INTERNATIONAL JOURNAL OF ECONOMIC AND ADMINISTRATIVE ACADEMIC RESEARCH

Available online, ISSN: 2757-959X | www.ijerdergisi.com | Economic and Administrative Academic Research

LINEAR ANALYSIS OF THE RELATIONSHIP BETWEEN THE REAL INTEREST RATE AND THE INFLATION RATE IN AFGHANISTAN

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ARTICLEINFO

Research Article

Received :12/08/2024
Accepted : 13/09/2024

Keywords:
Interest Rate, Inflation Rate, SPSS, Eviews

ABSTRACT

Inflation, defined as the continuous rise in the general price level, is often associated with capitalist economic systems, where the interest rate reflects the cost of money and debt securities. This study analyzes the relationship between real interest rates and inflation in Afghanistan, proposing that better understanding of this link can help economic agents regulate inflation through interest rate adjustments at decision-making levels.

Using an applied quantitative descriptive research design, time series data from the World Development Indicator (WDI) were analyzed via correlation and Ordinary Least Squares (OLS) linear models, employing SPSS and Eviews software. The data passed normality tests (Kolmogorov-Smirnov, Shapiro-Wilk, and skewness-kurtosis), and the model demonstrated a strong fit, with an adjusted coefficient of determination of 97.7%. The Breusch-Pagan-Godfrey test confirmed homoscedasticity of residuals, while the Breusch-Godfrey test indicated no autocorrelation. The Jarque-Bera test's p-value (>0.05) further validated residual normality. Finally, a stability test confirmed the long-term stability of the relationship between real interest rates and inflation in Afghanistan.

The study concludes that real interest rates have a significant impact on inflation, as evidenced by an OLS coefficient of 0.942 and an intercept of 14.273. The adjusted R^2 value of 0.977 shows that 97% of the variation in inflation can be explained by changes in real interest rates.

Uluslararasi İktisadi Ve İdari Akademik Araştirmalar Dergisi, 4(2), 2024, 30-42

AFGANİSTAN'DA REEL FAİZ ORANI İLE ENFLASYON ORANI ARASINDAKİ İLİŞKİNİN DOĞRUSAL ANALİZİ

MAKALE BİLGİSİ

Araştırma Makalesi

Geliş :12/08/2024
Kabul : 13/09/2024

Anahtar Kelimeler:
Faiz Oranı, Enflasyon Oranı, SPSS, Eviews

ÖZ

Enflasyon, genel fiyat düzeyindeki sürekli artış olarak tanımlanmakta ve genellikle kapitalist ekonomik sistemlerle ilişkilendirilmektedir; bu sistemlerde faiz oranı, para ve borçlanma araçlarının maliyetini yansıtır. Bu çalışma, Afganistan ekonomisinde reel faiz oranları ile enflasyon arasındaki ilişkiyi analiz etmekte ve bu ilişkinin daha iyi anlaşılmasının, ekonomik aktörlerin faiz oranı ayarlamaları yoluyla enflasyon seviyelerini kontrol etmelerine olanak tanıyacağını öne sürmektedir.

Uygulamalı nicel tanımlayıcı bir araştırma tasarımı kullanılarak, Dünya Kalkınma Göstergesi (WDI) kaynaklarından elde edilen zaman serisi verileri, SPSS ve Eviews yazılımlarıyla korelasyon ve En Küçük Kareler (OLS) doğrusal modelleri aracılığıyla analiz edilmiştir. Veriler Kolmogorov-Smirnov, Shapiro-Wilk ve çarpıklık-basıklık normalite testlerinden geçmiş, model ise %97,7 uyarlanmış determinasyon katsayısı ile güçlü bir uyum sergilemiştir. Breusch-Pagan-Godfrey testi, artıkların homoscedastisitesini doğrulamış, Breusch-Godfrey testi ise artıklar arasında otokorelasyon olmadığını göstermiştir. Jarque-Bera testinin p-değeri (>0,05) model artıklarının normal dağılımını desteklemiştir. Son olarak, stabilite testi reel faiz oranı ile enflasyon arasındaki ilişkinin uzun vadeli istikrarını doğrulamıştır.

