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## **Testing for the Fisher Hypothesis in Namibia**

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### ***Abstract***

*This paper analyses the relationship between interest rate and inflation in Namibia. The objective is to test whether the Fisher hypothesis holds in the long run. Using monthly data for the period 1992:01 – 2011:12, the paper employed time series techniques, namely, unit root tests and cointegration test. The unit root test reveals that the series are non stationary. The cointegration test shows that there is no cointegration among the variables. Hence, the long run relationship between inflation and interest rate is non existent. The study rejects the Fisher hypothesis in the Namibian context. In the absence of cointegration the study could not proceed with Granger causality test.*

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**Keywords:** Fisher Effect, Nominal Interest Rate, Inflation, Cointegration test, Namibia

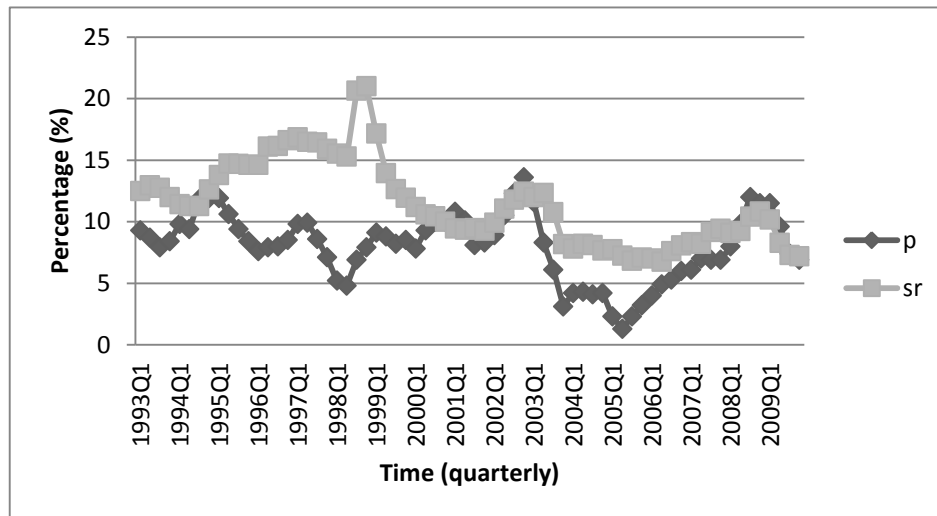
**JEL Classification:** E43

## 1. Introduction

The relationship between inflation and interest rate has been at the center of research in economics. This is due to the fact that the accurate prediction of interest rate trend is critical to all economic agents. Its upswings and downswings are closely related to the inflation rate (Tekler, Alp and Kent, 2012). Theoretical assertion such as that of Fisher (1930) suggests that inflation is the main determinant of interest rates. A one per cent increase in the inflation rate leads to a one per cent increase in the rate of interest. This implies that interest rates change in proportion to the changing inflation, or real interest rates are invariant to the inflation. Hence, they are expected to move in the same direction.

In the context of Namibia, data seem to show different trends. For instance, in comparing the Namibian inflation rate against the Namibian interest rate (short-term), the two variables move in the opposite directions in the periods 1993-2000 (see figure 1). High levels of inflation rates are associated with low levels of interest rates and low levels of inflation are associated with high levels of interest rates, meaning there is divergence. This is contrary to the one-on-one relationship between the two variables as Fisher postulates. However, in the latter years, the two variables move on the same direction in the periods of 2001 to 2009. High levels of interest rates are associated with high levels of inflation rates, meaning there is convergence. These trends raise questions that requires empirical verification.

**Figure 1: Namibian Inflation Rate (P) and Interest rate (short-term (SR))**



In the light of the above scenario, the major objective of this paper attempts to examine whether the Fisher hypothesis hold good for Namibia. The motivation for the study is inspired by the fact that; firstly, there is no published study (to the author's knowledge) that has examined this relationship in Namibia. Secondly, Namibia is a developing country and findings of the study would help policy makers to take appropriate policy initiatives. Hence, understanding the relationship between interest rates and inflation is central to the study of financial markets and for policy making in these markets. The article is organized as follows: the next section presents a literature review on the Fisher hypothesis. Section 3 discusses the methodology. The empirical analysis and results are presented in section 4. Section 5 concludes the study.

