THE RELATIONSHIP BETWEEN INFLATION RATE AND NOMINAL INTEREST RATE IN BOLIVARIAN REPUBLIC OF VENEZUELA: REVISITING FISHER'S HYPOTHESIS

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Abstract

Stability of economics over the world represented by understanding the relationship among the interest rate and inflation rate. This paper investigates the relationship between inflation rate and nominal interest rate based on Fisher equation, using a monthly frequency data in case of Venezuela between 1/1/1990 to 31/12/2016. The Dickey Fuller (ADF) test and Phillips-Perron (PP) test both have empirically used to check the unit root. Also, Johansen for Co-integration test is exploited to study the equilibrium relation for long run between the inflation rate and the nominal interest rate in the time series data. The result shows that both variables are non-stationary at Level I (0) in both tests (ADF and PP), after converting the variables to first difference I (1) with taking the log both of interest rate and inflation rate become stationary. The Johansen co-integration null hypothesis is failed to be rejected in both tests Trace-statistics test and Max-Eigen statistics. This means that the long-run equilibrium relation between the inflation rate and nominal interest rate in Venezuela during 1990 to 2016 is not existed, i.e. the Fisher hypothesis does not hold through the sub-period in Venezuela.

Keywords: nominal interest rate, inflation rate, Fisher Hypothesis, United Kingdom, co-integration, relationship, Johensen test, Bolivarian Republic

JEL Codes: E31, E43

Introduction

Studying the causal relationship between inflation rate and short-term interest rate (nominal rate) recently becomes under consideration, whereas the economists has resumed looking at this relation after negligence from the early 1930s to the late of 1960s (Wood, 1981), when the economic situation has dramatically changed (Li and Zheng, 2017), the relationship between these both rates commonly known as the Fisher equation. The Fisher equation can be defined as one-to-one relationship between the expected inflation and the nominal interest rate, assuming the real interest rate is stationary, constant (Fisher, 1930). The co-movement of expected inflation and nominal interest rate is of crucial interest for central banks and investors. If the Fisher hypothesis does hold, the real interest rate must be independent of changes in inflation and monetary shocks at any given time (Ray, 2012).

The relationship between the interest rate and the inflation has attracted much attention in recent years, since 1930s when Irvin Fisher presented his equation to examine this relationship, which is maintains that the nominal interest rate is the sum of the constant real rate and the expected decline in the purchasing power of money. For the several years money has been a central issue in monetary policy making, when the economic world is changing rapidly and targeting monetary becomes less and less attractive, effective attraction of investments is one of the most urgent problems of governance of the world community (Sharapatyuk, 2016), but the instability of money demand function is the main reason to keep this subject as one of the most debatable studies, wherein the authorities give a big importance to controlling the nominal interest rate at the money market, and monitor the behaviour of real rates.

Testing the relationship between the nominal interest rate and the inflation rate is important for many reasons such as the fundamental role of interest rate on investments, savings when the interest rate became as the key component of the financial market, banks face transformation in the evolution of interest rate liberalization (Wang, 2016), and other operations, which are executed based on this variable, as well as the big impact on the monetary policies, economic and financial models such as the capital asset pricing model (CAPM).

The emerging economies are becoming increasingly important in the world economy, representing more than 50% of the world population (Dash, 2017). The importance of choosing Venezuela as a case study, comes from it has been full swing the highest inflation rate in 2017 by 652.67 percent compare with the previous year according to Statista (2018). So, we think that Venezuela is a good example to study the relation among the aforementioned variables by looking at the nominal interest rate and studying whether it can be determined the expected inflation rate. This paper has organized in six chapters; Introduction, Literature Review, Data and Methodology, Result and Discussion, Conclusion and lastly References list.

Literature Reviews
Theoretical Framework
Fisher equation is also known as Fisher hypothesis which suggests that there exist a positive relationship between rates of interest (nominal) and expected inflation. Fisher equation or hypothesis provides theoretical basis for studying the relationship between the interest rate and expected inflation. The implication of the Fisher equation affects the debtors and creditors and also important for the effectiveness of the monetary policy and efficiency in banking sectors. The Fisher hypothesis supports strongly the US economy in particular and for the industrial countries in general (Hassan, 1999).