Çalışma, reel faiz oranlarının enflasyon üzerinde önemli bir etkiye sahip olduğunu ortaya koymuştur; bu, yaklaşık 0,942'lik bir OLS katsayısı ve 14,273'lik bir kesişim değeri ile kanıtlanmıştır. Modelin uyarlanmış R^2 değeri olan 0,977, enflasyondaki değişimlerin %97'sinin reel faiz oranlarındaki değişimlerle açıklanabileceğini göstermektedir.

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1. INTRODUCTION

The Fisher equation, a well-known concept in economic literature, asserts that there is a consistent connection between the nominal interest rate and the inflation rate over the long term. This relationship can have causation from both sides, and therefore, research on this topic has been a significant concern for economists for many years, with some researchers rejecting Fisher's relationship and others confirming it.

The Irving Fisher equation states that the nominal interest rate (im) can be expressed as the sum of the real interest rate (ir) and the inflation rate (p), written as im = ir + p. This implies that changes in the nominal interest rate can be attributed to alterations in both the real interest rate and the inflation rate. In essence, the nominal interest rate is determined by the combined impact of these two rates. (Faridoon, 2009. Pp. 615-616)

Based on conducted studies, it has been observed that no general relationship (between the interest rate and inflation) that is universally applicable under all conditions and can be declared temporally and spatially unlimited has been discovered so far. The only certainty in this regard is the variability of the relationship between the interest rate and inflation under different temporal and spatial conditions, from the significance of the relationship to its intensity and direction. The main motivation and necessity for choosing this topic (Analyzing the relationship between real interest rates and inflation in the economy of Afghanistan) were the lack of previous research in this area in Afghanistan and the existence of different theories in this field with different results in practice from the relationship between these two macroeconomic variables according to foreign studies. This necessitates an empirical study of the nature of this relationship (the impact of the real interest rate on inflation) in the economy of Afghanistan. The findings of this research provide the possibility of policy-making and rational behavior for economic agents (policymakers and investors).

1.1. Research Background

John Bates Clark held the view that the real interest rate remains constant, in contrast to Marshall. He focused on how the inflation rate affects the nominal interest rate, asserting a direct relationship. According to Clark, the nominal interest rate should change in proportion to the inflation rate, ensuring a constant real interest rate. As a result, he made modifications to the nominal interest rate model (Clark, 1895).

Kandel and colleagues, in their 1996 study titled "Real Interest Rate and Inflation," identified a negative relationship between inflation and the real interest rate, supporting the theoretical framework proposed by Tobin and Mundell (Kandel, Ofer, & Sarig, 1996).

In a study titled "The Relationship between Nominal Interest Rate and Inflation," Booth and Siner utilized the co-integration technique to explore the correlation between prevailing interest rates in European countries and the inflation rates of 9 European countries and the United

States. The research revealed a one-to-one positive relationship between inflation and the interest rate in all cases except one (Booth & Ciner, 2001).

In an article titled "The Fisher Effect: Can It Be Tested," Cooray reviewed the literature on this topic globally and noted that, while most recent studies confirm Fisher's findings, there is evidence challenging the one-to-one relationship postulated by Fisher's model between the interest rate and inflation. The results indicated a positive relationship between the interest rate and inflation for the United States but did not establish a one-to-one relationship, a necessary condition of Fisher's theory. The evidence for the United States largely aligned with Fisher's effect, while results for other industrialized countries were not very clear (Cooray, 2002).

In their examination of the interest rates of G7 countries in the long term, Ghazali and Ramlee concluded that there is no real relationship between these two variables in these countries (Ghazali & Ramlee, 2003).

Lardic and Mignon conducted research covering the time span from 1970 to 2001 in the G7 country group, and their results confirmed Fisher's assumptions about the long-term relationship between the inflation rate and the interest rate (Lardic & Mignon, 2003).

