to identify candidate distributions (Petrou et al. (2021). Skewness measures symmetry, wherein a value of zero indicates a fully symmetric distribution, while

kurtosis indicates how heavy the tails of a distribution are, with a value of three for a normal distribution (Reimann et al., 2012). By plotting the kurtosis and square skewness of the collected data on a graph and overlaying the values that common distributions would take, one can infer the candidate distributions that may best describe the data (Petrou et al., 2021). The Akaike Information Criterion (AIC) was then used to select the best distribution following Portet (2020).

3.3 Methodology

The paper compares the forecast performance of two econometric models in forecasting core inflation in Eswatini. These are discussed sequentially below using a multivariate framework wherein covariates are used as predictors of core inflation over 12 months forecast horizon ($h=12$).

3.3.1 Ordinary Least Squares (OLS)

The first model considered is the simple OLS model wherein core inflation is expressed as a linear function of a set of predictors. The basic equation estimated has the following form, following Inoue et al. (2015);

$$Y_{t+h} = \beta'_{h,t} x_t + \mu_{t+h} \quad t = 1, 2, \dots, T$$

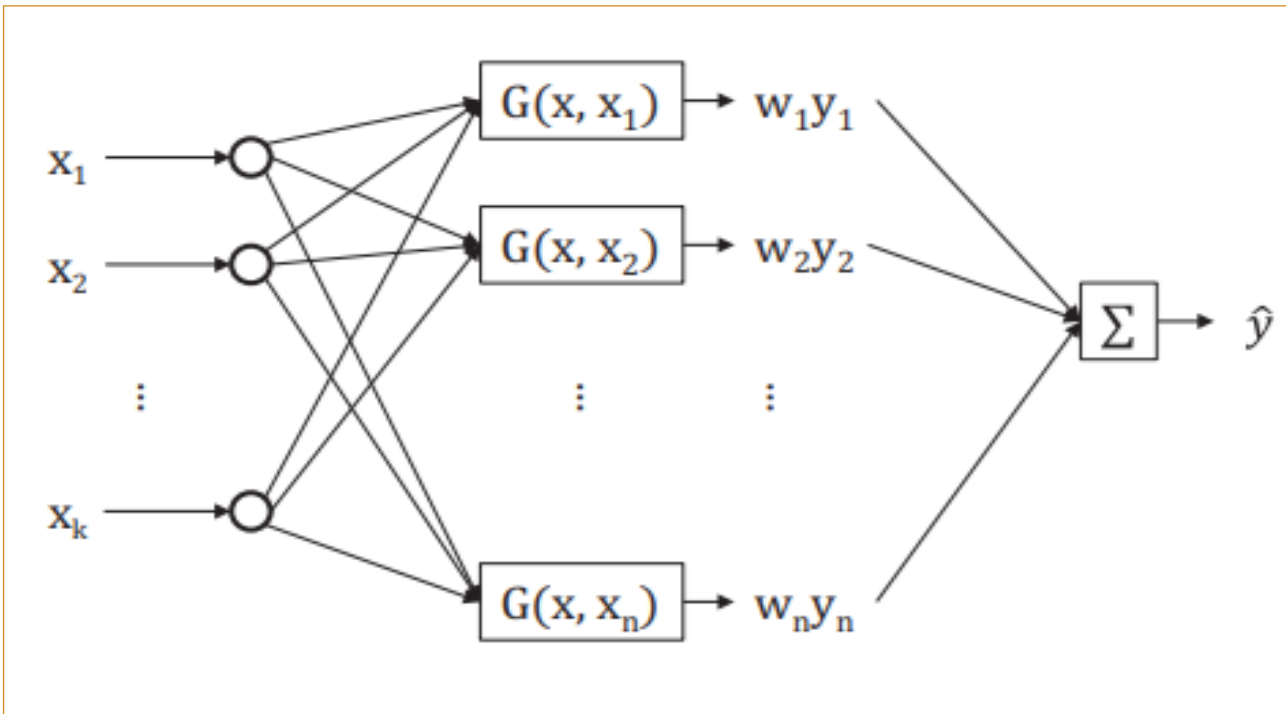
where $x_t = (x_{t1}, x_{t2}, \dots, x_{tp})'$ is a $p \times 1$ vector of stochastic regressors, $\beta_{h,t} = (\beta_{h,1}', \beta_{h,2}', \dots, \beta_{h,p})'$ is a $p \times 1$ vector of time-varying parameters; μ_{t+h} is an unobservable disturbance; h denotes the forecast horizon, where $1 \leq h < \infty$ and $h \in \mathbb{Z}^+$ and

T denotes the full sample size. The primary interest here is predicting Y_{t+h} using information available at time T .

3.3.2 Generalized regression neural networks

The study considered the generalized regression neural networks (GRNN) by Specht (1991) as a univariate forecasting option. According to Martínez et al. (2021), a GRNN is a variation of a radial basis neural network used primarily for classification and regression. A GRNN is an artificial neural network made up of three layers: the input, hidden and output layer, as seen in figure 2.

Figure 2: General architecture of GRNN



Source: Martínez et al. (2021)

The hidden layer has radial basis neurons whose centers are the training examples. Normally, the radial basis function is the multivariate Gaussian function;

$$G(x, x_i) = \exp\left(-\frac{\|x - x_i\|^2}{2\sigma^2}\right) \dots \dots (2)$$

where x_i and σ are the center and the smoothing parameter, respectively, and x is the input vector. The output of a hidden layer neuron is related to the closeness of the input vector to the center, scaled by the smoothing parameter. Given a training set consisting of n training patterns $\{x_1, x_2, \dots, x_n\}$ and their associated targets $\{y_1, y_2, \dots, y_n\}$, the output for an input pattern x is computed in two steps. First, the hidden layer produces a set of weights associated with the closeness of x to the training patterns:

$$w_i = \frac{\exp\left(-\frac{\|x-x_i\|^2}{2\sigma^2}\right)}{\sum_{j=1}^n \exp\left(-\frac{\|x-x_j\|^2}{2\sigma^2}\right)}$$

The weights sum to one and represent the contribution of every training pattern to the final result. Next, the output layer computes the output as:

$$\hat{y} = \sum_{i=1}^n w_i y_i$$

Consequently, a weighted average of the training targets is obtained, where the weights are related to the closeness of the input to the training patterns (the closer, the higher). The role of the smoothing parameter is to control how many targets have

significant weights in the weighted average, that is, the level of smoothing in the output. When σ is large all of the targets have a small and similar weight, so the result is close to the mean of the targets. On the other hand, when σ is small, only the targets whose patterns are close to the input have significant weights.

3.3.3 Bayesian VAR

Kenny et al., (1998) note that the Bayesian approach has typically been applied to multivariate vector autoregressions rather than to the univariate models. Boymirzaev (2025) outlines the following procedure for the BVAR, wherein the reduced form of the VAR model is expressed as follows:

$$Y_t = B_1 Y_{t-1} + B_2 Y_{t-2} + \dots + B_p Y_{t-p} + u_t, \quad t=1, \dots, T \quad (3)$$

where Y_t is an $n \times 1$ vector of endogenous variables and u_t represents an $n \times 1$ vector of error terms, assumed to be independently and identically distributed (i.i.d) according to a multivariate normal distribution with mean zero and variance-covariance matrix Σ

$$u_t \sim N(0, \Sigma)$$

B_l (for $l = 1, 2, \dots, p$) are an $n \times n$ coefficient matrices representing the impact of past values of y^t on the present.

$$Y_t = X_t \beta + u_t \quad t = 1, \dots, T$$

where $X_t = (I_t \otimes W_t)$ is an $n \times nk$ matrix, $k = np$. $W_t = (Y_{t-1}', Y_{t-2}', \dots, Y_{t-p}')'$ is $k \times 1$ vector containing all lagged endogenous variables. $\beta = \text{vec}(B_1, B_2, \dots, B_p)$ is $nk \times 1$ vector containing all unknown coefficients. In this framework, $\otimes$ represents the Kronecker

product, and the $\text{vec}(\cdot)$ operator transforms a matrix into a column vector by stacking its columns. The key objective is to estimate the parameters β (lag coefficients) and Σ (covariance matrix of residuals) using Bayesian methods.

$$f(\beta, \Sigma | Y) = \frac{f(Y | \beta, \Sigma) f(\beta, \Sigma)}{f(Y)}$$

where $f(Y | \beta, \Sigma)$ is the likelihood function of the data, denoted as $L(Y | \beta, \Sigma)$ and $f(\beta, \Sigma)$ represents the prior distribution of the parameters, incorporating prior knowledge. $f(Y)$ is a normalizing constant that ensures the posterior integrates to one, but does not depend on β or Σ . Since $f(Y)$ is independent of the parameters, the posterior distribution simplifies to:

$$f(\beta, \Sigma | Y) \propto L(Y | \beta, \Sigma) f(\beta, \Sigma)$$

The posterior density $f(\beta, \Sigma | Y)$ summarizes all available information about the parameters after observing the data, and can be used to derive point estimators for β and Σ . The prior density $f(\beta, \Sigma)$ represents subjective beliefs about the parameters before observing the data. The selection of an appropriate prior distribution is a critical component in setting up the model. While several alternatives have been proposed in the academic literature, this paper employs the Litterman (Minnesota) prior following Boymirzaev (2025).

The Minnesota prior distribution assumes that the coefficients matrix B follows a normal distribution, with a specified prior mean assigned to the first own lag, while the remaining coefficients are set to zero. Consequently, this prior distribution assumes that the variables exhibit autoregressive behavior of order one (AR(1)), encompassing white noise and random walk components.

Litterman (1986) proposes a multivariate normal prior distribution for β with prior mean, β^* and the variance of the prior Ω^* .

$$\beta \sim N(\beta^*, \Omega^*)$$

The variance of the prior Ω^* is specified in a

structured manner and is determined by the following relationships for the VAR coefficients.

$$\begin{aligned} & \left(\frac{\lambda_1}{l_{\lambda_3}} \right)^2 & \text{if } i = j \\ & \left(\frac{\sigma_i \lambda_1 \lambda_2}{\sigma_j l_{\lambda_3}} \right)^2 & \text{if } i \neq j \\ & (\sigma_1 \lambda_4)^2 & \text{for the constant} \end{aligned}$$

In this presentation, i represents the dependent variable in the i^{th} equation, while j denotes the independent variables within the same equation. When $i = j$, the coefficients correspond to the own lags of the variable i . The terms σ_i and σ_j indicate the variances of the error terms derived from autoregressive (AR) regressions, estimated using OLS based on the variables included in the VAR model. The ratio $\frac{\sigma_i}{\sigma_j}$ in the equation's accounts for potential differences in scale between variables i and j . The λ s are parameters to set that control the tightness of the prior. The values of these parameters can be determined based on the forecast performance of the model. Moreover, the values of these hyperparameters can be determined using the marginal likelihood.

The Minnesota prior offers a computationally efficient approach to deriving the posterior distribution of VAR coefficients. However, its principal limitation is the assumption of a known residual covariance matrix. A more general and flexible alternative is to employ a Normal-Wishart prior distribution, which accounts for the uncertainty in both the β coefficient parameters and the Σ covariance matrix by treating them as unknown. The prior distribution of β is assumed to be a multivariate normal distribution.

$$\beta \sim N(\beta_0, \Sigma \otimes \Phi_0)$$

Analogous to the Minnesota prior, β_0 is defined as a $q \times 1$ vector, while Φ_0 is a $k \times k$ diagonal matrix. The residual variance-covariance matrix, Σ implies that the Kronecker product $\Sigma \otimes \Phi_0$ yields a covariance matrix of dimension $nk \times nk$ or equivalently $q \times q$. The prior for Σ is an inverse Wishart distribution given below.

$$\Sigma \sim IW(S_0, \alpha_0)$$

Here, S_0 is defined as the n -scale matrix for the prior, whereas α_0 specifies the prior degrees of freedom.

3.3.4 Forecast evaluation

The paper used classical statistics to evaluate the forecasting accuracy of the three models considered herein. The classical loss functions will include the Mean Absolute Error (MAE), Mean Absolute percent Error (MAPE), and the Root Mean Squared Error (RMSE).

The Mean Absolute Error is defined by the equation;

$$MAE = \frac{1}{n} \sum_{i=1}^n |e_i|$$

And the Root Mean Square error of the form;

$$RMSE = \sqrt{\frac{1}{n} \sum_{i=1}^n |e_i|}$$

Lastly the Mean absolute error which is of the form;

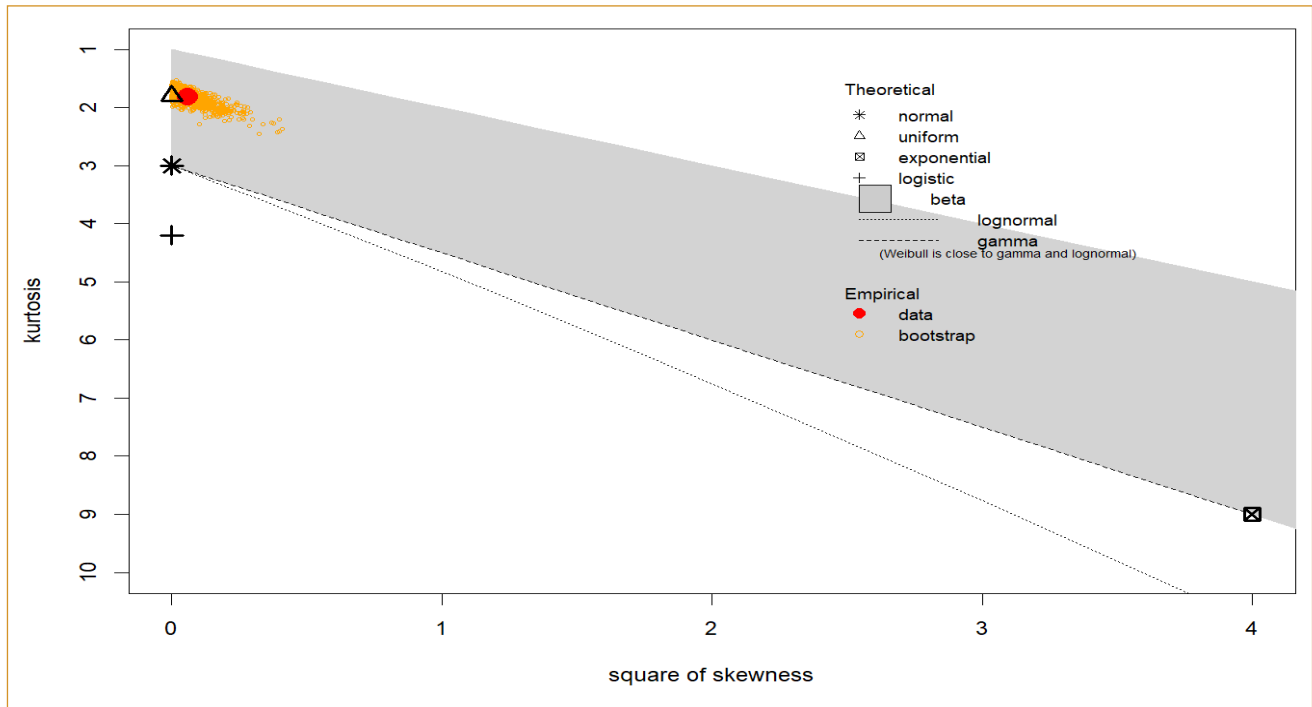
$$MAPE = \frac{1}{T} \sum_{t=1}^T 100 \times \left(\left| \frac{e_t}{y_t} \right| \right)$$

4. Results and discussion

4.1 Data generating process

The study employed the Cullen-Frey plot presented in figure 3 to identify the candidate distribution of core inflation. Based on the plot, the core inflation data generating process could follow a normal, logistic, lognormal, or gamma probability distribution. The study used the AIC and Bayesian information criteria to identify the candidate distribution that best fits the data.

Figure 3: Cullen-Frey plot



From Table 1, we observe that the normal distribution is the best fit candidate distribution for core inflation

in Eswatini as it bears the minimal statistics for both information criteria.

Table 1: Goodness of fit

Goodness-of-fit criteria	normal	lognormal	gamma	logistic	exponential
Akaike's Information Criterion	1290.748	1297.825	1294.8	1304.8	1765.39
Bayesian Information Criterion	1296.885	1303.962	1300.9	1311	1768.459
Goodness-of-fit statistics	normal	lognormal	gamma	logistic	exponential
Kolmogorov-Smirnov statistic	0.1093992	0.1268634	0.1214	0.0974	0.5175973
Cramer-von Mises	0.4686365	0.6105797	0.5576	0.4323	11.3305271
Anderson-Darling statistic	2.8301703	3.5889607	3.2984	2.899	53.0695929

Source: Author

The fact that the data generating process of the variable of interest in this study follows a normal distribution situated the methodology chosen on a stronger footing as some of the models to be used assume a normal distribution.

4.2 Unit root test

The study used the Phillips-Perron test to test for the presence of a unit root in the data owing to its ability to account for structural breaks. The consideration

for structural breaks is important because data related to prices tends to inherently bear the effects of structural shifts in the economy. The results are presented in table 3 wherein the log-transformed variables are initially tested at levels, and then after taking first differences. All of the variables are integrated of order one. This is an important result for this study since OLS requires that variables be integrated of the same order.

Table 3: Unit root test

Variables	Level (trend and intercept)		1 st Difference-(trend and intercept)	
	PP Statistic	P-Value	PP Statistic	P-Value
Log(CORE_CPI)	-1.592737	0.7917	-14.54218	0.0000
Log(EXCH)	-3.029832	0.1273	-10.47553	0.0000
Log(FOOD_CPI)	-1.715826	0.7402	-9.250266	0.0000
Log(FUEL_CPI)	-2.103912	0.5395	-9.211720	0.0000
Log(HOUSING_CPI)	-2.734532	0.2242	-13.59849	0.0000
Log(OIL)	-2.525693	0.3155	-9.041789	0.0000
Log(RSA_CPI)	-1.869972	0.6657	-9.603144	0.0000
Log(SERVICES_CPI)	-1.632985	0.7759	-14.26415	0.0000
Log(ELECTRICITY_CPI)	-2.232223	0.4683	-16.01646	0.0000

4.3 OLS Model

The study estimated equation (1) for establishing the base model upon which the OLS forecast was to be made. The results are represented in table 4 wherein we observe the model statistics were generally robust. Specifically, coefficient of determination was

robust with the predictors explaining 99.9 percent of the variation in core CPI. Additionally, the overall fit of the model was robust with the F-statistic high and statistically significant, while all of the predictors in the model were also statistically significant.

Table 4: OLS model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(ELECTRICITY_CPI)	-0.022246	0.006402	-3.475107	0.0007
LOG(FOOD_CPI)	0.040404	0.011014	3.668326	0.0003
LOG(EXCH)	-0.025394	0.004313	-5.887966	0.0000
LOG(RSA_CPI)	0.250845	0.017694	14.17706	0.0000
LOG(OIL)	-0.012642	0.001276	-9.911237	0.0000
LOG(SERVICES_CPI)	0.730409	0.014531	50.26602	0.0000
DUMCOVID	-0.006000	0.001602	-3.744281	0.0003
DUMAPRIL	-0.012855	0.003285	-3.913324	0.0001
C	0.185187	0.030277	6.116503	0.0000
R-squared	0.999607	Mean dependent var		4.534511
Adjusted R-squared	0.999586	S.D. dependent var		0.150413
S.E. of regression	0.003061	Akaike info criterion		-8.684387
Sum squared resid	0.001387	Schwarz criterion		-8.509188
Log likelihood	690.7244	Hannan-Quinn criter.		-8.613233
F-statistic	47059.45	Durbin-Watson stat		1.479782
Prob(F-statistic)	0.000000			

Prior to forecasting, the model residuals were tested for normality, homoskedasticity and serial correlation with view of ensuring that they do not violate the key tenets of the classical linear regression model.

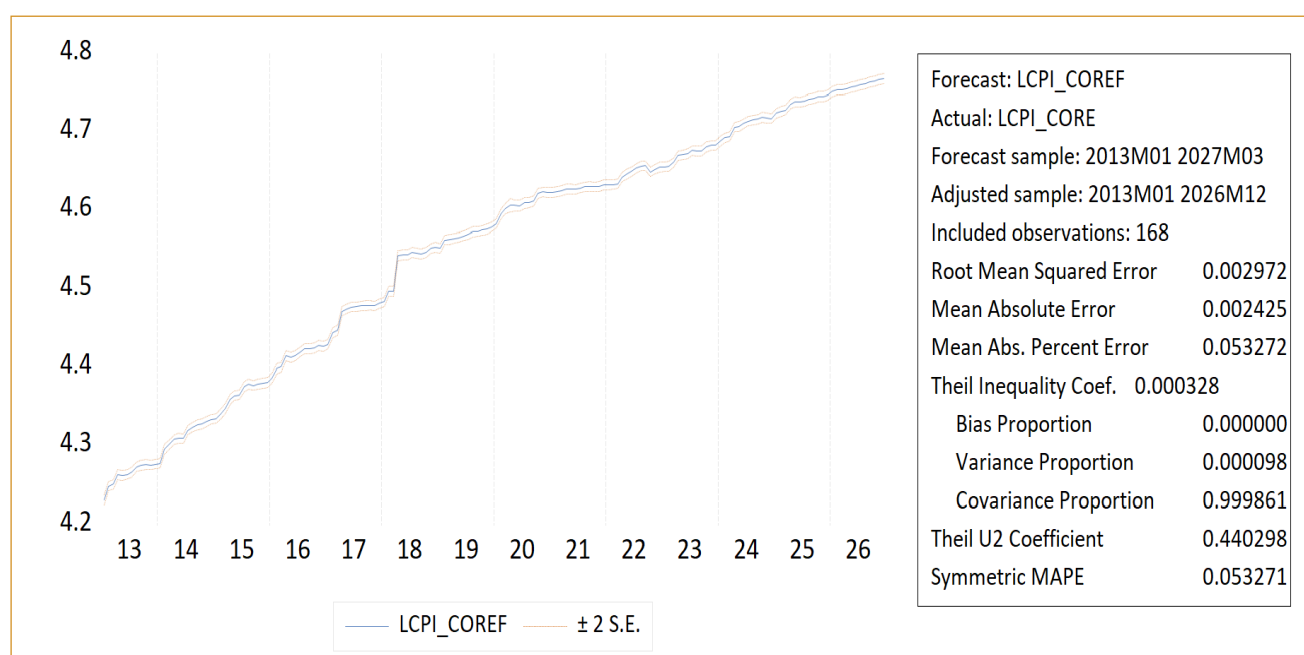
The results are presented in table 5 below wherein we observe that the model cleared all tests at the 5 percent level of significance.

Table 5: Residual tests

Diagnostic Tests	Test-Statistic	p-value
Breusch-Godfrey (serial correlation)	2.075215	0.10804
Breusch-Pagan-Godfrey (heteroscedasticity)	2.06894	0.1070
Jarque-Bera	1.158327	0.560367

The study considered the MAE, RMSE and MAPE of the model which came out relatively low as evident in figure 4. This was further confirmed by a tighter fitting in-sample graph wherein LCPI_CORE is the original series while LCPI_COREF is the fitted series.

The standard errors bands are quite narrow and closely hug the series. The MAPE is very robust at 5.3 percent while the RMSE and MAE are relatively low, pointing to strong forecast performance.

Figure 4: Forecast evaluation for OLS model

4.4 GRNN model

This section presents the summary of the estimated GRNN model (table 6) along with the ancillary model forecast performance measurement statistics. The code for the model was run in a way that permitted the model to automate the selection of the training data set. Additionally, dimensions of trend and seasonality

were handled using a rolling origin function and lagging, respectively, following Martínez et al. (2021). The univariate model is not as robust as the MAPE is at 34.7 percent, pointing to a need to potentially include some covariates to improve the model's ability to predict the evolution of core inflation in Eswatini.

Table 6: Forecast evaluation for GRNN model

Multiple-Step Ahead Strategy: recursive				
Sigma (smoothing parameter): 1.791375,				
Autoregressive lags: 1 2 3 4 5 6 7 8 9 10 11 12,				
Type of training samples transformation: additive,				
Forecasting horizon: 12				
Forecast Evaluation				
RMSE	MAE	MAPE	SMAPE	
0.4485	0.4009	0.3472	0.3467	

4.5 Bayesian VAR

The study estimated a number of BVAR specifications with varied levels of tightness in the hyperparameters. Initially, the study estimated a model with the Normal-Wishart prior, which has the benefit of accounting for the uncertainty in both the coefficient parameters and the covariance matrix by treating them as unknown (Boymirzaev, 2025). This is the advantage of the Normal-Wishart prior over the Litterman/Minnesota prior, which was also estimated for comparison. The study noted, however, that owing to the fact that the data is used in log levels, there is a significant possibility of non-stationarity in the results. Consequently, it also estimated the model with Sims and Zha (1997) priors, which are merely

an augmentation of the Normal-Wishart prior with dummy initial observation and sums-of coefficients applications, following recommendations by Dieppe et al. (2016).

The results of the model forecasts are presented in table 7 where the model with Sims-Zha priors produced better forecast evaluation results than the Normal-Wishart specification. From table 7, the model with Sims-Zha priors has a relatively low average absolute percentage error of about 18.8 percent. Similarly, the MAE and RMSE are the lowest of the specifications, with the Theil inequality coefficient also being close to zero, which generally indicates strong forecast accuracy relative to the scale of the series.

Table 7 BVAR forecast performance

Prior type	RMSE	MAE	MAPE	Theil
Sims-Zha (normal-Wishart)	0.011117	0.008559	0.188063	0.001225
Normal-Wishart	0.019115	0.014119	0.306407	0.002107
Litterman / Minnesota	0.026915	0.021532	0.467707	0.002967

4.6 Comparison of the three best models

Table 8 presents the comparison of the three models with their specific forecast evaluation criteria given.

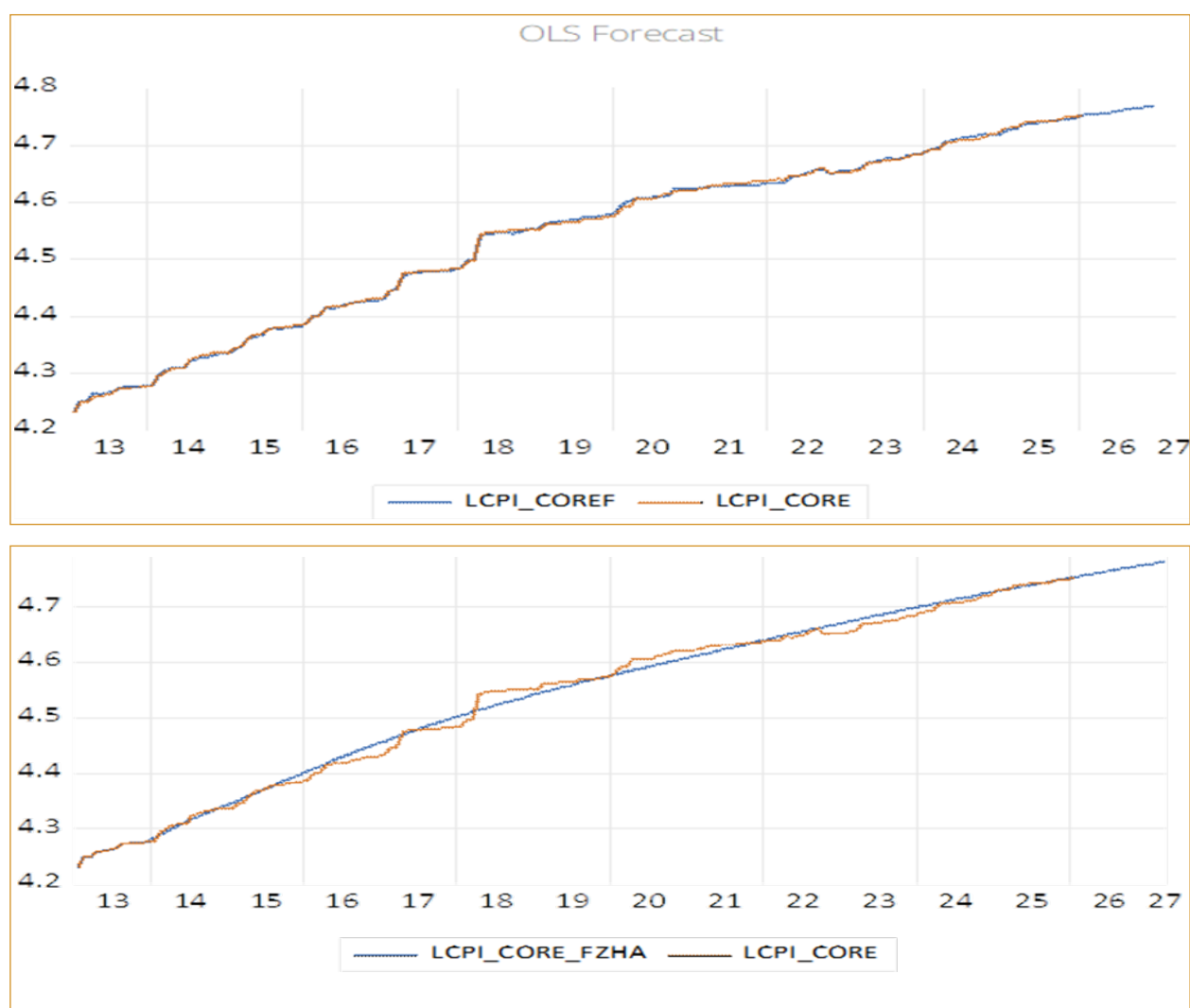
Based on these results, the OLS model is the best model for forecasting core inflation in Eswatini.

Table 8 Model comparison

Model	RMSE	MAE	MAPE
BVAR	0.011117	0.008559	0.188063
GRNN	0.4485	0.4009	0.3472
OLS	0.002972	0.002545	0.053272

The study went on to evaluate the in-sample forecast of the best two models, and the results in figure 5

point to a better in-sample forecast for the OLS over the BVAR.

Figure 5 In-sample forecast OLS vs BVAR

The log-transformed series (LCPI_CORE) is plotted alongside the in-sample forecast LCPI_CORE_FZHA for BVAR and LCPI_COREF for OLS. Carriero et al. (2011) found that BVAR models with Sims-Zha priors were among the best specifications of the model in dynamic macroeconomic environments. The findings of the study are consistent with Meyer and Pasaogullari (2010), who found that simple OLS models worked better than other specifications investigated in forecasting inflation in stable steady state environments.

GRNN. The OLS was found to be the model with the lowest MAPE, MAE, and RMSE, and therefore, the study concludes that this is the best model among the options considered.

This represents the first instalment of efforts to empirically predict future movements in core inflation in Eswatini. This study recommends that future empirical work in this area explore more machine learning models within a multivariate framework to augment the univariate approach employed herein.

5. Conclusion and recommendations

This study set out to find the optimal model for forecasting core inflation in Eswatini. Three candidate models were considered, namely OLS, BVAR, and

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The Macroeconomic Effects of Public Debt in SADC Countries

By

Kamohelo Dooda¹, Bongani Hlophe² and Mcebo

Zikalala,³

Abstract

Recent years have seen debt-to-GDP ratios across the SADC region rise in from an average of 34.9 percent in 2010 to 66 percent by 2021. This shift in the levels of public indebtedness has potentially stark implications for the macroeconomic landscape of member countries. Therefore, understanding the macroeconomic effects of rising public debt is crucial for policymakers in the region as excessive accumulation of debt can result in a high risk of debt distress, macroeconomic instability, and crowding-out of private investment. This study employed the Cross-Sectional Panel ADRL model to examine the macroeconomic impact of public debt for a panel of 14 SADC countries over the period 2000-2024. The study found that public debt had a negative and significant linear impact on nominal output in both short-run and long-run periods. Additionally, testing for nonlinearity in the debt-growth nexus showed that this relation is nonlinear. Causal analysis indicated the existence of Ganger causality running from public debt to inflation, the exchange rate and the fiscal balance. Finally, threshold analysis put the optimal debt-to-GDP ratio for the region at 47 percent. Based on the results, the study recommends a fundamental recalibration of regional fiscal strategy anchored on country-specific high return yielding investment from borrowed funds.

Key words: SADC, panel data, CS-ARDL, debt, growth

1. Introduction

1.1 Background

Public debt has long been a subject of intense debate among economists and policymakers, with its impact on key macroeconomic variables remaining a central point of contention. For the Southern African Development Community (SADC), debt has often been a double-edged sword: while providing fiscal space for infrastructure development and counter-cyclical spending, excessive borrowing has also raised sustainability concerns, particularly when debt is externally denominated or associated with volatile global financial conditions.

In the past two decades, SADC has experienced rapid changes in debt dynamics. During the early 2000s, debt relief initiatives such as the Heavily Indebted Poor Countries (HIPC) programme and the Multilateral Debt Relief Initiative (MDRI) provided a temporary reprieve. However, debt levels began to climb again in the 2010s, driven by rising infrastructure investment, social spending, and external shocks such as the 2008 Global Financial Crisis (GFC) and the 2015 commodity price collapse. This trajectory underscores a critical vulnerability: SADC economies remain highly susceptible to global disruptions, which can rapidly convert fiscal space into fiscal strain.

The COVID-19 pandemic served as a stark illustration of this vulnerability, exacerbating pre-existing pressures. Governments across the region were compelled to increase borrowing significantly to finance emergency health responses and provide economic stimulus, even as revenues contracted. Consequently, the average debt-to-GDP ratio, which stood at 34.9 percent in 2010, surged to over 66 percent in recent years, decisively breaching the SADC macroeconomic convergence target of 60 percent established to ensure stability (SADC Secretariat, 2002; Kessler, 2022). This breach of the convergence target carries significant macroeconomic consequences. By 2021, debt servicing was consuming up to 42.2 percent of government revenues in the region, diverting resources away from productive public investment in

¹ Kamohelo Dooda is an Economist at the Central Bank of Lesotho

² Bongani Hlophe is a Senior Economist, Modelling and Forecasting, in the Research Department. Email: bonganih@centralbank.org.sz

³ Mcebo Zikalala is a Principal Economist, Public Finance, in the Research Department. Email: Mceboz@centralbank.org.sz

health, education, and infrastructure (Martin, 2022).

This escalating debt burden, coupled with rising global borrowing costs, has fundamentally eroded the fiscal buffers SADC nations need to respond to future shocks. Understanding the precise macroeconomic effects of this debt accumulation is therefore a critical policy necessity for safeguarding regional stability and growth.

1.2 Problem Statement

Despite the increasing body of literature on public debt globally and the growing concerns about the effect of public debt on macroeconomic variables, there is still limited and inconsistent information on the macroeconomic effects of public debt for SADC countries. While it is established that member states struggle with high, and varying levels of debt distress, a comprehensive analysis of debt's impact beyond aggregate GDP growth is lacking. This gap limits effective policy formulation. The problem is threefold:

- Existing studies within SADC have predominantly concentrated on the debt-growth nexus, often neglecting other critical stability variables such as inflation, exchange rate, and fiscal balances (Mosikari & Eita, 2021). A holistic, multi-variable assessment is needed to capture the full spectrum of debt's macroeconomic impact.
- Much of the regional literature relies on aggregated panel techniques that impose homogeneity across countries, thereby masking significant national heterogeneity in debt dynamics, economic structure, and institutional quality (Eberhardt & Presbitero, 2013). This obscures the need for tailored, country-specific policy responses.
- The region's operational debt ceiling of 60 percent of GDP lacks a clear, empirically derived foundation. The non-linear and threshold effects of public debt remain debated, with no consensus on the level at which debt becomes detrimental to growth within the SADC context (Biyase, 2019). Policymakers are thus navigating without a robust, evidence-based guide for sustainable debt levels.

These interconnected gaps hinder the ability of regional and national authorities to design targeted strategies for debt sustainability and macroeconomic stability. This study, therefore, represents an attempt to generate such evidence, offering a foundation for more targeted and sustainable debt management across SADC.

1.3 Policy justification

A fragile and shifting global economic landscape, marked by geopolitical tensions and protectionist trade policies, poses a direct threat to internationally integrated regions like SADC. For member states reliant on arrangements such as the African Growth and Opportunity Act (AGOA), such fragmentation risks economic slowdowns and revenue losses, transmitted through reduced export earnings and exchange rate pressures (Mathiasen & Martinez, 2025; Kohlscheen et al., 2025).

Confronted with these external vulnerabilities and constrained fiscal space, SADC countries may face increased borrowing to offset economic shortfalls, which would widen deficits and raise debt-servicing costs. A precise understanding of public debt dynamics is therefore essential to build fiscal resilience and to advance core regional development agendas, specifically the SADC Regional Indicative Strategic Development Plan (RISDP 2020–2030) and SADC Vision 2050, which aim to foster sustainable development and deepen regional integration.

1.4 Research Aim

To provide a contemporary and nuanced empirical analysis of the macroeconomic effects of public debt on SADC countries, with a focus on examining the existence of the non-linear relationships and heterogeneous impacts, and their implications for debt sustainability, fiscal space, and policy management.

1.4.1 Specific Objectives

1. To empirically assess the dynamic relationship between public debt and key macroeconomic variables, including economic growth (nominal GDP), inflation (consumer price index), exchange rate (local currency to the US dollar), government spending and fiscal balance.

2. To investigate the existence of non-linear and threshold effects of public debt, identifying the points beyond which it becomes detrimental to macroeconomic stability and performance within the SADC context.
3. To empirically assess the causal relationship between public debt and other macroeconomic variables within the SADC region.
4. To provide evidence-based policy recommendations for sustainable debt management, fiscal frameworks, and macroeconomic stability in the SADC region.

1.4.2 Research Questions

1. What are the short-run and long-run effects of public-debt on key macroeconomic variables specifically nominal GDP, inflation, exchange rate, government spending, and fiscal balance-in SADC countries?
2. Does the relationship between public debt and nominal growth exhibit non-linearity or a debt threshold, and if so, what is the optimal threshold for SADC countries?
3. Is there a causal relationship between public debt and other macroeconomic variables in SADC countries, and if so, what is the direction of causality?
4. What policy recommendations for sustainable debt management in the SADC region emerge from the empirical findings on the debt-growth nexus?