Equation of Fisher hypothesis can be defined as:

$$RIR = NIR - IFR \qquad \text{or} \qquad NIR = RIR + IFR, \qquad (1)$$

where *NIR* is the nominal interest rate, *RIR* is the real interest rate and *IFR* is the inflation rate then Fisher.

The Fisher equation states that a one-unit increase in IFR causes a one-unit increase in the nominal interest rate (Elhindi), this one to one relation between inflation and nominal interest rate is known as Fisher effect.

Critical Literature Reviews

Revisiting the relationship between the interest rate and inflation rate, which is known as a Fisher effect have become a widely investigated, to confirm whether the Fisher hypothesis still a valid to represent the relationship between these two variables.

Many researchers have found that the Fisher hypothesis is hold in long term, i.e. a positive relationship between the interest rate and inflation rate is appeared. Hence some of them (Phylaktis and Blake, 1993) studied the relation between the two rates (interest and inflation) in three countries have a high background inflation rate these are; Argentina, Brazil and Mexico. This study has concluded that there is a long run equilibrium relationship among the nominal interest rate and inflation. Another study was done by Hassan (1999), where it was used a quarterly data from 1957 Q1 to 1991 Q2 by applying co-integration technique for Pakistan. Hassan (1999) concluded that there exists a long run relationship between the nominal interest rate and inflation. Million (2004) utilized a monthly data for treasury bills rate and consumer price index between January of 1951 to December of 1999. The Fisher effect was strongly appeared in a situation where the stochastic trend in excited in both the inflation and the nominal interest rate and in such situation, he found strong correlation between the inflation and nominal interest rate. Also in the same year Granville and Mallick (2004) have found that a long run relationship between the nominal interest rate and inflation rate, when they were using Johansen co-integration of annual data for the UK between 1900 to 2000. Later, Macri (2006) has used Johansen technique of co-integration to analyses a quarterly short-term data from first quarter of 1979 to second quarter of 2005 for Australia. There is a positive long run co-integration relationship between the nominal interest rate and inflation rate in Australia. Westerlund (2008) studied Fisher effect for the 20 countries of OECD. The panel quarterly data from 1980 to 2004 collected and using co-integration techniques. The result showed that there is an exciting of relationship between the interest rate and inflation rate in data. Beyer and Haug (2009) studied Fisher hypothesis for 15 countries of OECD using co-integration techniques like ARDL and Johansen co-integration test. Similarly, they found the Fisher co-integration relationship is exciting through OECD countries in long term. Lastly, Saeidi and Vailan (2011) have used an annual data ranging from 1991 to 2009 in Iran. They found that the Fisher hypothesis effect is valid in Iran in short, midterm and long term. Furthermore the study of Teker et al. (2012) investigated on the long-run relationship between the interest and the inflation rates in Turkey during the period of 2002 to 2011 using threshold vector error correction (T-VEC) analysis. The results showed that if the percentage change in the difference between inflation and interest rates is more than 11%, this status distinguishes the effect of error correction, and in situations where the difference is above the threshold value, a shock experienced in interest rates rapidly converges to equilibrium, finally According to the T-VEC equations; the interest rate and the inflation are positively affected by their past two and one periods respectively. Ayub et al. (2014) have studied the casual of relationship between inflation rate and interest rate in Pakistan through the sub-period 1973 to 2010, using both ADF and PP tests of unit root and co-integration technique like Johanson and Engle Granger, the result of studying showed that existing of relationship between the inflation rate and interest rate. Baciu (2014) highlighted the significant statistical connections between the inflation rate and the main macroeconomic variables in Romania covering the period of 1997-2013 applying the explorative

method of principal components Analysis. The main findings presented on the period of June 1997- July 2005 the inflation rate is strongly correlated with the growth of monthly net average nominal wage, other findings showed the period after adoption of the direct targeting regime in August 2005; also it is observed a strong correlation between the inflation and the reference interest rate.