In a study titled "Revisiting the Fisher Effect," Carneiro and colleagues examined their research monthly for three countries: Argentina, Brazil, and Mexico, in the time range from 1980 to 1997. The research confirmed Fisher's assumptions for two countries and did not confirm them for Mexico (Carneiro, Divino, & Henrique, 2004).

In an article entitled "Structural Breaks, Inflation, and Interest Rates: A Case Study of G7 Countries," Clemente and colleagues examined the Fisher test regarding the G7 country economies. Two variables, interest rate and inflation, were investigated, and the research results only confirmed the Fisher hypothesis for the United States, France, and Japan (Clemente, Montañés, & Reyes, 2004).

In an article titled "Revisiting Fisher's Hypotheses," Kasman and colleagues evaluated the validity of Fisher's assumptions using data from 33 developed and developing countries and confirmed the credibility of Fisher's assumptions (Kasman, Kasman, & Turgutlu, 2005).

In Jensen's analysis, titled "Testing the Long-Term Fisher Effect," Fisher's theory underwent scrutiny across 17 industrialized nations, encompassing Australia, Austria, Belgium, Canada, Denmark, France, Germany, Switzerland, Greece, Ireland, among others. The examination involved monthly and quarterly computations, exploring short-term and long-term nominal interest rates. The findings revealed that, over the long term, inflation in these countries exhibited a notable degree of stability, remaining unaffected by external and financial shocks. The test results suggested that, in line with Fisher's theory, a sustained alteration in inflation does not impact the nominal interest rate in a permanent manner, establishing a neutral relationship between the two variables (Jensen & Mark, 2006).

Ekrem and Aykut, using monthly observations and frequentist ratios, studied the economic situation of Turkey from 1984 to 2003. According to their findings, the future path of inflation in the Turkish economy is determined by the nominal interest rate (Ekrem & Aykut, 2006).

Based on the results of a study by Tillmann titled "Does the Interest Rate Affect Inflation Dynamics," conducted for the United States and the United Kingdom in the time period 1960-2004, and also for the European region in the time period 1970-2003, using the VAR model within the framework of three variables: interest rate, labor share, and inflation rate, it was found that the current values of interest rates have a lasting effect on inflation dynamics, indicating a permanent impact (Tillmann, 2007).

In their research in Nigeria, Obi, Nurudeen, and Gobna studied the relationship between the interest rate, inflation, and economic productivity. The findings of this research show that, in the long term, Fisher's effect in Nigeria is effective (Obi, Nurudeen, & Gobna, 2009).

2. Research Methodology and Materials

In this study, a descriptive quantitative research design of an applied nature has been employed to assess the Analyzing of relationship between real interest rates and inflation in the economy of Afghanistan. The required information for this research has been gathered through library research, published scientific articles, Central Bank of Afghanistan and World Development Indicator website’s.

The economy of Afghanistan is considered as the statistical community for this research, and a purposive sampling method is used for sampling. The data for this research covers the years from 2006 to 2017, regarding the real interest rate and inflation rate in Afghanistan. The reason for choosing these years is the unavailability of statistics and figures for the real interest rate and inflation rate in other years and time periods. The findings of this research have been analyzed using EViews and SPSS.

2.1. Research Limitations:

Limited Availability of Mid-Term Data in Afghanistan: The absence of data for periods shorter than one year within Afghanistan limits the ability to conduct a more accurate analysis of the relationship between monthly and annual real interest rates and inflation rates in the country's economy.

Insufficient Transparency in Da Afghanistan Bank's Monetary Policies: The unavailability of comprehensive information regarding Da Afghanistan Bank's monetary policies, due to weak cooperation and reluctance to disclose such data, creates a challenge for conducting in-depth research.

Lack of Prior Domestic Studies in Afghanistan: There is a lack of previous domestic research in Afghanistan on this topic, limiting the availability of relevant references and comparative analysis for the study.