2. Literature Review

2.1 Theoretical Literature

Theoretical perspectives on public debt range from beneficial to detrimental, with a consensus that the impact is highly context dependent. Keynesian theory suggests debt-financed spending can boost a weak economy by stimulating demand, while neoclassical and monetarist views warn that it can crowd out private investment and reduce long-term growth by raising future tax burdens (Keynes, 1936). The Ricardian equivalence hypothesis goes a step further,

arguing that rational households will save more in anticipation of future taxes, nullifying the effect of government borrowing (Elmendorf and Mankiw, 1999; Friedman & Schwartz, 1963; Barro, 1974). More recent theories highlight a non-linear debt-growth nexus, suggesting that a moderate debt-to-GDP ratio may be growth-enhancing, but excessive debt creates a debt overhang that discourages investment (Reinhart & Rogoff, 2010; Kumar & Woo, 2010). Beyond the debt level, the composition (e.g., short-term vs. long-term, domestic vs external) is also crucial for determining sustainability (Jónasson et al., 2024; He & Xiong, 2012). Together, these perspectives show that the effect of public debt is complex and depends on its size, structure, and the broader economic environment.

2.1.1 Keynesian Theory

This theory was tabled by John Maynard Keynes in 1936, and it highlights the positive role public debt plays to stimulate economic growth, particularly during periods of recession. Keynes argues that government debt can close the gap in private sector demand, increasing employment and output. The theory postulate that when private sector fails to use resources, government borrowing through deficit financing can mobilise them. Hence, public debt can increase private consumption and positively affect macroeconomic indicators such as output and unemployment.

2.1.2 Neoclassical and Monetarist Perspectives

Neoclassical and monetarist theorists converge in their skepticism toward debt-financed fiscal policy, emphasising that government borrowing crowds out private investment. From a neoclassical standpoint, high public debt adversely affects growth, not only by raising long-term interest rates and reducing available credit for firms (Elmendorf & Mankiw, 1999; Kumar & Baldacci, 2010), but also through the future tax increases required to service the debt, which can discourage capital formation (Salmon, 2021). Monetarists, notably Friedman, extend this argument by highlighting the monetary channel: increased government borrowing elevates demand for loanable funds, raises interest rates, and reduces interest-sensitive private spending—nullifying any short-term demand stimulus (Friedman & Schwartz, 1963). Together, these perspectives underscore a central critique: in the long run, debt-driven fiscal expansion may simply reallocate, rather than augment economic activity.

2.1.3 Ricardian Equivalence Theory

In sharp contrast to the crowding-out critique, the Ricardian equivalence theorem, popularised by Robert Barro (1974), posits that government debt has no real effect on aggregate demand or economic activity. This theory is based on the assumption of rational, forward-looking consumers who understand that current government borrowing must be repaid in the future through higher taxes. Therefore, when the government issues new debt, households do not feel wealthier. Instead, they anticipate a future tax liability and increase their savings to offset this future obligation. This increase in private saving perfectly counteracts the government's borrowing, leaving aggregate demand, interest rates, and investment unchanged. From this perspective, whether the government finances spending through taxes today or through debt to be repaid by taxes tomorrow is irrelevant to the economy's real performance.

2.1.4 Debt Overhang Theory

While the Ricardian view suggests debt is neutral, the debt overhang theory highlights distinctly negative consequences at high levels. The theory, famously explored by Krugman (1988), posits that if a country's debt stock is so large that its future value exceeds the country's expected repayment ability, the anticipated burden of debt service acts as a "tax" on any future economic output. This disincentivises both domestic and foreign investors from undertaking new, productive projects because they expect a significant portion of any future profits to be captured by creditors. Consequently, this leads to a reduction in investment, which hinders long-term economic growth and can trap a country in a vicious cycle of low growth and high debt.

2.1.5 The Non-Linear Debt-Growth Nexus and Threshold Effects

Modern theoretical research has moved away from viewing the debt-growth relationship as linear, instead, uncovering a more complex, non-linear dynamic often referred to as the debt threshold effect. Evidence suggests that at low levels, public debt can be beneficial, financing productive investment in infrastructure, education, and health, thereby supporting growth. However, beyond a certain point, the burden of debt servicing, reduced fiscal space, and declining investor confidence begin to slow economic activity, consistent with the debt overhang hypothesis (Reinhart & Rogoff, 2010; Pattillo et.al., 2002). These observations underpin the debt threshold theory

inspired by the work of Laffer (1974) on debt levels and economic outcomes. This theory posits that while debt can stimulate growth at manageable levels, once a critical debt-to-GDP ratio is reached, the benefits diminish and the costs—through higher interest rates, crowding out of private investment, and the expectation of future taxation—begin to dominate (Blanchard, 2019). In summary, both theory and evidence establish that public debt is harmful only after it breaches a country's sustainable fiscal limit.

2.1.6 Debt Composition

Beyond the overall level of public debt, a key insight from modern theory is that the composition of a country's debt is just as important as its magnitude. The source, maturity, and terms of a country's debt can have fundamentally different macroeconomic implications. A high share of foreign-currency-denominated debt exposes an economy to significant exchange rate risk, where a domestic currency depreciation can substantially increase the local value of the outstanding debt (Jónasson et al., 2024). Similarly, an over-reliance on short-term debt can create significant rollover risk, where a government may face a liquidity crisis if it is unable to refinance its maturing obligations (He & Xiong, 2012). Furthermore, the source of borrowing is a key consideration; concessional debt from international financial institutions is often a superior choice to commercial debt due to its more favourable terms, even in the face of devaluation (International Monetary Fund [IMF], 2002). Moreover, a large volume of government domestic debt can crowd out private-sector credit, hindering private investment and growth (Jato & Nwankwo, 2024).

2.1.7 Debt Sustainability and the Growth-Interest Rate Differential

Contemporary frameworks for debt sustainability highlight the growth-interest rate differential as a core metric for assessing a country's long-term debt trajectory (Checherita-Westphal & Semeano, 2021). This theory, which is also referred to as the Fiscal Space Hypothesis, posits that a country's public debt can be managed sustainably if its economic growth rate (g), consistently exceeds its effective interest rate on debt (r). This provides policymakers with a crucial metric for evaluating the fiscal health of a nation, taking into account both solvency (the ability to pay debt in the long-run) and liquidity (the ability to make timely payments). This concept is closely tied to a country's debt-carrying capacity, which is determined

not just by the $g-r$ differential, but also by factors such as institutional quality, export diversification, and its level of foreign reserves (Ostry et al., 2010; IMF, 2013).

Synthesis for the SADC Context:

The theoretical landscape reveals that public debt is neither inherently good nor bad; its impact is contingent on context. For SADC countries, this implies that the effect of debt is likely shaped by region-specific factors. The non-linear and threshold theories suggest that the 60 percent convergence target may not be optimal for all members. Moreover, the emphasis on debt composition highlights the risks posed by the region's high share of foreign-currency debt. Finally, the growth-interest rate differential framework provides a crucial lens for assessing sustainability, especially for commodity-dependent economies with volatile growth. These theories collectively argue against a one-size-fits-all policy and underscore the need for an empirical analysis that accounts for heterogeneity and non-linear effects—a gap this study addresses.

2.2 Empirical Literature

2.2.1 Global Evidence

Empirical evidence reflects the theoretical debates, with results often yielding mixed conclusions. A key finding from influential global studies is the non-linear relationship between debt and growth. Reinhart and Rogoff (2010), for example, provided historical evidence suggesting that debt levels can substantially slow growth, with a widely cited inflection point around 90 percent of GDP. However, their findings were later scrutinised by Herndon, Ash and Pollin (2014), challenging the universality of this specific threshold while still acknowledging the existence of a non-linear relationship.

Other studies reinforced this nuanced view. Checherita-Westphal and Rother (2012) demonstrated that the negative effects of debt become more pronounced in the long-run, implying intergenerational costs. This research highlights that the true impact of borrowing extends beyond immediate growth figures. Égert (2015) further questioned the idea of universal benchmarks, showing that a country's debt-carrying capacity is uniquely shaped by its economic structure, fiscal frameworks, and institutional quality.

2.2.2 Evidence from Developing Economies

Research in developing countries consistently indicates that debt tolerance is lower than in advanced

economies and that debt has a more pronounced impact on macroeconomic variables. Pattillo et. al., (2002), found that external debt becomes harmful to growth beyond thresholds of 35–40 percent of GDP. Furthermore, high shares foreign currency denominated debt amplify vulnerability to external shocks, as depreciation mechanically raises the local-currency burden of debt servicing (Rojas-Suarez, 2023). This vulnerability is compounded by factors like a high dependence on commodity exports, making economies susceptible to global price shocks. Gündüz (2017) reinforces this finding by showing that adverse shocks to real non-oil commodity prices are a prominent factor in raising the risk of debt distress.

2.2.3 African and SADC Evidence

Focusing on the SADC region, empirical studies reflect these global debates but also highlight unique regional complexities and methodological progression. Sanusi, Meyer, and Hassan (2019) focused on SADC and reported a non-linear relationship, identifying a threshold of about 57 percent of GDP, above which debt undermines growth. Country-specific studies reveal additional macroeconomic effects. In South Africa, Makhoba and Kaseeram (2022) found that debt, while having positive short-run effects on growth, tends to crowd out private investment in the long-run. In Mozambique, Afonso and Ibraimo (2018), documented a non-linear relationship between debt and inflation, with institutional quality mediating the effect. Makoto et al., (2021) emphasised that external debt is more destabilising than domestic debt in several SADC members.

Institutional studies by the AfDB (2022) and UNECA (2021) further stress that a lack of transparency and accountability in debt management amplifies vulnerability in the region. The SADC's macroeconomic convergence framework sets a debt ceiling of 60 percent of GDP. However, empirical evidence suggests that growth-maximising debt levels may be far lower for some countries, highlighting the importance of country-specific debt targets rather than reliance on a uniform regional benchmark.

2.3 Methodological Approaches in the Literature

To accurately capture these complex, context-dependent relationships, methodological choices are paramount. Early panel studies often imposed restrictive homogeneity assumptions. The Pooled Mean Group (PMG) estimator advanced this by

allowing heterogeneous short-run dynamics while estimating a common long-run relationship. However, for regions like SADC where countries are subject to common shocks (e.g., commodity prices, global financial conditions), cross-sectional dependence can bias results. This necessitates second-generation techniques like the Common Correlated Effects Pooled Mean Group (CCEPMG) estimator, which controls for such shared unobserved factors. This study employs the CCEPMG approach to address this specific challenge, bridging a key methodological gap in the regional literature.

2.4 Transmission Channels of Public Debt

While much of the literature has emphasised the debt-growth nexus, public debt also transmits its effects through other macroeconomic variables that are particularly relevant for SADC economies. This study focuses on five key channels: economic growth, inflation, exchange rate, government spending and fiscal balance.

Growth: The most widely studied channel is economic growth, where the relationship is often non-linear. At moderate levels, debt-financed productive public investment can stimulate output by improving infrastructure and human capital, crowding in private activity. However, beyond sustainable thresholds, excessive debt harms long-term growth through two primary mechanisms. First, the crowding-out effect occurs when high domestic debt issuance raises real interest rates in shallow financial markets—common in SADC—making private investment more expensive. Second, the debt overhang effect arises when a large stock of debt, especially external, creates expectations that future profits will be heavily taxed for debt service, discouraging investment regardless of current interest rates. Both channels reduce private capital formation and potential growth, as evidenced in SADC studies such as Makhoba and Kaseeram (2022), where short-run stimulus gives way to long-run constraints.

Inflation: High public debt is frequently associated with inflationary pressures, especially where fiscal dominance undermines monetary policy independence. Fiscal deficits financed through central bank borrowing directly fuel price instability, as evidenced by persistent inflation episodes in countries such as Malawi. Afonso and Ibraimo (2018), using Mozambican data, demonstrate that public debt can have a non-linear effect on inflation, with

institutional quality mediating the extent of fiscal dominance.

Exchange Rates: Exchange rate vulnerability represents another critical transmission channel. With a large share of SADC public debt denominated in foreign currencies, depreciation directly increases debt-servicing costs, mechanically raising debt-to-GDP ratios without additional borrowing. Episodes of currency volatility in Zambia and Mozambique have vividly illustrated how external debt exposure heightens exchange rate fragility, feeding back into debt sustainability concerns (Banda-Muleya, 2021).

Government Spending: Public debt has significant implications for the composition and sustainability of government spending. As debt-servicing obligations rise, fiscal resources are increasingly diverted away from productive and social expenditures such as infrastructure, education, and health. This erosion of funding for public investment undermines long-term development prospects and progress toward the Sustainable Development Goals (SDGs) (UNECA, 2021).

Fiscal Balance: Finally, closely related, public debt exerts sustained pressure on the overall fiscal balance, a core determinant of macroeconomic stability. High debt servicing costs can widen fiscal deficits, limiting the government's ability to respond to economic shocks with counter-cyclical measures. In SADC—where many economies face revenue volatility due to commodity dependence—this pressure is particularly acute. Governments are often forced into difficult trade-offs between fiscal consolidation (through spending cuts or tax increases) and preserving growth-supportive expenditure. This dynamic can initiate a feedback loop: deteriorating fiscal balances prompt further borrowing, which in turn deepens indebtedness and further constrains future fiscal space—a vulnerability starkly illustrated in the post-COVID-19 period (World Bank, 2023; IMF, 2024).

In summary, the transmission mechanisms of public debt extend well beyond growth, encompassing price stability, exchange rate dynamics, the composition of public expenditure and fiscal balance. A comprehensive analysis of these channels is therefore necessary to capture the full macroeconomic impact of debt in the SADC region.

2.5 Research Gap

The review of theoretical and empirical literature

highlights three critical gaps.

First, the macroeconomic impact of debt remains narrowly understood. While the debt-growth nexus is frequently studied, robust evidence on the relationship between debt and other stability variables—such as inflation, exchange rate, fiscal expenditure and budget balance—is scarce. A holistic, multi-variable assessment is needed.

Second, the significant variation in debt effects across SADC countries is inadequately mapped. Aggregate regional analyses mask critical national differences, yet there is limited systematic evidence on the nature and extent of this heterogeneity. This constrains the development of tailored, effective policy guidance for individual member states.

Third, the specific debt level at which macroeconomic performance deteriorates in SADC is empirically unresolved. The regional convergence target of 60 percent of GDP lacks a clear empirical foundation, creating uncertainty for fiscal planning.

This study addresses these gaps by providing a comprehensive, multi-variable analysis of debt's macroeconomic effects. Using a framework that accounts for both regional patterns and national heterogeneity, it identifies nuanced impacts and quantifies critical debt thresholds, offering insights that are both regionally relevant and nationally actionable.

3. Data and methodology

3.1 Data

The paper employed panel estimation to control for individual heterogeneity, identify unobservable

characteristics, and provide more reliable estimates, (Baltagi, 2005; Asterious, Pilbeam and Pratiwi, 2020). The analysis utilised data from 14 member states in SADC over a 25-year period (2000 - 2024), namely Angola, Botswana, Eswatini, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, Tanzania, Zambia and Zimbabwe resulting in a total of 350 observations. Data were sourced from member states through the SADC secretariat office, and the selection of countries for the analysis was based on their responses to the data request questionnaire. Given that the data consist of a panel of 14 countries over 25 years, with $N = 14$ and $T = 25$, it was appropriate to apply the panel Autoregressive Distributed Lag (ARDL) approach for the analysis.

The panel analysis focused on six key macroeconomic variables: public debt (debt-to-GDP and public debt stock) (Yildirim and Erdogan, 2021; Hojdan, 2024), GDP (nominal GDP) (Yildirim and Erdogan, 2021; Hojdan, 2024), consumer price index (CPI) (Afonso and Ibraimo, 2018; Saungweme and Odhiambo, 2021), exchange rates (Afonso and Ibraimo, 2018), government expenditure (Afonso and Ibraimo, 2018), and the fiscal balance. This analysis aimed to ascertain the macroeconomic effects of public debt in the SADC region. Data gaps were identified in the submitted dataset, with some member states missing observations for certain variables required for the analysis period. To address these missing observations in the SADC dataset, gaps were filled using data from the IMF and the World Bank (WB). See Table 1.

Table 1: Summary Statistics

Variable	Units	Obs. (N,T)	Mean	St. Dev.	Min	Max
Gross Domestic Product	USD	350 (N= 14, T=25)	9.398	1.454	6.422	13.036
Consumer Price Index	Index	350 (N= 14, T=25)	4.520	1.257	0.996	19.906
Exchange rate	Index	350 (N= 14, T=25)	3.735	2.273	0.000	15.404
Debt to GDP	Ratio	350 (N= 14, T=25)	54.281	38.549	6.010	248.122
Public debt	USD	350 (N=14, T=25)	19190.6	44772.6	248.403	309140.0
Government Expenditures	USD	350 (N= 14, T=25)	8.443	2.603	-0.937	16.547
Fiscal Balance	USD	350 (N= 14, T=25)	-1,195.14	4,235.54	-41,147.18	11,888.67

Source: SADC Member states, IMF and WB

To detect multicollinearity within the independent variables and maintain model reliability, the pairwise correlation matrix was used. Table 2 below shows the results of the pairwise correlation matrix wherein we

observe that all of the coefficients are below 0.70, indicating no fundamental problem of exact linear relationships among the regressors.

Table 2: Pairwise Correlation Coefficient between Independent variables

. Corr lngdp lcpi lexch lgov_exp DebttoGDP Fiscal_balance_level (Obs = 350)						
	lngdp	lcpi	lexch	lgov_exp	DebttoGDP	Fiscal_balance_level
lngdp	1.0000					
lcpi	-0.0819	1.0000				
lexch	0.1714	0.2221	1.0000			
lgov_exp	0.6389	-0.2134	0.2717	1.0000		
DebttoGDP	-0.1787	0.2128	0.1354	-0.2546	1.0000	
Fiscal_balance_level	-0.5062	0.0090	0.0657	-0.2887	-0.0286	1.0000

Source: Authors' Computation

3.2 Methodology

3.2.1 Model specification and estimation

To examine the macroeconomic effects on public debt in the SADC region, this paper employed a panel autoregressive distributed lag (ARDL) approach involving 14 countries with balanced annual data from 2000 to 2024. The panel ARDL, initiated by Pesaran and Smith (1995) and Pesaran et al. (1999) was selected for its robustness in capturing multiple interactions over time and its flexibility in handling data with different integration levels (Hodjan, 2024). Additionally, the panel ARDL technique can estimate both short-run

and long-run coefficients simultaneously, allowing for a comprehensive economic interpretation. This dual estimation provides insights into immediate effects and the eventual long-run relationship. Recognising that the economies under consideration may respond differently to variations in public debt, the panel ARDL incorporates cross-sectional heterogeneity, to account for country-specific dynamics. This characteristic is essential as it acknowledges that middle-income countries are likely to exhibit different responses to public debt due to their distinct fiscal policies and economic structures (Hodjan, 2024).

$$Y_{it} = \alpha_i + \sum_{j=1}^p \phi_{ij} Y_{i,t-j} + \sum_{k=1}^6 \sum_{j=0}^{q_k} \beta_{k,i,j} X_{k,i,t-j} + \mu_t + \varepsilon_{it} \quad (1)$$

Where Y_{it} is the dependent variable nominal GDP for country i at time t ($i = 14, t=1 \dots 25$), let the regressors be:

$X_{1i,t}$: Public debt to GDP,

$X_{2i,t}$: Consumer price index

$X_{3i,t}$: Exchange rate,

$X_{4i,t}$: Government spending

$X_{5i,t}$: Debt squared

$X_{6i,t}$: Fiscal balance

μ_t : Time dummies/ common shocks

α_i : Country fixed effects (time-invariant)

ε_{it} : Idiosyncratic errors

To estimate the macroeconomic effects of public debt, the Pooled Mean Group (PMG) estimator was utilised. This technique is suitable for the study due to the reasonably large number of countries involved and aligns with the objectives of the study. The PMG estimator, initiated by Pesaran et. al., (1999), assumes homogeneity in the long-run coefficients, while allowing for heterogeneity in the short-run dynamics. This premise is particularly appropriate for regionally integrated countries, which may share similar long-run economic trends while experiencing distinct short-term fluctuations. The PMG is also well-suited for panels with many cross-sections, which characterised the structure of the dataset.

Various studies have indicated a non-linear relationship between public debt and economic growth, postulating that debt may initially promote growth, but after a certain threshold, further accumulation of debt is linked to a slowdown in growth (Reinhart and Rugoff, 2010; Baum et. al., 2013). To assess the existence of a non-linear relationship between debt and GDP, the study tested the hypothesis of a non-linear effect of government debt on GDP by estimating a regression using the PMG estimators. The variable debt-squared was generated as a square of public debt to test the non-linear hypothesis (Egert 2012; Bhimjee and Leao, 2020). Additionally, a non-linear autoregressive distributed lag (NARDL) model was employed to capture the asymmetric effects and potential threshold behaviour in the debt-to-GDP nexus. The NARDL model is particularly essential

for this analysis due to its ability to model non-linear changes and differentiate between positive and negative variations in debt, providing a more nuanced understanding of how debt influences macroeconomic performance over time.

3.2.2 Panel Unit Root

Prior to estimation of the main equation, a cross-sectional dependence test was conducted to determine whether the panel in the data are cross-sectionally dependent or independent, using the CD-test for cross-sectional dependence, as explained by Pesaran (2004) and Pesaran (2015). In the presence of cross-sectional dependence within the panels, the Pesaran panel unit root test (xtcips) was performed to assess the stationarity of the variables in the dataset. Both the levels and first differences of the variables were tested for non-stationarity, while maintaining the null hypothesis for each test. Additionally, the Im-Pesaran-Shin (IPS) tests, which allow for heterogeneity among cross-sectional units, along with traditional tests such as the Augmented Dickey-Fuller (ADF), that account for autocorrelation and heteroskedasticity were employed to test unit root. Determining whether the variables are integrated of order zero, $I(0)$, or order one, $I(1)$, is a crucial step when using the Pooled Mean Group (PMG) estimator. This distinction ensures the validity of long-run equilibrium relationships and the reliability of the error correction mechanism associated with the PMG.

3.2.3 Cointegration analysis

To analyse the long-run relationship between the variables, the study used robust cointegration tests, specifically the Kao (1999), Pedroni (1999) and Westerlund (2005) tests. These tests are essential for detecting whether a cointegration relationship exists within the panel data. The Kao test is a residual-based test that assumes homogeneity of the cointegration vectors across cross-sections. In contrast, the Pedroni test accommodates heterogeneity among different units in the panel. Lastly, the Westerlund tests allows for the examination of cointegration in the presence of cross-sectional dependence, providing a more flexible framework for understanding the dynamic interactions among the panel data. By utilising these tests, the analysis ensures a thorough investigation of the potential long-run equilibrium relationship in the data, which is crucial for the validity of the subsequent PMG estimation.

3.2.4 Cross-Sectional Dependence

Cross-sectional dependence—where unobserved common factors create spurious correlations between countries—is a common challenge in panel data. To mitigate it, robust estimation techniques are essential. Failing to address this challenge can result in biased and inconsistent estimators. To rectify this issue, the paper utilised the CS-ARDL of Common Correlated Effects Pooled Mean Group (CCEPMG) estimator, pioneered by Pesaran (2006) and further developed by Chudik and Pesaran (2015). The CCEPMG estimator is a second-generation model that extends the standard PMG approach by incorporating cross-sectional averages of the dependent and independent variables as proxies for the unobserved common factors. This technique effectively captures cross-sectional dependence and allows for heterogeneous coefficients across panel units, while preserving long-run relationships and short-run dynamics consistent with the PMG model. The CCEPMG estimation was used to ascertain the direction of the relationship between public debt and other macroeconomic indicators.

3.2.5 Threshold estimation

To estimate the appropriate threshold for debt-to-GDP in the SADC region, the paper used the dynamic panel threshold model by Seo et al. (2019). This involves estimating the following model

$$Y_{it} = X_{it}'\beta + (1, X_{it}')\delta I\{q_{it} > \gamma\} + \mu_{it} + \varepsilon_{it} \quad (2)$$

$$i = 1, \dots, n : t = 1, \dots, T$$

where X_{it} may include lagged dependent variables and q_{it} is the threshold variable. This model assumes that T is fixed while the sample size n grows to infinity. This, therefore, means that incidental parameter μ_{it} is removed with the first-difference transformation,

and the unknown parameters $\theta = (\beta', \delta', \gamma)'$, are estimated through the general method of moments (GMM) developed by Seo and Shin (2016). Dynamic threshold estimation was employed because the macroeconomic effects of debt are non-linear and happen over time, with high-debt regimes portraying different underlying dynamics.

3.2.6 Causality Test

To assess whether there is a causal relationship between public debt and growth in the SADC region in the context of the panel ARDL model, the Dumitrescu-Hurlin Panel Granger Causality test was applied (Dumitrescu and Hurlin, 2012; Sunde, 2017). This test is designed to detect Granger causality in the panel data, allowing for heterogeneity across the cross-sectional units. Furthermore, this test allows for lagged relationships in the dataset and can be suitably used for both balanced and unbalanced panels.

3.2.7 Modelling software

The empirical analysis was conducted using Stata 18.0 software, selected for its advanced features in estimating sophisticated panel data techniques such as the built-in common correlated effect pooled mean group (CCE-PMG) estimator. This model is robust in handling cross-sectional dependence and enhancing the reliability of both long-run and short-run parameter estimation. Furthermore, Stata 18.0 offers comprehensive panel data commands and through documentation.

4. Results and Discussion

Panel data analysis requires addressing cross-sectional dependence and heterogeneity before estimation (Yildirim and Erdogan, 2022). The Delta test (Pesaran and Yamagata, 2008) assesses slope homogeneity to determine if coefficients vary significantly across panels (Yildirim and Erdogan, 2022). See Table 3 below:

Table 3: Slope Heterogeneity test

	Delta	P-value
	8.225	0.0000
adj.	9.693	0.0000

Source: Authors' Computation

The Delta test results suggest rejection of the null hypothesis of slope homogeneous, in favour of the alternative. This indicates that the slope coefficients are heterogeneous across the panels, meaning the slope coefficients differ for each cross-sectional unit. Resultantly, the slope coefficients should be estimated individually, justifying the usage of mean group estimators such as the pooled mean group.

The cross-sectional dependence test was conducted using the CD-test for cross-sectional dependence by Peseran (2004) and Peseran (2015). The CD-test posits that the correlations of the cross-sections

must not equal zero to avoid deviations (Yildirim and Erdogan, 2022). The results of the CD-test indicate high values for all variables, with p-values smaller than 0.05 implying the rejection of the null hypothesis of cross-sectional independence. Therefore, there is evidence of cross-sectional dependence within the panel data of the SADC member states. The methods and analysis techniques utilised should be adjusted for cross-sectional dependence to avoid bias in the results estimation. Table 4 below summarises the cross-sectional dependence results:

Table 4: Cross-Sectional Dependence Results (CD-test)

Variable	CD-test	P-value	
LGDP	40.939	0.0000	***
LCPI	22.039	0.0000	***
LEXCH	34.303	0.0000	***
LDEBT	32.07	0.0000	***
LDEBT_SQ	32.423	0.0000	***
Debt-to-GDP	14.407	0.0000	***
Fiscal balance	9.827	0.0000	***
LGOV_EXP	40.423	0.0000	***

Source: Authors' Computation

The panel unit root tests for all the selected macroeconomic variables were conducted using three methods. The IPS and ADF unit root tests assume cross-sectional independence, while the Cross-sectional Im-Pesaran-Shin (CIPS) accounts for cross-sectional dependence. The unit root results, summarised in Table 5, indicate which variables of interest exhibit both stationary and non-stationary characteristics. Gross domestic product (GDP), debt-to-GDP, government expenditures (GOV_EXP) and fiscal balance are classified as I (0), meaning they are stationary at levels based on the IPS and ADF.

Moreover, consumer price index (CPI), exchange rate (EXCH), public debt stock and non-linear debt (DEBT_squared) are integrated to order one I (1) based on the IPS and ADF test, meaning they are stationary at first difference. However, based on the CIPS unit root test only, exchange rate and debt-to-GDP are I (1) while CPI, public debt stock and DEBT_squared; GDP and GOV_EXP; and fiscal balance are I (0).

See Table 5:

Table 5: Panel Unit Root

	IPS Test		ADF Test		CIPS Test	
	p-value		p-value		cips	
Test in logarithmic levels						
Gross Domestic Product	0.0066	***	0.0002	***	-2.207	*
Consumer Price Index	0.3698		0.3099		-2.367	**
Exchange rate	0.9999		0.9999		-0.591	
Public debt stock	0.9997		1.0000		-2.596	***
Debt_squared	0.9999		1.0000		-2.547	***
Debt-to-GDP	0.0400	**	0.0000	***	-1.616	
Fiscal balance	0.0003	***	0.0000	***	-3.391	***
Government Expenditures	0.0073	***	0.0104	**	-2.308	**
Test in first logarithmic differences						
Gross Domestic Product	0.0000	****	0.0000	****	-4.542	***
Consumer Price Index	0.0000	****	0.0000	****	-3.616	***
Exchange rate	0.0000	****	0.0000	****	-3.772	***
Public debt	0.0000	****	0.0000	****	-5.048	***
Debt_squared	0.0000	****	0.0000	****	-4.985	***
Government Expenditures	0.0000	****	0.0000	****	-4.534	***

Source: Authors' Computation, ***, **, * denotes the rejection of the null hypothesis of a unit root for 90%, 95% and 99% respectively. Critical values for CIPS: -2.14 (10%), -2.25 (5%), -2.45 (1%)

Three cointegration tests were performed to test for the existence of a long-run relationship between the macroeconomic variables namely GDP, debt-to-GDP, CPI, exchange rate, government expenditures and fiscal balance in the panel data. All three cointegration tests namely Kao (1999), Pedroni (1996, 2004) and Westerlund (2005) reflected that the null hypothesis

of no cointegration in the heterogenous panel was rejected and it was established that there is cointegration within some panels in the data, although weak cointegration was found with the Westerlund test with a significance level of 10 percent. The results for all the cointegration test are summarised in Table 6 below:

Table 6: Cointegration test results

Variable (in log)	KAO		Pedroni		Westerlund	
	Adf		pp			
LGDP,LCPI,LEXCH,I.DebttoGDP,LGOV_EXP,Fiscal_balance						
t-statistic	-3.8800		-2.0313		-1.3428	
p-value	(0.0000)	***	(0.0211)	**	(0.0897)	*

Source: Authors' computation, ***, **, * denotes the rejection of the null hypothesis of a unit root for 90%, 95% and 99% respectively.

A linear specification of the panel CS-ARDL of the CCEMPG was estimated. The results of the model showed that, in the short-run, three variables namely debt-to-GDP, government expenditures and exchange rate reflected a significant relationship with nominal GDP growth in the SADC region. Debt-to-GDP had a statistically significant negative effect on growth, although very small. This was in line with

prior expectations as supported by literature from the debt-to-GDP nexus school of thought (Reinhart & Rogoff, 2010). A 1.0 percent increase in the debt-to-GDP ratio leads to a -0.003 percent decline in nominal GDP growth for the SADC region. This finding underscores the adverse macroeconomic implication of rising debt burden. This study is of the view that the observed negative relationship between

debt-to-GDP and nominal growth may be explained intuitively by structural financing constraints faced by developing countries. Particularly, high-risk premium associated with external borrowing increasing capital costs combined with private sector crowding out on

domestic debt which discourages private investment and slows economic activity (Asteriou, et al., 2020). In addition, financing project with limited worth for future growth can hinder growth.

Table 7: Estimation results for the CS-ARDL of CCEPMG

		Number of obs	=	322
		Number of groups	=	14
		F (224,98)	=	3.04
		Prob > F	=	0.00
		R-squared	=	0.13
		R-squared (MG)	=	0.71
		Root MSE	=	0.09
		CD Statistic	=	1.36
		p-value	=	0.1735
(Dynamic) Common Correlated Effects Estimator - Mean Group (CS ARDL)				
D.LGDP	Coef.	Std. Error	P-value	Level of significance
Short-run Estimate				
Mean Group:				
_cons	0.147835	1.486935	0.921	
LD.lgdp	0.053051	0.0943207	0.574	
DebttoGDP	-0.003179	0.0018592	0.087	*
lgov_exp	0.291630	0.1140008	0.011	**
lcpi	-0.370644	0.2570995	0.149	
L.DebttoGDP	0.003517	0.0028823	0.222	
L.lexch	0.478184	0.1183757	0.000	***
L.lgov_exp	-0.185035	0.1195959	0.122	
L.lcpi	-0.3002	0.3512114	0.393	
L.Fiscal_balance_level	0.000026	0.0000581	0.650	
Adjust. Term				
Mean Group:				
lr_lgdp	-.9469483	0.0943207	0.000	***
Long-run Estimate				
Mean Group:				
lr_DebttoGDP	0.001484	0.0021856	0.497	
lr_Fiscal_balance_level	0.000046	0.0001004	0.647	
lr_cons	1.514622	2.008266	0.451	
lr_lcpi	-.858161	0.2401749	0.000	***
lr_lexch	0.655612	0.1804216	0.000	***
lr_lgov_exp	0.106495	0.0985241	0.280	

Source: Authors' computation, ***, **, * denotes level of significance 1%, 5% and 10% respectively

In contrast, as shown in Table 7, contemporaneous government expenditures exerted a statistically significant positive effect on economic growth. Moreover, lagged exchange rate had a positive and a significant effect on nominal GDP growth for the region in the short-run. In the long-run, both consumer price index and the exchange rate are statistically significant determinants of economic growth across SADC; consumer price index negatively affects growth, while exchange rates positively influences growth. However, debt-to-GDP exhibits a positive but statistically insignificant relationship with nominal growth in the long-run.

The error correction term is significant and negative, reflecting convergence in the long-run, with a speed of adjustment of 94.7 percent (-0.9469), implying that about 94.7 percent of the discrepancy between actual and equilibrium independent variables is corrected annually between the selected SADC countries.

The CD-test (Pesaran) results indicates that there is

no cross-sectional dependence in the error term and fails to reject the null hypothesis of weakly cross-sectional independence. The mean group R-squared (MG) can explain 71 percent of the variation in the panel data for the SADC region.

To test for the non-linear relationship between debt and growth, two techniques were explored, with the first procedure introducing a non-linear variable namely debt squared. This method was premised on literature and adopted to test for the non-linear hypothesis between debt and growth (Egert, 2012; Bhimjee & Leao, 2020). The non-linear debt hypothesis, linked to the debt Laffer curve, suggests that the relationship between public debt and economic growth follows a non-linear pattern. There exists a threshold level of debt beyond which further increases in public debt exert a negative effect on economic growth. See Table 8 below:

Table 8: Non-linear estimation results for the CS-ARDL of CCEPMG

				Number of obs	=	322
				Number of groups	=	14
				F (224,98)	=	3.21
				Prob > F	=	0.00
				R-squared	=	0.12
				R-squared (MG)	=	0.74
				Root MSE	=	0.08
				CD Statistic	=	-0.30
				p-value	=	0.7664
(Dynamic) CCEPMG (CS ARDL)						
D.LGDP	Coef.	Std. Error		P-value	Level of significance	
Short-run Estimate						
Mean Group:						
_cons	-2.546504	2.123067		0.230		
LD.lgdp	0.0654443	0.0920595		0.477		
DebttoGDP	-.0173794	0.0041548		0.000	***	
ldebt_sq	0.0418205	0.0067391		0.000	***	
L.DebttoGDP	0.0041276	0.0019830		0.037	**	
L.lexch	0.4607218	0.1563829		0.003	***	
L.lgov_exp	-.2069412	0.0719052		0.004	***	
L.lcpi	-.3657963	0.237778		0.532		
L.Fiscal_balance_level	0.0000428	0.0000685		0.532		
Adjust. Term						
Mean Group:						
lr_lgdp	-.9345557	0.0920592		0.000	***	
Long-run Estimate						
Mean Group:						
lr_DebttoGDP	-.0113929	0.0037216		0.002	***	
Lr_Fiscal_balance_level	0.0001362	0.0001352		0.314		
lr_cons	-4.981968	3.808621		0.191		
lr_lcpi	-.4691354	0.3712831		0.206		
lr_ldebt_sq	0.0565122	0.0170162		0.001	***	
lr_lexch	0.7459052	0.2971605		0.012	**	
lr_lgov_exp	-.2108991	0.0974317		0.030	**	

Source: Authors' computation, ***, **, * denotes level of significance 1%, 5% and 10% respectively

Following the introduction of a non-linear parameter—debt squared in the CS-ARDL CCEPMG—the estimation results improved from the linear specification. The non-linear model estimation reflected that in the short-run, debt-to-GDP, the non-linear parameter debt squared, exchange rate and government expenditures had a statistically significant effect on growth for the SADC region. Contemporaneous debt-to-GDP and lagged government expenditures had a negative effect on growth, indicating that an average increase of 1.0 percent on the debt-to-GDP ratio for the region results in a decline of 0.017 percent in nominal growth, validating the linear estimation results and prior expectations. Similarly, a 1.0 percent increase in the previous year's government spending, resulting in a 0.206 percent decrease in nominal growth, in line with the linear estimation and prior expectation. In contrast, contemporaneous debt squared, exchange rate and lagged debt-to-GDP had a statistically significant positive effect on the growth, with the debt squared variable confirming the non-linearity of the relationship between debt and GDP for the SADC region.

In the long-run, debt-to-GDP and government expenditures continue to portray a strong negative and significant relationship with growth. However, debt squared and exchange rate reflected a strong positive and significant effect on growth, with the debt squared parameter validating the non-linear debt and GDP nexus for the SADC region over the

long-term.

