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Examining the Relationship between Term Structure of Interest Rates and Economic Activity in Namibia

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Abstract: This paper analysed the forecasting ability of yield-curve as a predictor of the short-run fluctuations in economic activities in Namibia. The study employed the techniques of unit root, cointegration, impulse response functions and forecast error variance decomposition on the quarterly data covering the period 1996 to 2015. The results revealed a negative relationship between the term structure of interest rates and economic activities, though statistically insignificant. This suggests that the yield-curve has no forecasting ability as a predictor of economic activity in Namibia.
Keywords: Yield-curve; Forecasting; Economic activity; Namibia; Cointegration; Impulse response function.

1. Introduction

In economics, modelling interest rate is important because it is a macroeconomic variable and its trends are critical for macroeconomic policy analysis. In particular, analysing the trend of interest rates or yields of financial instruments for both money market and capital market instruments of different maturities is known as the yield curve (Bonga-Bonga, 2010). The yield curve is the plot of the interest rates on bonds with different terms to maturity but the same risks, liquidity and tax considerations (Mishkin, 2004). Usually, the yield on government bonds of different maturity is used to represent the yield curve in particular the yields on the 10-year government bond and the 3-month Treasury bill are the benchmarks for representing the long- and short-term interest rates respectively Bonga-Bonga (2010). Bonga-Bonga further stated that in general longer term interest rates are usually higher than shorter term interest rates or better known as "normal yield curve". This is said to reflect the higher "inflation-risk premium" that investors demand for long-term bonds.

The significance of the term structure is that economic theory suggests that it is driven by the expectations of participants in financial markets. Therefore, the term structure naturally contains information useful for discovering forecasts of market participants (Harvey, 1988). For example, if market participants anticipate rates to decrease during economic downturn, they will either opt to lock into current higher rates or increase capital gain prospects via longer term assets. That is why, economic expectations affects investor's behaviour which, in turn, affects the term structure of interest rates. The latter therefore should contain information that can be used to forecast expected short-run fluctuations of future economic activity (Shelile, 2006). This implies that the term structure has a forecasting ability of economic growth.

There is a lot of evidence on the positive association of term structure interest rate and economic activity especially in developed countries. However, there are very few studies conducted in developing countries and more so in Namibia. It is against this background that this paper will investigate the predictive ability of the term structure of interest rates with respect to economic activity in Namibia. The paper is organized as follows: the next section presents a literature review. Section 3 discusses the methodology. The empirical analysis and results are presented in section 4. Section 5 concludes the study.

2. Literature Review

2.1. Theoretical Literature

The theoretical framework for term structure of interest rates evolved over the years. In particular, it is built on four different theories namely Market Segmentation Theory (MST), Preferred Habitat Theory (PHT), Pure Expectation Theory (PET) and the Liquidity Premium Theory (LPT). However, only the expectation theory has been discussed in this study.

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The theoretical foundation of the yield curve as a predictor of real economic activity and future inflationary conditions is grounded in the expectation theory of the term structure (Monetary Authority of Singapore, 1999). In this regard, the expectation theory posits that the long-term interest rate is a weighted average of present and expected future short-term interest rates. That is why if future short-term interest rates are expected to remain constant, then the long-term interest rates will be equated to the short-term interest rates plus a constant risk premium. However, if future short-term interest rates are expected to increase, then the current long-term interest rates will exceed the sum of the current short-term interest rates. In this case the yield curve will be upward sloping. Even if the short-term interest rates are expected to remain constant, the yield curve will still be upward sloping because, holders of long-term securities would require a positive term premium to compensate them for the risk of capital loss in an event that future interest rates are higher than expected (Browne and Manasse, 1989).

One of the most important underlying assumptions about the expectation hypothesis is that financial securities with different maturity date are considered as perfect substitutes. This suggests that the only criterion of preference over a variety of securities is their expected return (Kaya, 2007).