## **2. Literature Review**

The Fisher (1930) hypothesis suggests that expected inflation is the main determinant of interest rates. It postulates that the nominal interest rate consists of an expected 'real' rate plus an expected inflation rate. Hence, a one-to-one relationship between inflation and interest rates is implied. However, the hypothesis also suggest that real interest rates were unrelated to the expected rate of inflation and were determined entirely by the real factors in an economy, such as the productivity of capital and investor time preference. Mundell (1963) maintains that there is no one-to-one adjustable relationship between nominal interest rate with expected inflation rate. Rather, he theorizes the Mundell-Tobin effect, that nominal interest rates would rise less than one-for-one with inflation. This is due to the fact that in response to inflation the public would hold less in money balances and more in other assets, which would drive interest rates down.

According to Sathye, Sharma and Liu (2008), the Fisher hypothesis has implications in the context of real purchasing power of money, asset valuation and capital market efficiency. In principle, the Fisher hypothesis could be extended to any asset, such as stocks, in this case nominal asset returns will move one for one with the expected inflation, meaning that if inflation rises to a higher level, stock prices should also rise along with inflation (Al-Khazali, 1999). Hence, asset such as stocks offers a hedge against inflation, hence a positive relationship between inflation and stock prices.

Fama (1970) contested Fisher's hypothesis by affirming that there is a negative relationship between inflation and stock prices. This gave birth to the theory of "Efficient Capital Market", the definitional statement of this theory is that in an efficient market prices "fully reflect" available information. The argument put forward is that because all information about the market is immediately reflected in the prices, an increase in the level of inflation will lead to an increase in

the nominal value of securities such as stocks relative to the real value. Mishkin (2004) clarified Fama's hypothesis by arguing that securities such as stocks represent ownership of real assets. When the nominal value of these securities surpasses their real value as a result of the inflation effect, investors would sell their financial assets (i.e. stocks) in exchange for real assets. The selling of these financial assets leads to decline in the financial assets price due to an increase in the market supply. This implies a negative relationship between inflation and these financial instruments.

Empirical literature has verified a positive relationship between inflation rate and interest rate. Among them are Mundel (1963), Tobin (1965), Feldstein (1976) and Mishkin (1981). However, there are other studies who found no strong relationship between the two variables. Among them are, Mishkin (1992) and Ghazali (2003). Brazoza and Brzezina (2001) and Fave and Auray (2002) are among the studies that found long-run relationship between interest rate and inflation.

Booth and Ciner (2001) have studied the relationship between interest rate and inflation rate using cointegration in 9 European countries and U.S. The findings confirm a long-run relationship between the two variables, except for one case.

Lardic & Mignon (2003) examined the relationship between interest rate and inflation rate in G-7 countries using Engel-Granger cointegration method. The findings from their study confirm that there is a long-run relationship between interest rate and inflation rate.

Berument, Seylan and Olgun (2007) investigated the validity of the Fisher hypothesis for the G7 countries. The study estimated a version of the GARCH specification. Furthermore, the study also tested the augmented Fisher relation by including the inflation uncertainty. The findings reveal that there is a positive relation between interest rates and expected inflation, for the G7 countries and 45 developing economies. The simple Fisher relation holds in all G7 countries but in only 23 developing countries. There is a positive and statistically significant relationship between interest rates and inflation uncertainty for six of the G7 and 18 of the developing countries and this relationship is negative for seven developing countries.

Sathye et al (2008) studied a relationship between short-term nominal interest rate and inflation in the context of the Indian financial market. They employed Augmented Dickey-Fuller, co-integration and Granger-causality test on monthly data of inflation and nominal short term interest rates during the period of April 1996 to August 2004. The findings are that expected inflation and nominal short-term interest rates are co-integrated in the Indian context. Hence, the

present study does not reject the Fisher effect in the Indian financial market. Furthermore, the test shows that expected inflation is Granger caused by nominal short term interest rates.

Mahdi and Masood (2011) analyzed the relationship between interest rates and inflation in Iran, in the context of Fisher's hypothesis by using the Johansen's co-integration approach and then vector error correction model (VECM) approach. The result shows that there is one co-integration relation, so there is one co-integration equation too. Consequently, the results show that there is a long run relationship between these variables in Iran. Also, the results show that the long run relationship between the weighted average of interest rate is weak, while the long run relationship between rental rates of housing and inflation is strong.