The error correction term is significant and negative showing a convergence between short-run and the long-run with a speed of adjustment of 93.45 percent. The CD-test result for the model indicated no cross-sectional dependence in the estimation and the mean group R-squared (MG) results explained 74 percent of the variation in the SADC panel data.

The second method to test for the non-linear relationship between debt and GDP was to estimate a non-linear CS-ARDL CCEPMG model (NARDL) to capture the asymmetric effect and potential threshold behaviour in the debt-to-GDP nexus.

The results of the NARDL estimation for the CS-ARDL of the CCEPMG reflected slight improvement and further complimented the results of the introduction of a non-linear term for debt squared. These results concretised the findings that in the short-run, contemporaneous debt-to-GDP had a negative and statistically significant effect on nominal GDP growth in the SADC region. Lagged debt-to-GDP also had a positive and a statistically significant effect on nominal growth. Furthermore, the negative debt asymmetric changes had a positive and weakly significant effect on nominal growth in the short-run. This implied that in the short-run, a reduction in debt accumulation can marginally boost nominal GDP growth. See Table 9 below:

Table 9: Panel Asymmetric CS-ARDL of CCEPMG (NARDL)

			Number of obs	=	322
			Number of groups	=	14
			F (224,98)	=	2.33
			Prob > F	=	0.00
			R-squared	=	0.11
			R-squared (MG)	=	0.71
			Root MSE	=	0.09
			CD Statistic	=	0.22
			p-value	=	0.8287
(Dynamic) CCEPMG (CS ARDL)					
D.LGDP	Coef.	Std. Error	P-value	Level of significance	
Short-run Estimate					
Mean Group:					
_cons	0.2477917	1.554701	0.873		
LD.lgdp	0.0713669	0.0914118	0.435		

DebttoGDP	-.0114968	0.0058964	0.051	*
neg_debt	0.0004743	0.0002551	0.063	*
pos_debt	0.000142	0.00013	0.275	
L.DebttoGDP	0.0108399	0.0046984	0.021	**
L.lexch	0.1918398	0.2635914	0.467	
L.lgov_exp	-.1483335	0.2020524	0.463	
L.lcpi	0.2305941	0.3696675	0.533	
L.Fiscal_balance_level	0.000157	0.0002046	0.443	
Adjust. Term				
Mean Group:				
lr_lgdp	-.9286331	0.0914118	0.000	***
Long-run Estimate				
Mean Group:				
lr_DebttoGDP	0.0007959	0.0035731	0.824	
lr_Fiscal_balance_level	0.0009066	0.000975	0.352	
lr_cons	0.7467153	2.282787	0.744	
lr_lcpi	-1.253475	1.159456	0.280	
lr_lexch	0.9432395	0.926526	0.309	
lr_lgov_exp	-.0133292	0.3474692	0.969	
lr_neg_debt	0.000781	0.0003904	0.045	**
lr_pos_debt	0.0002927	0.0002515	0.245	

Source: Authors' computation, ***, **, * denotes level of significance 1%, 5% and 10% respectively

However, the NARDL results depicted that in the long-run, none of the key macroeconomic variables had a statistically significant effect on nominal growth. Debt-to-GDP had a positive, yet statistically insignificant effect on growth. The negative debt asymmetric changes had a positive and statistically significant effect on nominal growth in the long-run, indicating that in the long-run, lowering debt improves nominal GDP growth slightly.

The error correction term was significant and negative showing a convergence in the long-run with a speed of adjustment of 92.86 percent. The CD-test result for the model indicated no cross-sectional dependence

in the estimation, and the mean group R-squared (MG) results explained 71 percent of the variation in the SADC panel data.

To capture the heterogenous nuanced responses on the effects of debt-to-GDP on nominal GDP growth, the paper conducted an in-depth analysis of how each of the 14 SADC member states reacted. The paper disentangled both the short-run and long-run effects of the debt-to-GDP ratio on nominal growth, along with the influence of the non-linear parameter debt squared on nominal growth for individual state to capture potential threshold effect and curvature in the debt-growth nexus. See Table 10 below:

Table 10: Results of NARDL Group-specific coefficients and Non-linear Debt squared

Short-run Estimation	Debt to GDP			Debt Squared		
	Coefficient	Std. Error	P-value	Coefficient	Standard Error	P-value
Angola	-0.006304	0.0035846	0.079 *	0.0520733	0.0155603	0.001***
Botswana	-0.0622186	0.0335513	0.064 *	0.045438	0.0284233	0.110
Eswatini	-0.0503015	0.0246083	0.041 **	0.0857747	0.0196887	0.000***
Lesotho	0.0170988	0.0068855	0.013 **	0.074545	0.0675354	0.270
Madagascar	-0.0211385	0.0042424	0.000 ***	0.0715585	0.016236	0.000***
Malawi	-0.0076013	0.0022006	0.001 ***	0.0440048	0.0160356	0.006***
Mauritius	-0.0044661	0.0149957	0.766	-0.0123731	0.0088967	0.164

Short-run Estimation	Debt to GDP			Coefficient	Debt Squared	
	Coefficient	Std. Error	P-value		Standard Error	P-value
Mozambique	-0.0110944	0.0038216	0.004 ***	0.0312889	0.0106751	0.003***
Namibia	0.0181035	0.0195469	0.354	0.0340712	0.0100306	0.001***
Seychelles	0.000931	0.0182418	0.959	0.0474906	0.0070393	0.000***
RSA	-0.0075268	0.0060935	0.217	0.0428566	0.0196829	0.029**
Tanzania	-0.0194462	0.004382	0.000 ***	0.0268881	0.0076845	0.00***
Zambia	-0.0013454	0.0024961	0.590	0.0178495	0.019795	0.367
Zimbabwe	-0.0056463	0.0024056	0.019 **	0.0240214	0.0205822	0.243
Regional Average	-0.0114968	0.0058964	0.051 *	0.0418205	0.0067391	0.000***
Long run Estimation						
Angola	0.0116597	0.008663	0.178	0.069977	0.0236876	0.003***
Botswana	-0.0218723	0.0207612	0.292	0.0359144	0.0253837	0.157
Eswatini	0.0008151	0.008648	0.925	0.0697563	0.0249031	0.005***
Lesotho	0.0362887	0.012844	0.005***	0.2577001	0.2335552	0.270
Madagascar	0.0053954	0.0017321	0.002***	0.065812	0.015323	0.000***
Malawi	-0.0036824	0.0016311	0.024**	0.0289672	0.0224239	0.196
Mauritius	-0.0096642	0.0291247	0.740	-0.0190264	0.0140779	0.177
Mozambique	-0.0051295	0.0043448	0.238	0.035445	0.012048	0.003***
Namibia	0.0100216	0.0217048	0.644	0.0480664	0.0135577	0.000***
Seychelles	-0.0075848	0.011339	0.504	0.054217	0.0061744	0.000***
RSA	0.0056161	0.0261806	0.830	0.0808665	0.0372658	0.03**
Tanzania	-0.0061942	0.004152	0.136	0.0247114	0.0106878	0.021**
Zambia	-0.0020244	0.0031322	0.518	0.0212929	0.023491	0.365
Zimbabwe	-0.0025028	0.0020684	0.226	0.0174708	0.0214244	0.415
Regional Average	0.0007959	0.0035731	0.824	0.0565122	0.0170162	0.001***

Source: Authors' computation, ***, **, * denotes level of significance 1%, 5% and 10% respectively

The group specific results of the NARDL coefficients revealed that, in the short-run, 8 of the 14 SADC member states, specifically Angola, Botswana, Eswatini, Madagascar, Malawi, Mozambique, Tanzania and Zimbabwe exhibited negative and statistically significant effects of the debt-to-GDP ratio on nominal GDP growth. This finding implied that for every 1.0 percent increase in the debt accumulation, it is associated with a contractionary effect on nominal GDP growth for these 8 SADC countries.

In contrast, Lesotho depicted positive and statistically significant effects of debt-to-GDP effects on nominal GDP. Specifically, a 1 percent increase in debt accumulation is associated with an increase in nominal GDP growth. This can be attributed to Lesotho's distinctive public debt profile, which is overwhelmingly external ($\approx 80\%$) and largely concessional ($\approx 70\%$ of external debt). This structure likely minimises the crowding-out and debt overhang effects prevalent in the region, allowing borrowed funds to finance growth-supporting investment at a

sustainable fiscal cost.

The results further revealed that 8 of the 14-member states displayed non-linear debt dynamics characteristics for both the short-run and the long-run, namely Angola, Eswatini, Madagascar, Mozambique, Namibia, Seychelles, South Africa and Tanzania. Only Malawi exhibited non-linear debt dynamics for the short-run. The inclusion of the debt squared non-linear term was statistically significant for these countries, indicating that the relationship between debt and nominal GDP growth was not purely linear. This implies that the short-run effects of debt accumulation vary depending on the level of indebtedness, with potential threshold effects.

In the long-run, Lesotho and Madagascar portray positive and statistically significant debt-to-GDP ratio effects on nominal growth. Specifically, a 1.0 percent increase in debt-to-GDP accumulation exhibited a positive effect on nominal GDP growth. In contrast, Malawi reflected a negative and statistically significant

effect of debt-to-GDP on nominal growth, consistent with its short-run estimation results.

A critical finding from the dynamic panel threshold model is that the growth-maximising debt-to-GDP ratio for the SADC region is 47 percent, substantially below the official 60 percent convergence target. This threshold implies that maintaining public debt within this range is linked to growth, while exceeding this level may lead to adverse effects on economic

performance. This finding is below the threshold of 57 percent of debt-to-GDP by Sanusi et al., (2019) due to several factors. These include deference in datasets, variation in methodological approaches as well as usage of distinct explanatory variables. The paper adopted a novel econometric approach using the dynamic panel threshold model to estimate the appropriate threshold for debt-to-GDP in the SADC region. Table 11 presents the results.

Table 11: Dynamic Panel Threshold Estimation

Ingdp	Coefficient	Std. Error	z	P>z	[95% conf. interval]	
Lag_y_b	1.176206	0.586043	2.01	0.045	0.027583	2.324829
lcpi_b	0.069162	0.170687	0.41	0.685	-0.26538	0.403702
lexch_b	0.1521177	0.062131	2.45	0.014	0.030343	0.273893
lgov_exp_b	-0.2472044	0.291139	-0.85	0.396	-0.81783	0.323417
Fiscal_balance_level_b	-0.0000155	4.21E-06	-3.68	0.000	-2.4E-05	-7.2E-06
kink_slope	-0.0090372	0.001559	-5.8	0.000	-0.01209	-0.00598
r	46.99791	20.83272	2.26	0.024	6.166531	87.82929

Source: Authors' computation

To test for the macroeconomic effects of public debt on macroeconomic variables, the paper used the Dumitrescu and Hurlin Granger non-causality test. Based on the results of the causality test between debt and macroeconomic variables, there was no evidence that debt granger-cause nominal GDP growth and government expenditures in the SADC panel dataset, as the p-values for both the Z-bar and Z-bar tilde are very high, well above the p-value of 0.05. However,

reverse causality was found as nominal GDP growth and government expenditure granger caused debt.

The granger causality test further revealed that, there was evidence that debt granger caused consumer price inflation, exchange rate volatility and the widening fiscal balance in the SADC panel dataset, as the p-value for both the Z-bar and Z-bar tilde are very low below the p-value of 0.05. See table 12 below.

Table 12: Granger Causality Estimation

Dumitrescu & Hurlin (2012) Granger non-causality Test results	W-bar	Z-bar	Z-bar tilde
Ingdp debt	0.9391	-0.1612 (0.8719)	-0.3668 (0.7138)
lgov_exp ldebt	1.0352	0.0930 (0.9259)	-0.1547 (0.8771)
lcpi ldebt	2.9093	5.0515 (0.0000) ***	3.9814 (0.0001) ***
lexch ldebt	7.2901	16.6420 (0.0000) ***	13.6496 (0.0000) ***
Fiscal_balance_level ldebt	1.9630	2.5478 (0.0108) **	1.8929 (0.0584) **
Reverse causality			
ldebt Ingdp	3.1490	5.6858 (0.0000) ***	4.5105 (0.0000) ***
ldebt lgov_exp	3.4069	6.3680 (0.0000) ***	5.0795 (0.0000) ***

Source: Authors' computation, p-values show in parathesis and ***, **, * denotes level of significance 1%, 5% and 10% respectively

5. Conclusion, Recommendations and Limitations

5.1 Conclusion

This study analysed the macroeconomic effects of public debt on a panel of SADC economies. Using a panel ARDL approach that accounts for cross-sectional dependence, the core finding is that public debt exerts a significant negative linear impact on nominal output. Extending the analysis confirms a robust non-linear debt-growth nexus, with this effect statistically significant in eight of the fourteen member states, underscoring substantial national heterogeneity. Furthermore, Granger causality tests reveal that public debt drives inflation, exchange rate volatility, and fiscal balance deterioration, highlighting its direct threat to macroeconomic stability. A critical policy finding, derived from a dynamic panel threshold model, is a growth-maximising debt-to-GDP ratio of 47 percent, which is substantially below the SADC's 60 percent convergence target.

These results indicate that rising debt in SADC is frequently associated with adverse growth outcomes and instability, suggesting that high borrowing costs, the crowding-out of private investment, or financing low-return projects may undermine potential growth benefits. Consequently, for SADC to successfully advance the sustainable development and regional integration goals of the RISDP 2020–2030 and Vision 2050, fiscal policy must be recalibrated. This requires moving beyond a uniform debt ceiling to implement country-specific debt anchors informed by empirical thresholds and ensuring borrowed funds are rigorously allocated to high-return, productivity-enhancing investments. Only through such evidence-based and differentiated strategies can public debt be transformed from a source of vulnerability into a sustainable engine for achieving SADC's development ambitions.

5.2 Recommendations

Building on the empirically identified growth-maximising public debt threshold of approximately 47 percent of GDP, this study proposes a multi-level strengthening of fiscal and debt management frameworks in the SADC region. The estimated threshold is not intended to replace existing regional

convergence targets, but rather to complement them by providing an evidence-based early-warning benchmark for policy calibration.

A. Regional Reforms

- Retain the 60 percent debt-to-GDP convergence target as the formal regional anchor, while institutionalising a tiered, evidence-based framework to guide fiscal policy. This framework should establish clear operational bands:
 - » Below 47 percent: Growth-supportive, productive borrowing is permissible, with a focus on high-return public investments.
 - » Between 47 percent and 60 percent: Tighter debt management and higher scrutiny of new borrowing are required, mandating rigorous project appraisal and active liability management.
 - » Above 60 percent: Countries must face corrective and stabilisation measures, including mandatory fiscal consolidation plans and engagement with regional surveillance mechanisms.

Evolve the SADC Secretariat's role into an active surveillance and capacity-building hub, tasked with monitoring these tiers, providing early warnings, and facilitating peer-learning forums to share best practices in debt management.

B. National Fiscal Reforms

- Establish country-specific, medium-term debt anchors aligned with the regional tiered framework, calibrated to individual debt-carrying capacity, growth potential, and vulnerability to shocks.
- Adopt Medium-Term Fiscal Frameworks (MTFFs) with embedded debt sustainability analysis to protect productive spending.
- Introduce fiscal rules with automatic adjustment triggers (e.g., on expenditures or the primary balance) that activate when debt approaches national limits, ensuring timely and rule-based fiscal correction.

- Prioritise domestic revenue mobilisation to reduce borrowing dependency.

C. Debt Management Reforms

- Link all new borrowing to high-return investments in infrastructure and human capital.
- Actively optimise debt composition to favour concessional, long-term, and local-currency instruments.
- Closely monitor the growth-interest rate differential ($g - r$) as a core sustainability metric.

D. Institutional Strengthening

- Mandate greater debt transparency, including comprehensive reporting of terms and contingent liabilities.
- Enhance fiscal-monetary policy coordination to mitigate debt-fueled inflationary and exchange rate pressures.

Together, these reforms—anchored by the 47 percent threshold—provide a practical roadmap for

transforming public debt from a source of vulnerability into a sustainable instrument for financing SADC's development goals, ensuring borrowing enhances growth without compromising long-term fiscal stability.

5.3 Limitations and recommendations for future research

This study acknowledges two primary limitations. First, while the CS-ARDL estimator was appropriately selected to address cross-sectional dependence, its performance is best suited for panels with a larger number of time periods and cross-sections. Our panel dimensions ($T=25$, $N=14$), though sufficient for estimation, are at the lower bound for this method. Consequently, future research exploring the debt-growth nexus in SADC would benefit from a panel with larger N and T . Second, the empirical analysis was constrained by the lack of disaggregated public debt data. The unavailability of separate series for domestic and external debt components prevented the study from providing nuanced empirical prescriptions on the distinct growth effects of each debt type.

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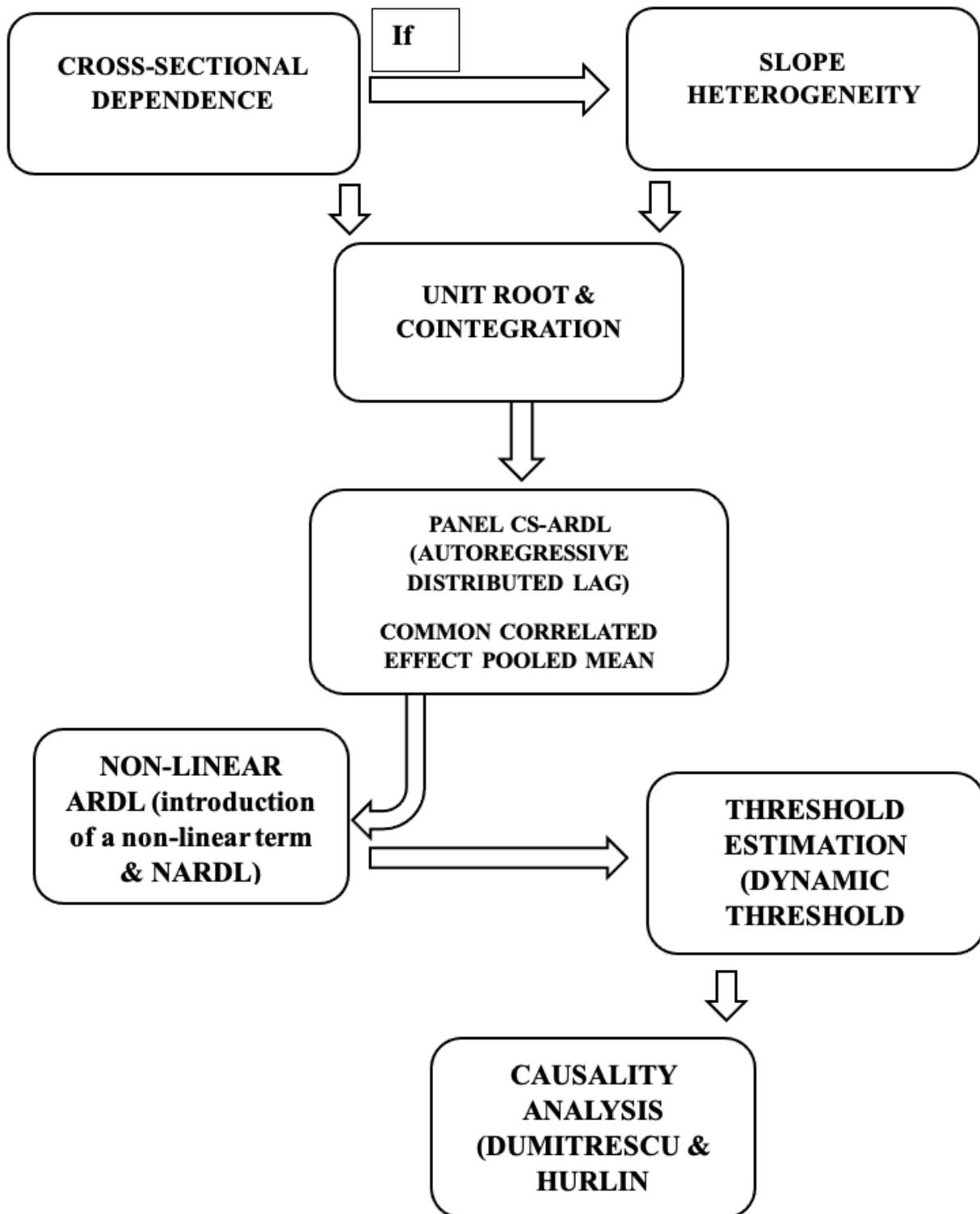
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ANNEX 1: Summarized Visualization of Methodological Process Flow

Impact of Fin-Tech-Led Innovations on the Effectiveness of Monetary Policy in Eswatini

By Simiso Mkhonta¹

Abstract

The study investigates the impact of financial technology innovation on the effectiveness of monetary policy in Eswatini for the period 2013M01-2020M12. The study constructed a FinTech index for Eswatini using the Principal Component Analysis. The 2-stage least squares was used to determine the effects of the FinTech index on the velocity of money and the demand for money. The results suggest that an increase in the FinTech index leads to decreases in the velocity of money and demand for money in the economy and is associated with high levels of mobile money deposits compared to withdrawals captured in the FinTech index. The effect of FinTech on monetary policy effectiveness was found to be positive but insignificant.

1. Introduction

Financial sectors across the globe have experienced rapid increases in financial technology (Fintech). Africa has huge potential in e-money development compared to other regions given her massive untapped capacity. The concentration of e-money development in Eastern Africa has dissipated to other regions offering broad based development. Since the turn of the decade there has been an increase in access to, and use of financial accounts enabled by mobile technology (Global Findex 2025). The data show high levels of phone ownership and internet use and increased ownership and usage of mobile-enabled accounts in every region of the world². In many low-income and emerging market economies

around the world, digital currencies – denominated in legal tender and exchanged through features of smart phones – have gained widespread adoption (Huang 2024). This increase is driven by the ease and usefulness of mobile technology (Hornuf et al; 2024). Consequently, policy makers from both the advanced and developing economies have shown increasing interest in the impact of fintech on the transmission of monetary policy. Conceptually Huang et al (2024) states that monetary policy transmission can occur through credit, bank rates, asset prices and the exchange rate. The channels may either weaken or strengthen monetary policy transmission. Only through empirical analysis can the impact on monetary policy transmission be ascertained.

The paper therefore investigates empirically the effects of e-money³ development on monetary policy effectiveness, velocity of money and the demand for money in Eswatini for the period 2013 to 2020. The remainder of the paper is arranged as follows. Section 2 covers fintech landscape in sub-Saharan Africa, the CMA- Eswatini compared to Lesotho and Namibia and monetary policy conduct in these countries. Section 3 reviews related literature. Section 4 constructs a financial technology index for Eswatini. Section 5 is Data Overview. Section 6. Models Fintech and Monetary Policy and Section 7 Analyzes Data and presents Methodology and Section 8 Estimates the models and presents and interprets the results and finally, Section 9 Concludes.

2. FinTech Landscape in sub-Saharan Africa

There has been an intense proliferation of FinTech start-ups across the world, particularly in Europe, North America and Asia with Africa however lagging (Brij and Varun; 2020). Sub-Saharan Africa (SSA) with a less-developed financial infrastructure and an unbanked population of 60% is an opportunity for Fintech to thrive. The drive to ensure access to fintech by closing the vast population gaps lacking access to fintech will undoubtedly change the financial

¹ Simiso Mkhonta is a Principal Economist, Modelling and Forecasting, in the Research Department. Email: simisom@centralbank.org.sz

² where worldwide, 79 percent of adults have an account at a bank or similar financial institution, with a mobile money provider, or both, up from 74 per cent in 2021 (Klapper et al; 2025).

³ Mobile/e- Money means: it refers to the use of mobile phones and associated technologies to facilitate financial transactions.

landscape and present challenges and opportunities for monetary policy. McKinsey & Company (2022) found that between 2020 and 2021, the number of tech startups in Africa tripled to around 5 200 companies of which just under 50 per cent were FinTech's. Hornuf et al (2024) endeavored to understand why the sub-Saharan population is adopting fintech and concluded that perceived ease and usefulness are the most important factors. Nevertheless, digital and financial knowledge impose a barrier to financial inclusion and adoption of fintech.

The report predicted that by the end of 2025 the potential revenue for Africa would be estimated at USD 30 billion. It has though proved to be a challenge given the perceived potential, macroeconomic headwinds and funding constraints slowing down estimates to USD 47 billion in 2028 after recording USD 10 billion in 2023. The huge increase of USD 4 billion recorded from 2020 to 2021 dampened between 2021 and 2023, increasing by an average of only USD2 billion per year due to the challenges.

Kenya has been ranked among China, Korea and Malaysia as achieving macroeconomic significance in the rapid expansion of Fintech credit and an outlier in fintech performance in Africa (Cornelli et al., 2023). The Global Findex report of 2025 further revealed that across low-and middle-income economies, 61 percent of adults, or 82 percent of account owners, made or received a digital payment in 2024, a 27-percentage point increase from 2014, establishing digital payment as the most popular financial service.

Mabe and Simo-Kengne (2025) assessed the role of fintech risk, measured by Fintech Financial Stress Indicator (FFSI) in molding bank dynamics in 41 banks across 11 African economies over the semi-annual period from June 2004 to December 2020. They concluded that financial innovation initiatives may yield performance benefits for banks, if excessive risk taking was kept in abeyance. Be that as it may traditional banks have faced increased competition from Fintech start-ups (KPMG, 2022). The report said that while fintech investment in Europe, Middle East and Africa region have fallen due to geopolitical tensions and supply chain disruptions, there is increasing focus on underdeveloped fintech markets, including Africa. Cash still accounts for 90 per cent of transactions in Africa leaving huge potential for fintech revenues to grow.

In 2014 mobile money accounts were concentrated in the economies of East Africa and have since spread to economies in West Africa and beyond. Across the four regions of Africa (Central Africa, East Africa, Southern Africa and West Africa) about 40 per cent of adults have a mobile account. The Southern African region increased mobile money accounts to match the East African region at around 20 per cent compared to around 4 per cent in 2014 (Global Fintech Database; 2025).

FinTech has therefore in the last decade grew drastically by 24 per cent in SSA influenced by the main drivers, favorable demographics and high use of internet and mobile technology the report concluded. Hornuf et al (2025) noted that policymakers need to focus on enhancing digital and financial literacy and setting standards for technology compatibility to create a supportive regulatory environment for mobile fintech adoption in Sub-Saharan Africa. Anne-Laure (2020) advocated for an integrative approach in developing a common understanding and interpretation of Fintech as a socially constructed phenomenon at the intersection of research and technology management.

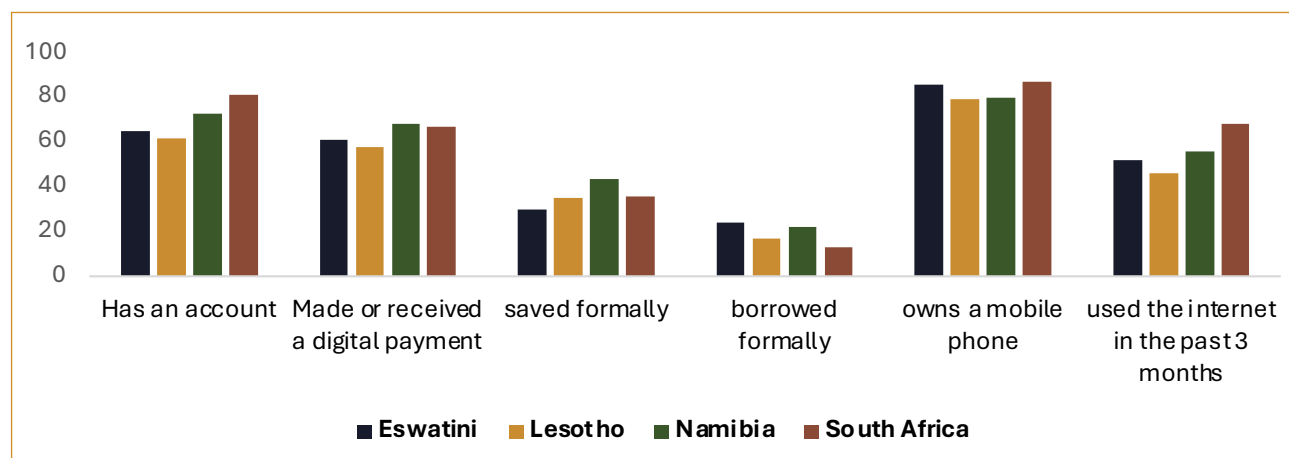
Challenges facing fintech development in sub-Sahara Africa are a fragmented fintech landscape with changing policies across different countries creating compliance difficulties. African fintech developers are poached by companies headquartered outside Africa and 80% fintech executives have reported difficulties in hiring skilled professionals (Fintech Magazine Africa). Be that as it may, Africa remains with immense potential, but sustained growth will rely heavily on regulatory clarity, investment shifts, and talent development. Anne-Laure (2020) further pointed out that FinTech startups are pushing vintage financial institutions to clarify their strategies, develop new capabilities and transform their cultures; and Fintech start-ups benefit from technology-enabled capabilities, characterized by higher knowledge intensity and lower internal resource dependency. High flexibility in fintech firms as they adjust to market dynamics and embracing innovation coupled with traditional banking matching standards will maintain Africa's long-term success. Not only has fintech improved personal and household situations but has also enabled business development in Sub-Saharan Africa.

(i) Eswatini and Regional FinTech Landscape

Eswatini along with Lesotho, Namibia and South Africa are members of the Common Monetary Area (CMA) of Southern Africa. South Africa is the biggest economy in the CMA, and the smaller economies in the CMA are heavily trade dependent on the South African market. As a result, the national currencies of

Eswatini, Lesotho and Namibia conveniently trade at par to the South African rand, which is legal tender in all three territories. Central banks of the 3 countries therefore pursue monetary policies that support respective national currencies' peg to the South African rand.

Figure 1: Financial Account and Mobile Phone Ownership and Use



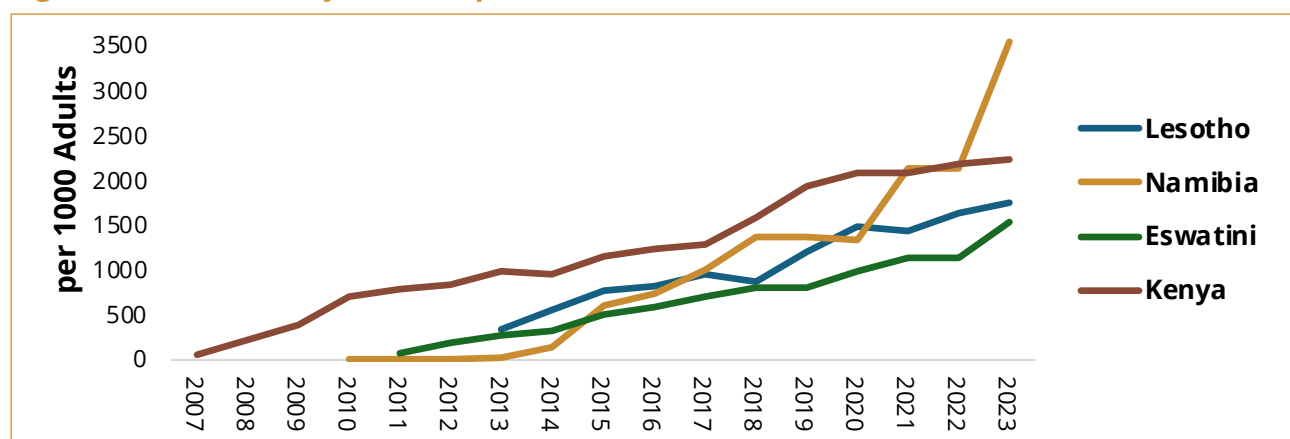
Source: Global Findex database 2025

South Africa with the largest economy in Southern Africa has the highest developed, largest and sophisticated financial system. South Africa therefore leads in the CMA on the number of mobile money accounts ownership at 81 per cent followed by Namibia at 73 per cent, then Eswatini at 65 per cent and least is Lesotho at 62 per cent (see figure1). Namibia is developing faster than Eswatini and Lesotho in the fintech industry in term of e-money intensity. Lesotho has outpaced Eswatini which has a generally lower trend than the other two. Namibia reached 1000 mobile money accounts per 1000 adults in 2017; Lesotho followed at 950 and Eswatini was at 750 and Kenya had already surpassed 1200 (see figure 2).

Due to the unrealistic South Africa data from the same source Kenya as a fintech hub is used to compare the countries under study, and the region is not far

off Kenya's trend. The three countries have set up fintech start-ups frameworks. Fintech development in these countries has occurred on the pedal of their respective National Financial Inclusion Strategies. This could act as a starting point for the development of a comprehensive regulatory framework going forward.

Eswatini's banking and payment sector, supervised by the CBE, comprises 3 commercial banks, a newly licensed fintech bank, building societies, of which one is migrating to a bank and the other is under curatorship. According to the World Bank 2021 estimates, there are about 6.4 bank branches for every 100,000 adults in Eswatini. Three of the four commercial banks in Eswatini are of South Africa origin. There are predominantly 3 MMSPs serving over 650,000 adults using both electronic and paper instruments and channels operate in Eswatini.

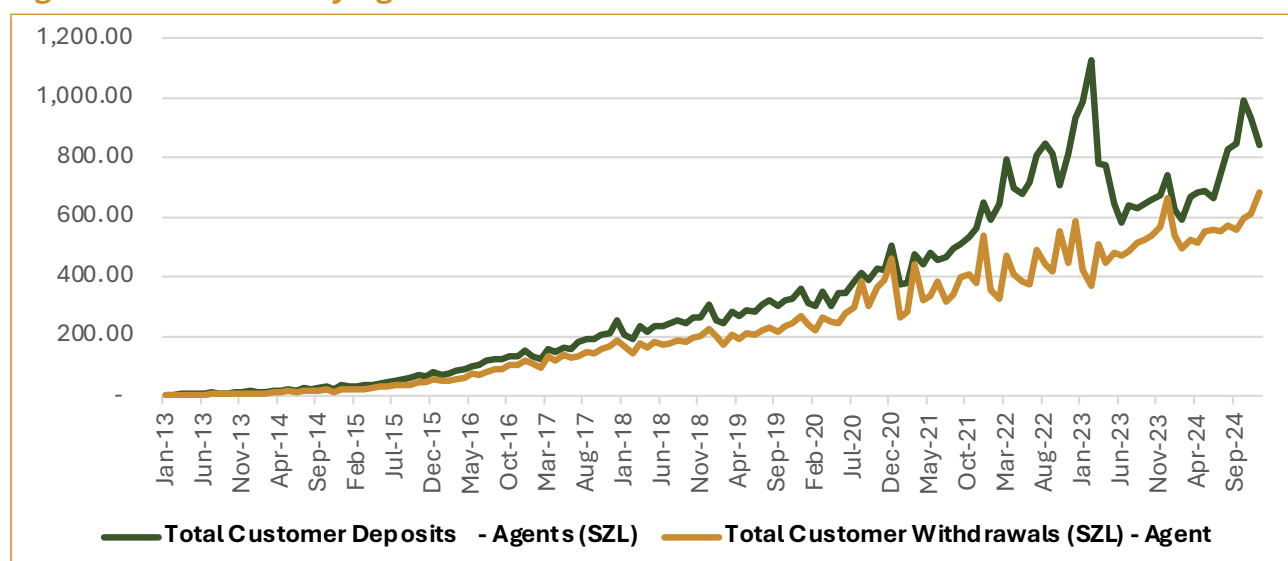
Figure : Mobile Money Account per 1000 Adults

Source: World Bank

The Eswatini payment landscape comprises two major infrastructures, the Swaziland Interbank and Settlement System (SWIPSS) and Eswatini Clearing House (ECH). SWIPSS provide real-time gross settlement (RTGS) for high-value critical payments and ECH processes interbank retail payments. To modernize the payment system, the CBE developed the 2009-2016 National Payment System Strategy, compromising key guidelines and regulations and requisite processes for a more efficient and reliable modern payment system. Because of today's digital antecedents, CBE has revised their approach with a 2021-2025 strategy that seeks to create key ecosystem enablers for a modern and minimal friction payment system, as well as meeting current and future payment needs and mitigating new risks that may threaten financial system stability.

In Eswatini, by far the largest financial services account provider is MTN i.e. mobile money services accounts that is used by most consumers taking up any account. All low-income consumers at 98.4 percent use MTN mobile money on a stand-alone basis in Eswatini, and 88 percent of middle-income earners. Instacash went live in Eswatini in 2021 and was licensed to fully operate in February 2022

resulting in large increases in mobile transaction with deposits accelerating to surpass 1 billion in 2023 (see figure 3 below). Eswatini's counterparts in region have advanced depicting a broad-based regional development in fintech activities, most probably trickling from South Africa the dominant. Footprints of big fintech companies based in South Africa replicate in the smaller states of Eswatini, Namibia and Lesotho. The dominant mobile money operators are MTN, Econet's EcoCash and Vodacom's M-Pesa in Lesotho. Mobile money in Lesotho is fast accessible, and inclusive, while EFT and banking systems need upgrade. Cross-border remittances in the region depend on third-party intermediaries that charge high fees. Mobile payments in Namibia have experienced phenomenal growth, especially in underbanked areas where the bank infrastructure can be scarce. The main mobile payment platforms are Pay Today, MobiPay and eWallet by FNB with Nedbank, a promising mobile money service. Driving e-money is a significant majority of the population that is under the age of 30, highly mobile phone-literate, receptive to digital financial services and conversant with the usage of internet services.