According to Dube and Zhou (2013) the interest in examining the yields of different maturities is linked to the monetary policy transmission channel of interest rate. This is the key channel through which change in monetary policy stance is transmitted to the economy via effects on the market interest rates or affect a whole spectrum of interest rates to achieve a stable and low inflation with economic growth. Thus, the relationship between the term structure of interest rates and economic activity and its link to recession may be explained by the effects of the monetary policy on the term structure of interest rates. However, the degree to which monetary policy may affect economic activity depends on the impact that short-term interest rates have on long-term interest rates. For instance, monetary policy contraction in form of an increase in short-term interest rates results in a flat yield curve. Consequently, according to the expectations theory, market participants will expect a decline in future inflation due to an increase in short-term interest rates. Furthermore, a monetary contraction causes a decrease in consumer spending due to high interest rate levels. Subsequently, economic growth declines (Mohapi and Botha, 2013).

Moolman (2002) argues that market participants may believe that an increase in short-term interest rates might lead to economic recession. Thus, “owing to investor expectations of a future recession, the yield curve may flatten to the extent that short-term interest rates increase above the long-term interest rates, inducing an inverted yield curve because of the market participants’ increased probabilities of the occurrence of a future recession” (Mohapi and Botha, 2013). Alternatively, a decrease in short-term interest rates, investors will expect an increase in future inflation. Accordingly, the yield curve will be steep, inducing a positively sloped yield curve suggesting an increase in long-term interest rates above short-term interest rates. Because of the positive relationship between the term structure of interest rates and economic activity, this would lead to an economic expansion.

2.2. Empirical Literature

There is voluminous empirical literature on the relationship between term structure of interest rates and economic growth. A number of selected studies are presented in the table below.

Table-1. List of selected empirical studies

Author	Country	Period and Frequency	Methodology	Findings
Chen (1991)	USA	1954-1988 (quarterly)	OLS, Forecasting model	The term structure of interest rates can predict future growth rate of gross national product.
Nel (1996)	South Africa	1974-1993 (quarterly)	OLS, Other econometric model	The yield curve is positively related to the growth in the real gross domestic product.
Estrella and Mishkin (1997)	USA, France, Germany, Italy, UK	1973-1995 (quarterly)	OLS, VAR, Probit model	The term structure of interest rate can be used to predict economic activities and inflation.
Davis and Fagan (1997)	European union countries	1970-1992 (quarterly)	OLS	The long-term maturity is statistically significant for output and inflation with the exception of Italy, France and Spain.
Harvey (1997)	Canada	1958-1998 (quarterly)	OLS, CCPA model	The term structure of interest rates contains important information about economic growth.
Kim and Limpaphayom (1997)	Japan	1975-1991 (quarterly)	GMM	The term structure of interest rates is useful for discovering the expectations of market participants.
Alles (2001)	Australia	1976-1993 (quarterly)	OLS, Other regression model	There is a positive relationship between term structure interest rates and economic growth.

Peel and Ioannidis (2002)	USA, Canada	1972-1999 (quarterly)	OLS, Output growth forecast model	The term structure of interest rates has a significant predictive content for real gross domestic product.
Moolman (2002)	South Africa	1979-2001 (quarterly)	OLS, Probit model	The term structure of interest rates predicts the turning points of the business cycle.
Shelile (2006)	South Africa	1987-1995 (quarterly)	GMM	The term structure if interest rates successfully predicted real economic activity.
Khomo and Aziakpono (2007)	South Africa	1980-2004 (quarterly)	Probit model	The term spread provides predictive information about recessions.
Mohapi and Botha (2013)	South Africa	1980-2012 (quarterly)	Non-linear dynamic probit model	S.A. term spread accurately predicted all its recessions since 1980; Chinese term spread accurately predicted the 1996 and 2008 S.A recessions; U.S. term spread predicted some recessions; while German term spread predictions were counter-cyclical
Oyedele (2014)	Nigeria	1986-2008 (quarterly)	DOLS	There is a positive, significant long-run relationship between term structure of interest rates, inflation and economic growth.