2.2. Reviewing the linear regression model

The linearity of a linear regression model is required in both parameters and variables, indicating that the powers of the parameters and variables in this model are set to one (Azimi, 2019).

$$Y_i = \beta_1 + \beta_2 X_i + u_i \ \ldots \quad (1)$$

The function denoted as (1) is also known as the social regression function. This function is utilized as a theoretical and conceptual basis, but in the real world, its coefficients are estimated through sample observations (Azimi, 2019).

$$\hat{Y}_i = \hat{\beta}_1 + \hat{\beta}_2 X_i + \hat{u}_i \ \ldots \quad (2)$$

The function (2), recognized as the sample regression or estimated function, is always characterized by a difference between the true regression model and the estimated model, which is illustrated by the model's disturbance term. The estimation of regression coefficients in this study is grounded in the method of ordinary least squares. This method was discovered by a German mathematician named Friedrich Gauss. In this approach, the following equations are employed to calculate the intercept and slope coefficients of the regression function (Azimi, 2019):

$$\hat{\beta}_1 = \bar{Y} - \hat{\beta}_2 \bar{X} \qquad , E(\hat{\beta}_1) = \beta_1 \ \ldots \quad (3)$$

$$\hat{\beta}_2 = \frac{cov(X_i, Y_i)}{Var(X_i)} = \frac{\sum x_i y_i}{\sum {x^2}_i} \qquad , E(\hat{\beta}_2) = \beta_2 \ \ldots \quad (4)$$

The coefficient of determination for a regression model is calculated using the following equation (Azimi, 2019):

$$r^2 = \frac{\sum(\hat{Y}_i - \bar{Y})^2}{\sum(Y_i - \bar{Y})^2} = \frac{ESS}{TSS} \ \ldots \quad (5)$$

The adjusted determination coefficient has been calculated using the following formula (Azimi, 2019):

$$\bar{r}^2 = 1 - \frac{(1 - r^2)(N-1)}{N-K-1} \ \ldots \quad (6)$$

The following formula is used to calculate the statistical value of F: (Azimi, 2019)

$$F = \frac{\frac{r^2}{K-1}}{\frac{1-r^2}{n-K}} \dots \quad (7)$$

The Jarque-Bera test has been employed to assess the normality of residuals in this study, and the calculation method is described as follows (Azimi, 2019):

$$JB = n\left[\frac{S^2}{6} + \frac{(EK)^2}{24}\right] \dots \quad (8)$$

The Durbin-Watson table has been utilized to examine serial correlation among residuals. The statistical significance of the Durbin-Watson can be measured using the following formula (Azimi, 2019):

$$DW = \frac{\sum_{t=2}^{n}(\varepsilon_t - \varepsilon_{t-1})^2}{\sum_{t=1}^{n} \varepsilon^2 t} \dots \quad (9)$$

3. RESULTS

Table 1: Figures related to the interest rate and inflation in Afghanistan.

Year	Interest	Inflation GDP deflator
2006	10.08	7.17
2007	-8.59	22.38
2008	12.47	2.18
2009	17.47	-2.11
2010	5.71	9.44
2011	4.15	10.56
2012	6.18	8.30
2013	9.89	4.72
2014	14.72	0.24
2015	8.97	5.53
2016	9.25	5.26
2017	8	4.98

In Table (1), figures related to the real interest rate and inflation rate are presented, including an outlier referred to in statistical language as an "outlier." Outliers, defined as data