Figure 3: Mobile Money Agents Transactions

Source: Central Bank of Eswatini

(ii) Internet Usage

Namibia had an internet usage of 57 per cent in 2020 and Eswatini and Lesotho following at 49.0 per cent and 43.7 per cent respectively. The aftermath of COVID-19 in Namibia saw mobile accounts per 1000 adults increase drastically from 2021 to 2023 by an average of 24.5 per cent with higher usage of internet and technology than Eswatini and Lesotho which grew by an average 15.0 per cent (see graph 4 in appendix)

According to Africa FinTech Radar preliminary trends and learnings (June 2021) the COVID-19 pandemic triggered deep digital change globally, not least in Africa, which represents nearly half (46%) of all global mobile-money accounts. FinTech spreading and deepening has remained elevated in Africa's main hubs of South Africa, Kenya and Nigeria. Eswatini, Lesotho and Namibia sharing borders with South Africa one of Africa's fintech hub would be expected to accelerate in e-money development in the future through trickling-down effects. Fintech development in Eswatini, Lesotho and Namibia could take the form of the banking sector South Africa which has replicated in the 3 smaller states that peg their currency to South Africa. In the three countries mobile money remains integral part of the financial system. Farmers in rural districts use it to receive payments for produce without needing a card machine. Families pay school fees and utility bills straight from their phones. Much

of the population has had the first real experience for formal finance in mobile banking.

(iii) Monetary Policy in Eswatini, Lesotho and Namibia

As earlier alluded, Eswatini, Lesotho and Namibia are members of the Southern African Common Monetary Area (CMA). All three countries pursue a credible peg at par to the South African Rand. The Central banks of the respective countries in conducting monetary policy impose direct control of the lending rate, by setting it at a positive margin of 350 basis points above the monetary policy rate. The monetary policy transmission to lending rates thus determined is a direct translation of the policy rate to the market rates. The three countries in the CMA pegging to the South African rand conduct their monetary policy with the basic aim of curbing outflows to anchor the peg (fixed exchange rate regime) by keeping domestic short-term interest rate aligned at a premium to South Africa's.

Eswatini, Namibia and Lesotho operational target under the fixed exchange rate regime become the level of international reserves. The effectiveness of monetary policy is therefore measured by how much it can steer international reserves to the target. An estimation of monetary policy transmission to treasury bill rate, which is determined by market forces, is added to the analysis.

3. Theoretical and Empirical Literature Review

(i) Impact of Fintech on Monetary Policy

The literature on fintech and monetary policy in Africa is limited. Most studies in emerging and developed economies have found fintech to improve the transmission of monetary policy including the few studies that have been carried out for developing nations.

Huang et al (2024) focused on the adoption of E-money as a FinTech phenomenon either enhancing or incapacitating monetary policy transmission in sub-Sahara Africa. From one angle non-bank deposit-taking e-money issuers (EMIs) like your mobile money operator can complement banks. They bring into the banking system previously unbanked depositors, leading to higher financial intermediation and improved monetary policy transmission. On the other hand, they can be substitutes of banks by moving depositors away from banks to EMIs, weakening monetary policy transmission in the process.

The authors explore empirically the role of e-money on monetary policy transmission, using panel data covering 21 countries at a monthly frequency, and 47 countries at an annual frequency, for the period between 2001 and 2019. They also present case studies of frontrunners in e-money development in sub-Saharan Africa-Ghana, Kenya, Nigeria, Tanzania, and Uganda. They found that e-money adoption has fostered monetary policy transmission, measured as the responsiveness of interest rates to the policy rate, growth in bank deposits and credit and competition among banks and efficiency gains in financial intermediation, measured by deposit-to-lending rate spreads. The paper found that the effects on monetary policy transmission are more pronounced where financial inclusion was limited. Fintech development was found to encourage competition and enhance monetary policy transmission.

Conceptually, fintech proliferation could weaken monetary policy transmission by loosening credit controls. It could be through diversion from strict credit regulations, flat interest due to high competition

(Buchak et al, 2018 and Hasan et al 2020; Elliot et al ,2020; Chen et al. 2018), and the doubling down/up effects of the financial accelerator (Gertler and Gilchrist, 1994; Kiyotaki and Moore, 1997; Bernanke et al., 1999).

There are various channels through which FinTech can influence monetary policy transmission outlined by Huang et al (2024), Zhou (2022), and Franco (2024). There are generally four mechanisms through which FinTech enhances monetary policy transmission. Firstly, money circulating outside the banking system is drawn into the system when the value created because of mobile money operations is ultimately deposited into the traditional banking system¹. This increases the liquidity in the banking system and the volume of loanable funds, strengthening the credit channel of monetary policy transmission. Secondly, digitization and financial inclusion improve market efficiency and thus move savings from traditional instruments (e.g., currencies, gold, and real estate), which are less sensitive to monetary policy, into bank deposits. The substitution of assets thereof with digitization and financial inclusion could enhance asset prices. Thirdly, higher competition in the banking sector to attract large wholesale depositors, pressured by the entrance of mobile money operators lead to lower banks' excess reserves and thus strengthening the transmission of monetary policy to bank lending rate-the bank rate channel. Finally, safe and convenient e-money increases the demand for domestic deposits, reducing external deposits and outflows and thus reducing the currency risk premium-the exchange rate channel.

On the other hand, there are other channels that depress the transmission of monetary policy. Firstly, e-money can reduce the supply of loans if deposits at banks are not loanable. Regulation would require the mobile money issuers to hold liquid trust accounts equivalent to the aggregate balance of their clients' e-wallet, crowding out loanable deposits. Further, if e-money is regarded safer than deposits and there is no limit to the size of e-wallets this could lead to a reduction of deposits and impairment of the bank lending channel of monetary policy transmission. Secondly, e-money could increase the propensity

¹ It enables users to store, send, and receive money electronically using their mobile devices. Mobile money services typically involve partnership between mobile network operators and financial institutions. Allowing users to create virtual accounts linked to their mobile phone numbers. This enables them to perform a wide range of financial activities, such as transferring money, paying bills, making purchases, and accessing other financial services.

to invest in other assets that are less sensitive to monetary policy changes, such as cryptocurrencies particularly in small economies which are price takers in the international markets. The resultant depressed domestic asset prices as demand shifts to international markets weakens monetary policy transmission through the asset price channel.

Hawthorne and Patel (2024) used a discrete choice model of demand for banking and mobile services in Botswana, Eswatini, Lesotho and South Africa to confirm the substitution effects of mobile money. They found that mobile money users face a price inelastic demand curve compared to traditional banking buoyed by product differentiation with the ease and usefulness of the mobile phone. Mobile money was found to be a substitute for traditional banking. However, the substitution is weakened by low financial literacy levels that hold back the potential growth of e-money especially through younger consumers in the rural areas, who are likely not in position to use banking services as readily as a substitute.

Tonuchi et al (2020) set out to determine the extent monetary policy effectiveness contributes to achieving financial inclusion. They use the Johansen's cointegration test and fully modified Ordinary Least Squares (OLS) with quarterly time series data from 2009 to 2019 in Nigeria. Measures of monetary policy effectiveness such as inflation rate and lending rate all had a significant effect on financial inclusion in the country. Interestingly, they further discovered that when accounting for FinTech the model improves the effectiveness of the monetary policy to inflation rate and lending rate hence on financial inclusion.

Zhou (2022) established that social networks play a key role in consumers' adoption of FinTech lending, which amplifies the effects of a monetary stimulus in the USA. The author provides a casual estimate of the network effect (modelling heterogeneous agent with social learning) on FinTech adoption using country-level data. The refinancing channel of monetary policy weakened due to complications in loan origination process discouraging consumers and capacity constraints lender's responses in periods of low rates. Rapid growth in financial technology eases such frictions, coupled with consumers' social networks can propagate FinTech adoption further amplifying the impact of monetary policy shocks. The author shows that FinTech lending displays a sizable

spillover effect across social networks, and that this effect is particularly strong in areas with higher social and economic mobility and for refinancing mortgages as opposed to home-purchasing mortgages.

Wong and Eng (2019) investigated the impact of the emergence of a decentralized peer-to-peer platform that matches lending and borrowing without collateral requirements challenging bank lending and balance-sheet channels of monetary policy transmission. The authors augment the New Keynesian macroeconomic models with two-sided platform, group identity and a novel platform density channel of monetary transmission. Without a bank-based intermediation (Bernanke and Blinder; 1992) the bank lending channel becomes obsolete. As the individual lender has no claims against the central bank, the policy rate would have no leverage on interest rate the individual is willing to offer via the platform. A platform channel is created with the advancement of financial technology and any element that could deter platform, such as platform loan default rate, would weaken the platform density channel but revitalize traditional channels of monetary transmission and vice versa.

Franco (2023) investigated the transmission of monetary policy through a fintech lending channel. The author employs static and dynamic equilibrium models on a detailed dataset on fintech nonbanks activities in the United States. They discover that in the United States lenders tend to accelerate the monetary policy transmission to mortgage rates while they lessen the pass-through to mortgage volumes. The pass-through is driven by technology and funding structure. Technology has brought automation into processing mortgage loans applications, reducing approval/decline turnaround time. Most of the fintech lenders are usually nonbanks and have short-term funding structure. The former may assist in increasing the efficacy of monetary policy and could propel lending volumes. Whilst the latter could be substituted for mainstream credit institutions in cycles of monetary policy tightening thus dampening its efficacy.

Buchak et al (2018) in studying fintech, regulatory arbitrage, and the rise of shadow banks supports the view that the overregulated banking sector leads to sprouting of shadow banking to arbitrage regulation and thus weakening monetary policy transmission. Shadow banks are non-depository

institutions outside the ambit of traditional banking regulation. Fintech lenders were found to charge a mark-up of 14-16 basis points and appear to provide convenience rather than cost savings to borrowers which findings are somehow in line with the study by Hawthorne and Patel (2024) earlier alluded. The growth in shadow banking in the US grew from 30 per cent in 2007 to 50 per cent in 2015. A quarter of the growth was accounted for by fintech lenders underscoring the significance of FinTech in monetary policy transmission.

Hasan et al (2020) estimate an interacted panel vector autoregression (IPVAR) in their analysis of how monetary policy shocks vary with the degree of FinTech adoption in China. They employ a parsimonious IPVAR with real GDP, consumer prices, bank loans, and housing prices as endogenous variables in response to exogenous monetary policy shocks, while also considering the interaction with FinTech adoption. The authors found that the adoption of FinTech weakens the transmission of monetary policy. The varying degree of FinTech adoption across regions in China results in varied responses to monetary policy with high FinTech adopting regions experiencing weaker effects on monetary policy transmission and vice versa.

Yueteng and Jiajun (2023) investigated how fintech influences retail banking and the effectiveness of monetary policy transmission with a focus on competition between FinTech companies and banks in the deposit market in China. They first found that FinTech competition induces negative deposit demand shocks and crowds out banking deposits. Traditional banks more exposed to FinTech companies competition do not cut credit but redirect it to bonds reducing liquid assets. Traditional Banks reaction to FinTech competition led to smaller declines in loan and deposit growth during monetary tightening, weakening the effects of monetary policy transmission.

Mumtaz, Smith and Mahmood (2020) examine what effect the array of innovations in fintech have had on monetary policy in 30 countries. Using the Generalized Method of Moments (GMM), the authors analyzed the relationship between money demand and the transmission mechanism of monetary, discovering that lower monetary policy rates led to an increase in money demand across countries. When they include fintech in their models they determine

that mobile technology, Internet technology, and all digital currencies are robust predictors of money demand. The results suggest that fintech influences the demand for money, hence monetary policy. The results confirmed that there is no change in income velocity and the money multiplier during both pre-fintech and post-fintech periods. The authors note that firms use different modes of fintech to facilitate business transactions, may influence income velocity, money demand, and output gap for different countries.

Furthermore, the authors concluded after using the product market equation and the cost function that since the emergence of fintech implementation of monetary policy may have had significant effect on the output gap, particularly.

Chen (2021) investigated the impact of digital payments on the velocity of money in the Chinese market, defining the velocity of money in circulation at M2 for quarterly periods from 2012 to 2021. The author carries out the analysis using MIDAS-PDL model and comparing it with traditional OLS. Digital payments have a significant and positive effect on the velocity of money in circulation, while the opportunity cost of money has a significant negative effect on the velocity of money circulation.

Otoakhia (2023) examined the role of payment systems on the movement of velocity of money in Nigeria using quarterly data from 2010 q1 to 2022 q3. The study generated a normalized index of payment systems using a principal component analysis of the four most evolving payment instruments (Automated Teller Machine, Point of Sales, Web and Mobile Pay). The author found that a one-standard-deviation shock in the index leads to velocity of money decreasing overtime despite some positive and negative changes. The author concluded that payment systems encourage cash hoarding when propensity to spend is low and amid heightened economic uncertainty, and the velocity of decreases.

Generally, fintech has been found to weaken monetary policy transmission when in a tightening cycle as economic agents switch from traditional to digital borrowing and enhancing the transmission during an easing cycle. Social groups and peer to peer transfers are important conduits for transmission (Zhou, 2022; Wong and Eng, 2019).

4. Constructing FinTech index using Principal Component Analysis

There is wide range of variables that capture financial inclusion and technology. Selecting an appropriate measure of financial inclusion and technology would result in the loss of valuable information carried by the rest of the variables. The information captured by the variables differs from penetration, availability, and usage of digital financial services which could be summarized compactly without loss of information using the principal component analysis. Principal component analysis is a technique for reducing the dimensionality of such a set of variables, increasing interpretability but at the same time minimizing loss of information. Many techniques have been developed for this purpose, but principal component analysis is one of the oldest and widely used. The PCA achieves this by creating new uncorrelated variables that successively maximize variance. The new uncorrelated variables derived from the dataset are referred to as the principal components. Basically, one reduces the dimensionality of a data set while preserving as much variability as possible. The PCA technique important strength is in its parametric weights as opposed to non-parametric techniques that derive subjective weights of the variables in the index. The study constructs a fintech index in line with Nguyen; 2020 and Camara and Tuesta; 2014 who construct multidimensional indices for developing and developed countries using two-stage PCA.

From world bank data sources, the following fintech/ financial inclusion indicators are used to construct a fintech index for Eswatini. Each financial inclusion indicator relates to different dimensions defining financial inclusion (Sarma; 2012). The variables that measure

Penetration: mobile subscriptions per 100 people, registered mobile accounts per 1000 adults and total number of active mobile customers.

Availability: ATMs per 100 000 adults, registered mobile money agents per 100 000 adults and total number of mobile agents per 1000 adults.

Usage: and person to person mobile transactions.

There are two reasons for subdividing the financial inclusion indicators; we obtain disaggregated

information that is essential for policy making and for methodological purposes, since the sub-indices contain highly inter-correlated indicators, they are estimated first, escalating to the overall index rather than estimating the overall index directly from the financial inclusion indicators. Empirical evidence (Mishra, 2007) supports that PCA is biased towards the weights of indicators which are highly correlated with each other.

(i) The Correlation matrix

The study examines the correlation matrix of the financial inclusion indicators (see Table 3 appendix). A brief interpretation of the correlation matrix structure suggests that the number of mobile subscriptions and registered mobile money accounts are highly correlated to the other indicators. These indicators could display the general trend in the market embodying characteristics of principal component. ATMs per 100 000 adults are weakly correlated with the other indicators suggesting that the financial indicators either substitute ATMs or are growing independent of them.

The relationships of the fintech indicators revealed by the correlation matrix could be supported by the World Global Findex report of 2025. The report states that of people over the age of 15 in low-income countries, nearly 32 per cent said they had mobile money accounts opposite 26 per cent with a bank account. While access to both types of accounts has been growing over the years, mobile money accounts have expanded faster in recent years. Mobile money accounts are accounts that are accessible even with basic mobile phones, can receive, send and store money and are linked to an individual's phone number. The report found that any growth in the number of banked people in low and middle-income countries was equivalent to the growth of people using mobile money exclusively or in combinations with traditional accounts. Countries where mobile money account ownership surpass traditional bank account ownership were mostly located in Sub-Saharan Africa with Zambia at 45 per cent, followed by Kenya and Uganda at 42 per cent and Ghana at 40 per cent in 2024 (Buchholz; 2025).

(ii) Estimation of the Financial Technology Index.

In the first phase, as earlier indicated, the study estimates the three sub-indices: penetration,

availability and usage defining financial inclusion. In the second phase, the dimension weights and overall financial inclusion index is estimated by using the dimensions as explanatory variables.

The overall financial inclusion/fintech index is determined as follows:

$$FI_t = \omega_1 Y_t^p + \omega_2 Y_t^a + \omega_3 Y_t^u + \varepsilon_t \quad (1)$$

Where superscripts p , a and u denote penetration, availability and usage respectively.

4.2.1 First Stage PCA

The first stage aims to estimate the dimensions, that is, the three unobserved endogenous variables Y_t^p , Y_t^a and Y_t^u and the parameters in the following system of equations:

$$Y_t^p = \beta_1 ms_100p_t + \beta_2 rmmac_1000a_t + \beta_3 tmacu_t + \varepsilon_{tp} \quad (1a)$$

$$Y_t^a = \theta_1 atms_100000a_t + \theta_2 iinter_pop_t + \theta_3 tma_t + \varepsilon_{ta} \quad (1b)$$

$$Y_t^u = \alpha_1 mmt_100a_t + \alpha_2 vmt_gdp_t + \alpha_3 ppmt_t + \varepsilon_{tu} \quad (1c)$$

Where ms_100p_t is mobile subscription per 100 people, $rmmac_1000a$ is registered mobile money accounts per 1000 adults, $tmacu_t$ is the total mobile active customers, $atms_100000a_t$ is ATMs per 100000 adults, $iinter_pop_t$ is individuals using the internet as a per cent of GDP, tma_t is total mobile agents, mmt_100a_t is mobile money transactions per 100 adults and vmt_gdp_t is the value of mobile money transactions as a per cent of GDP and $ppmt_t$ is person to person mobile transactions.

5. Data Overview

Data source: The data sources are World Bank publications and the Central Bank of Eswatini (CBE) National payments division, and the data are on yearly and monthly frequency respectively. Financial technology indicators from these sources are used to construct the financial technology index for Eswatini using Principal Component Analysis (PAC). Though the data from the CBE National Payments Division end in December 2024 comes on monthly intervals, the World Bank data are only comprehensive up to December 2020 and come on an annual basis. Hence for the construction of a more robust financial

technology index including more indicators from the World bank publication the study covers the period 2013 to 2020.

Data Limitations and Treatments: The annual data from the World Bank publication are interpolated on log linear basis in e-views to obtain monthly data points. Hence PCA is used to address issues of noise resulting from the interpolated data.

6. Modelling Fintech and Monetary Policy

The study will first examine fintech and the stability money in the economy in line with (Mumtaz and Smith, 2020; Oyadeyi, 2025; Parveen et al, 2020 and Chen, 2021). The authors assess stability in the demand for money and velocity of money. The study ends ultimately by addressing the main purpose of the study which is to assess fintech and the effectiveness of monetary policy.

6.1.1 Fintech, Money Velocity, and Demand for Money

Approaches to the demand for money vary from the Fischer's approach where he posited that prices depend on money demand while transaction volume and velocity of money is constant. Fischer's exchange equation is expressed as:

$$MV = PT \quad (1)$$

Where M is money supply, V is the velocity of money, P is the price level and T are transactions in economy. The general framework for long-term demand for money (Sriram; 2001):

$$\frac{M}{P} = f(S, OC) \quad (2)$$

Where the demand for real money balances is a function the chosen scale of variables (S) to represent economic activity and the opportunity cost (OC). Real GDP is used by most studies reviewed by Sriram; 2001 as a gauge for economic activity and control variables are predominantly the cpi, exchange rate and opportunity cost variables featuring mainly short to long term rates. The study adopts from Praveen

et al; 2020, Chen; 2021, Bartram et al; 2024 and Oyadeyi; 2025 in constructing the models for the velocity of and demand for money. Economic activity and opportunity cost are accounted for as the main features of the model and country relevant control variables are added to complete the models.

The velocity of money indicates economic activity, inflationary pressures and policy effectiveness. This means that, on the one hand, high velocity of money (the more unit of currency exchanges hands/transact) encourages economic activity. Lower velocity on the other hand shows that economic agents prefer liquidity, investment in short term and long-term liquid assets, treasury bills and bonds respectively as opposed to real spending to boost economic activity. The transmission mechanism is derived from Keynes (1936) postulation that economic agents hold cash for transactions and precautionary purposes driven by the substitutional effects of the level of interest rates on real and money market investments. The study invokes Irving Fischer's velocity of money, incorporated in line with Chen; 2021, on the analysis of the impact of digital payments on the velocity of

money in the Chinese market and Oyadeyi; 2025, on financial innovation and money demand in Nigeria: exploring the impact of banking innovations, fintech development and digital payment channels on the money demand. Irving Fischer's equation will be re-arranged in two ways to express the demand for and velocity of money:

$$Md_t = \frac{PT_t}{V_t} \quad (2a) \quad \text{money demand}$$

And

$$v_t = \frac{PT_t}{Ms_t} \quad (2b) \quad \text{velocity of money}$$

Hence

$$Md_t = f(y, cpi, findex, disc_rate, er) \quad (3)$$

$$V_t = f(y, findex, cpi, disc_rate) \quad (4)$$

Variables from the Eswatini's economy are listed in following table:

Table 1: Variable Description

Category	Variables	Frequency	Description
Dependent Variables	<i>Md</i>	Monthly	Broad money supply (M2) defined is demand deposit +time and savings deposit.
	<i>V</i>	Monthly	Velocity of money defined as the Ratio of GDP to broad money
Independent	<i>findex</i>	monthly	Financial inclusion/technology index calculated for financial inclusion indicators.
Control variables	<i>y</i>	monthly	Gross domestic product
	<i>cpi</i>	monthly	Consumer price index
	<i>disc rate</i>	monthly	Discount rate (monetary policy rate).
	<i>er</i>	monthly	Exchange rate (local unit to US dollar)
	<i>tbr_sp</i>	monthly	Eswatini's Treasury bill rate spread against South Africa's
	<i>res_tar_dev</i>	monthly	Eswatini's international reserves deviation from 3 months target.

Where Y is output, cpi is consumer price index, t is the discount rate and er is the exchange rate.

The Eswatini economy's liquidity or rather the demand for money in the banking sector is placed in real sector activity through credit to business and households against placements in short and long-term financial instruments offers in the 3 months

treasury bills and 3 to 10 years bonds (Central Bank of Eswatini Quarterly Reviews). The short and long-term financial instruments track their South African counterparts at a premium to curb capital flight. The monetary policy rate (discount rate) tracks short term rates.

The model specifications for money demand and velocity for money are:

$$lMd_t = \alpha_1 lindex_t + \alpha_2 disc_rate_t + \alpha_3 ler_usd_t + \alpha_4 lcpi_t + \varepsilon_t \quad (3a)$$

$$lvlc_t = \theta_1 lindex_t + \theta_2 disc_rate_t + \theta_3 cpi_t + \varepsilon_t \quad (4a)$$

Where lMd_t is the log of broad money (M2), $lindex_t$ is the financial technology indicator, ler_usd_t is the exchange rate of the local unit to the USD, $lcpi_t$ is the consumer price index.

6.1.2 Impact of Fintech Innovation and Effectiveness of Monetary Policy

The impact of financial technologies on the effectiveness of monetary policy is gauged by

Model specification:

$$lres_tar_dev_t = \beta_1 findex_mpst_t + \beta_2 ler_usd_t + \beta_3 tbr_sp_t + \beta_4 res_tar_dev_{t-1} + \varepsilon_t \quad (5)$$

Where $ires_tar_dev_t$ is the log of international reserves deviation from the 3 months target of import cover, $findex_mpst_t$ is the financial technology index and monetary policy stance interactive variable. The monetary policy is defined as the Eswatini policy rate less South Africa policy rate ($mpst_t$) and ler_usd_t is the log of the exchange rate of the local unit to the USD, is the Eswatini's treasury bill rate less South Africa's treasury bill rate.

7. Data Analysis and Methodology

The variables were all found to be $I(1)$ on performance of the ADF and Phillip Peron test. All the variables pass normality tests save for the exchange rate (er_usd). Endogeneity tests are performed on all the independent variables of the 3 equations to be estimated (see appendix tables 9). In simply terms, instrumental variables (IV) estimator of the classical linear regression model states that if the error

assessing the effects of the interactive variable of the financial technology index and the monetary policy stance. Under a fixed exchange rate regime international reserves become the target on which the fixed exchange rate is anchored. The Central bank of Eswatini is comfortable with 3 months of import cover at a target for international reserves.

distribution cannot be considered independent of the regressors' distribution, IV is appropriate. The IVs must be both relevant and valid, correlated with the endogenous regressors and at the same time orthogonal to the errors (Baum et al; 2003). It is therefore useful to test whether OLS is inconsistent and IV or GMM is required. The endogeneity tests are performed using J-statistics where independent variables along with the rest of the variables are regressed against the variable of interest ($findex$) and the null hypothesis of exogeneity cannot be rejected (see appendix tables 9). Excess domestic liquidity, base money and the treasury bills rate for the estimation of the demand for money, the base money and excess domestic liquidity for the velocity of money and the base money, South Africa's repo rate and domestic inflation are selected for monetary policy efficacy estimation, are selected as instrumental variables. The test fails to reject the hypothesis exogeneity for all the independent variables (see appendix tables 9). Due to the endogeneity problem identified the study

employs a generalized method of moments in the 2-stage least squares version is opted. GDP was left out of the estimation because it is part of the financial inclusion indicators used to construct the Findex for Eswatini and would be double counted. The data are seasonally adjusted by taking 3 months averages. The equations are corrected for autocorrelation and heteroskedasticity detected in tables 9 by estimating HAC (Newey-West) equation from the initial results equation.

8. Estimation Results Interpretation

(i) Velocity of money and the Demand for money

In this section the impact of fintech on the velocity

of money through estimating the equations (3b) using 2-stage least squares. The effect of financial technology captured by the Findex is negative and highly significant in line with the finding by Otoakhia; 2023 in the case of Nigeria. The mobile payment system has encouraged holding of cash within the system, hoarding to smoothen expenditure in hard times. Economic agents therefore transact with less cash by 0.09 percent with a percentage point increase in fintech activity. Figure 3 gives a picture of hoarding in mobile money transactions where deposits surpassing a billion Emalangeni in 2023 compared to withdrawals in the regions of +500 million Emalangeni and locking in +500 million in the system. The deposits show an accelerating trend compared to withdrawals, suggesting greater dampening effects on the velocity of money if the trend persists.

Table 2. Results of velocity of money and Demand for money.

	log (Md)	log (vlc_sa)	Md_HAC adj	vlc_HAC adj
independent variable				
log(findex)	-0.143*** (-12.927)	-0.09*** (-16.366)	-0.137***	-0.09*** (-10.81)
log(er_usd (-4))	-0.2*** (-1.77)		-0.25 (-1.168)	
disc_rate	0.030*** (3.177)	0.011 (1.288)	0.026 (2.744)	0.011 (0.012)
log(cpi_sa)	3.22*** (55.60)	0.374*** (31.041)	3.25*** (32.425)	0.374*** (23.021)
observations	90	90	90	90
R squared	0.95	0.53	0.94	0.53
J-statistics	0.00	0.00	0.00	0.00
Instruments rank	4	3	3	3

The impact of fintech on the demand for money is negative and highly significant. This is expected given the finding on the impact of fintech on the velocity of money. The demand for money's reduction due to a percentage point increase in the fintech index is 0.137 percent greater than effects fintech has on the velocity of money.

(ii) Money Policy Target and Findex Equation

The impact of findex on monetary policy is estimated by equation 5 through the interactive variable of the fintech and the monetary policy stance of Eswatini vis-à-vis South Africa's.

Table 3. Results for the Impact of Fintech on Monetary Policy.

	log(res_tar_dev)			HAC adj.
independent variable				
log (findex (-2)	0.021			
	(0.300)			
mpst (-2)		0.045		
		(0.39)		
log (findex_mpst)			0.008	0.008
			(0.310)	(0.278)
log (er_usd)	-0.056	-0.007	-0.0071	-0.0071
	(-0.319)	(-0.512)	(-0.512)	(-0.496)
TBR_SP	0.055	0.04*	0.039	0.039***
	(1.059)	(1.44)	(1.394)	(2.013)
log(res_tar_dev)	0.97***	0.95***	0.94***	0.94***
	(2.681)	(3.263)	(3.511)	(3.348)
observation	93	93	93	93
R squared	0.61	0.64	0.64	0.64
J-statistics	0.00	0.00	0.00	0.00
Instrument rank	4	4	4	4

Efficacy of monetary policy measured by the deviation of the international reserves from a 3-month target is not enhanced by fintech activity, though the impact is positive it is insignificant. International reserves are predominately driven by persistence, drawn from SACU receipts that are received consistently per quarter in equal tranches. The SACU receipts therefore change on an annual.

9. Conclusion and Policy Recommendation

The development of financial innovation has reduced the velocity on money and mobile money deposits

have in faster than withdrawals. Weakening consumer confidence could be driving the trend notwithstanding that the trend escalated during the COVID-19 period (see figure 3). If the trend persists under normal economic conditions, it could reduce deposit levels in the banking sector with volumes' value of mobile money transactions surpass the SZL 1 billion mark. Monitoring the trend with a deeper understanding of its drivers is necessary. The impact fintech on the efficacy of monetary policy though found to be insignificant, it could be temporal given that countries at advanced stages of financial technology found significant results.

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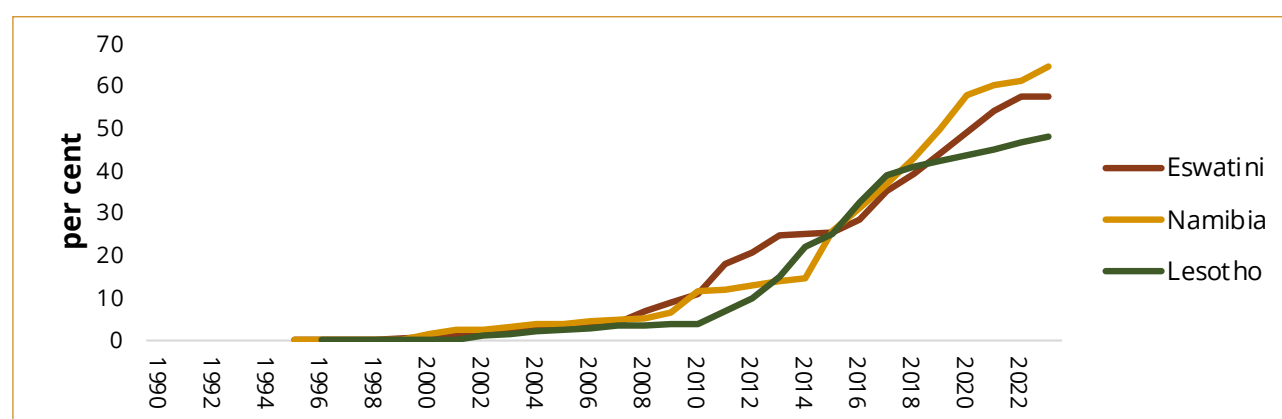
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Appendix

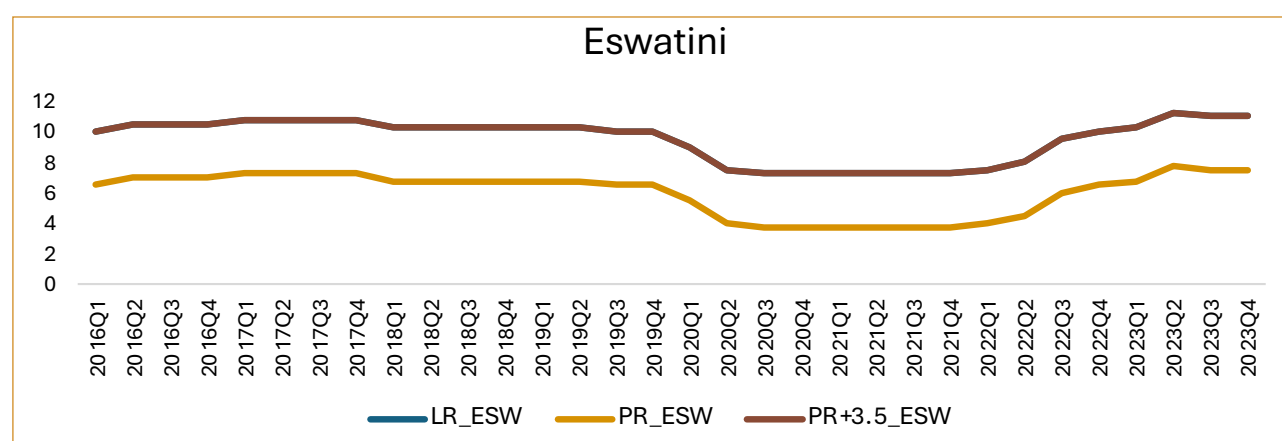
Table 2. E-Money Account Ownership.

E-Money Account Ownership		
Country	2011	2024
1. Eswatini	30%	65%
2. Lesotho	20%	61%
3. Namibia	60%	73%

Source: Global Findex 2025

Figure 4. Internet Usage

Source: fred.stlouisfed.org

Figure 5. Eswatini Policy Rate and Lending Rate.