Awomuse and Alimi (2012) investigated the relationship between inflation and interest rate in Nigeria using annual data for the period 1970 – 2009 in order to test whether the Fisher hypothesis holds. The study utilized Johansen cointegration and error correction mechanism. The results reveal that interest rates and inflation move together in the long-run but not on one-to-one basis. This implies that the whole Fisher hypothesis does not hold fully but there is a very strong Fisher effect. The results further shows that causality run strictly from expected inflation to nominal interest rates as suggested by the Fisher hypothesis and there is no "reverse causation".

Teker et al (2012) examined the relationship between deposit rates and consumer price index to test the Fisher hypothesis. The study employed the threshold vector error correction (T-VEC) analysis on the monthly data for the period 2002:01 – 2011:03. The findings show that interest rate and inflation are positively affected by their pass two and one periods respectively.

Based on the afore-mentioned literature, one can safely say the following: there are mixed findings with regard to the Fisher hypothesis ranging from those refuting, agreeing and no relationship at all. There are also different methodological approaches whether it is cross-country or individual country's studies. There is variation in terms of data frequency used ranging from monthly, quarterly and annually. There seem to be no study on Namibia that has tested the Fisher hypothesis. It is against this background this study intends to fill the gap and add to empirical literature for Namibia.

### **3. Methodology**

In analyzing the relationship between interest rate and inflation in Namibia, this study follows Mahdi and Masood (2011) in testing the validity of Fisher hypothesis. This study will ascertain the existence of such a relationship by implementing the following three-steps procedure:

(1) Testing for unit root and determine the order of integration for two variables by employing tests devised by Augmented Dickey - Fuller (ADF), Philips and Peron (PP) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS).

(2) Testing for cointegration and if there is cointegration relationship among the variables can be re-parameterised as an Error-Correction Model (ECM) which will contain both short and long-run effects Awomuse and Alimi (2012). The Johansen cointegration can be applied in this respect.

(3) Granger-causality. That is if there is cointegration there should be Granger-causality in at least one direction.

### 3.1 Unit Roots Tests

Most time series in economics exhibit a trend over time and when usually these time series are not stationary (contain unit root). Being non-stationary implies that the mean, variance and covariance is not constant over time. When data contains unit root it means any result accrue to such data will be spurious or nonsensical. Spurious regression implies that the relationship between variables may appear statistically significant, though there is no meaningful relationship among the variables. Hence, the whole idea for unit root test is to search for data generating process (DGP) namely:

(a) Pure random walk meaning no intercept and no time trend items:

$$\Delta y_t = \delta y_{t-1} + \sum_{i=1}^p \alpha_i \Delta y_{t-i} + \varepsilon_t \quad \dots 1$$

(b) Random walk with drift meaning intercept and no time trend item:

$$\Delta y_t = \alpha + \delta y_{t-1} + \sum_{i=1}^p \alpha_i \Delta y_{t-i} + \varepsilon_t \quad \dots 2$$

(c) Random walk with drift and time trend meaning intercept and time trend item:

$$\Delta y_t = \alpha + \gamma t + \delta y_{t-1} + \sum_{i=1}^p \alpha_i \Delta y_{t-i} + \varepsilon_t \quad \dots 3$$

There are various methods for testing unit roots such as Augmented-Dickey Test (ADF), extension to the dickey fuller test for example Pantula tests, Phillips Peron tests, Kwiatowski-Phillips-Schmidt-shin (KPS), Elliot-Rothenberg-stock point optimal (ERS) as Ng-Perron tests. This study will use ADF, PP and KPSS test for unit root.

### 3.2 Cointegration Tests

Cointegration is generally defined as a concept which mimics the existence of the long run equilibrium relationship among variables. In other words, it gives an indication as to whether the variables will converge in the long run to some sort of equilibrium.

This study employs the Johansen cointegration test in order to determine if there are any cointegrated equations. Since this will be done in the vector autoregressive (VAR) framework, the first step uses first difference as shown below:

$$Y_t = A_1 Y_{t-1} + A_2 Y_{t-2} + \dots + A_n Y_{t-n} + \varepsilon_t \quad \dots 4$$

whereas  $Y_t$  is lag length  $n$  ( $p \times 1$ ) vector endogenous variable, then first difference changes below:

$$\Delta Y_t = \sum_{j=1}^{n-1} \pi_j \Delta Y_{t-j} + \pi Y_{t-n} + \varepsilon_t \quad \dots 5$$

whereas  $\pi_j$  is a short term adjusting coefficient to explain short-term relationship,  $\pi$  is long term shock vector that includes long term information that tipsoff on the existence long term equilibrium relationship. Moreover rank of  $\pi$  decides the number of cointegrated vector.  $\pi$  has three hybrids:

- (a)  $rank(\pi) = n$ , then  $\pi$  is full rank, meaning all the variables are stationary series in the regression ( $Y_t$ )
- (b)  $rank(\pi) = 0$ , then  $\pi$  is null rank, meaning variables do not exhibit cointegrated relationship.
- (c)  $0 < rank(\pi) = r < n$ , then some of variables exist  $r$  cointegrated vector.

The Johansen cointegration approach uses rank of  $\pi$  to distinguish the number of cointegrated vector and examine rank of vector in testing how many of non-zero of characteristic roots exist in the vector. There are two statistic processes for cointegration.

(i) Trace test:

$$H_0 : rank(\pi) \leq r \text{ (at most } r \text{ integrated vector)}$$

$$H_1 : rank(\pi) > r \text{ (at least } r+1 \text{ integrated vector)}$$

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^n \ln(1 - \hat{\lambda}_i)$$

$T$  is sample size,  $\hat{\lambda}_i$  is estimated of characteristic root. If test statistic rejects  $H_0$  that means variables exist at least  $r+1$  long term cointegrated relationship.



(ii) Maximum eigenvalue test:

$H_0$  :  $rank(\pi) \leq r$  (at most  $r$  integrated vector)

$H_1$  :  $rank(\pi) > r$  (at least  $r+1$  integrated vector)

$\lambda_{\max}(r, r+1) = -T \ln(1 - \hat{\lambda}_{r+1})$

If test statistics accepts  $H_0$  that means variables have  $r$  cointegrated vector. This method starts testing from variables that do not have any cointegrative relationship which is  $r=0$ . Then test has added the number of cointegrative item to a point of no rejecting  $H_0$  that means variables have  $r$  cointegrated vector.

### 3.3 Causality Tests

In general economic models often assume different hypotheses to discuss variables' relationship and unsure about variables' cause and effect relationship. To cater for this Granger (1969) developed model based on lead and lag relations in forecasting. Granger causality test is considered a useful technique for determining whether one time series is good for forecasting the other. There are different situations under which Granger causality test can be applied. These include;

- (a) A simple bivariate Granger causality where there are two variables and their lags.
- (b) A multivariate Granger causality where more than two variables are considered and it is most applicable where more than one variable can influence the results.
- (c) Granger causality can also be tested in a Vector Autoregressive (VAR) framework where a multivariate model is extended to test for simultaneity of all included variables.

Granger used twin factors of VAR to find variables' causal relationship. The VAR can be considered as a means of conducting causality tests, or more specifically Granger causality tests.

It assumes two series  $X_t$  and  $Y_t$  that define those messages set.

$$X_t = \alpha_0 + \sum_{i=1}^k \alpha_{1i} X_{t-i} + \sum_{i=1}^k \alpha_{2i} Y_{t-i} + \varepsilon_{1t} \quad \dots 6$$

$$Y_t = \beta_0 + \sum_{i=1}^k \beta_{1i} X_{t-i} + \sum_{i=1}^k \beta_{2i} Y_{t-i} + \varepsilon_{2t} \quad \dots 7$$

To determine the variables' relationship the following test are conducted on the coefficients.

- (i)  $\alpha_{2i} \neq 0$  and  $\alpha_{1i} = 0$ : meaning Y lead X or X lag Y.
- (ii)  $\beta_{1i} \neq 0$  and  $\beta_{2i} = 0$ : meaning X lead Y or Y lag X.
- (iii)  $\alpha_{2i} = 0$  and  $\beta_{1i} = 0$ : meaning both variables are independent.

(iv)  $\alpha_{2i} \neq 0$  and  $\beta_{1i} \neq 0$ : meaning both variables are interactive each other and have feedback relationship.

### 3.4 Data and Data Sources

This study used monthly time-series data covering the period 1992:01-2011:12. The variables included are  $RS$ : Three-month Treasury bill in, percentage and  $CP$ : Consumer price level, in percentage. The data series for consumer price level for Namibia and 3-month treasury bills were obtained from various issues of Bank of Namibia's Quarterly Bulletins and Annual Reports.