Table 1 reports a number of empirical studies on the relationship between the term structure of interest rates and economic growth, ranging from least developed to most developed countries. Based on the afore-mentioned literature, the majority of studies revealed a positive relationship between term structure of interest rate and economic activities with the exception of a few. The findings by these studies are that there is ample evidence that indeed the term structure interest rate can predict economic growth. Furthermore, these findings were reached at using different methodologies ranging from OLS, VAR, Forecasting model, Probit model etc. However, there is no empirical study on Namibia on the subject matter. It is against this background that a study of this nature is necessary to fill the gap.

3. Methodology

3.1. Econometric or Analytical Framework and Model Specification

In order to analyse the relationship between the term structure of interest rates and real economic activity, the study follows Oyedele (2014). In particular, this study employs the vector autoregression (VAR) approach time-series data.

VAR is a system of dynamic linear equations where all the variables in the system are treated as endogenous. The reduced form of the system gives one equation for each variable, which specifies each variable as a function of the lagged values of their own and all other variables in the system. The vector autoregression process is described by a dynamic system whose structural form equation is given by:

$$Ay_t = \Psi + \Omega_1 y_{t-1} + \Omega_2 y_{t-2} + ... + \Omega_p y_{t-p} + B\mu_t \quad (1)$$

where A is an invertible $(n \times n)$ matrix describing contemporaneous relations among the variables; y_t is an $(n \times 1)$ vector of endogenous variables such that; $y_t = (y_{1t}, y_{2t}, ..., y_{nt})$; Ψ is a vector of constants; Ω_i is an $(n \times n)$ matrix of coefficients of lagged endogenous variables $(\forall i = 1,2,3,..., p)$; B is an $(n \times n)$ matrix whose non-zero off-diagonal elements allow for direct effects of some shocks on more than one endogenous variable in the system; and μ_t are uncorrelated or orthogonal white-noise structural disturbances i.e. the covariance matrix of μ_t is an identity matrix $E(\mu_t, \mu'_t) = 1$. Equation (1) can be rewritten in compact form as:

$$Ay_t = \Psi + \Omega\ (L) y_{t-i} + B\mu_t \quad (2)$$

where $\Omega(L)$ is a $(n \times n)$ finite order matrix polynomial in the lag operator L.

The VAR presented in the primitive system of equations (1) and (2) cannot be estimated directly (Enders, 2004). However, the information in the system can be recovered by estimating a reduced form of VAR implicit in (1) and

(2). Pre-multiplying equation (1) by A^{-1} yields a reduced form VAR of order *p*, which in standard matrix form is written as:

$$y_t = \Phi_0 + \sum_{i=1}^{p} \Phi_i y_{t-i} + \varepsilon_t \quad (3)$$

Where: $y_t = f(LNGDP_t, TEM_t, LNASI)$

Φ = matrix of coefficients of autonomous varibales.

A_i = Matrix of coefficients of all variables in the model.

y_{t-1}= is the vector of the lagged values of $LNGDP_t, TEM_t, LNASI_t$

ε_t = the vector of the error term

Given the estimates of the reduced form VAR in equation (3), the structural economic shocks are separated from the estimated reduced form residuals by imposing restrictions on the parameters of matrices A and B in equation (4):

$$A\varepsilon_t \quad B\mu_t \quad (4)$$

The model consist of four endogenous variables, hence the VAR model in matrix notation can be expressed in the following manner:

$$LNGDP_t = \alpha_1 + b_{11}LNGDP_{t-1} + b_{12}TEM_{t-1} + b_{13}LNASI_{t-1} + \varepsilon_t^{LNGDP}$$

$$TEM_t = \alpha_1 + b_{21}LNGDP_{t-1} + b_{22}TEM_{t-1} + b_{23}LNASI_{t-1} + \varepsilon_t^{TEM}$$

$$LNASI_t = \alpha_1 + b_{31}LNGDP_{t-1} + b_{32}TEM_{t-1} + b_{33}LNASI_{t-1} + \varepsilon_t^{LNASI}$$