Source: Central Bank of Eswatini quarterly review

Table 3. Fintech Indicators Correlation matrix

	ATMS_100000A	IINTER_POP	TMA	MS_P100P	RMMAC_1000A	TMACU	MMT_1000A	VMT_GDP	PPMT
ATMS_100000A	1.00	0.68	0.64	0.82	0.83	0.85	0.49	0.44	0.68
IINTER_POP	0.68	1.00	0.97	0.94	0.95	0.82	0.91	0.85	0.98
TMA	0.64	0.97	1.00	0.89	0.94	0.84	0.87	0.80	0.98
MS_P100P	0.82	0.94	0.89	1.00	0.96	0.89	0.84	0.81	0.92
RMMAC_1000A	0.83	0.95	0.94	0.96	1.00	0.93	0.80	0.74	0.96
TMACU	0.85	0.82	0.84	0.89	0.93	1.00	0.58	0.53	0.85
MMT_1000A	0.49	0.91	0.87	0.84	0.80	0.58	1.00	0.98	0.87
VMT_GDP	0.44	0.85	0.80	0.81	0.74	0.53	0.98	1.00	0.81
PPMT	0.68	0.98	0.98	0.92	0.96	0.85	0.87	0.81	1.00

Table 4. List of Financial Inclusion Variables

Variable		Source
	Penetration	
1.	(i) Mobile subscription per 100 people (MS_P100P)	World Bank
2	(ii) Registered mobile accounts per 1000 people (RMMAC_1000A)	World Bank
3.	(iii) Total number of mobile active customers (TMACU)	CBE
	Availability	
4.	(i) Registered mobile money agents per 100 000 adults	World Bank
5.	(ii) Total number of mobile agents (TMA)	CBE
6.	(iii) ATMs per 100 000 adults (ATMS_100 000A)	World Bank
7.	(iv) Internet connected population (IINTER_POP)	World Bank
	Usage	
8.	(i) Value of mobile transactions % of GDP (VMT_GDP)	CBE
9.	(ii) Total number of mobile transactions	CBE
	(iii) Total value mobile transactions (deposits and withdrawals)	CBE
10.	(iv) Person to person mobile transactions (PPMT)	CBE
11.	(v) Person to person value of mobile transactions	CBE
12.	(vi) Mobile transactions per 1000 adults (MMT_1000A)	World bank

Table 5

PRINCIPAL COMPONENTS ESTIMATES				
Availability				
Variable	PC1	PC2	PC3	norm. Weight
ATMs_1000000A	0.479297	0.874946	0.068869	0.7949
IINTER_POP	0.613785	-0.390251	0.686274	0.1968
TMA	0.627329	-0.286659	-0.724075	0.0083
Eigenvalue	2.384715	0.590507	0.024778	1.0

PRINCIPAL COMPONENTS ESTIMATES				
Penetration				
Variable	PC1	PC2	PC3	norm. Weight
MS_P100P	0.576512	-0.587433	0.567941	0.8952
RMMAC_100A	0.598695	-0.169332	-0.782873	0.0886
TMACU	0.556056	0.791359	0.254071	0.0162
Eigenvalue	2.685456	0.265902	0.048642	1.0

PRINCIPAL COMPONENTS ESTIMATES				
Usage				
Variable	PC1	PC2	PC3	norm. Weight
MMT_1000A	0.596789	-0.261001	-0.758763	0.9136
VMT_GDP	0.582867	-0.508880	0.633488	0.0823
PPMT	0.551460	0.820317	0.151565	0.0041
Eigenvalue	2.740747	0.247035	0.012218	1.0

PRINCIPAL COMPONENTS ESTIMATES				
Overall				
Variable	PC1	PC2	PC3	norm. Weight
YA	0.593049	-0.337570	-0.730985	0.9070
YP	0.550652	0.832403	0.062340	0.0841
YU	0.587430	-0.439490	0.679540	0.0089
Eigenvalue	2.721026	0.252321	0.026653	1.0

Figure 6. Eswatini Financial Technology Index

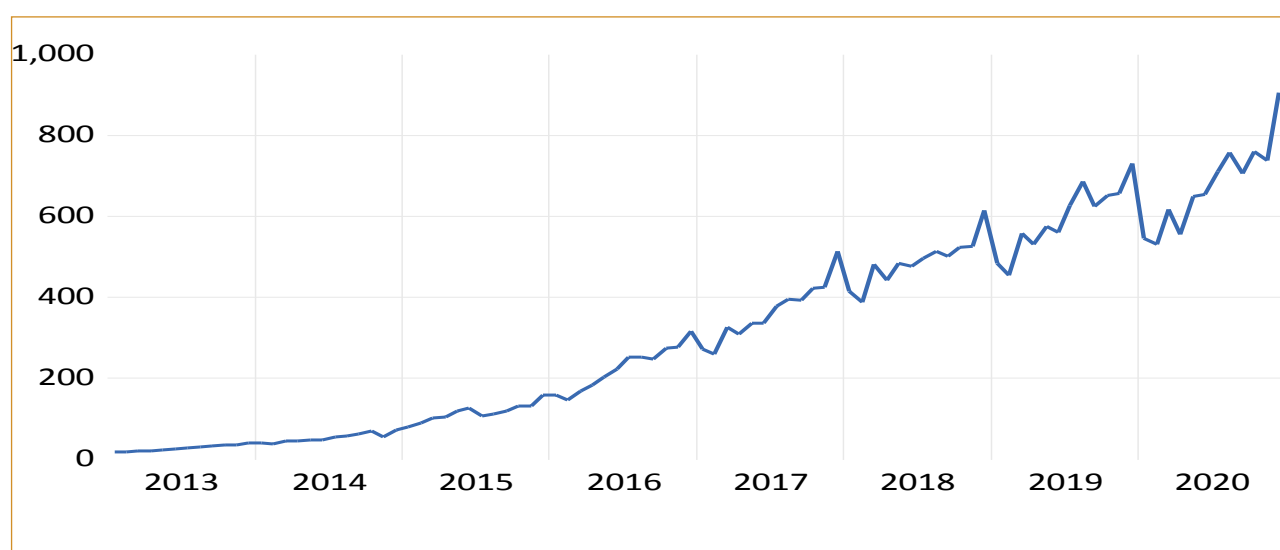


Table 7. Correlation matrix Money Demand Estimation

	M2	GDP_SA	DISC_RATE	ER_USD	CPI
M2	1.00	0.96	0.41	0.75	0.98
GDP_SA	0.96	1.00	0.38	0.79	0.98
DISC_RATE	0.41	0.38	1.00	0.16	0.36
ER_USD	0.75	0.79	0.16	1.00	0.81
CPI	0.98	0.98	0.36	0.81	1.00

Table 8. Unit Root Tests

Variable	ADF			Phillip Peron		
	specification	levels	first diff	levels	first diff	Decision
Money Demand (M2)	Intercept	-0.26	12.11***	0.18	-12.23***	I(1)
	Trend + intercept	-3.27*	-12.11***	-3.08	-12.29***	
	non	1.94*	-11.58***	2.80	-11.57	
y	Intercept	0.07	-10.55***	-0.06	-10.67***	I(1)
	Trend + intercept	5.87***	-10.56***	-2.78	-10.68***	
	non	2.19	-1.16	2.04	-10.32***	
disc rate	Intercept	-0.89	-5.62***	-0.66	-5.61***	I(1)
	Trend + intercept	-0.32	-6.00***	0.22	-6.00***	
	non	-0.54	-5.64***	-0.55	-5.62***	
cpi	Intercept	-1.82	-1.81	-0.99	-26.23***	I(1)
	Trend + intercept	0.33	-1.99	-4.91***	-28.18***	
	non	6.51	-0.28	5.90	-12.62***	
er	Intercept	-1.78	-7.50***	-1.58	-7.27***	I(1)
	Trend + intercept	-2.79	-7.47***	-2.44	-7.23***	
	non	0.87	-7.39***	1.19	-7.19***	
Findex	Intercept	2.54	-2.15	1.59	-15.11***	I(1)
	Trend + intercept	-3.45*	-2.37	-3.76**	-16.56***	
	Non	4.04	-0.29	3.74	-13.21***	

res_tar_dev	Intercept	-2.18	-4.11***	-3.20**	-13.39***	I(1)
	Trend+intercept	-2.33	-3.41*	-3.88**	-13.29***	
	non	-1.56	-340***	-2.08**	-13.47***	
mm	Intercept	-2.15	-12.23***	-4.15***	14.83***	I(1)
	Trend+intercept	-2.29	-12.17***	-4.22***	-14.76***	
	non	-0.80	-12.25***	-0.81	-14.80***	
vlc	Intercept	-1.263	-4.47***	-1.35	-4.63***	I(1)
	Trend+intercept	-2.505	-4.45***	-2.64	-4.58***	
	non	-1.135	-4.41***	-0.79	-4.62***	

Tables 8. Descriptive Statistics

	M2	GDP	DISC_RATE	ER_USD	CPI	MM
Mean	1220325	3368.417	5.989362	13.13936	108.6436	1.313516
Median	1244056	3343.585	6.5	13.45	110.2	1.306267
Maximum	1646744	3601.22	7.25	18.6	130.1	1.668486
Minimum	823345.4	3151.45	3.75	8.8	85.4	1.093198
Std. Dev.	252780.2	130.264	1.013958	2.188544	12.93524	0.114314
Skewness	-0.09428	0.182705	-0.44732	0.048514	-0.11771	0.579288
Kurtosis	1.422446	1.845953	2.098008	2.577467	1.660491	3.340602
Jarque-Bera	9.886568	5.739276	6.321375	0.736131	7.244678	5.833232
Probability	0.007131	0.056719	0.042397	0.692072	0.02672	0.054117
Sum	1.15E+08	316631.2	563	1235.1	10212.5	126.0975
Sum Sq.	1.46E+14	1.07E+09	3467.625	16673.87	1125084	166.8725
Sum Sq. Dev.	5.94E+12	1578091	95.61436	445.4444	15560.81	1.241427
Observations	94	94	94	94	94	96

	ER_USD_SA	GDP_sa	M2_sa	LER_USD
Mean	13.13516	4593114	1215590	2.561472
Median	13.36667	4673954	1234659	2.598972
Maximum	17.86667	5732065	1571718	2.923162
Minimum	8.933333	3430832	847230.3	2.174752
Std. Dev.	2.053659	693499.2	245346.1	0.170726
Skewness	-0.03197	-0.00014	-0.11886	-0.32283
Kurtosis	2.49307	1.693022	1.366718	2.505863
Jarque-Bera	0.989874	6.476896	10.32895	2.589111
Probability	0.609609	0.039225	0.005716	0.27402
Sum	1195.3	4.18E+08	1.11E+08	240.7784
Sum Sq.	16080.04	1.96E+15	1.4E+14	619.4579
Sum Sq. Dev.	379.5764	4.33E+13	5.42E+12	2.710715
Observations	91	91	91	94

Tables 9

Endogeneity Test:			
Equation: Findex impact on Money Demand and Estimation.			
Endogenous variables to treat as exogenous: LOG(MD_3MA) LOG(ER_USD_3MA) DISC_RATE LOG(CPI_3M)			
Specification: LOG(FINDEX) LOG(MD_3MA) LOG(ER_USD_3MA), DISC_RATE LOG(CPI_3M)			
Instrument specification: C LOG(BASE_MONEY) LOG(EX_DOMLIQ), TB_RATE_ES			
Null hypothesis: LOG(MD_3MA), LOG(ER_USD_3MA), DISC_RATE, LOG(CPI_3M) are exogenous			
	Value	df	Probability
Difference in J-stats	61.98286	4	1.11E-12
J-statistic summary:			
	Value		
Restricted J-statistic	61.98286		
Unrestricted J-statistic	0		

Money Demand and Findex Estimation				
Heteroskedasticity Test: Breusch-Pagan-Godfrey				
Null hypothesis: Homoskedasticity				
F-statistic	0.289174	Prob. F(4,85)		0.884263
Obs*R-squared	1.208295	Prob. Chi-Square (4)		0.876731
Scaled explained SS	0.916135	Prob. Chi-Square (4)		0.922235

Money Demand and Findex Estimation				
Breusch-Godfrey Serial Correlation LM Test:				
Null hypothesis: No serial correlation at up to 2 lags				
Obs*R-squared	58.10552	Prob. Chi-Square (2)		0.00

Endogeneity Test			
Equation: Findex Impact on Velocity of Money and Estimation			
Endogenous variables to treat as exogenous: LOG(VLC_SA) LOG(CPI_3M) DISC_RATE			
Specification: LOG(FINDEX) LOG(VLC_SA) LOG(CPI_3M) DISC_RATE			
Instrument specification: C LOG(BASE_MONEY) LOG(EX_DOMLIQ)			

Null hypothesis: LOG(VLC_SA) LOG(CPI_3M) DISC_RATE are exogenous			
	Value	df	Probability
Difference in J-stats	79.06013	3	0.00
J-statistic summary:			
	Value		
Restricted J-statistic	79.06013		
Unrestricted J-statistic	0.00		

Velocity and Fintech eqn				
Breusch-Godfrey Serial Correlation LM Test:				
Null hypothesis: No serial correlation at up to 2 lags				
Obs*R-squared	74.71974	Prob. Chi-Square(2)		0.00

Endogeneity Test				
Equation: Findex_Disc Impact on Monetary Policy Effectiveness				
Endogenous variables to treat as exogenous: LOG(GDP_SA) LRES_TAR_DEV LOG(ER_USD_3MA) TB_RATE_ES				
Specification: FINDEX_DISC LOG(GDP_SA) LRES_TAR_DEV LOG(ER_USD_3MA) TB_RATE_ES				
Instrument specification: C BASE_MONEY EX_DOMLIQ VLC_SA				
Null hypothesis: LOG(GDP_SA) LRES_TAR_DEV LOG(ER_USD_3MA) TB_RATE_ES are exogenous				
	Value	df	Probability	
Difference in J-stats	67.63116	4	0.00	
J-statistic summary:				
	Value			
Restricted J-statistic	67.63116			
Unrestricted J-statistic	0			

Monetary effectiveness eqn.				
Breusch-Godfrey Serial Correlation LM Test:				
Null hypothesis: No serial correlation at up to 2 lags				
Obs*R-squared	15.83375	Prob. Chi-Square (2)		0.000365

Monetary effectiveness eqn.				
Heteroskedasticity Test: Breusch-Pagan-Godfrey				
Null hypothesis: Homoskedasticity				
F-statistic	4.07607	Prob. F(4,88)		0.00445
Obs*R-squared	14.53725	Prob. Chi-Square (4)		0.005764
Scaled explained SS	12.8831	Prob. Chi-Square(4)		0.011861

An Assessment of Fiscal and Public Debt Sustainability in Eswatini

By

Bongani Dlamini¹ And Nomvuyo Hlophe²

Abstract

This paper seeks to review public debt sustainability in Eswatini, more specifically to evaluate how government reacts to rising debt levels. The primary balance and public debt was used as key variables. The choice of primary balance has been found suitable given that primary expenditures are more easily controlled by government. The primary balance was modelled using the autoregressive distributed lag (ADRL) method to test for cointegration. The study used data from 2005-2025 to examine both short run and long run relationships between the variables. The study found that the variables are cointegrated in the long run and that the long run coefficient of public debt to GDP is positive and statistically significant. This indicates that fiscal authorities react systematically to rising public debt ratio to ensure fiscal sustainability. In the short run the study found that the primary balance responds negatively to fiscal crisis and exchange rate depreciation. This shows that during a fiscal crisis the primary balance may deteriorate and threaten fiscal sustainability.

Key words: Public debt, Primary balance, Fiscal Sustainability, ARDL, Eswatini.

1. Introduction

Governments finance their operations through revenue they raise through taxes and borrowing. With governments undertaking projects of planned economic development on a large scale, it is not possible for them to meet the related expenditure entirely either through taxation or the creation of new money. There is a certain limit beyond which

revenue from taxation cannot be raised as it would then affect the level of investment, production and people's paying capacity in the country. Financing projects through the creation of new money (printing money) beyond a certain level becomes inflationary (Aggarwal, 2008). Hence governments often resort to borrowing as a source of resource mobilization.

Public borrowing is meant to finance developmental projects if it is to be meaningful and sustainable. In this manner it discourages unproductive expenditure since it comes at a cost to the taxpayer. In as much as there is a certain level of revenue which can be raised through taxation and printing money, there is also a limit to which a government can contract debt beyond which the country can become debt stressed and eventually be unable to service its debt.

The focus of this research is on providing a brief overview of public debt management in Eswatini and to establish whether the country still remains within sustainable debt levels when faced with a financial crisis. An analysis of the public debt portfolio will be made linking it to literature on public (sustainable) debt management. The research will proceed to give an explanation of what the consequences of the findings are regarding current debt levels.

2. Background

Eswatini is a small, landlocked country situated between Mozambique and South Africa. It is classified as a lower-middle income country based on Gross National Income per capita. It is a member of the Southern African Customs Union (SACU), a revenue sharing union amongst member countries, and the Common Monetary Area (CMA) where member countries' currencies are pegged to the Rand. For a long time, SACU revenues have been the major source of revenue for Eswatini, contributing on average 60 percent of total government revenue (based on an agreed revenue sharing formula).

Recently the country has been faced with macroeconomic challenges which include; the unsustainability of SACU receipts, with global financial

¹ Bongani Dlamini is a Principal Economist, Policy Research, in the Research Department. Email: bonganid@centralbank.org.sz

² Nomvuyo Hlophe is a Senior Economist, Public Finance, in the Research Department, Email: nomvuyohl@centralbank.org.sz

crisis resulting to declines in SACU revenues for the country; narrow domestic revenue base coupled with declining Foreign Direct Investment (FDI); the Middle Income Country (MIC) status that has resulted in non-concessional financing and limited access to grant assistance; increasing expenditure patterns which exceed revenue; and ensuring a sustainable budget deficit. Eswatini has been contracting debt from as early as the 1960's. Throughout this period the country has maintained healthy levels of debt although it has been operating without a debt strategy.

The Ministry of Finance is responsible for the technical and strategic policy functions relating to debt management. It has the legal authority to borrow because it is the ministry responsible for formulating the budget and assessing financing requirements. The mandate of the ministry is to ensure that terms and conditions of borrowings are met as well as ensure that debt levels remain sustainable and debt obligations are met. The Treasury Department which is affiliated to the Ministry of Finance but headed by the Accountant General is responsible for facilitating payments to the creditors via the Central Bank of Eswatini. The Central Bank on the other hand, is responsible for market development, issuing and settling domestic debt. It also plays an advisory role to the Ministry of Finance in the formulation of debt management policy as well as supporting the debt management function.

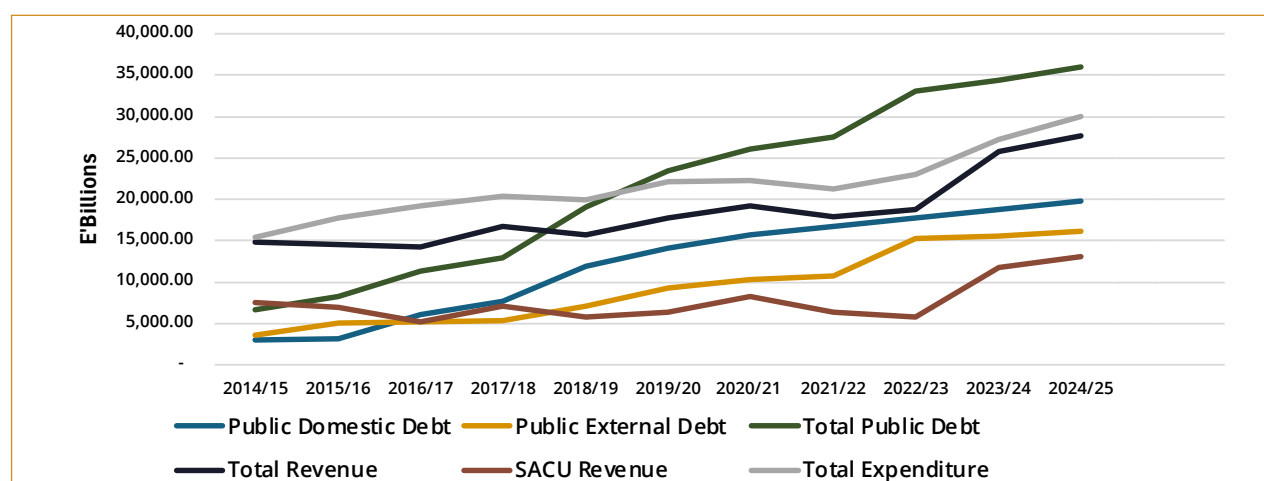
2.1 Trends in Public debt in Eswatini

Just like other countries, Eswatini experienced a severe financial crisis in 2009/2010 which had been looming since 2008 with massive declines in SACU

revenues after the global financial crisis. To date the country has not fully recovered from the crisis. At the onset of the financial crisis in 2010 when SACU revenue declined by over 60 percent the country has had to undertake some major reforms (both structural and institutional) to ensure financial stability. These reforms were stipulated in the Fiscal Adjustment Roadmap (FAR, 2010) document which was produced by the International Monetary Fund (IMF) in consultation with the Government of the Kingdom of Eswatini. Amongst others, reforms on the expenditure side include a wage freeze, a slowdown in the implementation of capital (investment) projects, and the Voluntary Exit Strategy to reduce the wage bill. On the revenue side the government had introduced VAT. These reforms were for the short to medium term. They were intended to reduce government expenditure (to bring the budget deficit to levels of about 3 percent of GDP. However, the challenge remained as this budget deficit was rarely met. This therefore means that there is still a huge financing gap for the government budget.

The Government of Eswatini (GoS) decided to mobilize resources through external and domestic borrowing. Consequently, parliament amended a legislation to increase the domestic debt ceiling from SZL 1 billion to SZL 5 billion and external borrowing is still on the increase. Although debt stock levels in Eswatini have been relatively low, government borrowing is still increasing. This kind of borrowing is unproductive because it had mostly been used to finance the government deficit and only most recently that it has been used to finance development projects.

Figure 1: Evolution of Public Debt in Eswatini



Source: Ministry of Finance

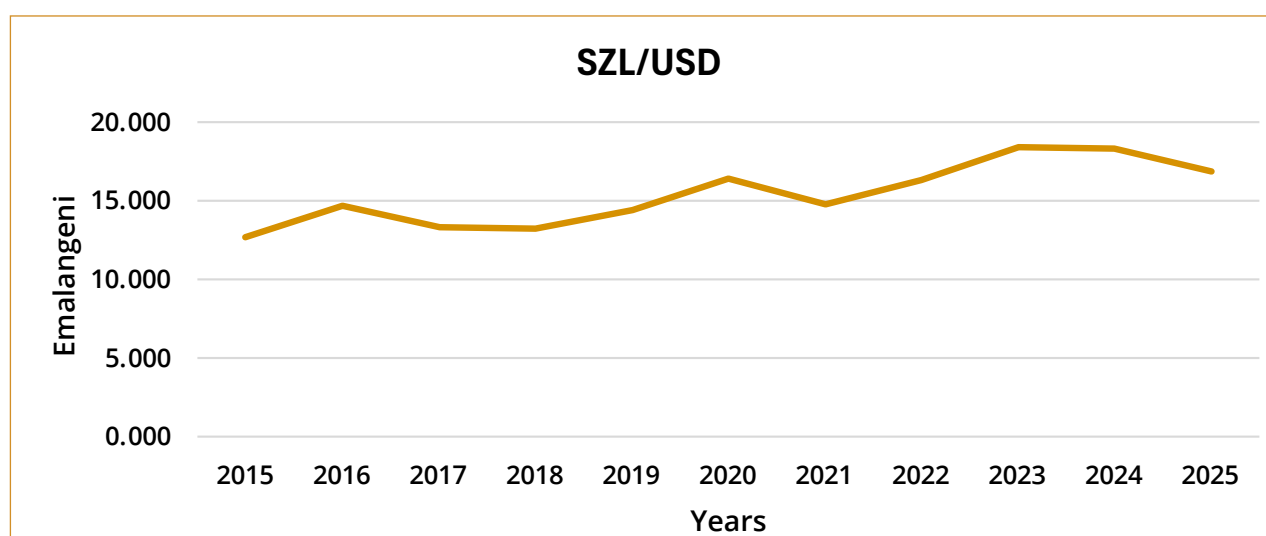
As illustrated in the Figure above, in 2014/15 Eswatini had very little debt evidenced by the almost equal levels of public revenue and public expenditure. Until around 2016/2017, public debt was predominantly foreign. There exists a pattern that external debt was used to finance infrastructure development while domestic debt was specifically used for budget deficit financing. This is mirrored by the increase in domestic debt around the same period as when the country experienced a decline in SACU revenues. Since a bulk (over 60 percent) of revenues were from SACU transfers, when the financial crisis hit the country (2009/10 to 2011/12), foreign donors perceived a default risk on the country and reacted by withholding credit to Eswatini.

2.1 Exchange Rates Developments in Eswatini

Exchange rates serve as a link between the local and overseas markets for various goods, services

and financial assets. Using the exchange rate we are able to compare the prices of goods, services and assets quoted in different currencies. Volatility in the exchange rate has varying economic consequences. Of these is that exchange rate movements can affect actual inflation as well as expectations about future price movements. In a similar way that exchange rates can affect domestic prices of imported goods, they can affect the cost of servicing (interest and principal payments) the country's foreign debt. A Lilangeni appreciation reduces the amount of Lilangeni needed to buy foreign exchange to service debt obligations. While for a depreciation, the reverse will hold true. The Figure below illustrates the movements in nominal exchange rates of the local currency (Lilangeni) to the US dollar from 2015 to 2025. During the period under review the exchange rate of the Lilangeni was consistently depreciating up to 2023 when the local currency was at its lowest (around 18.45 to the dollar), causing the cost of servicing debt to increase.

Figure 2: Exchange Rate Movement (Lilangeni/US Dollar 2015-2025)



Source: Central Bank of Eswatini

3. Literature Review

The literature review provides a brief definition of the debt management function and then gives an outline of theoretical underpinnings of debt management, debt sustainability, and practices

of debt management in general, and in Eswatini specifically with an attempt to highlight shortcomings in debt management practices in relation to best practice. Also, empirical literature gives a comparison of the different approaches to measuring public debt sustainability as well as find a fitting model to be used for the purpose of this paper.

3.1 Debt Management

Historically a key concern of debt management policy was its impact on monetary policy. The concern was that a large issuance of domestic debt would crowd out the private sector and to some extent would raise interest rates. There has been over the years a separation of responsibilities for debt management and monetary policy. This suggests that monetary policy is no longer a concern of debt management policy (or vice versa). The primary concern of debt management policy has now shifted to minimising costs (Leong, D. 1999).

Theories on optimal government debt management have emphasised a variety of goals over time. They include macroeconomic stabilisation, developing national financial markets, supporting monetary policy, and minimising costs and risks. The inclusion of macroeconomic goals for government debt management clearly distinguishes it from debt management in the private sector where cost considerations dominate (Wolswijk, G., De Haan, J. 2005).

Debt management is the process by which the government acquires and utilizes the debt efficiently and effectively for budgetary purposes. It refers to the technical and institutional aspects of organizing public debt. The technical aspects focus on the need to determine the level of financing requirements and to ensure that terms and conditions of those borrowings are commensurate with the future debt service capacity of the country. The institutional aspects deal with the organizational, legislative, accounting and monitoring of new borrowing as well as the total stock of debt (Hanif, 2002).

Contemporary economic wisdom does not consider public debt as a major problem per se; rather the problem is the mismanagement and unsustainability of the public debt. The modern theory of public debt sustainability discerns a fundamental relationship between economic stability and debt sustainability in a country. Inadequate debt management and a permanent and unlimited growth of the debt to GDP ratio may result in some negative tendencies and changes in main macro-economic indicators such as crowding out of private investment, instability of the financial system, inflationary pressures, and exchange rate fluctuations. (Hanif, 2002)

Missale (1999), states that the paramount objective of debt management should be that of reducing the country's fiscal vulnerability. Risk minimisation is accomplished by choosing debt instruments which both ensure a low return variability and provide a hedge against variations in the primary budget, and in the returns of the other liabilities. He further states that reducing the uncertainty of the debt ratio, for any expected cost of debt service, is valuable in that it lowers the probability that debt stabilisation may fail because of severe shocks to the budget. This strategy is consistent with the asset-and-liability management approach.

There are also certain social and political implications of an unsustainable debt burden. Persistent and high public debt calls for a large portion of budgetary resources for debt servicing. Consequently, the government is forced to cut allocations for other public services and will thus face serious difficulties in executing its electoral manifesto.

3.2 Sustainable Debt

Growing public debt is a worldwide phenomenon. It has become a common feature of the fiscal sectors of most economies. Persistent and high public debt calls for a large piece of budgetary resources for debt servicing. Almost all countries incur debt to provide adequate public services, finance construction of infrastructure, and pursue full employment and economic growth. However, debt may facilitate or deter economic growth depending on its level (Smyth and Hsing, 2015).

Wyplosz (2021), states that debt sustainability is a vexing issue. Its importance is immediately obvious but it escapes any easy definition. He argues that unlike price stability and full employment which also cannot be simply defined, they can be measured with a reasonable degree of precision; however, debt sustainability cannot even be measured directly. Every country therefore must grapple with the issue of debt sustainability.

A country's public debt is considered sustainable when government budget constraints can be met without disrupting its monetary and fiscal policies. This implies that the amount of the public debt should not exceed the present value of all future primary surpluses. In other words for a country's debt to be considered sustainable, all its future surpluses

should be considered adequate to cover repayment of the current debt stock, taking into account the time value of money. Maintaining stable monetary and fiscal policy is crucial. Ultimately, government budget constraints can be met by acknowledging circumstances in which default on the debt (non-payment) or monetisation will occur in ways that are consistent with mathematical expressions; whether these expressions will anticipate full payment of debt in all periods (budget equation) or will hold a perception that some contractual obligations will not be kept (pricing equation), (da Costa, undated).

There are various indicators for determining a sustainable level of external debt. These indicators are primarily in the form of ratios and they aid policy makers in their external debt management duties. These indicators can be thought of as measures of a country's solvency in that they consider the stock of debt to exports ratio, government debt to current fiscal revenue ratio, share of foreign debt to total debt, and short term debt to total debt (IMF, 2010).

While external borrowing can increase a country's access to resources, domestic borrowing only transfers resources within the country. Since Central Banks in developing countries cannot print the hard currency necessary to repay external debt, external borrowing is usually associated with vulnerabilities that may lead to debt distress. It is only external debt that generates a "transfer" problem (Panizza, 2018).

From the above argument, it would seem that issues of human resource capacity and political will in as far as debt management is concerned are a real cause for concern in emerging economies. Both technical expertise and political will seem to be lacking in developing countries regarding debt management. As a result these economies find themselves caught in the debt trap. Ways in which this could be avoided need to be explored to avoid the perpetual slipping back of these economies into indebtedness and to prevent those that have not reached that stage from getting there. This is because even though developing countries may receive debt relief, this itself comes with negative consequences such as limited access to further credit.

3.3 Empirical Literature

Unsustainable debt path eventually leads to a sharp adjustment if not a crisis, leading to a generalized

failure of economic agents to meet their obligation. Thus, the concept of fiscal sustainability is key (Ley, 2009). Contemporary literature has provided various definitions of fiscal sustainability. Examples include Buiter (1985) who defines fiscal policy as sustainable if the government's net worth to GDP ratio is maintained at its present level. In a similar fashion, Blanchard (1990) defines sustainable fiscal policy as a policy that ensures that the ratio of debt to GDP converges back towards its initial level. The major problem with these definitions is that there is no theoretical reason why the debt/GDP ratio should converge back towards the initial level and not to any other level (Krejdli, 2016).

This problem was resolved by the more general definition of fiscal sustainability, that fiscal policy is sustainable if the present value of future primary surpluses is equal to or greater than the current level of debt. In other words, fiscal sustainability requires that primary surplus to GDP ratio must not be less than the outstanding stock of sovereign non-interest bearing debt/GDP times the difference between the long-term real interest on debt and the long run growth rate of real GDP. Primary surplus, on the other hand, is defined as the overall budget balance minus debt service interest cost plus net interest income on assets plus the monetary issuance of the sovereign (that is, the change in the stock of base money issued by the central bank). Therefore, this definition of sustainability which is derived from the intertemporal budget constraint (IBC) makes the requirement of convergence of the debt/GDP ratio towards its initial level only a special case.

Consequently, the literature is replete with different approaches in the studies of fiscal sustainability from the government intertemporal budget constraints. The most common approaches are purely model-based where fiscal reaction functions are achieved by iterating the government budget constraint.

Bohn's (1998) multivariate Ordinary Least Squares (OLS) estimation including government expenditure and business cycle indicator yielded significant positive response of primary surplus to changes in debt/GDP in the USA. He argued that the positive coefficient provide reliable information about sustainability irrespective of how interest rate and GDP growth compare. Thus, if debt/GDP ratio keeps growing, a sustainable fiscal policy must ultimately respond by moving towards primary surpluses.

He emphasized that a strict positive and at least linear response of the primary surplus to changes in the debt/GDP ratio turns out to be sufficient for sustainability. The potency of this sustainability test is that it does not entail any assumption about interest rate dynamics. In addition, it is applicable to economies with indiscriminate debt management policies, uncertainty, risk aversion and whether or not interest rates are above or below growth rate.

Following Bohn (1998), Khalid et al (2017) also estimated the fiscal reaction function for Pakistan using a Vector Auto Regression (VAR) technique with three main variables including fiscal deficit, output gap and inflation. Turrini (2018) estimated the fiscal reaction function of European Union in good and bad time by regressing business-cycle adjusted fiscal balance on lag of the business-cycle adjusted fiscal balance, debt, output gap and election dummy. Alfonso and Hauptmeier (2019) and Eggert (2020) have followed the same line of research which incorporates business-cycle variable to the function as an independent variable. All these authors results were at par with those of Bohn (1998).

Burger et al (2021) extended the model with lag of primary balance and output gap to examine the fiscal sustainability and fiscal reaction function of South Africa using OLS, VAR, Generalised Methods of Moments (GMM), State-Space, threshold VAR and Vector Error Correction Models (VECM). They found that the South African government indeed did tighten fiscal policies when facing shocks to the debt/GDP position during the sample period. Similarly, Doi, Hoshi and Okimoto (2011) examined Japan's fiscal sustainability incorporating a quadratic term (a deviation of the previous debt from the mean), output gap and government expenditure using both simple linear OLS and non-linear Markov-Switching models. They found Japan's government debt to be explosive as both models showed significant negative response of primary balance to changes in debt/GDP ratio. In line with Doi et al (2011), Hall (2013) examined US fiscal reaction function with the assumption that the economy follows a Markov process. He found that the US fiscal policy has a strong tendency to lower primary deficit when debt/GDP ratio is high.

4. Methodology

Since the study attempts to empirically evaluate how government reacts to rising public debt level, the key variables used in the study includes primary balance and public debt. The primary balance is simply defined as the sum of revenues excluding non-interest expenditure (that is total expenditure minus interest payment); while public debt is the sum of domestic and external debt (including government guaranteed debt). The choice of primary balance was reasonable, given the fact that the primary expenditures are more easily controlled by government. Besides, the use of primary balance helps to evaluate the impact of automatic stabilizers and discretionary policy action while recognizing the effect of debt services over business cycle.

4.1 Modelling Primary Balance Performance

There are various approaches to modelling primary balance performance as noted in the review of literature. This study adopts the standard econometric techniques by first testing for unit roots. Secondly, the Bounds Testing autoregressive distributed lag (ARDL) method will be employed to test for cointegration, since the technique is robust and indifferent about the order of integration of the economic and financial time series. The ARDL bounds test cointegration procedure was developed by Pesaran et al. (2001), and is based on the assumption that the variables are $I(0)$ or $I(1)$. Thus, before applying this test, we determine the order of integration of all variables using the unit root tests. The objective is to ensure that the variables are not $I(2)$ to avoid spurious results. In the presence of variables integrated of order two, we cannot interpret the values of F statistics provided by Pesaran et al. (2001). The empirical model used here draws from the works of Bohn (1998), Khalid et al (2017) and Nguyen (2013). However, since the level of primary surplus a country runs is likely to be influenced by a number of other variables apart from debt level, the model is augmented to include a range of potential country-specific determinants of primary surplus behaviour. Thus the reduced-form long run specification of primary balance equation is of the form;

$$pb_t = \alpha_0 + \beta_1 d_{t-1} + \gamma_i X_{t-1} + \varepsilon_t$$

Where pb_t is the ratio of primary balance to GDP, d_{t-1} is public debt-to-GDP ratio at the end of the previous period, X_{t-1} includes other variables that influence the long run fiscal sustainability in an economy, ε_t is an error term. The study conducted by Abiad et al (2015) was followed in selecting the range of country-specific variables for X_{t-1} . In particular, the economic determinants of primary balance behaviour used in this study include GDP gap, to capture the influence of business cycles, commodity prices (proxied by oil prices), to capture the effects of price movement on the fiscal position; CPI inflation, to capture inflation effect on fiscal balance; and the exchange rate to

capture the effect of persistent depreciation on fiscal position regarding external debt services and the pass through effect on inflation.

4.2 Cointegration Test

The first step in the ARDL bounds approach is to estimate the equation below by ordinary least squares (OLS). This would test for the existence of a long-run relationship among the variables by conducting an F test for the joint significance of the coefficients of the lagged levels of the variables.

$$\begin{aligned} \Delta pb_t = & \alpha_0 + \beta_1 pb_{t-1} + \beta_2 d_{t-1} + \beta_3 GGAP_{t-1} + \beta_4 \log OIL_{t-1} + \beta_5 \log CPI_{t-1} + \beta_6 \log EXC_{t-1} \\ & + \sum_{i=1}^p \gamma_1 \Delta pb_{t-i} + \sum_{i=1}^p \gamma_2 \Delta d_{t-i} + \sum_{i=1}^p \gamma_3 \Delta GGAP_{t-i} + \sum_{i=1}^p \gamma_4 \Delta \log OIL_{t-i} \\ & + \sum_{i=1}^p \gamma_5 \Delta \log CPI_{t-i} + \sum_{i=1}^p \gamma_6 \Delta \log EXC_{t-i} + \varepsilon_t \end{aligned}$$

Where pb_t and d_{t-1} are as previously explained, GGAP is GDP gap, which is the ratio of potential GDP to actual GDP as measured by the HP Filter, OIL are prices of crude oil which is a proxy for commodity prices, CPI is inflation, and EXC are the US Dollar exchange rate to the Lilangeni. The null hypothesis to be tested is $H_0 : \beta_i = 0$ against the alternative $H_1 : \gamma_i \neq 0$. Two sets of critical values for a given significance level can be determined (Pesaran et al., 2001). The first level is calculated on the assumption that all variables included in the ARDL model are integrated of order zero, while the second one is calculated on the assumption that the variables are integrated of order one. The null hypothesis of no

cointegration is rejected when the value of the test statistic exceeds the upper critical bounds value, while it is accepted if the F-statistic is lower than the lower bounds value. Otherwise, the cointegration test is inconclusive.

4.3 Error Correction Model

Whenever the existence of a long-run relationship is found, it will also have an equivalent parsimonious short run error correction model (ECM). The first step is to estimate the long run primary balance equation presented below.

$$pb_t = \alpha_0 + \beta_1 pb_{t-1} + \beta_2 d_{t-1} + \beta_3 GGAP_{t-1} + \beta_4 \log OIL_{t-1} + \beta_5 \log CPI_{t-1} + \beta_6 \log EXC_{t-1} + \varepsilon_t$$

Where all the variables are as previously explained. This equation gives the long run elasticity's of the coefficients. From literature, the key parameter to judge for policy solvency is β_1 in the above equation. A positive value of β_2 ($\beta_2 > 0$) shows that the government tries to increase primary surplus to react

to debt build-up. The literature also suggests that the solvency condition requires that the size of the coefficient should be closer to one and statistically significant. An associated short run ECM presented below can be estimated. This equation takes the form;

$$\begin{aligned} \Delta pb_t = & \alpha_0 + \sum_{i=1}^p \gamma_1 \Delta pb_{t-i} + \sum_{i=1}^p \gamma_2 \Delta d_{t-i} + \sum_{i=1}^p \gamma_3 \Delta GGAP_{t-i} + \sum_{i=1}^p \gamma_4 \Delta \log OIL_{t-i} \\ & + \sum_{i=1}^p \gamma_5 \Delta \log CPI_{t-i} + \sum_{i=1}^p \gamma_6 \Delta \log EXC_{t-i} + \alpha ECM_{t-1} + \varepsilon_t \end{aligned}$$

Where γ_i are the short run dynamic coefficients of the model's convergence to equilibrium and α is the speed of adjustment, the lagged ECM variables are the residuals obtained from the long-run equation. Once the ECM model has been estimated, the cumulative sum of recursive residuals (CUSUM) and the CUSUM of square (CUSUMSQ) tests are applied to assess the parameter stability (Pesaran and Pesaran, 1997).

4.4 Unit root tests

There are various tests for identifying non-stationarity or the presence of unit roots in time series data,

however this study will limit itself to the Augmented Dickey-Fuller (1979) tests and the Phillips-Perron (1988) tests.

4.5 Diagnostic Checks

Once the model has been estimated, it will be subjected to various diagnostic tests, which assess the stochastic properties of the model. The following tests will be undertaken:

Table 1: Diagnostic Tests

Stochastic property	Diagnostic test
Serial correlation	Breusch-Godfrey LM test
Heteroskedasticity	White test
Normality of the residuals	Jarque-Bera test
Model stability	Ramsey RESET test.

4.6 Data

This study will use annual data from 2005 to 2025 to examine both short run and long run relationships between the variables. Data will be collected from the Central Bank of Eswatini, the Central Statistics Office, Ministry of Finance, and the Ministry of Economic Planning and Development. The Hodrick Prescott filter will be used to produce data for output gap.

are the starting point in any cointegration analysis as well as regression analysis. In non-stationary series, the order of integration is therefore determined by the number of times it has to be differenced to attain stationarity. Since this study uses the ARDL approach, the sole reason for conducting the test is to determine if there exist a variable which is $I(2)$, since it can invalidate the estimation if it is available. The Augmented Dickey-Fuller (1979) and Phillips-Perron (1988) tests results are presented in the table below.