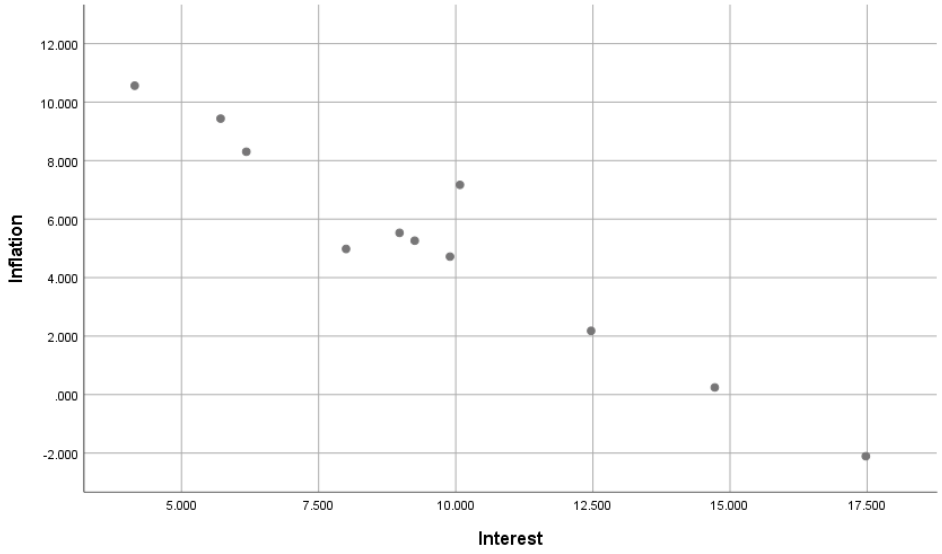
points deviating from the mean by at least three standard deviations, either positively or negatively, identify the numbers (-8.58837) and (22.38202) corresponding to the year 2007 as outliers. For the purpose of analysis, they are excluded from consideration.

Table 2: Tests of Normality

Inflation rate	Shapiro-Wilk			Normality Test Based on Skewness and Kurtosis	
	Statistic	Df	Sig.	Skewness	Kurtosis
	0.962	11	0.796	0.645	0.108
Interest rate	0.958	11	0.744	-0.506	-0.205

According to Table (2), the normal distribution of figures for the inflation rate and real interest rate is indicated by the Shapiro-Wilk (Interest rate Sig. = 0.744 > 0.05, DF=11 and Inflation Rate Sig.= 0.796>0.05/, df=11). Additionally, Table (2) demonstrates that the kurtosis and skewness for both variables fall within the interval (-1, 1), confirming the normal distribution of these two variables.

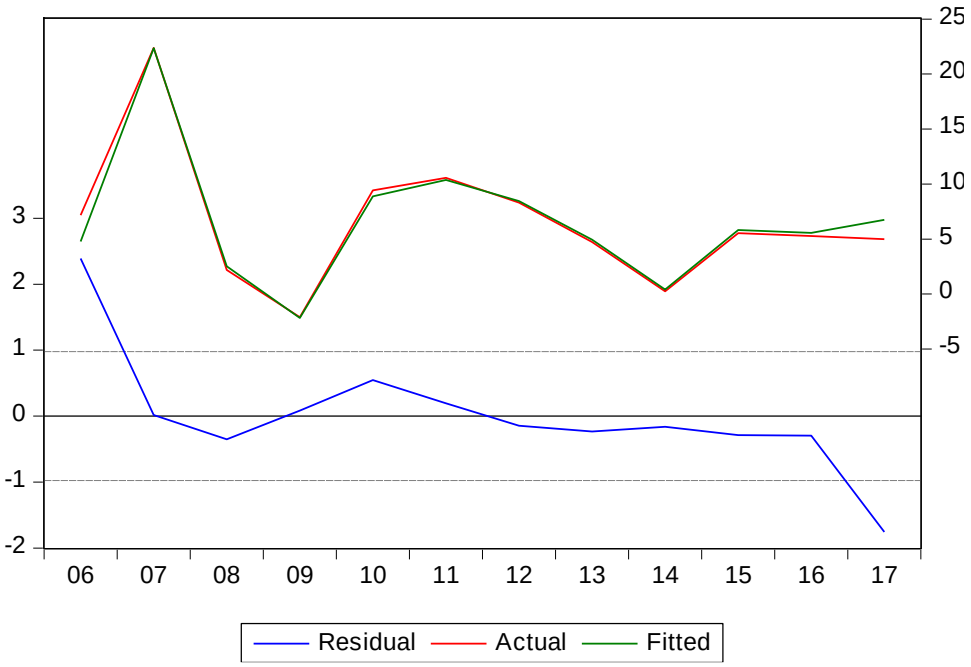
Figure 1: Linearity of the Relationship between Variables



In Figure (1), a negative linear relationship between the real interest rate and inflation rate in the Afghan economy is illustrated through a scatter plot. The plot suggests that an increase in the real interest rate is associated with a decrease in the inflation rate, and vice versa. The concentration of points around the line implies a strong correlation between the two rates in

Afghanistan. The scatter plot indicates that predicting inflation based on the real interest rate in Afghanistan is highly accurate due to the high concentration of points around the line.

