THE RELATIONSHIPS BETWEEN INTEREST RATES AND INFLATION CHANGES: AN ANALYSIS OF LONG-TERM INTEREST RATE DYNAMICS IN DEVELOPING COUNTRIES

Hossein Asgharpur
Department of Economics,
University of Tabriz, Iran,
Tel:+989123497414,
asgharpurh@gmail.com

Lotfali Agheli Kohnehshahri
Economic Research Center,
Tarbiat Modares University, Tehran, Iran,
Tel: +982188003281,
Fax: +982188008571,
aghelik@modares.ac.ir

Azhdar Karami
Bangor Business School,
University of Wales,
Bangor, UK.
Tel: +44 1248 388350,
abse06@bangor.ac.uk.

Abstract

Interest rates lie at the centre of monetary policy, not just as passive reflectors on money supply but rather as one of the main policy instruments. Interest rates have played a central role macroeconomic policy. In developing countries, interest rates have also enjoyed high popularity as policy instruments. For instance, high interest rate has been an essential component of many stabilization programs in countries with chronic inflation during the 1980s. This paper deals with theoretical and empirical aspects of the interactions between interest rates and inflation in developing countries. In the theoretical part reviewing literature revealed that many researchers argue that increasing inflation rate results in increasing interest rate. It is also argued that increasing product costs by increasing interest rate raises product's prices and consequently inflation. This research examines the causal relationship between the interest rate and inflation rate in a panel of 40 selected Islamic countries using new causality approach and applying panel data methodology over the 2002 – 2005 periods.

The results of this study show a unidirectional causality from interest rate to inflation rate in 40 Islamic countries. The findings have practical policy implications for decision makers in the area of macroeconomic planning particularly in Islamic countries. The results imply that banks must reduce interest rate to decrease the inflation.

Keywords: Interest rates, Inflation, Hsiao Causality, Panel Data, Islamic countries

1. Introduction

Since the changes in interest rate have considerable effects on decision-making of economic agents, it has been one of the main policy variables in macroeconomics; and it has attracted the attention of economic agents and participants to itself. On the other hand, various factors have influence on interest rate. One of the basic macroeconomic variables related with interest rate is inflation rate. Based on theoretic issues and empirical studies, there is bidirectional causality relationship between interest rate and inflation rate. Of course, some studies have rejected a strong bidirectional relationship between two-mentioned variables. This issue in the context of Islamic countries is of great importance; so that wide discussions have accomplished among Islamic specialists. Some Islamic economists particularly in Iran believe in increased interest rate results in higher production costs and raising prices (inflation). Also, the economic theories indicate that increased inflation rate gives rise to higher interest rate.

The main point in considering the relationship between interest rate and inflation rate is causality test. The previous causality tests have focused mostly on Granger causality test which has essential difficulty; thus the newer tests of causality such as Hsiao test must be applied. Currently, most econometric studies focus on panel data methodology because of its strength.

If the interest rate is fixed in an economy by banking authorities, effects of inflation on interest rate will not be justified. Since causality between interest rate and inflation rate has proved for developed countries, the hypothesis test in this regard is more valid for different countries. In this paper, causality relationship is tested using panel data of 40 Islamic countries over the 2002-2005 periods.

The structure of our paper is as follows: section 2 reviews theoretical basics of interest rate and inflation rate relationship. In section 3, the methodology is discussed. Section 4 devotes to data, model and its estimation. Finally, Section 5 presents concluding remarks.

2. Theoretical basics

We can apply the existing macroeconomic theories to study the relationship between interest rate and inflation rate. To do this, the influence mechanism of interest rate on inflation is considered and vice versa.

According to macroeconomic literature, when the price level is increased, firstly the real balances will be affected. In other words, the higher price level is a cause for lower real supply of money. In Keynesian context of analysis, decreased real money supply distorts whole economy. This means disequilibrium. In the next phase, the supply of bonds is increased. The final result is a lower price for bonds and higher interest rate. So there is a positive causal relationship from inflation rate to nominal interest rate. In other words, increased inflation rate provides some increases in interest rate.

The influence mechanism of interest rate on inflation can be explained in various ways. One method is to apply user cost of capital. The increased interest rate raises the user cost of capital (Branson, 1979) that results in

higher production costs. This changes raise inflation by shifting the aggregate supply curve to the left side. Also, the changing interest rate impacts on inflation through influencing the money volume. In the endogenous money models which money supply is a function of interest rate, the money supply is increased when interest rate goes up. So, according to quantity theory of money, the more money supply results in inflation in the short- and long-run. Although money supply has not significant effect on inflation in the recession period, however the impact of money supply on inflation is positive and significant in the medium– and long– run in normal conditions.

Generally speaking, the relationship between nominal and real interest rates indicates a positive relationship between inflation rate and nominal interest rate. This debate has presented by William Douglas before 1840s. Then, Henry Thornton used this idea for explaining the nominal and real interest rates relationship. Alfred Marshal (1890) has introduced the relationship between nominal interest rate and inflation rate:

$$r = n - p - n\,p \qquad (1)$$

where r, n and p refer to real interest rate, nominal interest rate and inflation rate, respectively; and *np* represents cross effect of nominal interest rate and inflation rate. Therefore, there is positive relationship between nominal interest rate and inflation from Marshal point of view.