5. Findings and Discussion

According to Granger (1969), stationarity tests are the pre-tests for avoiding spurious regressions. They

Table 2: Unit Root Tests Results

Augmented Dickey-Fuller				Phillips Perron			
Variable	Intercept	Trend and Intercept	None	Intercept	Trend and Intercept	None	I(d)
Pb/GDP	-3.292**	-3.396***	-3.307*	-2.844***	-2.900	-2.920*	I(0)
Debt/GDP	-4.279*	-4.241**	-4.256*	-4.261*	-4.155**	-4.244*	I(1)
Log EXC	-4.076*	-4.199*	-3.403*	-3.881*	-4.224**	-3.291*	I(1)
GDPGAP	-3.974*	-3.909**	-4.045*	-3.605**	-3.577**	-3.642*	I(0)
Log CPI	-5.633*	-2.006	1.603	-8.244*	-2.718	5.534	I(0)
Log OIL	-5.009*	-4.885*	-5.078*	-5.009*	-4.881*	-5.078*	I(1)

Note: ***, **, * = significant at the 1%, 5%, 10% level

A variable is stationary if the ADF statistic is greater than the MacKinnon critical values for the rejection of hypothesis for unit root. From the table above, some of the variables are not stationary at their levels because the ADF statistic is smaller than the MacKinnon critical values for the rejection of hypothesis for unit roots and therefore had to be differenced to make them stationary. This means that the null hypothesis for unit root is not rejected for these variables. Furthermore no variable was found to be $I(2)$, which means we can proceed with the ARDL estimation procedure.

there is cointegration between the variables. This is to establish if the linear relationship of the variables is stationary. If the null hypothesis of no cointegration is rejected then the linear combination of the variables is stationary, hence a non-spurious long-run relationship exists between the variables and as such, consistent estimates of the long run relationship is evident. To test for cointegration between these variables, the ARDL bounds testing approach was employed, results of which are reported below.

5.1 ARDL Results for cointegration

After determining the order of integration of the variables, the next step is to determine whether

Table 3: ARDL Bounds Test

Test Statistic	Value	k
F-statistic	8.363521	6
Critical Value Bounds		
Significance	I0 Bound	I1 Bound
10%	2.12	3.23
5%	2.45	3.61
2.5%	2.75	3.99
1%	3.15	4.43

From these results, it is clear that there is a long-run relationship amongst the variables when FDI is the dependent variable because its F-statistic (8.36) is higher than the upper-bound critical value (4.43) at the 1% level. This implies that the null hypothesis of no cointegration among the variables is rejected.

5.2 The long-run equation

Once cointegration is established, the ARDL long-run model is estimated, whose results are shown below.

Table 4: Long Run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LPDNGDP(-1)	0.857892	0.609790	1.406863	0.0930
GGAP	-0.001531	0.000818	-1.872385	0.0939
LOIL	0.754665	0.320841	2.352145	0.0432
LCPI	-1.543995	1.051976	-1.467709	0.1762
LEXCH	0.803264	0.924728	0.868649	0.4076
DUM	-0.758581	0.537547	-1.411189	0.1918
C	2.495118	1.669663	1.494384	0.1693

Specifically, the long run coefficient of public debt to GDP ratio is positive and statistically significant, in par with Bohn (1998), indicating that fiscal authorities react systematically to rising public debt ratio to ensure fiscal sustainability. Fiscal authorities moderate primary deficit to GDP by 0.86 percent when there is a percentage increase in public debt to GDP in the long run. Furthermore, this coefficient is the key parameter to judge for policy solvency. A positive value shows that the government tries to increase primary surplus to react to debt build-up. In addition, the solvency condition requires that the size of the coefficient should be closer to one and statistically significant (Alfonso, 2005). The result suggests a much stronger response of Eswatini's fiscal authorities to sufficiently higher debt levels than the response to low-to-moderate debt levels, indicating the desire to satisfy the intertemporal budget constraint in the long run.

Consistent with Abiad et al (2005), the long run coefficient of commodity prices, proxied by oil prices, is positive and statistically significant as expected. In particular, Eswatini is a net-importer of oil, so increases in oil prices tend to increase government expenditure which warrants the accumulation of higher primary surpluses to stabilise the debt.

However, as an exporter of sugar, increases in their prices are expected to boost primary surpluses. Also, the long run response of primary balance to output gap was negative and statistically significant, implying a strong pro-cyclical policy. Although with an expected positive sign, but statistically insignificant, the positive effect of exchange rate depreciation on primary balance may result from either the pass through effect of the former to inflation and hence higher real interest rate or via increases in external debt stock. Any of these exchange rate channels requires greater fiscal effort to preserve fiscal sustainability. Furthermore CPI inflation, which captures inflation effect on fiscal balance, was found to be insignificant, which shows the lack of pass through from inflation to primary balance. The dummy variable which captures the effect of the 2009/10 financial crises is negative as expected but statistically insignificant. An analysis based on the sign shows that the fiscal crises did have an impact on the primary balance.

5.3 The Error Correction Model

Thus we obtain the short-run dynamic parameters by estimating an error correction model associated with the long-run estimates, and the results are presented below.

Table 5: Short Run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LPDGDP(-1))	-1.086060	0.519426	-2.090883	0.0661
D(PBGD(-1))	-0.527931	0.486104	-1.086044	0.3270
D(GGAP(-2))	0.001253	0.000508	2.467703	0.0357
D(LOIL)	0.777471	0.313342	2.481221	0.0349
D(LCPI)	-6.106995	2.848361	-2.144038	0.0606
D(LCPI(-1))	-3.022388	2.505075	-1.206506	0.2584
D(LEXCH)	0.891362	0.725453	1.228697	0.2503
D(LEXCH(-2))	0.919583	0.686327	1.339862	0.2131
D(DUM)	-1.123420	0.308568	-3.640747	0.0054
CointEq(-1)	-1.030219	0.267271	-3.854588	0.0039

After estimating the short run equation it is subjected to a number of diagnostic tests to ascertain its stability and credibility. The model passed all the diagnostic tests against; serial correlation (Breusch–Godfrey LM test), heteroskedasticity (White heteroskedasticity

test), and normality of errors (Jarque–Bera Test). The Ramsey RESET test also suggests that the model is well specified. All results of these tests are shown in Table 6.

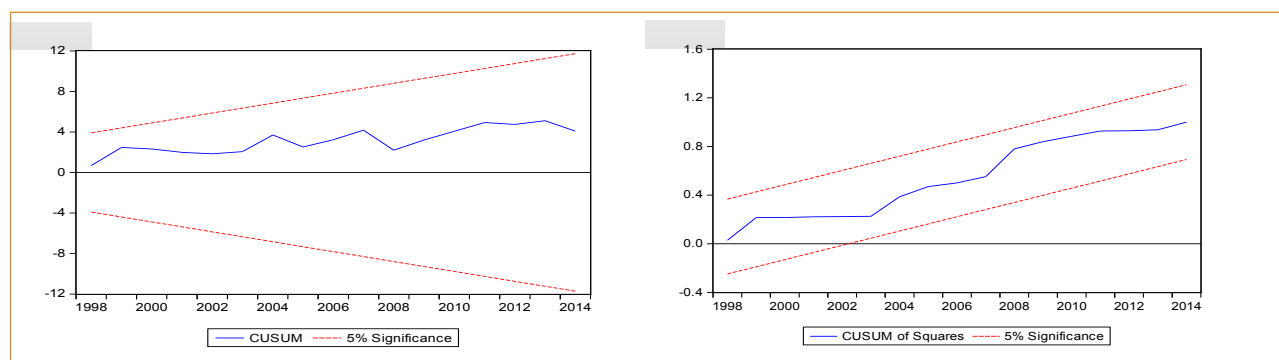
Table 6: Results of diagnostic tests

Significance	X ² statistic	Probability
Breusch–Godfrey serial correlation LM test	2.98	0.13
White Heteroskedasticity test	0.53	0.88
Jarque–Bera test	0.65	0.72
Ramsey RESET test (log likelihood ratio)	0.14	0.72

+

Once the ECM model has been estimated, the cumulative sum of recursive residuals (CUSUM) and the CUSUM of square (CUSUMSQ) tests are applied to assess parameter stability (Pesaran and Shin, 1997). The CUSUM test (Brown, Durbin, and Evans, 1975) is based on the cumulative sum of the recursive residuals. This option plots the cumulative sum together with the 5 percent critical lines. The

test finds parameter instability if the cumulative sum goes outside the area between the two critical lines. The figure below plots the results for CUSUM and CUSUMSQ tests. The results indicate the absence of any instability of the coefficients because the plot of the CUSUM and CUSUMSQ statistic fall inside the critical bands of the 5 percent confidence interval of parameter stability.

Figure 3: Plot of the CUSUM and CUSUMSQ statistic

Source: Authors Calculations

Analyses for the results for the short run ECM are presented in this section. The coefficient of the lagged error-correction term is significant at the 1% level with the expected negative sign, which confirms the result of the bounds test for cointegration. Its value is estimated at -1.03, which implies the speed of adjustment to equilibrium after a shock. Approximately 100 percent of disequilibria from the previous year's shock converge back to the long-run equilibrium within a year. Also, the significant of the error correction term indicates that the explanatory variables Granger-cause primary balance in the long run model. Furthermore the results show that the long run explanatory variables also affect the dependent

variable in short run and most of these variables maintained their long run signs. Unlike in the long run, the short run coefficient of public debt to GDP ratio is negative and statistically significant, indicating that fiscal authorities do not react systematically to rising public debt ratio to ensure fiscal sustainability in the short run.

In the short run, primary balance responds negatively to the fiscal crises dummy and insignificantly to exchange rate depreciation. In particular, the short run estimates show that the fiscal crisis experienced in 2010/11 in Eswatini lead to a deterioration of primary balance to the tune of approximately 1.12

percent of GDP in the short run, threatening the sustainability of the fiscal policy. In other words, the expenditure overruns during the crisis would require an improvement in primary deficit by 1.12 percent of GDP to restore fiscal sustainability, *ceteris paribus*. However, the short run response of primary balance to changes in commodity prices, output gap, and inflation was positive and significant. That shows that the effect of changes in these variables influence the primary balance in the short run. The short run effect of crude oil price maintained its positive influence on primary balance, while the CPI was found to have a negative influence in both the short and long run.

In sum, the empirical results affirm the existence of fiscal pressures during the fiscal crisis which threatens long term sustainability of Eswatini's public finance. The results suggest that the fiscal adjustment through the accumulation of public domestic debt through Government papers may result in the accumulation in total public debt to GDP. Accordingly, this study reveals that the current fiscal policy stance, if maintained, is more likely to engender debt explosion, going forward. This therefore warrants a drastic change in policy direction, like budget reduction, that would ensure long term fiscal sustainability and enhance investors' confidence in the economy.

6. Conclusion and Recommendation

6.1 Conclusion

The major objective of this paper was to assess of Fiscal and Public Debt Sustainability in Eswatini. The ARDL modelling approach was used in the study. The advantage of this approach is that it combines both $I(0)$ and $I(1)$ variables, as long as they are not $I(2)$. The first step therefore was to test for stationarity of the variables. Results of the ADF and PP stationarity tests show that the variables are integrated at different orders. The ARDL Bounds cointegration test was performed to establish the existence of a long run relationship among the variables, results of which show the existence of such a relationship.

Once cointegration was established, the ARDL long-run model was estimated and coefficients of the long-run relationship were found to be significant except for CPI and the exchange rate, although all the variables carry the expected signs. Specifically, the long run coefficient of public debt to GDP ratio is positive and statistically significant, indicating that fiscal authorities react systematically to rising public debt ratio to ensure fiscal sustainability. Fiscal authorities moderate primary deficit to GDP by 0.86 percent when there is a percentage increase in public debt to GDP in the long run.

Since cointegration was found to exist, an ECM was estimated. The coefficient of the lagged error-correction term is significant at the 1% level with the expected negative sign, which confirms the result of the bounds test for cointegration. Its value is estimated at -1.03, which implies the speed of adjustment to equilibrium after a shock. Approximately 100 percent of disequilibria from the previous year's shock converge back to the long-run equilibrium within a year. Also, the significant of the error correction term indicates that the explanatory variables Granger-cause primary balance in the long run model. In the short run, primary balance responds negatively to the fiscal crises dummy and insignificantly to exchange rate depreciation. In particular, the short run estimates show that the fiscal crisis experienced in 2010/11 in Eswatini lead to a deterioration of primary balance to the tune of approximately 1.12 percent of GDP in the short run, threatening the sustainability of the fiscal policy. Furthermore the coefficient of public debt to GDP ratio is negative and statistically significant, indicating that fiscal authorities do not react systematically to rising public debt ratio to ensure fiscal sustainability in the short run.

6.2 Recommendations

In the light of the findings in the study, the following policy recommendations are offered:

- To avert potential short term insolvency due to recent development in interest payments and the wage bill, government should emphasize more concessional sources of borrowing rather than

the resort to non-concessional borrowing from capital and money markets which has serious implications for debt dynamics.

- To minimize loss of effort and improve the efficiency of revenue mobilization of the Eswatini Revenue Authority, the various agencies should be streamlined further to enhance efficiency whilst putting measures in place to ensure fair service conditions to staff in order to boost efficiency.
- In view of the difficulty of expanding the tax net to embrace the large self-employed sector of the economy, the authorities could consider more innovative ways such as employing the services of cooperatives and associations to reach out to the informal sector or the self-employed.
- To ensure long term fiscal sustainability, there is the need to introduce fiscal anchors such as a

Fiscal Responsibility Act with expenditure rules to curtail overruns especially during financial crises. In addition, proper coordination between fiscal and monetary authorities should be fostered.

- To mitigate debt explosion, especially in the short-run, there is a need to monitor more closely the interest and exchange rates movements as these have the potential to spiral the debt out of control on the short-run which would lead to liquidity constraints for the government.
- More rigorous efforts need to be applied in spreading the risk of the debt portfolio between local and foreign currency denominated debt; between fixed and variable interest rate debt; and long term and short term debt since some variables effects in the short and others in the long run.

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The Money Demand Function and its Implications on Macroeconomic Variables in Eswatini

By Thandeka Simelane¹

Abstract

The study investigates the money demand function and its implications on macroeconomic variables in Eswatini. This is achieved by employing an Autoregressive Distributed Lag (ARDL) model on data spanning 2010Q1 to 2025Q3. The results of the study indicate the existence of a long run positive relationship between the velocity of money and the GDP (with a lag), a positive relationship between velocity of money and the ratio of demand deposits to time deposits and a negative relationship between the velocity of money and consumer price index (CPI). However, there is no significant long-run relationship between the velocity of money and the discount rate, Real Effective Exchange rate (REER) and the currency in circulation to demand deposits. In the short run, the results indicate the existence of a positive relationship between the velocity of money and GDP, a positive relationship between the velocity of money and the ratio of currency in circulation to demand deposits and a positive significant relationship between velocity of money and the ratio of demand deposits to time deposits.

Key words: ARDL, velocity of money, currency in circulation, demand deposits

1. Introduction

The seminal work of Keynes (1936) introduced the concept of liquidity preference theory explaining that individuals hold money for transactions, precautionary

and speculative motives. Keynes (1936) argued that the interest rate is the “price of liquidity,” linking monetary composition and preferences directly to the velocity of money. This framework provided the theoretical foundation for later studies on how GDP growth, inflation, and deposit structures influence currency in circulation. Faig, M., & Jerez, B. (2006) provides an extension to Keynes (1936) and develops a theoretical model showing how precautionary motives for holding money reduces its velocity. The authors argue that uncertainty in consumption and income leads households and firms to maintain larger liquid balances, slowing circulation. Their findings extend Keynesian liquidity preference theory and highlight that monetary policy effectiveness is weakened when precautionary motives dominate.

Fisher (1911) defined the quantity theory of money through the equation of exchange linking money supply, velocity of money, price levels and transactions as follows;

$$MV = PT$$

Where;

M: Money supply

V: Velocity of money

P :Price level

T: Transactions/output

The velocity of money is formally defined as the ratio of nominal GDP to the money supply, representing the frequency with which a unit of currency circulates in the economy (Fisher, 1911; Friedman, 1956; Mishkin, 2019). Later, Friedman emphasized the relative stability of velocity in the long run, supporting monetarist policy rules, while Mishkin highlighted its variability due to financial innovation, interest rates, and inflationary conditions. Although Keynes (1936) did not express velocity in the GDP to money supply ratio (GDP/M) form, his liquidity preference theory indirectly shaped the concept by linking money demand motives to the speed of circulation.

The stability and determinants of the demand for money remain central to effective macroeconomic management, particularly in small open economies such as Eswatini. A well-specified money demand

¹ Thandeka Simelane is a Senior Economist, Policy Research, in the Research Department. Email: thandekam@centralbank.org.sz

function is crucial for monetary authorities, as it influences the formulation and transmission of monetary policy, inflation control, and overall economic stability. However, in recent years, structural changes in financial systems, evolving payment technologies, and external shocks have created uncertainty regarding the behavior of key monetary aggregates and their relationship with macroeconomic variables. In Eswatini, limited empirical evidence exists on the dynamics of the velocity of money and its interaction with critical variables such as output (GDP), inflation (CPI), interest rates, exchange rates, and financial deepening indicators. While monetary theory suggests stable long-run relationships between money demand and its determinants, these relationships may vary across economies and over time, thereby necessitating country-specific empirical investigation.

The study therefore seeks to investigate the existence of a relationship between velocity of money (money demand) and macroeconomic variables in Eswatini. This relationship is established for both the long-run and in the short-run. The rest of the paper is organized as follows: Section 2 reviews existing literature, followed by methodology in Section 3, empirical results and the conclusion in Sections 4 and 5, respectively.

2. Literature Review

Existing literature on velocity of money includes, amongst others, a study by Sharma and Syarifuddin (2019), who investigated the determinants of Indonesia's income velocity of money using monthly data and applying the Autoregressive Distributed Lag (ARDL) model. Their results indicated that in the long run, tax revenue and short-term interest rates have a positive relationship with velocity, while industrial production exerts a negative influence. In the short run, money demand plays a more important role,

showing a negative relationship with velocity. These findings suggest that shocks have limited short-term impact but matter more in the long run.

To examine the stability of money demand determinants in Southeastern Europe, Kjosovski and Petkovski (2017) estimated a pooled mean group ARDL model for seven countries covering the period January 2005 to December 2014. Their results established that in the long run, industrial production had a positive relationship with money demand, while the exchange rate and the European debt crisis exerted negative effects. In the short run, the exchange rate remained a key determinant, also showing a negative relationship with money demand. Their findings indicate that, despite periods of turbulent transition, real money demand exhibited relative stability.

A study by Okafor et al. (2013) applied the Vector autoregression (VAR) and Engle-Granger cointegration approaches using quarterly data for the period 1985 to 2012 and found that in Nigeria, inflation and government expenditure had a positive relationship with the income growth and velocity of money, while interest rates and exchange rate depreciation had a negative effect in the long run. On the other hand, Oyadeyi (2024), in applied the Quantile ARDL approach to inflation, interest rates, exchange rates, Government Expenditure and Financial development proxies, confirmed similar long-run drivers but emphasized structural breaks and highlighted that velocity responds differently across quantiles of inflation and financial development.

3. Methodology

3.1 Data

Quarterly data spanning from the period (2010Q1 to 2025Q3) is employed in the study based on reviewed literature and it is obtained from several data sources as detailed in Table 1 below.

Table 1: Variables

Variables	Definition	Data Source
V	Velocity of Money	Own computation from Central Bank of Eswatini and Central Statistics office data
GDP	Gross Domestic Product	Central Statistics Office
Disc_rate	Discount rate	Central Bank of Eswatini data
CPI	Consumer Price Index (CPI)	Central Statistics Office
REER	Real Effective Exchange Rate (REER),	Central bank of Eswatini
cc_dd	Ratio of Currency in Circulation to Demand Deposits, proxy for financial development (Oyadeyi (2024)	Own computation from Central Bank of Eswatini data
dd_tt	Ratio of Demand deposits to Time deposits, proxy for financial development and financial sophistication	Own computation from Central Bank of Eswatini data
dum	Dummy variable for the 2020 COVID-19 pandemic where 1 is for the period 2020Q1 to 2022Q1 and 0 elsewhere	Own computation

3.2 Model Specification

The study investigates the existence of a long run relationship between money demand and selected macroeconomic variables in Eswatini. This is achieved by employing an Autoregressive

Distributed Lag (ARDL) model proposed by Pesaran and Shin (1999) with further extensions by Pesaran et.al (2000) and Pesaran et. al (2001) for the period 2010Q1 to 2025Q3. We specify and estimate the relationship between the money demand and economic fundamentals as follows;

$$V_t = \beta_0 + \beta_1 \ln GDP_t + \beta_2 \text{Disc_rate}_t + \beta_3 \ln CPI_t + \beta_4 \ln REER_t + \beta_5 cc_dd_t + \beta_6 dd_tt_t + Dum_t + \mu_t \quad (1)$$

Where V is the Velocity of Money, Disc_rate is the Discount rate, $\ln CPI$ is the logarithm of the Consumer Price Index (CPI), $\ln REER$ is the logarithm of the Real Effective Exchange Rate (NEER), cc_dd is the ratio of Currency in Circulation to Demand Deposits, dd_tt is the ratio of Demand deposits to Time deposits, Dum is the Dummy variable for the COVID-19 pandemic for the global financial crisis and μ is the error term.

The ARDL model has several advantages over other cointegrating models in that one can estimate both the long and short-run parameters simultaneously. In addition, the ARDL can be applied where the variables are integrated of different orders $I(1)$ and $I(0)$ excluding $I(2)$ and it performs better in smaller samples.

The Bounds test methodology by Pesaran et al (2001) based on the unrestricted error-correction model technique is used to estimate the long run relationship between the specified variables. The Bounds test is a joint test of all lagged levels of the regressors (Shin et al., 2013) using the Pesaran et al (2001) F-statistic tests on the null hypothesis that there is no cointegrating relationship between velocity of money and independent variables. The F-statistic is then compared with the upper and lower bounds critical values by Pesaran et al (2001). Once cointegration is established, we proceed to estimate the long-run coefficients then the error correction model to calculate the speed of adjustment (Masih et al. 2008).

The estimated ARDL model is as follows:

$$\begin{aligned} \Delta \ln V_t = & \alpha_0 + \sum_{i=1}^p \gamma_1 \ln V_{t-i} + \sum_{i=0}^q \gamma_1 \Delta \ln GDP_{t-i} + \sum_{i=0}^q \gamma_2 \Delta \text{Disc_rate}_{t-i} + \sum_{i=0}^q \gamma_3 \Delta \ln CPI_{t-i} \\ & + \sum_{i=0}^q \gamma_4 \Delta \ln REER_{t-i} + \sum_{i=0}^q \gamma_5 cc_dd_{t-i} + \sum_{i=0}^q \gamma_6 dd_tt_{t-i} + \sum_{i=0}^q \gamma_7 Dum_{t-i} + \gamma_2 \ln GDP_{t-1} + \\ & \gamma_2 \text{Disc_rate}_{t-1} + \gamma_2 \ln REER_{t-1} + \gamma_4 cc_dd_{t-1} + \gamma_4 dd_tt_{t-1} + \gamma_4 Dum_{t-1} + \varepsilon_t \quad (2) \end{aligned}$$

Where α_0 is the restricted constant only applicable to the long-run relationship.

4. Empirical Results

4.1 Stationarity Tests

Stationarity tests were conducted in the data to establish stationarity of the variables at levels or at first difference. The Augmented Dickey Fuller (ADF)

by Hansen (1995) and Philips Perron (PP) were used to test for stationarity of the variables and the results are presented in Table 2 below.

Table 2: Results of Unit Root Tests

Variable (at levels)	Augmented Dickey Fuller Test		Philips Perron Test		Order of Integration
	Intercept	Trend and Intercept	Intercept	Trend and intercept	
V	-4.097588***	-5.425131***	-5.051471***	-5.430898***	I(0)
lnGDP	-1.215875	-1.227164	-0.029801	-6.391027*	I(1)
lnCPI	-2.476219	-1.121916	-3.401903**	-0.872148	I(1)
lnREER	-2.163824	-2.954454	-1.872790	-2.544790	I(1)
Disc_rate	-2.326587	-2.485035	-2.039046	-2.110412	I(1)
cc_dd	-2.066148	-4.490223***	-2.285111	-4.412041***	I(1)
dd_tt	-3.009896**	-3.330256*	-2.860951*	-3.278217*	I(0)

***, **, * stands for significance at 1%, 5% and 10%

From the results in Table 2 above, the velocity of money(V) and dd_tt are stationary at levels whereas lnGDP, ICPI, lnREER, Disc_rate and cc_dd are non-stationary (integrated of order 1).

4.2 Cointegration Test

The ARDL Bounds tests procedure with Lower and Upper Bound critical values taken from Pesaran et al(2001), were used to establish the existence of a long-run relationship among variables and the results

are presented in Table 3 below.

The results of the Bounds test indicate an F-statistic of 4.674680 which is above all the upper-bound values at 1%, 5% and 10% level of significance, suggesting a rejection of the null hypothesis of no co-integration between the velocity of money(V) and the independent variables. These results give us grounds to proceed with estimating the ARDL model to obtain the long-run and short-run models.

Table 3: Bounds Test

F-Bounds Test	Value	10% Significance level		5% significance level		1% significance level	
		I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
F-Statistics	4.674680						
60 observations	60	2.044	3.104	2.373	3.540	3.129	4.507
65 observations	65	2.043	3.094	2.373	3.519	3.092	4.478

4.3 Estimated Results

4.3.1 Short- Run Results

The results in Table 4 suggest the existence of a short-run positive significant relationship between velocity of money and GDP. Furthermore, a 1 per cent

increase in GDP increases the velocity of money by 0.73 per cent.

Table 4: Short-Run Results

Variable	Coefficients	P-Values
$\Delta \ln GDP$	0.731291	0.0000***
Δcc_dd	1.590750	0.0000***
Δdd_tt	0.572386	0.0000***
CointEq(-1)	-0.598942	0.0000***

***, **, * stands for significance at 1%, 5% and 10%

On the other hand, there exists a positive significant relationship between the velocity of money and the ratio of currency in circulation to demand deposits(cc_dd) suggesting that the use of more liquid forms of money increases the velocity of money (Keynes, 1936). In addition, we note a positive significant relationship between velocity of money and the ratio of demand deposits to time deposits(dd_tt) which is consistent with liquidity driving faster currency in circulation (Aubin (2021) and Oyadeyi (2024)), highlighting the role of monetary composition in driving circulation.

Finally, the error correction term is highly significant with the negative sign indicating that deviations from the long-run equilibrium are corrected at about 60 per cent per period. In other words, if velocity strays from its long-run path, more than half of the gap is closed in the next period.

4.3.2 Long-Run Results

As illustrated in Table 5, in the long-run, there exists a significant positive relationship between the GDP of previous period and current velocity of money. This implies that economic growth in the previous period supports faster circulation of money in the current period. We also note a significant and negative relationship between CPI and velocity of money in the long-run. This could imply that higher consumer prices reduce velocity of money (demand for money) which could be explained by precautionary demand literature. Faig and Jerez (2006) demonstrate that uncertainty in expenditure needs leads households to hold precautionary balances, lowering velocity. Similarly, Pateiro-Rodríguez et al. (2024) show that inflationary environments intensify this precautionary motive, as erosion of purchasing power encourages agents to retain liquidity rather than circulate money.

Table 5: Long-Run Results

Variable	Coefficients	P-Values
Vel(-1)	-0.598942	0.0000***
$\ln GDP(-1)$	0.308869	0.0116**
Disc_rate	0.812215	0.2387
$\ln CPI$	-0.571337	0.0041***
$\ln REER$	0.230741	0.2837
cc_dd	0.465775	0.3284
dd_tt	0.314136	0.0241**
dum	0.001094	0.9614
c	-1.212104	0.1271

***, **, * stands for significance at 1%, 5% and 10%

Additionally, we observe a significant positive relationship between the velocity of money and the ratio of demand deposits to time deposits which is consistent with the Keynesian liquidity preference

theory (Keynes, 1936), which posits that economies with a stronger preference for liquid money experience faster circulation.

The Disc_rate, REER, cc_dd, dummy, constant have no significant relationship with the velocity of money during the period under review.

4.4 Diagnostic Tests

The diagnostic tests results in Table 6 below indicate that the model passed all the diagnostic tests. The Ramsey-RESET test results indicate that the model is well specified with an appropriate functional form. The Breusch -Godfrey Serial correlation test suggests that the residuals are not serially correlated whilst

the Breusch-Pagan-Godfrey Heteroskedasticity test suggests that the error variance does not depend on independent variables (constant variance over time). In addition, the normality test results suggest that the residuals follow the normal distribution. The results from the diagnostic tests imply a more robust and reliable model estimation of the relationship between the velocity of money, GDP, inflation, and liquidity ratios.

Table 6: Diagnostic Test Results

Variable	Test Statistic	P-values
Ramsey-RESET test(F-test)	1.946489	0.1539
Breusch-Godfrey Serial Correlation LM Test (F-test)	0.118411	0.8886
Breusch-Pagan-Godfrey Heteroskedasticity(F-test)	0.924881	0.5246
Jarque-Bera test for Normality	3.058948	0.216650

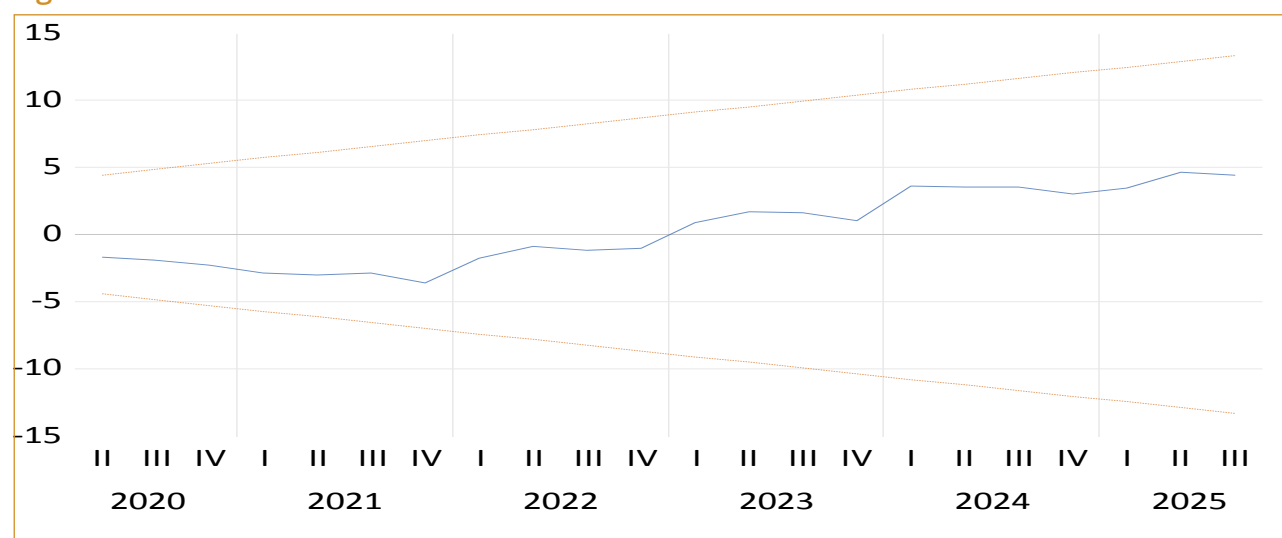
***, **, * stands for significance at 1%, 5% and 10%

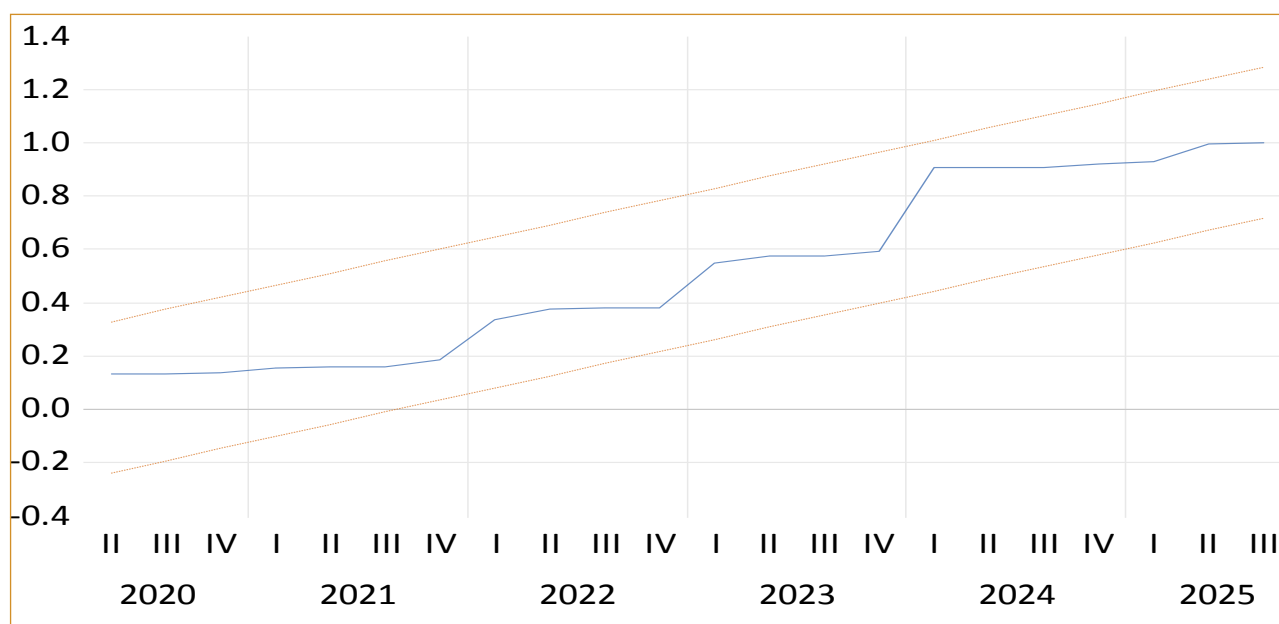
4.5 Stability Tests

Model stability was evaluated using the Brown, Durbin, and Evans (1975) framework for stability verification. Specifically, the Cumulative Sum (CUSUM) and Cumulative Sum of Squares (CUSUMQ) tests of recursive residuals were employed to assess whether

the estimated coefficients remained constant over time, thereby confirming the robustness of the model. As depicted in Figure 2 and Figure 3, the test statistics lie within the 5 per cent critical bounds, providing evidence that the parameters of the model are stable.

Figure 2: CUSUM Test





5. Conclusion

The findings from the study reveal that velocity of money is significantly influenced by GDP growth and liquidity composition in both the short and long run. Increases in GDP accelerate velocity of money (circulation), while higher ratios of currency in circulation to demand deposits and demand deposits to time deposits confirm that more liquid forms of money drive faster turnover, consistent with Keynesian liquidity preference theory. Conversely,

inflation reduces velocity through precautionary motives, as shown in literature. The highly significant error correction term indicates strong adjustment toward equilibrium, with deviations corrected by about 60 percent per period. Overall, the results emphasize the importance of economic growth, liquidity preferences, and inflation management in shaping monetary dynamics, while discount rate, exchange rate, and other controls show no significant effect.

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The Relationship between Bank Deposits and Macroeconomic Variables in Eswatini: A GMM Approach

By

Sive Kunene¹ and Ntobeko Dlamini²

Abstract

This study examines the macroeconomic determinants of bank deposits in Eswatini using annual data from 1990 to 2024 and the Generalized Method of Moments (GMM) estimation technique. The results indicate that total deposits and time deposits are positively influenced by broad money supply (M2), while real GDP and the Consumer Price Index (CPI) exert a statistically significant negative effect in both categories of deposits. The negative effect of GDP is against a priori expectation. The lagged values of both total deposits and time deposits, and the interest rate were statistically insignificant. For savings deposits, M2 remains a positive and significant determinant, while the lagged dependent variable has a negative effect. In this specification, real GDP, CPI, and the interest rate were statistically insignificant. The insignificance influence of the interest rate variable suggests that the interest rate channel of monetary policy transmission may be weak or ineffective in influencing deposit mobilization. This implies that adjustments in the policy rate are not being adequately transmitted to deposit rates. The Central Bank should therefore ensure that changes in deposit rates are commensurate with adjustments in the policy rate to strengthen this transmission mechanism. However, the weak response of deposits to interest rate changes may also reflect structural constraints within the domestic economic environment.

Key words: Bank Deposits, GMM, Interest rates, Eswatini

1. Introduction

The banking sector plays a central role in economic development through its core function of financial intermediation. By mobilizing savings and allocating capital to productive investment, banks enhance resource allocation efficiency and support sustained economic growth. Recent empirical evidence continues to affirm this relationship, particularly in developing and emerging economies where banking systems dominate financial intermediation (Banke and Yitayaw, 2022; Lamothe et al., 2024). In such contexts, banks serve as the primary conduit linking surplus and deficit sectors of an economy, making their role indispensable for economic transformation.

A key indicator of banking sector performance is deposit mobilization, which constitutes the principal source of loanable funds. Deposits not only determine banks' lending capacity but also reflect the level of financial deepening and public confidence in the financial system. Recent studies emphasize that deposit dynamics are shaped by both macroeconomic and institutional factors, including economic growth, inflation, financial stability, and political conditions (Banke and Yitayaw, 2022). In addition, emerging evidence highlights the role of broader macro-financial linkages such as income dynamics, exchange rate movements, and monetary conditions in influencing deposit accumulation, particularly in small open economies (Sharma, 2024; Nguyen, 2022).

The recent empirical literature further underscores that deposit behaviour is jointly determined by macroeconomic fundamentals and bank-level characteristics, including profitability, stability, and liquidity conditions. For instance, studies using panel data and dynamic estimation techniques (Naula et al., 2025; Barth et al., 2022) show that economic growth, inflation, institutional quality, and financial sector development play significant roles in shaping deposit mobilization across countries. However, despite these advances, the literature remains relatively limited in small, bank-dominated economies, where structural characteristics may alter conventional transmission mechanisms.

This gap is particularly relevant for Eswatini, a small open economy operating under a fixed exchange

¹ Sive Kunene is a Senior Economist, Policy Research, in the Research Department. Email: sivek@centralbank.org.sz
² Ntobeko Dlamini is a Senior Economist, Modelling and Forecasting, in the Research Department. Email: ntobekod@centralbank.org.sz

rate regime, which constrains monetary policy autonomy and may influence the interaction between macroeconomic variables and banking sector outcomes. While global evidence highlights the importance of macro-financial linkages in deposit dynamics, country-specific empirical studies remain scarce for Eswatini.