Where: ε_t^{LNGDP}, ε_t^{TEM} and ε_t^{LNASI} are the white noise error term and independent of the dependent variables. The matrix of coefficient is:

$$y_t' = [\Delta LNGDP_t \ \ \Delta TEM_t \ \ \Delta LNASI_t]$$

$$\begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix} \begin{bmatrix} \varepsilon_t^{LNGDP} \\ \varepsilon_t^{TEM} \\ \varepsilon_t^{LNASI} \end{bmatrix} = \begin{pmatrix} b_{11} & b_{12} & b_{13} \\ b_{21} & b_{22} & b_{23} \\ b_{31} & b_{32} & b_{33} \end{pmatrix} \begin{bmatrix} \mu_t^{LNGDP} \\ \mu_t^{TEM} \\ \mu_t^{LNASI} \end{bmatrix}$$

b_i = is a (3×3) matrix of parameters that are non-zero.

ε_i = is a (3×1) column vector of the random disturbance term.

The standard practice is that the main uses of the VAR model are the impulse response analysis and forecast error variance decomposition. The analysis is carried out in the following order. The first step requires a test for the univariate characteristics of data. This is done by using some formal testing namely, Augmented Dickey Fuller (ADF) test, the Phillips-Perrons (PP) and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests are applied (Gujarati, 2003; Pindyck and Rubinfeld, 1991). Thereafter, the following step would be to conduct tests for co-integration, i.e. if two or more series have long-run equilibrium. The Johansen cointegration test is used to determine the number of cointegration relations for forecasting and hypothesis testing. If co-integration is found among the variables, the adjustment of the short-run to the long-run equilibrium is obtained through the vector error correction model (VECM) and if no cointegration found then the VAR is estimated. However, there are many steps that must be followed before applying the Johansen test. First it is necessary to determine the number of lags since this has a big effect on the analysis. There are five criteria:, the sequential likelihood ratio (LR), Akaike information criterion (AIC), Schwarz information criterion (SC), Final prediction error (FPE) and Hannan Quinn information criterion (HQ) to choose from.

In empirical applications, the main use of the VAR is the impulse response function which function traces the response of the endogenous variables to one standard deviation shock or change to one of the disturbance terms in the system. Variance decomposition is an alternative method to the impulse response functions for examining the effects of shocks to the dependent variables. This technique determines how much of the forecast error variance for any variable in a system, is explained by innovations to each explanatory variable, over a series of time horizons (Stock and Watson, 2001).

3.2. Data, Sources and Data Measurements

The data used in this paper are of quarterly frequency for the period 1996:Q1 to 2015:Q1. Secondary data were obtained from the Bank of Namibia's various statutory publications, Namibia Statistical Agency's statutory publications and from Namibia Stock Exchange. The variables whose data has been collected are gross domestic product, all share index, 3-month Treasury bill and 10-year government bond.

4. Empirical Analysis and Results

4.1. Unit Root Test

In testing for unit root the Augmented Dickey-Fuller (ADF) and the Phillips-Perron (PP) tests were used. The use of more than one test statistic is to ensure robustness of the results thereof. Table 2, reports the results and shows that all variables are stationary in first difference with the exception of term structure of interest rate when you consider the model specification of intercept. The variables that are stationary in levels means they are integrated of order zero, whilst the variables that are stationary in first difference are integrated of order one. The concept of being stationary or not containing unit root implies that the variables has zero mean, constant variance and the residuals uncorrelated over time.

Table-2. Unit root tests: ADF and PP in levels and first difference

Variable	Model Specification	ADF	PP	ADF	PP	Order of Integration
		Levels	Levels	First Difference	First Difference	
$LNGDP_t$	Intercept	-0.061	-0.607	-10.081**	-25.700**	1
	Intercept and trend	-6.323**	-6.300**	-10.011**	-25.255**	1
TEM_t	Intercept	-3.010**	-2.603*	-7.234**	-7.509**	0
	Intercept and trend	-3.147*	-2.737	-7.184**	-7460**	1
$LNASI_t$	Intercept	-0.109	-0.062	-5.593**	-6.034**	1
	Intercept and trend	-1.358	-0.656	-6.788**	-6.789**	1

Source: author's compilation and values obtained from Eviews

Notes:(a)* and ** means the rejection of the null hypothesis at 10% and 5% respectively.