There are another researchers group have found that Fisher hypothesis has not always excited, where the relationship between the interest rate and inflation rate in one country can be different from period to other. Lanne (2001) has used unit root test and co-integration test for the US monthly data for period January 1953 to December 1990, and the result showed that Fisher effect showed the validity over the period of 1953:1 to 1079:12. Whereas the over the other time laps i.e. from 1979:11 to 1990:12 the data showed no validity of the Fisher hypothesis. Berument and Mehdi (2002) have investigated the effect of Fisher hypothesis for 26 countries, and they concluded that some of these countries supported the relation between the inflation and interest rate in long term. While the other some were not. Sundqvist (2002) studied the empirical investigation of Fisher effect for six countries in the long term, a using quarterly data between 1993 to 2000, the result concluded that the US and Japan have support what Fisher hypothesis has pointed out, while the rest of country were not. Alexander (2006) studied the relationship between the nominal interest rate and expected inflation rate for South Africa. Using co-integration technique for the period of 2000 to 2005, the study concluded that the short run relationship did not verify empirically whereas in the long run relationship the data verify the Fisher Equation for South Africa. Ergene (2015) attempted to examine the dynamic relationship between inflation, growth and interest rate under the informal economy using panel VAR and quarterly data during the period of 1960 to 2010, this paper contributed by given some results such as, the interest rate has a negative impact on both growth and the size of informal activities, while inflation does not have a significant effect on them, other results concluded that the fluctuations in interest rate are mostly carried out by the changes in inflation. The causal relation from inflation to interest rate is significantly stronger than the causal relation from interest rate to inflation.

While Ahmed and Abdelsalam (2017) examined the existence of the augmented version Fisher hypothesis including the inflation instability in Egypt during the period of 1997 to 2017, using the different ARCH family models; (ARCH-M), (E-GARCH), (APGARCH), (EGARCH (1,1,1) -M. the main results of this examination concluded that predicted inflation has a positive and significant impact in the first regime while it insignificant in the second regime, other finding showed that there is no relationship between the expected inflation and interest rate in both regimes, which is explained by the weakness of money market.

Third group of researches these have found counter result of exciting the relation between the interest rate and inflation rate in long term Paleologos and Georgantelis (1999) have applied a Johnsons technique of co-integration analysis for Greece from the period of first quarter in 1980 to the second quarter in 1996, in order to study the Fisher hypothesis validity for economy of Greece, they concluded that there is no one to one movement in nominal interest rate and inflation rate in long run for Greece economy. Herwartz and Reimers (2006) investigated the co-integration link between the inflation and nominal interest rate for around monthly time series data of 43 years of 114 for period of 1960:1 to 2004:6. The result showed that there exists a long run

relationship between nominal interest rates and inflation for number of the countries of the world under consideration. They also added that, although of finding either a high inflation rate or interest rate, the long run relationship not exists as mentioned by Fisher. Gul and Acikalin (2008) studied the effect of Fisher hypothesis in Turkey between 1990 to 2003, using Johansen co-integration method, the result highlighted that it is possible to determine the long-run relationship, but not the one-to-one relation between nominal interest rates and inflation, meaning that the full Fisher hypothesis does not hold. Charles et al. (2018) used modified consumer spending model during the period of 1981 to 2011 in Nigeria, in order to testing the effects of interest and inflation rates on consumer spending, the study based on the causal relationship between the consumer spending, interest and inflation rates using Granger causality Wald test. They concluded that indirect tax and savings as important determinants of PCE in Nigeria, the result of the Granger test concluded that future interest and inflation rates cannot be predicted using PCE.

The Data

To investigate the relationship between the aforementioned variables and in conformity with the availability of the necessary data and an accepted number of observations, data has been chosen from the Federal Reserve Bank of St. Louis and IECONOMICS websites. The data are in monthly frequency for Venezuela from 01/01/1990 to 31/12/2016, including 324 observations.