This study addresses this gap by examining the relationship between bank deposits and selected macroeconomic variables in Eswatini using an econometric approach. By identifying the key determinants of deposit growth, the study contributes to the emerging literature on deposit dynamics in developing economies and provides policy-relevant insights for maintaining financial stability. The findings are expected to support evidence-based decision-making by authorities, including the Central Bank of Eswatini, in promoting a resilient and well-functioning banking system.

1.1 Brief Overview of Banking Sector in Eswatini

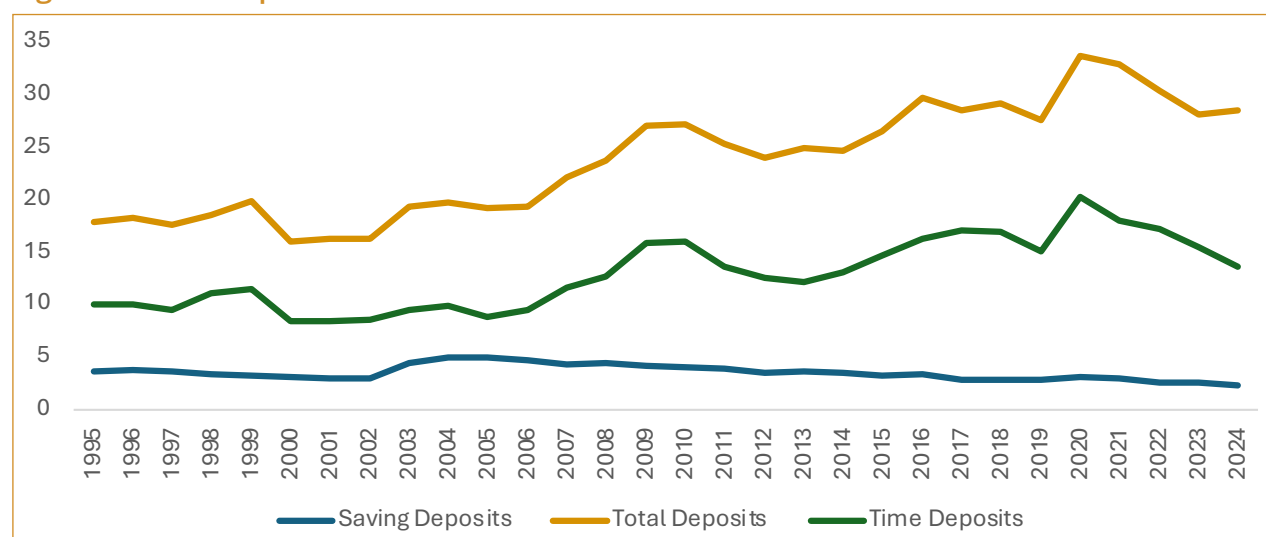
The banking sector in Eswatini plays a central role in the functioning of the domestic financial system and the broader economy. As the dominant component of the financial sector, commercial banks facilitate payments, mobilize savings, and provide credit to households and businesses. The sector is relatively small but well-developed, reflecting the country's status as a small open economy.

Eswatini's banking industry comprises four commercial banks operating through an extensive branch network across the country. The sector is regulated and supervised by the Central Bank of Eswatini, whose mandate is to maintain price and financial stability. Overall, the banking sector remains adequately capitalized, liquid, and profitable, supported by prudent regulatory oversight.

In recent years, the sector has undergone gradual transformation, driven by technological innovation and financial inclusion initiatives. Banks have increasingly adopted digital financial services, including online banking platforms, to expand access and improve efficiency. These developments have enhanced the accessibility of financial services, particularly in underserved areas. Consistent with these structural improvements, bank deposits in Eswatini exhibited an overall upward trend over the period 1995–2024, reflecting gradual financial deepening and increased participation in the formal banking system.

Despite these positive developments, the banking sector continues to face several structural challenges. These include a relatively narrow deposit base, limited domestic savings, and vulnerability to external economic shocks, given the country's close economic ties with South Africa. More recently, trends in bank deposits have increasingly reflected underlying macroeconomic conditions. While total deposits as a share of gross domestic product (GDP) rose from approximately 18 percent in the mid-1990s to about 28 percent in recent years, a noticeable decline has been observed since 2020.

Figure 1: Bank Deposits as a Share of GDP in Eswatini



Source: Central Bank of Eswatini

This contraction coincides with a period of heightened macroeconomic stress. Among these is the COVID-19 pandemic which led to a significant economic downturn. This saw the country's GDP contract sharply in 2020, followed by an uneven recovery and slower growth in subsequent years. At the same time, rising inflation driven largely by higher global food and fuel prices eroded real household incomes and reduced savings capacity, thereby weakening deposit accumulation. The decline in deposits is also associated with a reduction in time deposits, alongside a gradual decrease in savings deposits, reflecting tighter liquidity conditions and shifting financial behaviour among households and firms.

Overall, while Eswatini's banking sector remains stable and resilient, sustaining deposit growth and deepening financial intermediation will be critical for supporting long-term economic development.

2. Review of Literature

2.1 Theoretical Literature

Theoretically, the lifecycle hypothesis (Modigliani and Brumberg, 1954), the permanent income hypothesis (Friedman, 1957) and the buffer-stock theory (Deaton, 1989; Carroll et al., 1992) provide the most plausible explanation to savings behaviour from the depositors' perspective.

According to the lifecycle model, individuals' income for a particular period largely predicts consumption. This suggests that people make savings for smooth consumption over some time. Therefore, given the varying nature of income over the life of individuals, the stage of an individual's life determines his/her savings pattern, implying that during the working years of individuals, they are net savers and become dissavers on retirement (Modigliani and Brumberg, 1954).

Friedman (1957) asserts that the permanent income hypothesis assumes that current savings of individuals are reduced by higher future income. Changes in the temporal income of individuals are met by consumption smoothing, whereby tomorrow's higher spending is sustained by income windfall saved today. On the contrary, current savings are not justified by changes in permanent income, given that more can be consumed irrespective of the period (i.e.

both present and future).

The buffer-stock theory explains that people save more to protect their spending from unexpected income changes. When income is uncertain, individuals feel both impatient and cautious. They want to borrow against future income for current needs, but they also seek to save to avoid risks from future fluctuations. By saving more during times of higher income, they aim to maintain steady consumption during tougher times. Thus, their savings tend to increase when their income is high (Deaton, 1989 and Carroll et al., 1992).

2.2 Empirical Literature

Sheefeni and Nyambe (2016) examined the macroeconomic determinants of commercial banks' liquidity in Namibia using the Autoregressive Distributed Lag (ARDL) approach. Their findings indicate that GDP is the primary positive determinant of bank liquidity in Namibia. Inflation exerts a statistically significant negative effect on bank liquidity, while the interest rate shows a positive but statistically insignificant effect.

Apau and Sibindi (2025) investigated the determinants of bank deposit flows in South Africa using a dynamic panel two-step Generalized Method of Moments (GMM) approach applied to twelve commercial banks. The findings reveal that bank-specific variables, namely, past deposit flows, profitability, bank size, and the capital adequacy ratio, have a positive and statistically significant influence on deposit flows. Expenditure drivers exert a statistically significant negative effect on deposits. Contrary to a priori expectations, the results also indicate a positive relationship between the unemployment rate and deposit flows. Apau and Sibindi (2025) attribute this unexpected relationship to the adaptive nature of market interactions, noting that relationships among financial variables are unlikely to remain constant under varying economic conditions. The results also revealed a positive relationship between economic productivity and deposit flows.

Using an Ordinary Least Squares (OLS) method, results by Boadi et al. (2015) revealed that GDP and the real T-Bill rate lagged once have a positive significant effect on banks deposits in Ghana. The real savings deposit rate lagged once had a significant negative relationship with bank deposit, against a priori

expectation. This is on account of the high inflationary environment (Boadi, et al., 2015). Exchange rate volatility had a negative significant effect on deposit, in line with the a priori expectation.

Opoku-Asante et al. (2023) employed a co-integration approach to examine the relationship between bank deposits and macroeconomic variables in Ghana. The findings indicate that, in the long run, inflation, GDP, and public debt levels have a statistically significant positive relationship with bank deposits. In the short run, only the GSE All-Share Index (GASI) exerts a statistically significant influence on bank deposits; however, this effect does not persist in the long run, where the relationship remains positive but statistically insignificant.

Using a fixed-effects balanced panel of six commercial banks in Fiji, Chand et al. (2024) found that bank size, profitability, loan-to-deposit ratio, and bank stability positively influence deposits, while the capital adequacy ratio has a negative effect. Remittances and GDP per capita also show a positive association with bank deposits.

Pamba (2024) employed a two-regime Markov Switching Mean Vector Autoregressive (MSM-VAR) approach, distinguishing between periods of low and high liquidity volatility. The findings indicate that both macroeconomic and bank-specific factors respond differently to bank liquidity depending on prevailing market conditions. GDP growth exerts a positive effect on bank liquidity in both regimes, whereas exchange rate risk, credit risk, and return on equity have negative effects across regimes. Inflation negatively affects liquidity during periods of low liquidity volatility but has a positive impact under high liquidity volatility conditions. Similarly, bank size exhibits a positive effect on liquidity in the low-liquidity regime and a negative effect in the high-liquidity regime.

In Ethiopia, Banke and Yitayaw (2022) examined bank-specific and macroeconomic determinants of deposit mobilization using a balanced panel data from 14 commercial banks over the period 2011–2020. The result revealed that loan to deposit ratio, capital adequacy, economic growth, inflation, population growth, and political stability have a negative and statistically significant effect on commercial bank deposit mobilization. On the other hand, bank's

profitability has a positive significant impact on commercial bank deposit growth. Legass et al. (2025) used a panel OLS model using data from 2010-2019 and found that bank size, broad money supply, and inflation have significant positive effect on deposit growth of commercial banks in Ethiopia. The results further revealed that age, dependency ratio and population growth have a statistically significant negative effect on deposit growth.

In Nigeria, a study by Femi et al. (2021) on listed banks revealed that branch network and bank size have positive significant effects on bank deposits while financial intermediation ratio and economic growth have positive but insignificant effects with deposit. Money supply had a negative but significant effect on deposits. Eriemo (2014) used an VECM approach and the results revealed that in Nigeria, branches network, interest rates and the price level are key determinants for bank deposits. The general price level proxied through CPI had a significant negative coefficient.

Hailu (2024) studied the impact of key macroeconomic factors on the deposit mobilization performance of commercial banks in Ethiopia. Through the application of panel data regression analysis, the research explored the dynamics between deposit mobilization and various macroeconomic variables, including inflation, interest rates, real GDP, exchange rates, monetary supply, and GDP per capita. The results indicated that both inflation and the monetary supply exert a statistically significant negative effect on deposit mobilization. Furthermore, the investment deposit ratio also demonstrated a notable negative relationship with deposit mobilization. Conversely, GDP per capita showed a marginally significant positive correlation with deposit mobilization.

Kamugisha (2022) empirically examined the relationship between selected variables and bank deposits growth in Rwanda. The empirical results revealed that both macroeconomic and bank-specific factors play a role in determining bank deposits growth in Rwanda. Specifically, the results revealed that gross domestic product, government expenditure, number of bank branches and deposit interest rate have a long run influence on bank deposit growth in Rwanda.

Kofi et al., (2024) examined the linkages between macroeconomic variables and total deposits of Ghanaian banks. The Engle-Granger causality test

results indicated that inflation, GDP, public debt exhibited a significant positive long-run cointegration relationship. This suggested that the identified variables play a crucial role in explaining the fluctuations in total deposit levels within the Ghanaian banking industry.

Tun (2019) conducted a study of macroeconomic factors affecting deposits mobilization of private commercial banks in Myanmar targeting 24 private commercial banks. The study findings revealed that real interest rate, GDP per capita and exchange rate have a positive and significant effect on the deposits mobilization while money supply has a negative and insignificant impact on deposits.

Thao and Thanh (2021) investigated the macroeconomic and bank-specific factors that determine bank deposits in Vietnam. To explore the association, a fixed and random effect model was performed on a data set of 40 banks from 2006 to 2019. The results revealed that bank profitability and GDP have a positive effect on bank deposits. Bank size, bad loan and inflation showed an insignificant effect on bank deposits.

Yadav and Kishore (2017) used a VECM approach to examine the macroeconomic determinants of bank deposits in India. The study used monthly data for period January 2011 to December 2015. The results showed that money supply, index of industrial

production and Treasury bill rates were statistically significant at various lags with the money supply having positive impact on the amount of deposits while IIP and Treasury bill rate had a negative impact on deposits.

3. Methodology

This study investigates the determinants of bank deposits in Eswatini using annual data spanning 1990 to 2024, sourced from the Central Bank of Eswatini's quarterly bulletins. The analysis employs three categories of bank deposits—total deposits, time deposits, and savings deposits—as dependent variables, considered interchangeably. The explanatory variables include broad money supply, the general price level proxied by the consumer price index, real gross domestic product, and the interest rate proxied by the Treasury Bill rate.

The study uses the Generalized Methods of Moments (GMM) technique to cater for endogeneity, heteroskedasticity and autocorrelation. Lagged values of the independent variables are used as instruments. This model approach also allows for the J test which tests for over identification of the model. The GMM technique has also been used by authors like Apau and Sibindi (2025) in South Africa, who also conducted similar study.

$$\ln \text{TBD}_t = \varphi_0 + \varphi_1 \text{TBD}_{t-1} + \varphi_2 \ln \text{RGDP}_t + \varphi_3 \ln \text{M2}_t + \varphi_4 \text{IR}_t + \varphi_5 \ln \text{CPI}_t + \varepsilon_{it} \quad (1)$$

Where;

$\ln \text{TBD}$ is the log of time deposit

$\ln \text{RGDP}$ is the log of real GDP

IR is the interest rate proxied through the Treasury Bill Rate

$\ln \text{M2}$ is the log of broad money supply

$\ln \text{CPI}$ is the log of the consumer price index

ε is the error term

φ_0 is the intercept

$\varphi_1 - \varphi_5$ are coefficients of the regression equation

The study utilizes three models, in the second and third models, the dependent variable was replaced by log of time deposits (ITD) and the log of savings deposit (ISD), respectively. The lag of the dependent variable were also used as part of explanatory variables in the respective models.

Based on economic theory, the following are priori expectations.

Real GDP: an increase in GDP often improves disposable income which would lead to increased savings. The study expects a positive relationship between GDP growth and Time Deposits.

Broad Money supply: a priori expectation for this study is positive relationship between money supply and bank deposit.

Consumer Price Inflation: Higher inflation reduces real returns and therefore discourages savings, unless deposits rates keep pace with the inflation. This study expects a negative relationship between CPI and bank deposits.

Interest rate: the study expects a positive relationship between interest rates and bank deposits. Central bank policies influence market rates, thereby affecting deposits attractiveness.

Lags of the depend on variables: there is no a priori expectation on the lags of the dependent variables. The study starts by analysing the data using graphs and then goes on to conduct the Augmented Dickey Fuller Test (ADF Test) to determine their stationarity properties.

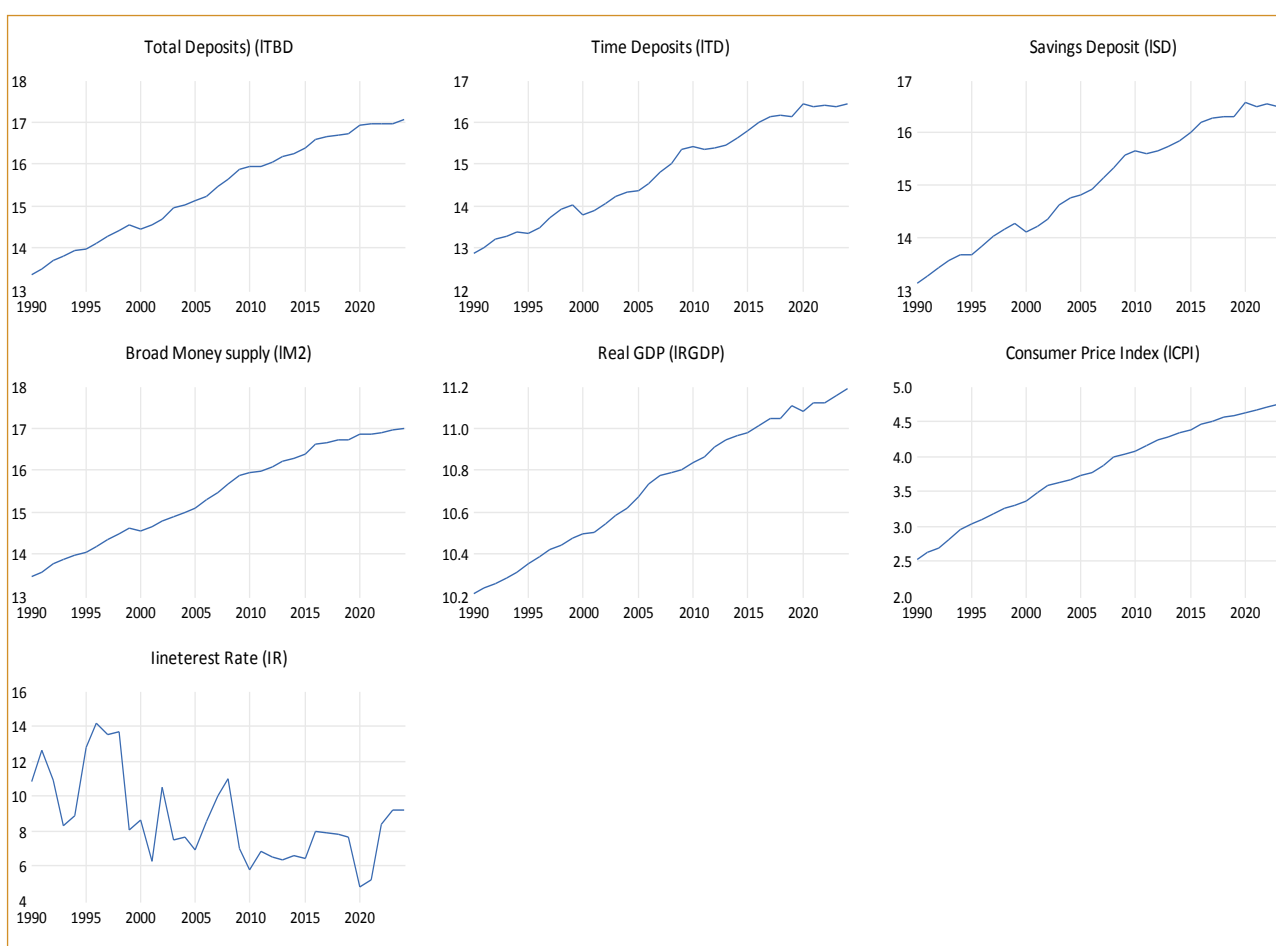
under consideration, namely; total bank deposits (ITBD), time deposit (ITD), savings deposits (ISD), consumer price index (ICPI), broad money supply (IM2), real GDP (IRGDP) and interest rates (IR) are non-stationary with a trend.

4. Results and Discussion

4.1 Graphical Analysis

The graphical analysis of the data is presented on Figure 2. The analysis indicates that all the variables

Figure 2: Graphical Analysis



4.2 Stationarity Test results

indicate that all the variables were non-stationary at levels and were stationary after first differencing I(1).

The Augmented Dickey Fuller (ADF) test results

Table 1: ADF Stationarity Test Rest

Variable	Levels	1 st Difference	Decision
ITBD	-1.165	-15.411***	I(1)
ITD	-1.382	-15.112***	I(1)
ISD	-1.926	-5.109***	I(1)
ICPI	-0.644	-5.592***	I(1)
IM2	-0.618	-5.004***	I(1)
IRGDP	-1.492	-7.310***	I(1)
IR	-2.659	-5.609***	I(1)

4.3 Empirical Results and Discussion

The results of the total bank deposits GMM model are presented on Table 2. The results indicate that bank total deposits (TBD) are positively influenced by M2 while real GDP and CPI have a negative significant effect. A 1 per cent increase in broad M2 would increase banking sector total deposits by 1.20 per cent ($p < 0.01$). A 1 per cent increase in real GDP would reduce bank deposits by 0.09 per cent ($p < 0.01$) and a 1 per cent increase in CPI would reduce bank deposits by 0.30 per cent ($p < 0.01$). The negative coefficient for real GDP is counterintuitive while the coefficients signs for M2 and the CPI are in line with the priori expectations. Conventional theory suggests that higher income and output should lead to increased savings and deposits. The negative coefficient of GDP may be explained by a substitution effect during economic expansion, wherein households and firms often allocate resources toward consumption and investment rather than deposit accumulation, reflecting the higher opportunity cost of holding deposits in periods of growth. Asongu (2021) found that informal financial systems in the Sub-Saharan Africa, influence savings away from formal banks, while Girma and Huseynov (2025) show

that financial development dimensions can hinder deposit growth despite overall economic expansion. Girma & Huseynov (2025) asserts that economic expansion may encourage investment in non-deposit financial assets rather than accumulation of bank deposits. Similarly, World Bank (2019) and Demirgüç-Kunt & Klapper (2012) emphasize that financial inclusion and structural factors shape whether GDP growth translates into formal deposit mobilization. Additionally, in Eswatini a sizeable number of big corporates are subsidiaries and transfers part of their proceeds abroad to parent companies as part of payment for services rendered and profit shares.

The lag of total bank deposits and the interest rate, proxied through T-bill rates, both have positive coefficients but were statistically insignificant. Theoretically, an increase in the policy rate should also result in an increase in deposit rates which should lead to an increase in bank deposits because of the improved yields (Beyer, 2024). The insignificant interest rate effect therefore indicates a weak deposit channel of monetary policy transmission. The J-statistic is statistically insignificant indicating that the instruments are valid.

Table 2: GMM Model Results for Total Bank Deposits

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LTDB(-1)	0.037	0.072	0.503	0.619
LRGDP	-0.086	0.017	-5.221	0.000***
LM2	1.200	0.076	15.718	0.000***
LCPI	-0.302	0.118	-2.580	0.015**
T-BILL	0.003	0.005	0.630	0.534
DUM2003_2005	0.143	0.033	4.275	0.000***
R-squared	0.999	Mean dependent var		8.549
Adjusted R-squared	0.999	S.D. dependent var		1.140
S.E. of regression	0.029	Sum squared resid		0.023
Durbin-Watson stat	1.094	J-statistic		2.599
Instrument rank	7	Prob(J-statistic)		0.107

NB: *** and **, denotes significance at 1% and 5%, respectively.

The results of the time deposits GMM model are presented on Table 3. The results indicate that bank time deposits are positively influenced by broad money supply (M2) while real GDP and the CPI have a negative influence. A 1 per cent increase in M2 would increase banking sector time deposits by 1.36 per cent ($p < 0.01$). A 1 per cent increase in real GDP would reduce bank time deposits by 0.22 per cent ($p < 0.01$) and a 1 per cent increase in the CPI would reduce time deposits by 0.64 per cent ($p < 0.01$). The negative coefficient for real GDP is against a prior

expectation while the coefficients signs for broad money supply and consumer price index are in line with the priori expectations. The possible explanation for the negative real GDP coefficient is as discussed in the proceeding discussion for Table 1. The lag of bank time deposits and the interest rate both have positive coefficients but were statistically insignificant. Once again, the insignificant interest rate indicates a weak deposit channel of monetary policy transmission. The J-statistic is statistically insignificant indicating that the instruments are valid.

Table 3: GMM Model Results for the Time Deposits

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ITD(-1)	0.125	0.101	1.238	0.226
IRGDP	-0.224	0.028	-7.923	0.000***
IM2	1.361	0.223	6.101	0.000***
ICPI	-0.639	0.279	-2.286	0.030**
IR	0.019	0.016	1.254	0.220
R-squared	0.997	Mean dependent var		8.004
Adjusted R-squared	0.996	S.D. dependent var		1.107
S.E. of regression	0.067	Sum squared resid		0.125
Durbin-Watson stat	1.669	J-statistic		0.129
Instrument rank	6	Prob(J-statistic)		0.720

NB: *** and **, denotes significance at 1% and 5%, respectively.

Table 4 presents the results for the banks total savings deposits GMM model. The results indicate that savings deposits are positively influenced by M2 while savings deposits lagged once has a negative influence. A 1 per cent increase in M2 would increase banking sectors' savings deposits by 0.09 per cent ($p < 0.01$). A 1 per cent increase in M2 would increase bank deposits by 1.62 per cent ($p < 0.01$) while a 1 per cent increase in savings deposits lagged once would reduce bank current deposits by 0.50 per cent. Real GDP, CPI and interest rate had negative coefficients but were statistically insignificant. Once again, the insignificant interest rate coefficient indicates a weak deposit channel of monetary policy transmission. The possible cause for the negative coefficient for GDP is as previous explained in the discussion for Table 1 while the negative coefficient for interest rates

could be explained by the following. In a constrained economy, an increase in interest rates would affect households and firms on their loan repayment ability and thus would impact deposits negatively instead of having a positive effect. According to Rulashe et al. (2025), the reliance on interest rates to influence savings has proven ineffective in contexts where economic inequalities limit the capacity of households to respond to such measures. On another note, there could be some substitution effect whereby savers move their funds to other higher interest-bearing assets like bonds thus reducing banks savings deposits. Once again, the insignificant interest rate indicates a weak deposit channel of monetary policy transmission. The J-statistic is statistically insignificant indicating that the instruments are valid.

Table 4: GMM Model Results for Total Savings Deposits

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LTS(-1)	-0.495	0.249076	-1.988896	0.0566*
LRGDP	-0.040	0.051819	-0.764734	0.4508
LM2	1.619	0.287924	5.624550	0.000***
LCPI	-0.269	0.302738	-0.887700	0.3823
T_BILL	-0.022	0.014965	-1.441113	0.1606
R-squared	0.993	Mean dependent var		8.264
Adjusted R-squared	0.992	S.D. dependent var		1.046
S.E. of regression	0.092	Sum squared resid		0.237
Durbin-Watson stat	1.007	J-statistic		2.542
Instrument rank	7	Prob(J-statistic)		0.281

NB: *** and *, denotes significance at 1% and 10%, respectively.

5. Conclusion and Policy Recommendations

The study examined macroeconomic determinants of bank deposits in Eswatini using the Generalized Method of Moments (GMM) approach. It used three models, with the dependent variables being total deposits, time deposits and total savings deposits, used interchangeably. The results revealed that total deposits are positively influenced by broad

money supply (M2) while real GDP and the consumer price index (CPI) have a negative significant effect. However, the negative relationship for real GDP is counterintuitive. The lag of total deposits, and the interest rate were insignificant. Commercial banks time deposits are positively influenced by M2 while real GDP and the CPI have a negative significant effect. Total savings deposits were found to be positively influenced by M2 while the lag of the dependent variable had a negative effect. Real GDP, CPI and

interest rate were statistically insignificant.

The insignificance of the interest rate, proxied through the T-Bill rate, on bank deposits in the selected categories indicates a weak deposit channel of monetary policy transmission. The Central Bank therefore needs to ensure that interest rate changes

on deposits are largely commensurate with changes in the policy rate to ensure effectiveness of the deposit channel of monetary policy transmission. However, the insignificance could also be a result of other structural factors in economy which can affect the transmission.

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ASYMMETRIC EFFECTS OF PUBLIC DEBT ON GDP IN ESWATINI

By

Mcebo Zikalala¹, Bongani Hlophe² and
Siphosethu Shabangu³

Abstract

Eswatini's public debt has escalated significantly in recent years, with increasing concerns about its economic impact on GDP growth and fiscal sustainability. Public debt measured as a percent of GDP, has increased from sustainable levels of 13.5 percent of GDP in 2014/15 to a forecasted 40.3 percent of GDP in 2025/26. This study employs the ARDL model as a benchmark to assess the symmetric impact of public debt on nominal GDP before proceeding to examining the impact of the asymmetric decomposition of public debt on the same using the NARDL model. The symmetric model points to an inverse relationship between public debt and nominal GDP suggesting that the accumulation of debt impacts nominal GDP negatively. The asymmetric model shows that this impact is stronger in the short-run and weaker in the long run. Based on the results, the study recommends that the government of Eswatini pursues a delicate balance of prudent debt reduction measures while ensuring the economy continues to grow.

Key words: Eswatini, ARDL, NARDL, nominal GDP, asymmetric impact, fiscal sustainability

1. Introduction

The relationship between public debt and gross domestic product has continued to be one of the most contested subjects in macroeconomics, particularly in developing economies, where scholars and policymakers often diverge in their assessment. Classical theoretical underpinning postulates that government borrowing can stimulate productive investment, accelerate capital formation and support long-run economic development. However, an increasing and growing body of literature cautions that beyond a certain threshold, debt accumulation may become a structural hinderance to economic dynamism (Elmendorf and Mankiw, 1999; Blanchard 1990; Shah, Dickenson, Tao, Wang and Zhang, 2024; Ibanez Martin, Rojas and Dabus, 2024). This friction between growth-enhancing and growth-retarding effects of public debt is especially acute in most African economies where fiscal vulnerabilities and shallow financial markets worsen the risk of unsustainable debt trajectory (Ncube and Brixiova, 2015).

Reinhart and Rogoff's seminal study (2010) catalysed a paradigm shift in the debt-growth nexus by empirically demonstrating that a public debt to GDP ratio above 90 percent is associated with markedly lower median growth rates. Thus, embedding the concept of a non-linear, threshold-dependent relationship into mainstream discourse which challenged the dominant view that debt effects were linear and context-specific. Although, subsequent scholars, disputed the robustness of this specific threshold on methodological grounds, the suggestion that effects of debt on growth is not uniform across debt levels has proven strong and has attracted considerable empirical attention. Checherita-Westphal and Rother (2012) concretised that for European economies debt dynamics are not homogeneous, with low to moderate debt level potentially crowding in investment and high debt levels crowding out private capital, suppressing total factor productivity and elevating sovereign risk premium.

Within the African context, the public debt dilemma continues to pose a significant socioeconomic

1 Mcebo Zikalala is a Principal Economist: Public Finance in the Research Department. Email: mceboz@centralbank.org.sz

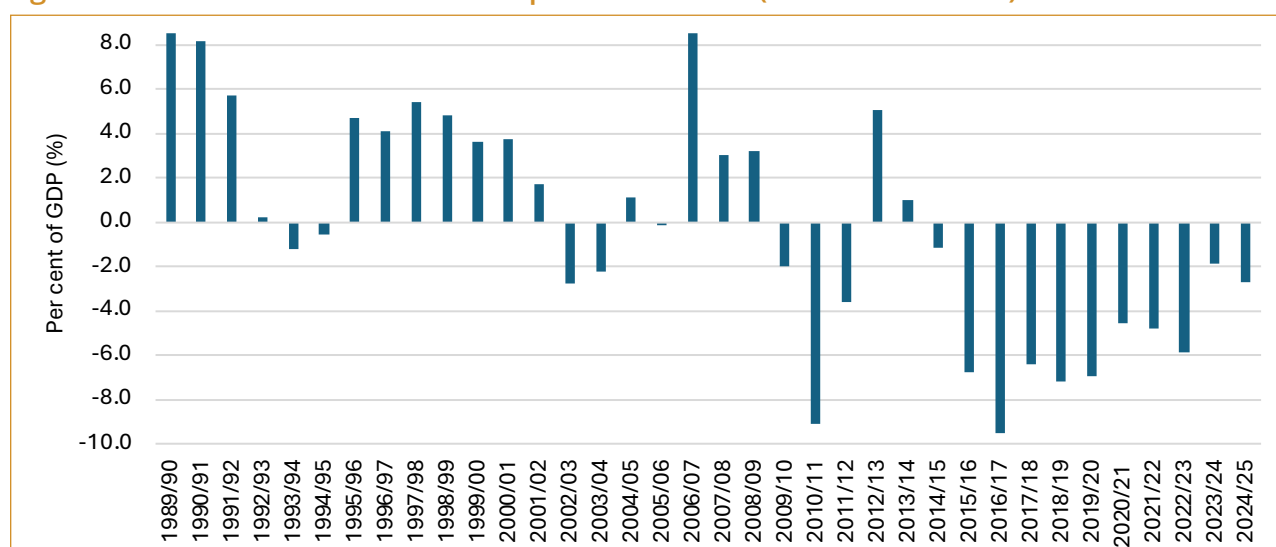
2 Bongani Hlophe is a Senior Economist: Modelling and Forecasting in the Research Department. Email: bonganih@centralbank.org.sz

3 Siphosethu Shabangu is an Economist: Public Finance in the Research Department. Email: siphosethuts@centralbank.org.sz

constraint, undermining fiscal sustainability and long-term development prospects. Policymakers grapple with the challenges that arise when major fluctuations in public debt ratios trigger pronounced economic upswings or downturns, often complicating macroeconomic management. Public debt, whether domestic or external, emerges when a government borrows money to improve its economy or to offset its deficits (Okoro, 2013). However, its implication extends beyond the fiscal balance. As Odhiambo,

Saungweme & Maluleke (2023), observes that debt dynamics affect a wide array of macroeconomic variables, such as domestic interest rates, inflation, consumption patterns, investment levels, private savings, overall fiscal and monetary conditions. Moreover, access to new and inexpensive credit lines, total factor productivity, International Monetary Fund (IMF) lending decisions, timing and size of financing, amongst other are all impacted by debt accumulation.

Figure 1: Eswatini Fiscal Balance as a per cent of GDP (1989/90 -2024/25)



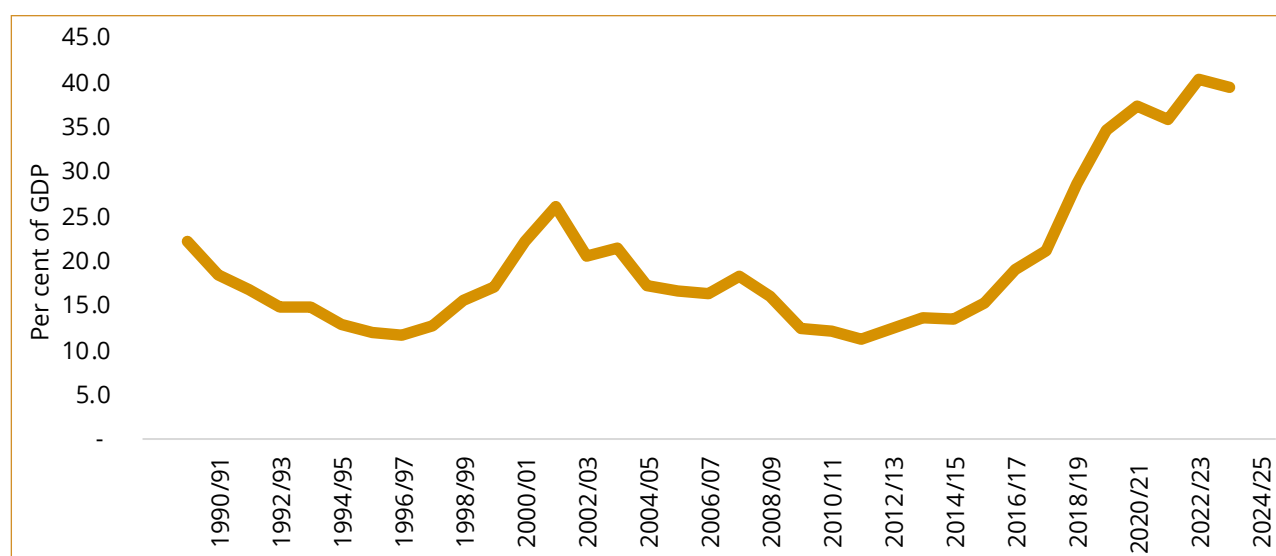
Source: Ministry of Finance, Medium Term Fiscal Framework (MTFF) April 2026

In the early 1990's and 2000's, Eswatini consistently recorded fiscal surpluses, as revenue outpaced expenditures. The exception to this pattern was observed during periods of economic turmoil, particularly drought prone years and during episodes of global crises, where the fiscal balance temporarily deteriorated. However, post 2013/14 the fiscal position shifted markedly, with the government persistently running fiscal deficit exceeding the Southern African Development Community (SADC) Convergence Benchmark of 3.0 percent of GDP. This pattern highlighted an imbalance between expenditure allocation and revenue mobilization reflected through structural pressures. Evidently, during the COVID-19 pandemic, fiscal consolidation measures were intensified. These efforts narrowed the deficit to below the 3.0 percent benchmark, restoring the fiscal balance to more prudent and manageable levels despite the economic headwinds induced by the pandemic.

Debt has become one of the key instruments utilised by Governments to finance the fiscal deficit.

However, the perpetual deficit has caused Eswatini's public debt to escalate significantly in recent years, with increasing concerns about its economic impact on GDP growth and fiscal sustainability. Public debt measured as a percent of GDP, has expanded from manageable levels of 13.5 percent of GDP in 2014/15 (about E6.654 billion) to a projected 40.3 percent of GDP in 2025/26 (E36.029 billion). This rapid accumulation has constrained the government's fiscal space, limiting its ability to allocate resources towards productive investment and social services. High debt levels reduced fiscal flexibility by diverting a significant portion of public revenue towards debt servicing obligation particularly interest and principal repayment, rather than towards growth enhancing expenditures such as infrastructure, education and health. The burden of interest payments alone has risen drastically, increasing from 2.2 percent of revenue (E325 million) in 2014/15 to a resounding estimated 11.3 percent of revenue (E3.336 billion) in 2025/26 (Ministry of Finance, 2026).