Figure 2: Ordinary Least Squares (OLS) Linear Model Fitting



The model's fitting quality is indicated by the calculated adjusted determination coefficient value of 97.7%. Figure (2) further confirms the model's fitting quality by showing a close match between actual and estimated values.

Table 3: Heteroskedasticity Test

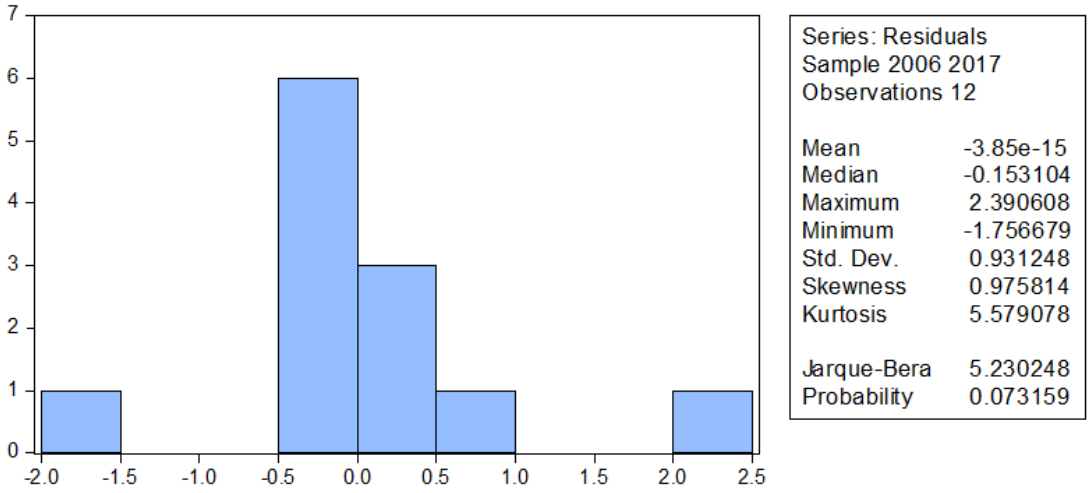
F-statistic	0.065524	Prob. F(1,10)	0.8032
Obs*R-squared	0.078117	Prob. Chi-Square(1)	0.7799
Scaled explained SS	0.124203	Prob. Chi-Square(1)	0.7245

Table 4: Serial Correlation LM Test

		0.4			0.
F-statistic	13762		Prob. F(2,8)	6745	
Obs*R-squared	24923	1.1 Square (2)	Prob. Chi-	5698	0.

In Table (4), the probability value for the chi-square test equals 0.779, which is smaller than 0.05, suggesting homogeneity of the residuals' variances.

Figure 3: Residual Normality Test



In Figure (3), the Jarque-Bera test shows a probability value larger than 0.05, supporting the normal distribution of model residuals.