John Bates Clark (1895) believes in fixed real interest rate. In his view, nominal interest rate should be changed proportional with inflation rate. Irving Fisher (1896) explained theory of inflation and interest systematically.

Fisher (1896) introduced the following relation:

$$r = n - P_e \qquad (2)$$

where r, n and P_e are real interest rate, nominal interest rate and expected inflation rate, respectively.

Darby (1975), Feldstein (1976), Mundel (1963), Tobin (1965), Nelson & Schewert (1977), Mishkin (1981, 1988) and Gibson (1982) have verified positive relationship between inflation rate and interest rate. On the other hand, Barsky (1987), Huizinga & Mishkin (1986), Mishkin (1992) and Ghazali (2003) have concluded that there is no strong relationship between interest rate and inflation rate. Lardic & Mignon (2003) have studied the relationship between interest rate and inflation rate in G-7 countries using Engel-Granger cointegration method. According to their study, there is a long-run relationship between interest rate and inflation rate.

Berumont *et al* (1999) concluded that increased inflation uncertainty results in raising the nominal interest rate. Million (2003) has tested long-run relationship between nominal interest rate and inflation rate using U.S. data. He concludes that Federal Reserve reduces the nominal interest rate when inflation rate is high; and it raises nominal interest rate when inflation rate is low. He argues that Federal Reserve authorities follow prices fixing policy and regulate its procedures based on inflation. He finally accepts Fisher theory.

Booth and Ciner (2001) have studied the relationship between interest rate and inflation rate using cointegration in 9 European countries and U.S. The conclusion supports the long-run relationship except for one case. Brazoza and Brzezina (2001); and Fave and Auray (2002) have confirmed a relationship between interest rate and inflation rate in the long-run.

So, based on these issues, it is expected that a bidirectional causal relationship will exist.

3. Methodology

As usual, the Granger causality test is used for causal testing among macroeconomic variables. In summary, if the past values of a time series variable Y can predict X_{t+1}
, we conclude that Y is a Granger cause of X and vice versa. In other words, this famous test is two-variable auto-regressive model as follows:

$$x_t = \alpha_0 + \sum_{i=1}^{m} \alpha_i x_{t-i} + \sum_{j=1}^{m} \beta_j y_{t-j} + u_t \quad (3)$$

$$y_t = \sigma_0 + \sum_{i=1}^{m} \sigma_i y_{t-i} + \sum_{j=1}^{m} \delta_j x_{t-j} + v_t \quad (4)$$

where x_t and y_t are time series variables; u_t and v_t are residual terms of two regressions. *t* indicates time; and *i* and *j* show lag length. In this test we have:

$$\begin{cases} H_0 : Null\ Hypothesis : \beta_j = \delta_j = 0 \\ H_A : Alternative\ Hypothesis : \beta_j \neq 0, \delta_j \neq 0, \exists j \end{cases} \quad (5)$$

Null hypothesis (H_0) indicates lack of causal relationship between x_t and y_t; and alternative hypothesis means at least a unidirectional causal relationship.
In above regressions:

1. if β_j, δ_j are significantly non-zero, there is bidirectional causal relationship between x_t and y_t.
2. if β_j and δ_j are significantly zero, there is no causal relationship between x_t and y_t.
3. if $\beta_j \neq 0$ and $\delta_j = 0$, there is unidirectional causal relationship from *Y* to *X*.
4. if $\beta_j = 0$ and $\delta_j \neq 0$, there is unidirectional causal relationship from X to Y(Gujarati, 2000).

Recently, new causality tests have been introduced. One important test is Hsiao causality test or adjusted Granger causality test. Since Granger causality test is very sensitive to choice of optimal lag length, the incorrect choice of lags may result in biased estimators in regressions (3) and (4).

To overcome the shortcomings of Granger causality test, Hsiao (1981) presented a systematic auto-regressive method to select optimal lag length for each variable(X or Y). This method is in fact a combination of Granger causality method and Akaike's final prediction error (AFPE); or mean square prediction error (MSPE).

In this paper, we use Hsiao causality test to determine the relationship between interest rate and inflation rate. This test is conducted in two phases.

In the first phase, the auto-regressive models are estimated so that every dependent variable is fitted on itself with one lag. Then the same model is estimated using two lags and so on. Indeed, *m* models are fitted as follows:

$$d(x_t) = \alpha + \sum_{i=1}^{m} \beta_i d(x_{t-i}) + \varepsilon_{1t} \quad (6)$$

where i *=1,2,3,...,m* refers to lag length. The choice of lag length depends on sample size and economic structure of each variable. To determine optimal *m*, we have to choose a large lag length and calculate *FPE* value of *m* for each regression as follows:

$$FPE = \frac{T+m+1}{T-m-1} ESS(m)/T \quad (7)$$

where *T* is sample size, and *ESS* and *FPE* are error sum of squares and final prediction error, respectively.