Figure 2: Eswatini Government Debt as a percent of GDP (1989 - 2024)



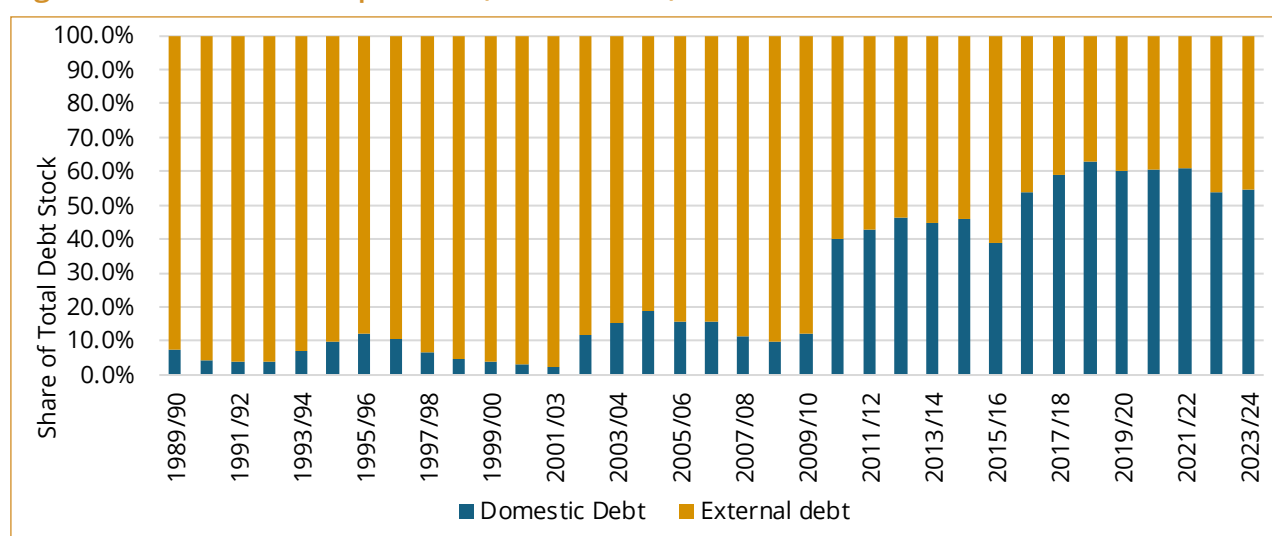
Source: Ministry of Finance, Medium Term Fiscal Framework (MTFF) April 2026

For two decades from 1990 to 2010, Eswatini's debt profile was largely shaped by external borrowing, with external debt accounting for about 90.9 percent of total public debt. The strong dependence on foreign financing reflected structural constraint such as reliance on concessional borrowing, underdeveloped domestic capital markets and the need to access international resources to fund development and fiscal deficits.

However, the global financial crisis of 2008/09 marked a turning point for debt dynamics for Eswatini. The second-round effects of the crisis disrupted

international capital flows and tightened external financing conditions. This led to a seismic shift in debt dynamics as domestic debt, which account for 12 percent of total debt in 2009/10 started to gain prominence as the government attempted to diversify funding sources and reduce external exposure by tapping into the domestic capital markets. Over the following decade, intentional policy measures such as issuance of government debt securities and the development of the local bond market contributed to the shift in debt dynamics. By 2023/24 domestic debt has grown to account for about 54.6 percent of total public debt, overtaking external debt.

Figure 3: Total Debt Composition (1989 to 2024)

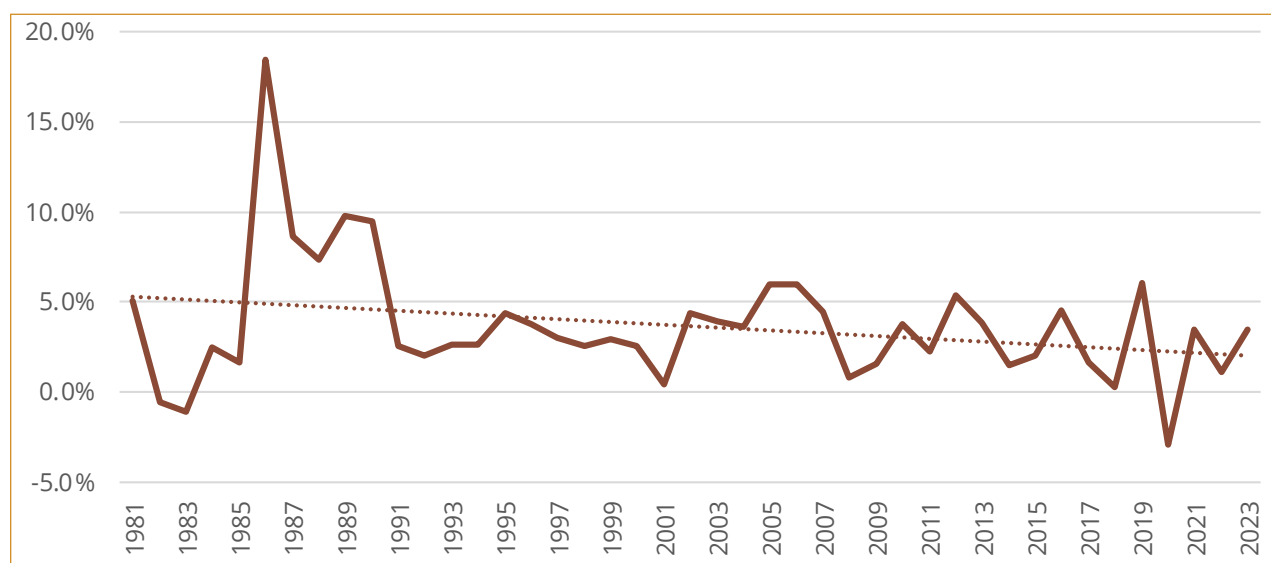


Source: Ministry of Finance, Medium Term Fiscal Framework (MTFF) April 2026

Eswatini's historical growth trends have reflected a steady declining trajectory over the past 4 decades. Between 1981 to 1990 real GDP growth averaged a robust 6.1 percent driven by an influx in investment as sanctions in neighbouring South Africa redirected capital flows into Eswatini. This period represented the expansion of the manufacturing sector in Eswatini. From 1991 to 2000, growth moderated to 2.9 percent

coinciding with the liberalization of South Africa, as some companies relocated back to RSA. Between 2010 to 2020, Eswatini's growth further decelerated to 2.5 percent reflecting the combined impact of external shocks coupled with persistent productivity challenges and limited economic diversification.

Figure 4: Eswatini Historical Real GDP Growth Trend (1981 to 2023)



Source: Central Statistics Office; National Accounts

Despite the growing body of literature on public debt at both global and regional levels, empirical research on the asymmetric effect of public debt on GDP in Eswatini remains limited. Previous studies have attempted to estimate the optimal debt threshold for the country: Ndzinisa and Sithole (2018) suggest that debt level around 46 percent of GDP could stimulate growth, while the Debt Sustainability Analysis (DSA) report for 2018 pinned the optimal debt level lower at 38 percent of GDP. Furthermore, politically, the debt level is targeted at 60 percent of GDP in line with the SADC convergence criteria. These divergent estimates underscore the uncertainty surrounding debt sustainability in Eswatini.

As a small landlocked lower-middle income economy in Southern Africa, Eswatini's public debt has exhibited a pronounced upward trajectory over the past 2 decades. This trend has been driven by persistent fiscal deficit, volatile Southern African Customs Union (SACU) receipts, constrained domestic revenue mobilization coupled with elevated recurrent expenditure pressures. Such structural vulnerabilities

have heightened concerns about the sustainability of debt accumulation. Yet despite such challenges there is conspicuous absence of empirical research into how public debt asymmetrically affects GDP in Eswatini, as this study is assumed to be the first of its kind for Eswatini.

This study attempts to cover a critical analytical gap, to assess if the GDP effects of debt accumulation are asymmetric, that is, if debt increases exert a disproportionately large hinderance on GDP than equivalent debt reduction stimulates it. Furthermore, the existing literature has not adequately addressed whether positive or negative changes in Eswatini's debt stock produce differential GDP outcomes.

The main objective of the study is to assess the asymmetric effects of public debt on nominal GDP in Eswatini using the Nonlinear Autoregressive Distributed Lag (NARDL) framework. The specific objectives are (i) to examine the symmetric (linear) long-run and short-run relationship between public debt and nominal GDP, (ii) to test whether the

effects of public debt on nominal GDP in Eswatini is asymmetric, and (iii) to provide evident based policy recommendations on debt management in Eswatini.

The study employed the Nonlinear Autoregressive Distributed Lag (NARDL) model from 1990 to 2024. This technique allows for the decomposition of the debt-GDP relationship into its positive and negative components. By generating insights specific to Eswatini's economic characteristics, the study contributes not only to national policy discourse but also to the broader literature on debt sustainability in developing countries.

2. Literature review

2.1 Theoretical Literature

Theoretical perspectives on public debt range from beneficial to detrimental, with a consensus that the impact is highly context dependent. Keynesian theory suggests debt-financed spending can boost a weak economy by stimulating demand, while neoclassical and monetarist views warn that it can crowd out private investment and reduce long-term growth by raising future tax burdens (Keynes, 1936). The Ricardian equivalence hypothesis goes a step further, arguing that rational households will save more in anticipation of future taxes, nullifying the effect of government borrowing (Elmendorf and Mankiw, 1999; Friedman & Schwartz, 1963; Barro, 1974). More recent theories highlight a non-linear debt-growth nexus, suggesting that a moderate debt-to-GDP ratio may be growth-enhancing, but excessive debt creates a debt overhang that discourages investment (Reinhart & Rogoff, 2010; Kumar & Woo, 2010). Beyond the debt level, the composition (e.g., short-term vs. long-term, domestic vs external) is also crucial for determining sustainability (Jónasson et al., 2024; He & Xiong, 2012). Together, these perspectives show that the effect of public debt is complex and depends on its size, structure, and the broader economic environment.

2.2 Keynesian Theory

This theory was tabled by John Maynard Keynes in 1936, and it highlights the positive role public debt plays to stimulate economic growth, particularly during periods of recession. Keynes argues that government debt can close the gap in private sector demand, increasing employment and output. The theory postulate that when private sector fails to use resources, government borrowing through deficit

financing can mobilise them. Hence, public debt can increase private consumption and positively affect macroeconomic indicators such as output and unemployment.

2.3 Neoclassical and Monetarist Perspectives

Neoclassical and monetarist theorists converge in their skepticism toward debt-financed fiscal policy, emphasising that government borrowing crowds out private investment. From a neoclassical standpoint, high public debt adversely affects growth, not only by raising long-term interest rates and reducing available credit for firms (Elmendorf & Mankiw, 1999; Kumar & Baldacci, 2010), but also through the future tax increases required to service the debt, which can discourage capital formation (Salmon, 2021). Monetarists, notably Friedman, extend this argument by highlighting the monetary channel: increased government borrowing elevates demand for loanable funds, raises interest rates, and reduces interest-sensitive private spending—nullifying any short-term demand stimulus (Friedman & Schwartz, 1963). Together, these perspectives underscore a central critique: in the long run, debt-driven fiscal expansion may simply reallocate, rather than augment economic activity.

2.4 Ricardian Equivalence Theory

In sharp contrast to the crowding-out critique, the Ricardian equivalence theorem, popularised by Robert Barro (1974), posits that government debt has no real effect on aggregate demand or economic activity. This theory is based on the assumption of rational, forward-looking consumers who understand that current government borrowing must be repaid in the future through higher taxes. Therefore, when the government issues new debt, households do not feel wealthier. Instead, they anticipate a future tax liability and increase their savings to offset this future obligation. This increase in private saving perfectly counteracts the government's borrowing, leaving aggregate demand, interest rates, and investment unchanged. From this perspective, whether the government finances spending through taxes today or through debt to be repaid by taxes tomorrow is irrelevant to the economy's real performance.

2.5 Debt Overhang Theory

While the Ricardian view suggests debt is neutral, the

debt overhang theory highlights distinctly negative consequences at high levels. The theory, famously explored by Krugman (1988), posits that if a country's debt stock is so large that its future value exceeds the country's expected repayment ability, the anticipated burden of debt service acts as a "tax" on any future economic output. This disincentivises both domestic and foreign investors from undertaking new, productive projects because they expect a significant portion of any future profits to be captured by creditors. Consequently, this leads to a reduction in investment, which hinders long-term economic growth and can trap a country in a vicious cycle of low growth and high debt.

2.6 The Non-Linear Debt–Growth Nexus and Threshold Effects

Modern theoretical research has moved away from viewing the debt–growth relationship as linear, instead, uncovering a more complex, non-linear dynamic often referred to as the debt threshold effect. Evidence suggests that at low levels, public debt can be beneficial, financing productive investment in infrastructure, education, and health, thereby supporting growth. However, beyond a certain point, the burden of debt servicing, reduced fiscal space, and declining investor confidence begin to slow economic activity, consistent with the debt overhang hypothesis (Reinhart & Rogoff, 2010; Pattillo et.al., 2002). These observations underpin the debt threshold theory inspired by the work of Krugman (1988) and Sachs (1989) on debt levels and economic outcomes. This theory posits that while debt can stimulate growth at manageable levels, once a critical debt-to-GDP ratio is reached, the benefits diminish and the costs—through higher interest rates, crowding out of private investment, and the expectation of future taxation—begin to dominate (Blanchard, 2019). In summary, both theory and evidence establish that public debt is harmful only after it breaches a country's sustainable fiscal limit.

2.7 Debt Composition

Beyond the overall level of public debt, a key insight from modern theory is that the composition of a country's debt is just as important as its magnitude. The source, maturity, and terms of a country's debt can have fundamentally different macroeconomic implications. A high share of foreign-currency-denominated debt exposes an economy to significant

exchange rate risk, where a domestic currency depreciation can substantially increase the local value of the outstanding debt (Jónasson et al., 2024). Similarly, an over-reliance on short-term debt can create significant rollover risk, where a government may face a liquidity crisis if it is unable to refinance its maturing obligations (He & Xiong, 2012). Furthermore, the source of borrowing is a key consideration; concessional debt from international financial institutions is often a superior choice to commercial debt due to its more favourable terms, even in the face of devaluation (International Monetary Fund [IMF], 2002). Moreover, a large volume of government domestic debt can crowd out private-sector credit, hindering private investment and growth (Jato & Nwankwo, 2024).

2.8 Debt Sustainability and the Growth–Interest Rate Differential

Contemporary frameworks for debt sustainability highlight the growth–interest rate differential as a core metric for assessing a country's long-term debt trajectory (Checherita-Westphal & Semeano, 2021). This theory, which is also referred to as the Fiscal Space Hypothesis, posits that a country's public debt can be managed sustainably if its economic growth rate (g), consistently exceeds its effective interest rate on debt (r). This provides policymakers with a crucial metric for evaluating the fiscal health of a nation, taking into account both solvency (the ability to pay debt in the long-run) and liquidity (the ability to make timely payments). This concept is closely tied to a country's debt-carrying capacity, which is determined not just by the $g-r$ differential, but also by factors such as institutional quality, export diversification, and its level of foreign reserves (Ostry et al., 2010; IMF, 2013).

2.9 Conceptual Framework: Transmission Channels of Public Debt

While much of the literature has emphasised the debt–growth nexus, public debt also transmits its effects through other macroeconomic variables that are particularly relevant for SADC economies. This study focuses on the six key channels: economic growth, inflation, exchange rate, fiscal balance, trade openness and Gross capital formation.

Growth: The most widely studied channel is economic growth, where the relationship is often non-linear. At moderate levels, debt-financed productive public

investment can stimulate output by improving infrastructure and human capital, crowding in private activity. However, beyond sustainable thresholds, excessive debt harms long-term growth through two primary mechanisms. First, the crowding-out effect occurs when high domestic debt issuance raises real interest rates in shallow financial markets—common in SADC—making private investment more expensive. Second, the debt overhang effect arises when a large stock of debt, especially external, creates expectations that future profits will be heavily taxed for debt service, discouraging investment regardless of current interest rates. Both channels reduce private capital formation and potential growth, as evidenced in SADC studies such as Makhoba and Kaseeram (2022), where short-run stimulus gives way to long-run constraints.

Inflation: High public debt is frequently associated with inflationary pressures, especially where fiscal dominance undermines monetary policy independence. Fiscal deficits financed through central bank borrowing directly fuel price instability, as evidenced by persistent inflation episodes in countries such as Malawi. Afonso and Ibraimo (2018), using Mozambican data, demonstrate that public debt can have a non-linear effect on inflation, with institutional quality mediating the extent of fiscal dominance.

Exchange Rates: Exchange rate vulnerability represents another critical transmission channel. With a large share of SADC public debt denominated in foreign currencies, depreciation directly increases debt-servicing costs, mechanically raising debt-to-GDP ratios without additional borrowing. Episodes of currency volatility in Zambia and Mozambique have vividly illustrated how external debt exposure heightens exchange rate fragility, feeding back into debt sustainability concerns (Banda-Muleya, 2021).

Fiscal Balance: closely related, public debt exerts sustained pressure on the overall fiscal balance, a core determinant of macroeconomic stability. High debt servicing costs can widen fiscal deficits, limiting the government's ability to respond to economic shocks with counter-cyclical measures. In SADC—where many economies face revenue volatility due to commodity dependence—this pressure is particularly acute. Governments are often forced into difficult trade-offs between fiscal consolidation (through spending cuts or tax increases) and preserving

growth-supportive expenditure. This dynamic can initiate a feedback loop: deteriorating fiscal balances prompt further borrowing, which in turn deepens indebtedness and further constrains future fiscal space—a vulnerability starkly illustrated in the post-COVID-19 period (World Bank, 2023; IMF, 2024).

Gross fixed capital formation: the interplay between public debt and gross fixed capital formation is cornerstone for macroeconomic theory and fiscal policy debates (Dahal, Bhattarai and Adhikari, 2024). High and increasing debt levels raise concern about fiscal sustainability and the potential erosion on future policy space. While debt-financed fiscal stimulus are often utilised as a policy tool during economic downturns, particularly in times of liquidity traps where monetary policy effectiveness might be limited, its long-term implications are essentially predicated on whether borrowing supports productive investments or merely sustains consumption. Meanwhile, increasing reliance on domestic borrowing to finance growing deficits can have adverse spillovers. As the government competes with the private sector for available loanable funds, and high public debt can crowd out of private sector investment, thus undermining gross capital formation necessary to sustain economic growth.

3. Methodology

To empirically assess the asymmetric effects of public debt on nominal GDP in Eswatini, the study employed the Nonlinear Autoregressive Distributed Lag (NARDL) model developed by Shin, Yu and Greenwood-Nimmo (2014). The NARDL model was selected due to its ability to accommodate asymmetry both in the short and long run through decomposition of the debt variable into its positive (debt increases) and negative (debt decreases) partial sum components, allowing deferential responses to be estimated separately. Secondly, the NARDL is suitable for small samples, which is a critical consideration given Eswatini's limited annual time series data (Pesaran, Shin and Smith, 2001). Moreover, it can handle mixed order of integration both $I(0)$ and $I(1)$ without requiring all variables to be integrated of the same order. Additionally, the NARDL can capture both long-run cointegration and short-run dynamics within a unified estimation framework (Shin et al., 2014). This approach is consistent with the empirical studies on the asymmetric effects of government debt on GDP growth; evidence from Namibia (Mosikari and Eita,

2021), and Bauma, Checherita-Westphal and Rother (2013), who documented nonlinear debt effects in euro area economies.

The study utilised annual time series data for Eswatini spanning from the period of 1990 to 2024, sourced

from the Ministry of Finance, the Central Statistics Office and the Central Bank of Eswatini.

The variable selected for the model are defined as follows:

Table 1: Data Variables and Description

Variable	Symbol	Definition	References	Data Source
GDP	GDP	Nominal GDP	Reinhart and Rugoff (2010), Checherita-Westphal and Rother (2012),	Central Statistics Office (CSO)
Public debt to GDP	Debt to GDP	General government debt as a share of GDP	Reinhart and Rugoff (2010), Checherita-Westphal and Rother (2012),	Ministry of Finance (M.o.F) and Central Bank of Eswatini (CBE)
Gross fixed capital formation	GCF	Investment as a percent of GDP	Woo and Kumar (2015), Akram (2016)	Central Statistics Office (CSO)
Inflation	CPI	Consumer price index	Kumar and Woo (2010)	Central Statistics Office (CSO)
Exchange rates	EXCH	Lilangeni to dollar exchange rate		Central Bank of Eswatini (CBE)
Fiscal balance	Fiscal balance	The gap between revenues and expenditures		Ministry of Finance (M.o.F)
Trade openness	OPEN	Sum of exports and imports	Dollar and Kraay (2004)	Eswatini Revenue Services (ERS) & Central Bank of Eswatini (CBE)

3.1 Model specification

As a benchmark, the study first estimates a symmetric

linear ARDL model following Paseran, Shin and Smith (2001)

$$\Delta Y_t = \beta_0 + \sum_{i=1}^P \gamma_i \Delta Y_{t-i} + \sum_{i=0}^Q \delta_i \Delta X_{t-i} + \rho Y_{t-1} + \phi X_{t-1} + v_t \quad (1)$$

Where:

Y_t is the nominal GDP at time t

x_t is a vector of predictors with (Public Debt to GDP (PD), Consumer Price Inflation (CPI), Gross capital formation (GCF), Trade openness (OPEN), Exchange rates (EXCH), Fiscal Balance)

V_t is the white noise error term

P and Q are optimal lag length selected via Akaike Information Criterion.

To capture asymmetry, the public debt variable PD_t is decomposed into partial sums processes of positive changes and negative changes following Shin et al (2014)

$$PD_t^+ = \sum_{j=1}^t \Delta PD_j^+ = \sum_{j=1}^t \max(\Delta PD_j, 0) \quad (2)$$

$$PD_t^- = \sum_{j=1}^t \Delta PD_j^- = \sum_{j=1}^t \min(\Delta PD_j, 0) \quad (3)$$

Where:

PD_t^+ captures the partial sum of positive changes in public debt (accumulation episodes)

PD_t^- captures the partial sum of negative changes in public debt (debt reduction episodes)

γ_2^+ and γ_2^- are the long run asymmetric coefficients associated with debt increases and decreases respectively

α_2^+ and α_2^- captures short-run asymmetric dynamics.

4. Results and Discussion

As a prerequisite for the ARDL model, all the variables must be integrated of order zero $I(0)$ or one $I(1)$ but never above. To establish the order of integration for the data series, the unit root test was conducted for all the 7 variables using the Augmented Dickey-Fuller

(ADF) and Phillip-Perron (PP) tests for stationarity. The benefit of the PP test is that it accounts for structural break if the data has any, yet the ADF does not. Out of the 7 selected variables, 5 were subjected to logarithmic transformation. These include nominal GDP, CPI, exchange rates, trade openness and gross capital formation. Debt to GDP and the fiscal balance were retained in their normal form without transformation. The results of the unit roots tests indicated that three of the variables namely the log transformed nominal GDP, CPI and gross capital formation were stationary at level, that is they are integrated of order zero. The other 4 selected variables namely Debt-to-GDP, Exchange rates, fiscal balance and trade openness were integrated of order one, meaning they are stationary at first difference. This outcome confirms the suitability of the data for the ARDL model framework.

Table 2: Unit Root Test Results

Variable	Argument Dicky Fuller (ADF)	Phillip-Perron (PP)	Order of Integration
Log(NGDP)	-6.4095 ***	-5.8180 ***	$I(0)$
Debt to GDP	-4.1831 ***	-4.1838 ***	$I(1)$
Log(CPI)	-9.6134 ***	-30.3480 ***	$I(0)$
Log(EXCH)	-5.8196 ***	-5.9975 ***	$I(1)$
Fiscal_Balance	-6.7262 ***	-7.4429 ***	$I(1)$
Log(Openness)	-6.1765 ***	-6.1659 ***	$I(1)$
Log(GCF)	-3.6787 ***	-3.7891 ***	$I(0)$

Source: Authors computation, ***, **, *, 1%, 5% and 10% level of significance respectively.

The ARDL model (1,0,1,0,0,2,1) was selected to assess the effect of public debt on GDP over a period of 33 years from 1992 to 2023 in Eswatini. The model showed a strong fit with an adjusted $R^2=0.79669$, meaning that 79.7 percent of the variation was explained by the data. The model used automatic lag selection based on the Akaike Information Criterion

(AIC), evaluating 1,458 possible combinations to capture both short-run dynamics and long-run equilibrium among the macroeconomic variables such as inflation, trade openness, gross fixed capital formation, fiscal balance, exchange rates and Debt-to-GDP.

Table 3: Bounds Test Results

Critical Value	Lower bound $I(0)$	Upper bound $I(1)$
1%	2.254	3.388
5%	2.685	3.960
10%	3.713	5.326
F-statistic 21.16463		

Source: Authors computation

The bounds test for the symmetric ARDL was conducted using restricted constant with a sample size of 33 observation and 6 independent variables. The computed F-statistics of 21.16 exceeded the upper bound critical values at the 5 percent and 1 percent critical values. This provided strong evidence against the null hypothesis of no level relationship,

confirming the existence of cointegration amongst the selected variables. Resultantly, there is a stable long-run equilibrium relationship amongst the 6 regressors, therefore we can proceed to estimate the error correction model (ECM) to capture both the long run dynamics and the short run adjustment.

Table 4: Cointegration Coefficients Results

Variable	Coefficient	Probability
Log(CPI)	1.063570	0.0000 ***
Log(EXCH)	0.155598	0.0616 *
Log(Openness)	-0.339685	0.0118 **
Fiscal_balance	0.000018	0.0870 *
Log(GCF(-1))	0.114781	0.5282
Debt-to-GDP	0.002731	0.0522**

Source: Authors computation, ***, **, *, 1%, 5% and 10% level of significance respectively.

Following the corroboration of cointegration through the ARDL bounds testing procedure, the long run relationship amongst the selected variable was estimated. The resulting cointegrating equation reflected that some variables exhibited statistically significant association with nominal GDP. Inflation proxied by log(CPI) reflected a positive and statistically significant relationship with nominal GDP in the long run, in line with prior expectation. This finding was consistent with Chimobi (2010) who reported similar evidence for Nigeria. This suggest that moderate increases in prices are associated with high nominal GDP, reflecting demand driven growth dynamics. Similarly, exchange rates, the fiscal balance and debt to GDP, displayed a positive and

weakly significant relationship with nominal GDP. This implied that currency depreciation may lead to weak expansionary effect. Furthermore, improve fiscal balance may support economic activity in the long run, and debt may support growth especially when invested towards productive capital expenditures. In contrast trade openness reflected a negative and statistically significant relationship with nominal GDP in the long run. This result is consistent with the finding of Yeboan and Lamin (2024) who reported the same for Ghana. This outcome highlights structural vulnerabilities in the external sector, where increased openness could expose the economy to external shocks and increased dependence on imports.

Table 5: Error Correction Model Results

Variable	Coefficient	Probability
COINTEQ	-0.452742	0.0000 ***

Source: Authors computation, ***, **, *, 1%, 5% and 10% level of significance respectively.

The error correction term (COINTEQ) reflected both statistical significance and a negative coefficient, thereby confirming convergence in the long run, with a speed of adjustment of 45.3 percent (-0.452742). This implied that about 45.3 percent of the discrepancy between actual and equilibrium independent

variables is corrected annually. This depicted a relatively modest adjustment mechanism, portraying the stability of the system and the tendency of the economy to revert back to equilibrium trajectory aftershocks.

Table 6: Short-run Results

Variable	Coefficient	Probability
Dlog(EXCH)	-0.004288	0.8043
Dlog(GFC)	0.218433	0.0000 ***
Dlog(GFC(-1))	0.171196	0.0000 ***
D(debt-to-GDP)	-0.002509	0.0141 **

Source: Authors computation, ***, **, *, 1%, 5% and 10% level of significance respectively.

In the short run, changes in public debt have a negative and statistically significant effect on nominal GDP growth. This result was consistent with the finding of Chudik, Mohaddes, Pasaran and Raissi (2015) who documented that rising debt levels can dampen economic activity in the short run. This implies that increases in debt levels in the short run may retard growth, exerting contractionary effects on output, possibly due to crowding out effects. Conversely, gross fixed capital formation (gfc) exhibits positive and significant relationship with GDP both contemporaneously and lagged. This indicates that investment plays a vital role driving short-term economic activity immediately and continued effects.

The result of the model confirms that while a stable long-run relationship exists among the variable, short run effects diverge. Investment (gross fixed capital formation) is a key driver of short-term growth, while increases in public debt retard growth in the short run. The negative relationship between debt to GDP and nominal growth further highlights the non-linear relationship between the two variables, confirming Ndzinisa and Sithole (2018) findings. This indicates that debt accumulation may only support growth when prudently managed and channelled towards

economically productive investments with a long-term multiplier.

To test for residual diagnostics three test were used namely, the Breusch-Pagan-Godfrey Homoskedasticity test, Breusch-Godfrey Serial Correlation LM Test and the Jarque-Bera test normality test. The Breusch-Pagan-Godfrey test confirms the null hypothesis of Homoskedasticity with a p-value of 0.5260 which was above 0.05. This implies that the residuals of the ARDL model are homoskedastic. Furthermore, The Breusch-Godfrey LM test also verified that the ARDL model residuals are free from serial correlation up to two lags. The p-value was reported at 0.7298 which was above 0.05, thus supporting the null hypothesis of no serial correlation up to 2 lags. Lastly, The Jarque-Bera test confirms that the residuals of the ARDL model follow a normal distribution with a p-value of 0.9501 which was above 0.05. This diagnostic outcome supports the robustness of the model, ensuring that hypothesis testing and confidence intervals are valid and unbiased. Together with the absence of heteroskedasticity and serial correlation, the normality result reinforces the overall reliability of the estimated model.

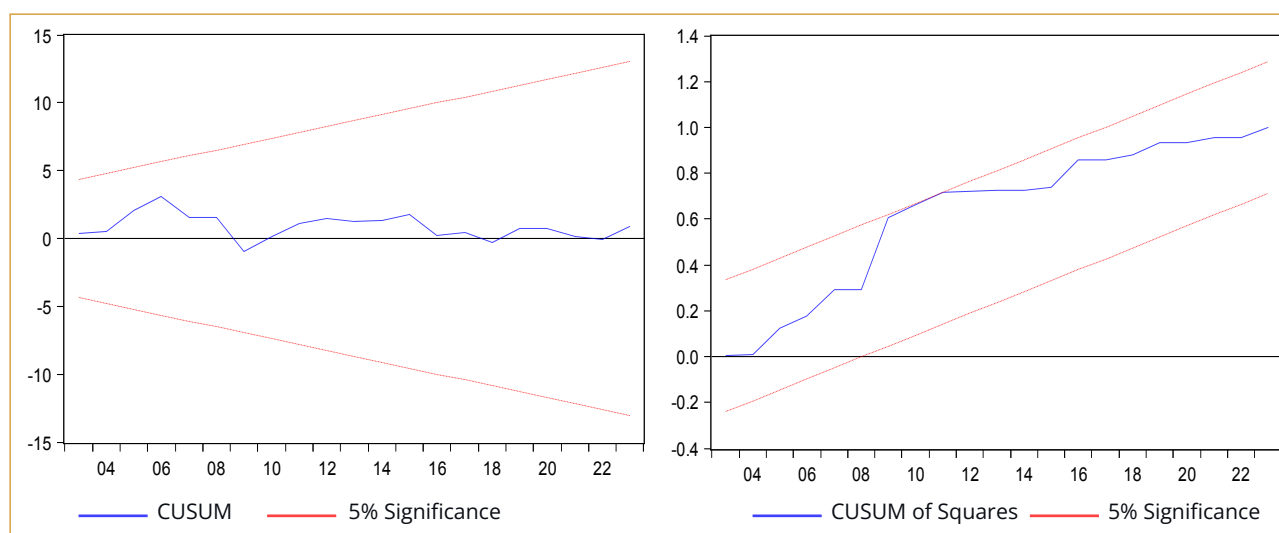
Table 7: Residual Diagnostics Test

Residual Diagnostic Test	F-statistic / Jarque-Bera	Probability
Breusch-Pagan-Godfrey Homoskedasticity test	0.937295	0.5260 ***
Breusch-Godfrey Serial Correlation LM Test	0.320331	0.7298 ***
Jarque-Bera test normality test	0.102171	0.950197 ***

Source: Authors computation, ***, **, *, 1%, 5% and 10% level of significance respectively.

To evaluate stability of the model, both the cumulative sum (CUSUM) and cumulative of squares (CUSUM of square) were used. The results indicate that for both cases the CUSUM and CUSUM of square test, the plotted line was within the 95% confident bounds. This outcome reflects that the model was stable as

the estimated coefficients do not systemically change overtime and the variance of the errors is stable. Consequently, there is no evidence of structural breaks or parameter instability, validating the reliability of the model across the sampled period.



Source: Authors computation

To examine whether the effects of public debt on GDP are symmetric or asymmetric, the coefficient symmetric test was employed within the Nonlinear ARDL (NARDL) framework. The results of the overall (joint) symmetry test confirmed the presence of asymmetry in the model, indicating that overall asymmetry is observed both in the long-run and the short-run. These results revealed that both the magnitude and dynamic adjustment of public debt change differ depending on whether debt is rising or falling. This outcome validates the adaption of a

nonlinear model framework and underscores the shortcomings of assuming a linear relationship between debt and GDP.

Additionally, the results revealed that there is strong evidence of long-run and short-run asymmetry in the relationship between public debt and GDP as the joint Chi-square and F-statistic p-values were statistically significant at 1 percent as seen in table 8. This reveals that the timing and adjustment path of positive and negative changes to debt vary across time.

Table 8: NARDL Coefficient symmetry Test

Joint (Long-Run and Short-Run)				
Symmetry by Sum				
DEBT_TO_GDP	F-statistic	(2, 16)	6.822720	0.0072
	Chi-square	2	13.64544	0.0011
Symmetry by Lag				
DEBT_TO_GDP	F-statistic	(2, 16)	6.822720	0.0072
	Chi-square	2	13.64544	0.0011

Source: Authors computation

The NARDL framework results presented in table 9 depict the asymmetric impact of the debt-to-GDP ratio on nominal output in the short run wherein a percent increase (positive change) in public debt depressed nominal economic activity by 0.001 percent, although the impact is not statistically significant. In contrast, a percent contraction (negative change) in the debt-to-GDP ratio increases nominal output by 0.013 percent.

Results in the long run, however, suggest that the impact is positive with both positive and negative decompositions of the debt-to-GDP ratio impacting output positively. While statistically significant for

both positive and negative changes, the impact it is not contemporaneous but is single lagged. These results are consistent with the findings of Mosikari and Eita (2021) who studied the case of Namibia.

What is noteworthy is the fact that the size of the impact is relatively stronger for negative changes in both long run and short run periods. In the long run, a 1 percent decrease in the debt to GDP ratio leads to nominal output growing by 0.0233 percent. This means that cutting the level of debt relative to output encourages more expansion in output.

Table 9: NARDL Asymmetric Changes Results

VARIABLE NAME	Coefficient	T-statistic	PROBABILITY
Long run			
Positive Debt changes (@CUMDP(-1))	0.003043	3.058939	0.0056***
Negative Debt changes (@CUMDN(-1))	-0.023398	-4.071307	0.0005***
Short run			
Positive Debt changes (@DCUMDP)	-0.000991	-0.359575	0.7239
Negative Debt changes (@DCUMDN)	-0.013238	-3.521163	0.0028***

Source: Authors computation, ***, **, *, 1%, 5% and 10% level of significance respectively.

5. Conclusion and Recommendations

5.1 Conclusion

This study sought to establish if the effects of debt accumulation on nominal output are asymmetric, that is, if increases in public debt exert a disproportionately large hinderance on nominal output than equivalent debt reduction stimulates it. Using annual data from 1990 to 2024 within an ARDL/NARDL framework, the study found evidence of asymmetric impact in the short run wherein debt accumulation becomes progressively inhibitive to output expansion. This follows a negative impact of debt on output found in the linear symmetric framework wherein a 1 percent increase in debt depressed nominal output by 0.0025 percent in the short run while in the long run nominal output grew by 0.0027 percent.

Other covariates of output considered included gross capital formation, the US Dollar-Lilangeni exchange rate, consumer price index, fiscal balance and the

trade openness index. The impact of foregoing variables on nominal output was consistent with a priori expectation as openness, a positive fiscal balance and gross capital formation encouraged output expansion while inflation had an inverse relationship with nominal output.

Based on the evidence presented herein, this study concludes that the relationship between public debt and economic growth in Eswatini is asymmetric particularly in the short run. The asymmetric nature of this relationship suggests that protracted periods of debt accumulation will invariably lead to periods where output growth is seriously constrained.

5.2 Recommendations

While this study did not go further to re-examine the debt-to-GDP tolerance levels for economic growth following earlier work by Ndzinisa and Sithole (2018), it was able to show that a decline in this ratio encourages nominal output expansion more than increasing it does. The results indicate that it is vital for Eswatini to keep its debt at manageable levels and achieve

fiscal sustainability in order to accelerate output growth. This can be achieved through having the GDP growing faster than the country's debt appetite. Also, the nature of the debt is something to be considered. Borrowing domestically hedges against exchange rate risk while risking domestic lenders should the government be insolvent. However, the government is limited in how much it can borrow local. This study therefore recommends that the government of Eswatini pursues a delicate balance of prudent debt reduction measures while ensuring the economy continues to grow. The positive impact of debt in the long run in the NARDL suggests that some bandwidth still exists since borrowing leads to output expansion. This can be achieved by keeping the debt appetite growing at rate below the output expansion rate. This submission is predicated on the premise that Eswatini is still operating within the acceptable levels

of the debt-to-GDP threshold for economic growth.

This study acknowledges that there could be multiple channels through which government debt impacts nominal GDP, this study focused on the direct relationship between government debt and nominal output. An investigation of the channels (direct or indirect) through which government debt has an impact on output falls outside the scope of this current study. Future studies should investigate the possible channels through which government debt affects GDP growth. Additionally, a recommendation is made for the re-evaluate the optimal debt threshold for Eswatini following recent major shocks (Covid-19 and Russia-Ukraine war) since the Ndzinisa and Sithole (2018) study.

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Contacts

-  CBE Complex, Nshakabili Road, Ezulwini
-  P. O. Box, 546 Mbabane (H100)
-  (+268) 2408 2000
-  info@centralbank.org.sz