First variable is a Consumer Price Index is used to indicate an increase in domestic prices of the commodities relatively more than increase in the prices of the commodities globally. It indicates the increase in the prices of goods and service over the time. And the other variable is a nominal interest rate refers to those interest rates which are considered before taking inflation into consideration or before adjusting the interest rate for inflation. And when the nominal rates adjusted for the inflation are called real interest rate (Shah and Waleed, 2010).
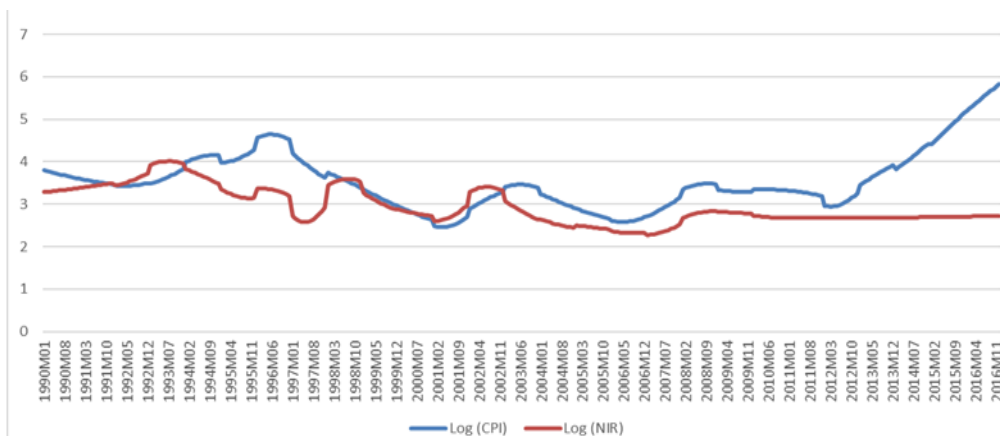

Figure 1. Fisher Hypothesis Relationship
Source: Statista (2018)

The Log has been taking for both variables in order to get stationary data at the

same order, as the CPI always gets stationary at second order I (2). In addition to that, the rate of interest that has been used through this paper is a short-term interest rate (three months Deposit rate). The Fisher hypothesis implies that short-term interest rates can efficiently predict future inflation trends.

The Hypothesis of Study

H_0: There is a long-run relationship between the nominal interest rate and the inflation;

H_1: The long-run relationship between the nominal interest rate and the inflation does not exist.

Methodology

Unit Root Test

The co-integration test among the study variables requires a previous test for the existence of a unit root for each variable, using the Augmented Dickey–Fuller (ADF) (1979) test on the following regression:

The ADF regression tests for the existence of unit root of, namely in all model variables at time *t*. The variable expresses the first differences with lags, and is a variable that adjusts the errors of autocorrelation. The coefficients are to be estimated. The null and the alternative hypothesis for the existence of a unit root in variable is: $H_0 = 0$ vs $H_1 \prec 0$.

Co-integration and Johansen test

Granger and Newbold (1974) have highlighted that, in terms of time series, if the variables are non-stationary in their levels, they can be integrated with integration order 1, when their first differences are stationary. These variables can be co-integrated as well, if there are one or more linear combinations among the variables that are stationary. If these variables are co-integrated, then there is a constant long-run linear relationship among them. There are two important ways to test for co-integration. The Engle and Granger methodology (1987) seeks to determine whether the residuals of the equilibrium relationship are stationary. The Johansen (1988) and Stock-Watson (1988) methodologies determine the rank of (π) which equals the number of co-integration vectors.