## 4. Empirical Analysis And Results

### 4.1 Unit Root Test

In testing for unit root the Augmented Dickey-Fuller (ADF), Phillips-Perron (PP) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests are applied. The KPSS was added as confirmatory tests due to the fact that the ADF and PP statistic has limitations of lower power and successive or persistent unit roots respectively. They tend to under-reject the null hypothesis of unit roots. The results of the unit root test in levels are presented in Table 1.

**Table 1: Unit root tests: ADF and PP in levels and first differences**

Variable	Model Specification	ADF	PP	ADF	PP	Order of integration
		Levels	Levels	First Difference	First Difference	
lnIR <sub>t</sub>	Intercept and trend	-2.36	-2.32	-9.73**	-9.93**	1
	Intercept	-1.48	-1.46	-9.75**	-9.95**	1
lnCP <sub>t</sub>	Intercept and trend	-3.32	-2.76	-7.28**	-13.27**	1
	Intercept	-3.10**	-2.59	-7.29**	-13.30**	1

Source: author's compilation and values obtained from Eviews

Notes:(a)at 5% the critical value -3.43 (intercept and trend), -2.87(intercept) for all variables (b)\*\* means the rejection of the null hypothesis at 5%

Table 1 show that the series were found to be non-stationary in level form with the exception of inflation whose results are conflicting. After differencing data the unit root test show that the series became stationary. This is also confirmed by the KPSS test as the results shows in table 2 below.

**Table 2: Unit root tests: KPSS in levels and differences**

Variable	Model Specification	KPSS		
		Levels	First Difference	Order of integration
lnIR <sub>t</sub>	Intercept and trend	0.15	0.05**	1
	Intercept	1.34	0.05**	1
lnCP <sub>t</sub>	Intercept and trend	0.12**	0.05**	1
	Intercept	0.58	0.05**	1

*Source: Author's compilation and values obtained from Eviews*

*Notes: (a) at 5% the critical value 0.15 (intercept and trend. 0.46(intercept) for all variables. (b)\*\* implies rejection of the null hypothesis at 5%.*

#### 4.2 Testing for Cointegration

**Table 3: Johansen Cointegration Test Based on Trace and Maximum-Eigen Values of the Stochastic Matrix**

Maximum Eigen Test				Trace Test			
H <sub>0</sub> :rank=r	H <sub>a</sub> :rank=r	Statistic	95% Critical Value	H <sub>0</sub> :rank=r	H <sub>a</sub> :rank=r	Statistic	95% Critical Value
r = 0	r = 1	10.52	14.26	r = 0	r >= 1	12.55	15.49
r <= 1	r = 2	2.03	3.84	r <= 1	r >= 2	2.03	3.84

*Source: Author's compilation using Eviews.*

*Note: Trace tests indicate no cointegrating equations at the 0.05 level, while the Max-eigen values also indicates no cointegrating. Sample period 1992:01 to 2010:06.*

Table 3 presents the results for the Johansen cointegration test based on trace and maximum eigen values test statistics. The results for both the maximum eigen values and trace test statistic reveal that there are no cointegration equations, because the test statistics are less than the critical values hence, accepting the null hypothesis of no cointegrating variables.

Since there is no cointegration among the variables, it implies that the long run relationship between inflation and interest rate is non existent. This also suggests that these variables may not be causally related at least in one direction. Hence, there is no need to conduct Granger causality test. One can safely conclude that the Fisher hypothesis is rejected in the Namibian context.

#### 5. Conclusion

This study looks at the relationship between inflation and interest rate in Namibia. This is due to the fact that the accurate prediction of interest rate trend is critical to all economic agents. This study used monthly time-series data covering the period 1992:01-2011:12. This study utilized the

following techniques, unit root, cointegration and Granger-causality. The results reveal that the Fisher hypothesis does not hold good for Namibia meaning that the variables are not causally related, not even in one direction. This does not necessarily imply that monetary authorities should not exercise caution when adjusting interest rates. Interest rates should be monitored and adjusted accordingly because it is a determinant factor in macroeconomic policy-making. The interest rate is affected by many components such as inflation rate, economic stability, monetary policy etc. Its effectiveness as a policy tool is reflected on the decisions of the economic agents. Future research should consider a different methodological approach to determine whether similar results would be obtained. Furthermore, quarterly frequencies may be more appropriate due to the fact that sometime monthly rate remains constant over a period.

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