4.2. Testing for Cointegration

The Johansen cointegration test based on trace and Maximum Eigen values test statistic was conducted in order to test for the presence of any long run relationship. The results for the trace statistic show that there is no presence of cointegration whilst the maximum eigen statistic shows at least one cointegrating vector. Econometric literature informs us that the trace statistic is more powerful than the maximum eigen. Therefore, one can conclude that there is no cointegration among the variables as shown in table 3. The absence of cointegration implies that only the VAR model can be estimated in order to make short run analysis.

Table-3. The Johansen co-integration test based on trace and maximal Eigen value

Maximum Eigen Test				Trace Test			
H_0: rank = r	H_a: rank = r	Statistic	95% Critical Value	H_0: rank = r	H_a: rank = r	Statistic	95% Critical Value
r = 0	r =1	21.895	21.132**	r = 0	r >=1	28.510	29.797
r <=1	r = 2	5.519	14.265	r <= 1	r >= 2	6.615	15.495
r <=2	r = 3	1.096	3.841	r <= 2	r >= 3	1.096	3.841

Source: author's compilation and values obtained from Eviews

Note: Max-Eigen test indicate 1 cointegrating equation at the 0.05 level (**) while Trace tests indicate 0 cointegrating equations.

4.3. VAR Stability Condition

It is important to determine whether VAR satisfy the stability condition based on the roots of the characteristic polynomial. If there is unstable VAR, the results of impulse response function and variance decomposition will be invalid. In this study VAR satisfies the stability condition as the value of its AR roots is less than one and there is no root that lies outside the unit circle. Moreover, the maximum lag length on the VAR stability that is based on the roots of the characteristic polynomial was found to be 4 as suggested by the majority of the criterion. The results are shown in tables 4 and 5 respectively.

Table-4. Roots of Characteristic Polynomial

Root	Modulus
0.978082 - 0.029073i	0.978514
0.978082 + 0.029073i	0.978514
0.633988	0.633988
-0.423095	0.423095
0.365538 - 0.124896i	0.386287
0.365538 + 0.124896i	0.386287

No root lies outside the unit circle.

VAR satisfies the stability condition.

Table-5. Optimal Lag Length

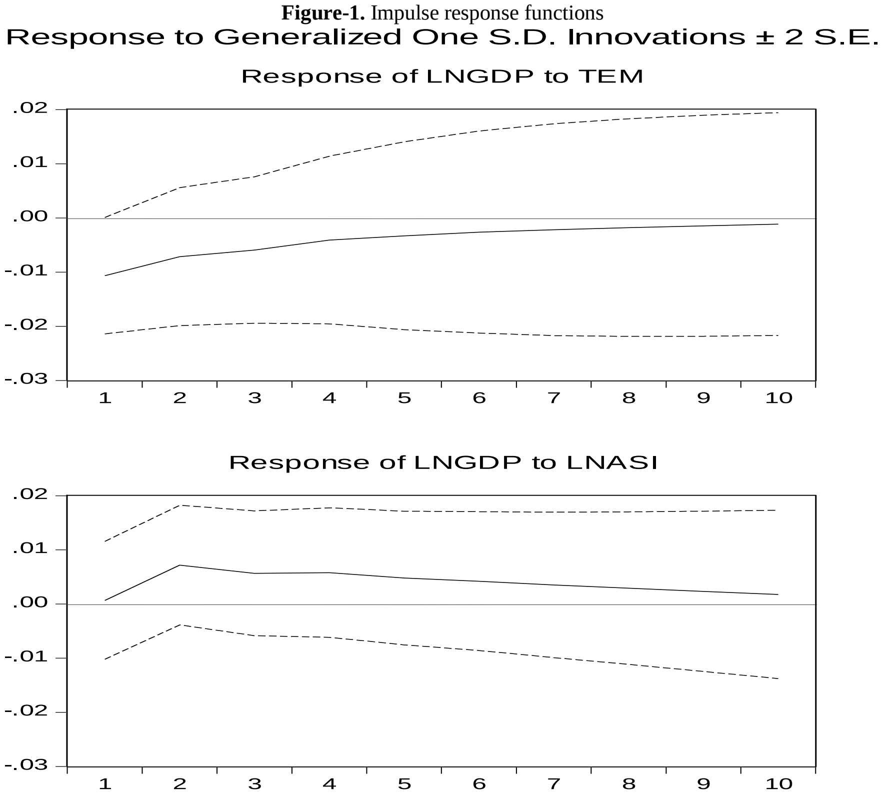
Lag	LogL	LR	FPE	AIC	SC	HQ
0	-150.3393	NA	0.018249	4.509980	4.607900	4.548779
1	117.9583	505.0308	8.90e-06	-3.116420	**-2.724743***	-2.961226
2	133.9833	28.75075	7.25e-06	-3.323038	-2.637602	-3.051448
3	148.9175	25.47601	6.12e-06	-3.497574	-2.518379	**-3.109587***
4	160.7929	**19.21020***	**5.66e-06***	**-3.582144***	-2.309191	-3.077762
5	166.4508	8.653184	6.33e-06	-3.483846	-1.917135	-2.863067
6	168.6680	3.195465	7.87e-06	-3.284354	-1.423884	-2.547179