Enders (2004) explained the Engle-Granger testing procedure; he began with the type of problem likely to be encountered in applied studies. Suppose that two variables and are believed to be *I* (1) and we want to determine whether there exists an equilibrium relationship between these two variables. Therefore, we need to estimate the long-run equilibrium relationship in the form:

$$y_t = \beta_{0+}\beta_1 z_t + e_t. \qquad (2)$$

In order to determine if the variables are actually co-integrated denote the residual sequence from this equation $\{\hat{e}_t\}$. Thus, the $\{\hat{e}_t\}$ series are the estimated values of the deviation from the long-run relationship. If these deviations are found to be stationary, the $\{y_t\}$ and $\{z_t\}$ sequences are co-integrated of order 1. It would be convenient if we could perform ADF test on these residuals to determine their order of

integration in the form:

$$\Delta\hat{e}_t = y\hat{e}_{t-1} + \varepsilon_t \Delta\hat{e}_t . \tag{3}$$

Since the $\{\hat{e}_t\}$ sequence is a residual from a regression equation, there is no need to indicate an intercept term; the parameter of interest in is, where $y = p - 1$. If the null hypothesis cannot be rejected $y = 0$, then it means that the residual series contain a unit root. Hence, we conclude that $\{y_t\}$ and $\{z_t\}$ sequences are not co-integrated. Instead, the rejection of the null hypothesis implies that the residual sequence is stationary and we conclude that $\{y_t\}$ and $\{z_t\}$ sequences are co-integrated. If the variables are co-integrated, the residual from the equilibrium regression can be used to estimate the error correction model (ECM) (Enders, 2004).

Additionally, according to Johansen (1988), the Johansen test can be seen as a multivariate generalization of the augmented Dickey-Fuller test. The generalization is the examination of linear combinations of variables for unit roots. The Johansen test and estimation strategy – maximum likelihood – makes it possible to estimate all co-integrating vectors when there are more than two variables. If there are three variables each with unit roots, there are at most two v vectors. For example, let r be the rank of (π) which equals the number of co-integrating vectors. There are two tests: 1. the maximum Eigen value test, and 2. the trace test. For both test statistics, the initial Johansen test is a test of the null hypothesis of no co-integration against the alternative of co-integration. The maximum Eigen value test examines whether the rank of the matrix (π) is zero. The null hypothesis is that rank $(\pi) = 0$ and the alternative hypothesis is that rank $(\pi) = 1$. If the rank of the matrix is zero, the largest Eigen value (λ) is zero, there is no co-integration and tests are done. If the largest Eigen value (λ) is nonzero, the rank of the matrix is at least one and there might be more co-integrating vectors. The test of the maximum (remaining) Eigen value is a likelihood ratio test. The test statistic is:

$$LR(r_0, r_0 + 1) = -T\ln(1 - \lambda r_{0+1}) , \tag{4}$$

where is $LR(r_0, r_0 + 1)$ the likelihood ratio test statistic for testing whether rank $(\pi) = $ versus the alternative hypothesis that rank $\pi = r_0 + 1$.

Moreover, Johansen (1988) explained the trace test. It is a test whether the rank of the matrix (π) is. The null hypothesis is that rank $\pi = r_0$. The alternative hypothesis is that $\prec \text{rank}(\pi) \leq n$, where n is the maximum number of possible co-integrating vectors. For the succeeding test if this null hypothesis is rejected, the next null hypothesis is that rank $\pi = r_0 + 1$, and the alternative hypothesis is that $+1 \prec \text{rank}(\pi) \leq n$. The test statistic is:

$$LR(r_0, n) = -T\sum_{i=r_{0+1}}^{n} \ln(1 - \lambda_i) , \tag{4}$$

where $LR(r_0, n)$ is the likelihood ratio statistic for testing whether rank $(\pi) = r$ versus the alternative hypothesis that rank $(\pi) \leq n$.

Result and Discussions

Econometric analysis begins by checking whether the sample size of secondary data is integrated in the same order. In other word, is the data stationary at same order? Unit root testing procedures like Augmented Ducky-Fuller (ADF) and Phillip-Perron (PP) are applied to check the data.

The Table-1 represents the result of ADF and PP tests for the both nominal interest and inflation rates at levels include a constant and trend. The output indicates that the nominal interest rate is non-stationary at both 1% and 5% significance level using both ADF and PP test. As well as, the inflation rate shows non-stationary data at level.