The optimal m or *m** is a lag length that minimizes *FPE*. In the first phase, *m** is determined.

In the second phase of Hsiao causality test, a regression model is estimated using *m**, however another variable is added to model and this process is repeated by fixing *m** and iterating lag (*n*) for new variable.

In other words, we have the following iterated regressions in this phase:

$$d(x_t) = \alpha + \sum_{i=1}^{m*} \beta_i d(x_{t-i}) + \sum_{j=1}^{n} \delta_i d(y_{t-j}) + \varepsilon_{2t} \quad (8)$$

where *j=1,2,3,...,n* indicates lag length for y_t. So, the optimal lag length of *n* or *n** must satisfy the following FPE:

$$FPE(m*,n) = \frac{T+m*+1}{T-m*-1} ESS(m*,n)/T \quad (9)$$

where *m*,n and T* are optimal lag length of x_t, y_t and sample size, respectively. Then the following regression is estimated with determination of optimal lag length of n (n*).

$$d(x_t) = \alpha + \sum_{i=1}^{m*} \beta_i d(x_{t-i}) + \sum_{j=1}^{n*} \delta_i d(y_{t-j}) + \varepsilon_{2t} \quad (10)$$

By eliminating y_t from regression (10) and obtaining *FPE(m*)* and comparing the result with *FPE(m*, n*)* that contains y_t, we conclude:

$$\begin{aligned} &FPE(m*) \prec FPE(m*,n*) \Rightarrow x \text{ is not caused by } y \\ &FPE(m*) \succ FPE(m*,n*) \Rightarrow x \text{ is caused by } x \end{aligned} \quad (11)$$

4. Data and Model

The basic model of interest rate as a function of inflation rate *(x)* is as follows:

$y_t = f(x_t)$ (12)

All variables are in percentages; and data have gathered from World Bank database for 40 Islamic countries over the 2002-2005 periods.

Since we use panel data of 40 countries for four years, So Hsiao causality test isn't applicable in ordinary manner. To resolve this problem we introduce a novel approach.

The variables of x and y for 2005 are given by x_1, y_1; for 2004 are given by x_2, y_2, for 2003 are given by x_3, y_3 and so on.

Hence, we estimate the following regressions:

$$y_{it} = \sum_{k=1}^{n} \alpha_k y_{it-k} + \sum_{j=1}^{m} \beta_j x_{it-j} + \varepsilon_{it} \quad \textbf{(13)}$$

$$x_{it} = \sum_{z=1}^{h} \delta_z y_{it-z} + \sum_{j=1}^{p} \gamma_j y_{it-j} + \eta_{it} \quad \textbf{(14)}$$

where x_{it} and y_{it} are inflation and interest rates for country *i* in period *t.*

4.1. Hypothesis testing

In new model, we use Wald test for testing causality. Decision is made as follows:

1. if the null hypothesis indicating $\sum_{j}^{m} \beta_j = 0$ is rejected, there is a casual relationship from inflation rate to interest rate.
2. if the null hypothesis indicating $\sum_{j}^{p} \gamma_j = 0$ is rejected, there is a casual relationship from interest rate to inflation rate.

4.2. Model Estimating

First we use Akaike and FPE criteria to determine the optimal lag length for inflation and interest rates. The results indicate two lags are optimal for both variables. The best results of model estimation are attained by SUR[1] method:

$$y_{it} = 0.32y_{it-1} - 0.15y_{it-2} + 0.43x_{it-1} - .0.10x_{it-2} + 0.09x_{it-3} \quad \textbf{(15)}$$

(t) 1.17 -3.01 3.12 -1.68 2.04 , R^2 adj.= 67.3

$$x_{it} = 0.40x_{it-1} + 0.25x_{it-2} - 0.07x_{it-3} - 0.13y_{it-1} + .0.20y_{it-2} + 0.11y_{it-3} \quad \textbf{(16)}$$

(t) 3.07 1.01 -2.12 -1.87 2.10 1.65 ,

R^2 adj.= 63.4

[1] . Seemingly Unrelated Regression

Based on regression outputs, the Wald test to determine causality is as follows:

Table 1: The Wald Test Results

Null Hypothesis:	$\sum_{j}^{3} \beta_j = 0$		
Chi-square	**1.827**	**Probability**	**0.203**
Null Hypothesis:	$\sum_{j}^{3} \gamma_j = 0$		
Chi-square	**3.43**	**Probability**	**0.045**

According to equations (13) and (14) and Wald test, we conclude that there is one-way causal relationship from interest rate to inflation rate.

5. Concluding remarks

Regarding the effectiveness of interest rate changes on decision-making of economic agents, the interest rate is a determinant factor in macroeconomic policy-making. The interest rate is affected by many components such as inflation rate, economic stability, and monetary policy.

In this paper, using 40 Islamic countries data for 2002-2005 years, we reviewed causal relationship between inflation rate and interest rate. The Hsiao test results indicate a unidirectional causal relationship from interest rate to inflation rate. The policy recommendation of this paper for Islamic countries is that interest received from private and public loans should be reduced without decreasing the interest paid to depositors.

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