* indicates lag order selected by the criterion

4.4. Impulse Response Functions

Figure 1 shows the response of economic growth to shocks in term structure of interest rates. The results show that economic growth responds negatively to such shocks and the variable moves toward the equilibrium as the horizon increases. The effects appear to be permanent due to the fact that the variable found a new level of equilibrium as it did not return to its initial level of equilibrium. These findings are in contradiction with theoretical expectation of a positive relationship between economic activity and term structure of interest rates. Therefore, one can conclude that term structure interest rate does not contain information about economic activity in the Namibian context. These findings are similar to that of Teriba (2006) who found that the term structure spread does predict real activity in Nigeria.

Figure-1. Impulse response functions



Source: author's compilation using Eviews

On the contrary, economic activity responds positively to all share indexes. The effects appear to be permanent because the variable found a new equilibrium though moved close its initial level as the horizon extends.

4.5. Forecast Error Variance Decomposition

Table 5 shows the results of the forecast error variance decomposition over the horizon of 10 quarters. The forecast error variance decomposition for economic activity is mostly attributed to itself in all the quarters with slight decrease. The contribution of the term structure of interest rate is only apparent at the 8th quarter while that of all share index is apparent as of 4th quarter though they are of very small magnitude as reported in table 6.

Table-6. Variance Decomposition

Quarter	LNGDP	TEM	LNASI
2	98.377	0.049	1.574
4	97.468	0.276	2.257
6	96.969	0.725	2.306
8	96.707	1.164	2.129
10	96.526	1.577	1.897

Source: author's compilation and values obtained from Eviews

5. Conclusion

This study examined the relationship between term structure of interest rates and economic growth in Namibia. This was done with the purpose of establishing whether the term structure of interest rate contains information about forecasting ability of short-run fluctuations in economic activities. The study was based on quarterly data covering the period 1996:Q1 to 2015:Q1, utilizing the technique of unit root, cointegration, impulse response functions and forecast error variance decomposition. The results for unit root test reveal that all variables are integrated of order one. However, there was no presence of cointegration relationship among the variables. Hence, the vector autoregression model was estimated from which the impulse response function and forecast error variance decomposition were derived. The findings of the impulse response function shows that economic activities respond negatively to shocks in term structure of interest rates but statistically insignificant. On the contrary, economic activities respond positively to shocks in all share index. In addition, the results of the forecast error variance decomposition reveal that most fluctuations in economic activities are largely due to itself and relatively in a very small magnitude, due to all share index. Therefore, one can conclude that the term structure of interest rates does not contain information about economic activities in Namibia. This behavior might be attributed to the fact that Namibia's economic growth has been stagnant if not relatively constant over time. Thus, one should be cautious in interpreting thee results. The effect of the term structure of interest rates on economic growth might also be indirect. It is in light of the above that the study recommends that Namibia should continue closely monitoring the trend between the two variables as these variables are interrelated in one way or another.

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