Figure 4: Test of Model Parameter Stability

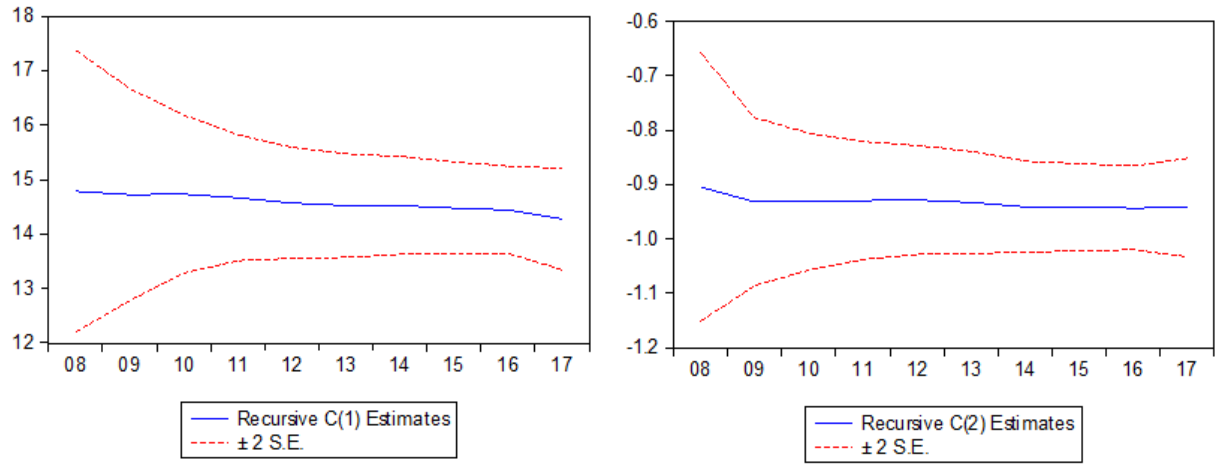


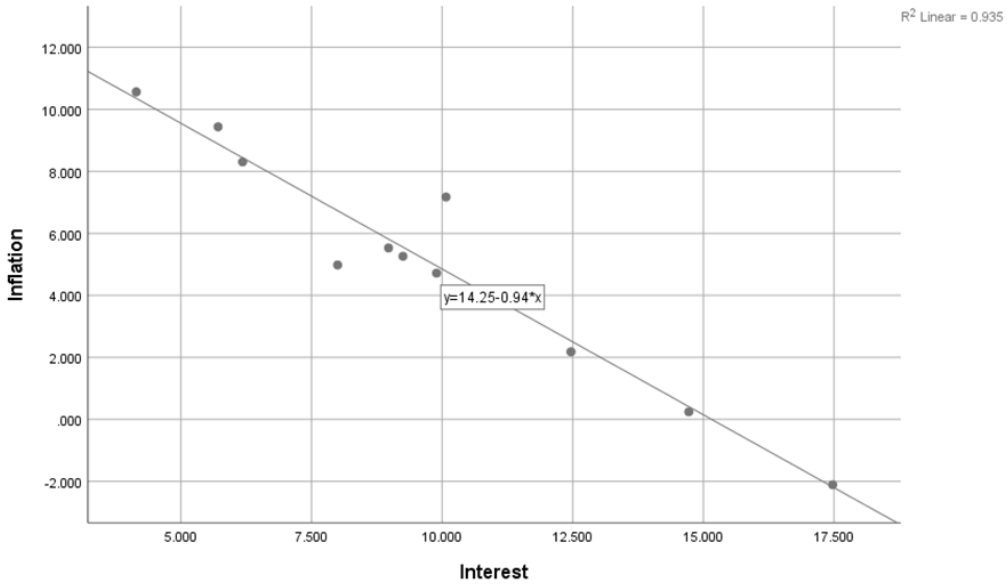
Figure (4) displays the stability of parameters over time, suggesting a stable relationship between the real interest rate and inflation.

Table 5: Pearson Correlation between Interest and Inflation

Sig.	N	r
0.000	11	0.967

In Table (5), the significance level of the Pearson correlation coefficient (Sig.=000<0.05, DF= 11, r = 0.967) is, indicating a significant relationship between the real interest rate and inflation rate in Afghanistan. The correlation coefficient value is 0.967, signifying an almost perfect correlation between the two variables. The negative correlation implies that an increase in the real interest rate leads to a decrease in inflation, and vice versa.