Table 1. Unit Root Test for Stationarity

Nominal Interest Rate					
Test	*Test statistics*	*1%*	*5%*	*Null Hypothesis*	*Status*
Augmented Ducky-Fuller	-2.696756	-3.988134	-3.424482	Fail to Reject H0	Non-stationary
Phillip-Perron	-2.930947	-3.986725	-3.423799	Fail to Reject H0	Non-stationary
Inflation					
Augmented Ducky-Fuller	-0.200123	-3.988036	-3.424435	Fail to Reject H0	Non-stationary
Phillip-Perron	0.341923	-3.986725	-3.423799	Fail to Reject H0	Non-stationary

After taking the first difference of nominal interest rate and inflation, both variables become stationary, which is integrated at first difference I (1) by using Augmented Ducky-Fuller and Phillip-Perron tests that can be verified from the Table 2.

Table 2. Unit Root Stationarity after First Difference

Nominal Interest Rate					
Test	*Test statistics*	*1%*	*5%*	*Null Hypothesis*	*Status*
Augmented Ducky-Fuller	-5.268169	-3.451351	-2.870682	Fail to Reject H0	Non-stationary
Phillip-Perron	-14.29658	-3.450474	-2.870302	Fail to Reject H0	Non-stationary
Inflation					
Augmented Ducky-Fuller	-3.623091	-3.988036	-3.424435	Fail to Reject H0	Non-stationary
Phillip-Perron	-13.19072	-3.986815	-3.423842	Fail to Reject H0	Non-stationary

To conclude unit root test, both nominal interest rate and inflation rate are not stationary at level but once both variables have converted to the first difference I (1),

both of them become stationary. Now it is possible to apply the Johansen Test of Co-integration as its condition is existing, i.e. the variables should be integrated at the same order.

Johansen Test of Co-integration: The Johansen test of co-integration used two different approaches for deciding the co-integration relationship between nominal interest and inflation rate i.e., trace statistic and max-Eigen statistic. The following is the output of the Johansen co-integration test for time based data for Venezuela.

Table 3. Co-integration Test

Johansen Co-integration Statistics						
Test Statistic	H0:	H1:	Eigen Value	Computed Value of Test statistics	Critical Value 5%	Decision
Trace-statistics	r = 0	r > 0	0.020479	6.770598	15.49471	Fail to Reject H0
	r = 1	r > 1	0.000533	0.170128	3.841466	
Max-Eigen statistics	r = 0	r > 0	0.020479	6.600471	14.26460	Fail to Reject H0
	r = 1	r > 1	0.000533	0.170128	3.841466	

It is clear from Table-3, that the computed value of the test statistic, both approaches of Johansen co-integration test, is less than the critical value at 5% level of significance so we cannot reject the null hypothesis. It is concluded that the existing of a co-integration or equilibrium relationship for long run between nominal interest and inflation rate in Venezuela for period of 1990-2016 is not appeared, which is that the fisher hypothesis does not hold in case of Venezuela.

Conclusions

The main objective of the study is to find out the equilibrium relationship for long run between the aforementioned variables, i.e. the study of the validity of the Fisher Hypothesis. It is found that both variables nominal interest rate and inflation rate for Venezuela from 1990 to 2016 show non-Stationary at I (0) and after taking first difference I (1) of both variables, they become stationary.

The result of Johansen co-integration test, it is obtained that there is no existing of long run relationship or co-integration among nominal interest rate and inflation rate at 5% significance level for period of 1990 to 2016 in Venezuela. That meaning the fisher hypothesis does not hold in Venezuela over the studying period. Building on that, we accept the alternative hypothesis H_1, and reject the null hypothesis, which shows the existence of the long-run relationship between the two variables. Our result consonant with investigations by Paleologos and Georgantelis (1999), Herwartz and Reimers (2006), and Gul and Acikalin (2008), which has proved that the Fisher hypothesis not valid. For further contributions we recommend to test the impact of fluctuations of inflation and interest rates on the performance of banks, especially on their profitability and level of safety (decrease/increase of risk). The other recommendation is to examine the relationship of these both variables on asset pricing by applying the Capital Asset Pricing Model (CAMP).

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