Figure 5: Regression Model Diagram



Considering Figure (5), the output results from the SPSS program indicate that the designed model for the real interest rate and inflation rate in the Afghan economy between 2006-2017 is a simple linear model: Inflation Rate = 14.25−0.94(Real Interest Rate). In this model, the real interest rate is the independent variable, and the inflation rate is the dependent variable. The linear relationship between these two variables is negative. The intercept of the model is 14.25, suggesting that if the real interest rate in the Afghan economy becomes zero, the inflation rate will be 14.25%. The slope of the model (0.94) indicates that a 1% increase in the real interest rate results in a 0.94% decrease in the inflation rate, and vice versa.

Table 6: Results of OLS Linear Model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	14.27381	0.466542	30.59490	0.0000
INTEREST	-0.942141	0.045370	-20.76582	0.0000
R-squared	0.977336	Mean dependent var		6.555007
Adjusted R-squared	0.975069	S.D. dependent var		6.185752
S.E. of regression	0.976701	Akaike info criterion		2.941739
Sum squared resid	9.539449	Schwarz criterion		3.022557
Log likelihood	-15.65044	Hannan-Quinn criter.		2.911818
F-statistic	431.2192	Durbin-Watson stat		0.898733
Prob(F-statistic)	0.000000			

Table (6) shows a probability value (Prob) of zero and less than 0.05, indicating the significance of the independent variable's effect on the dependent variable. The OLS coefficient value in the table is (0.942-), and the intercept value is (14.273). The adjusted determination coefficient of the model is (0.977), indicating a high level of model fit—97% of the variation in the dependent variable (inflation) is explained by the independent variable (real interest rate).

DISCUSSION

The relationship between real interest rates and inflation has been extensively studied, as demonstrated in prior research. Fisher's theory remains one of the most prominent frameworks, proposing a negative one-to-one relationship between real interest rates and inflation (Fisher, 1930). The findings of this study align with Fisher's model in terms of direction, showing a negative relationship between real interest rates and inflation in Afghanistan. However, the magnitude of this relationship in Afghanistan, with a coefficient of 0.94, suggests it is not exactly one-to-one, reflecting differences in local economic conditions.

Fisher's model assumes the independence of the real interest rate from inflation, a concept that this study's results challenge. In Afghanistan, the real interest rate is strongly correlated with inflation, indicating a dynamic interplay between the two variables, which is inconsistent with Fisher's assumption of a constant real interest rate. This deviation highlights the unique macroeconomic structure of developing economies, where inflationary pressures are more susceptible to external shocks.

In comparison, the work by Kandel, Ofer, and Sarig (1996) also tested Fisher's hypothesis, finding a strong inverse relationship between real interest rates and inflation. The findings of this study closely mirror theirs, reinforcing the notion that real interest rates are not independent of inflation expectations. In the Afghan context, this relationship is particularly strong, suggesting that controlling real interest rates can have significant implications for inflation management.

On the other hand, other studies, such as those by Ghazali and Ramele, found no significant relationship between interest rates and inflation, while research by Boat and Siner showed a positive relationship, further indicating that the real interest rate-inflation dynamic can vary significantly across different economic environments. The findings of this study thus contribute to the understanding of how real interest rates influence inflation specifically in Afghanistan.

CONCLUSION

The results of this study provide substantial evidence that the real interest rate plays a critical role in influencing inflation within Afghanistan's economy. By employing a robust OLS linear model and analyzing time series data, the study confirms the existence of a stable and significant relationship between these two variables. The adjusted coefficient of determination (97.7%) demonstrates a high level of model accuracy, suggesting that the real interest rate accounts for the majority of the variation in inflation. Additionally, diagnostic tests such as the Breusch-

Pagan-Godfrey and Breusch-Godfrey tests confirm the absence of heteroscedasticity and autocorrelation in the model, while the Jarque-Bera test reinforces the normality of the residuals.

These findings underscore the potential for economic policy interventions that target the real interest rate as a means to control inflation. By adjusting the real interest rate, policymakers can exert influence over inflationary pressures, providing a pathway to greater economic stability. This study's insights contribute to a deeper understanding of macroeconomic dynamics in Afghanistan and offer a foundation for future research and policy development in this area.

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