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FISHER EFFECT IN AUSTRIA CAUSALITY APPROACH

Abstract:

In this study, we aim to investigate relationship between interest rate and consumer price index in Austria by using quarterly data belonging 1990:Q1 to 2013:Q4.period in the context of Fisher (1930) hypothesis. We employ linear unit root test and causality tests. according to linear Granger causality test, there is no causal relationship between the variables in Austria. So the time domain causality analyses imply that Fisher’s hypothesis is not valid in Austria. Forth, frequency domain causality test results imply bi-directional causality while the Fisher effect is valid in the short run. Also the causality runs from inflation rate to interest rate in the long run. At the end of analysis, results imply that Fisher effect is not validity for Austria in this period.

Keywords:

Fisher Effect, Interest Rate, Inflation Rate, Causality

JEL Classification: C22, E43, E58

Introduction

The relationship between nominal interest rate and inflation rate is one of the most debatable issues in economics. The knowledge of this relation if there is and the knowledge of the direction of this relation would bring many advantages to central banks in monetary policies while dealing with inflation. The aim of this study is to discuss the effect of interest rate on consumer price index in Austrian economy. If Fisher effect is valid for Austrian economy, interest rate will be an important instrument for estimating future values of inflation rates. In the first part of the study, theoretical framework of Fisher effect and literature about Fisher effect will be reviewed. Then econometric methodologies and empirical data for testing Fisher hypothesis in Austrian economy will be evaluated.

1. Theoretical Framework and Literature Research

Fisher effect is based on the theory that nominal interest rates and expected inflation moves together without affecting real interest rate. Fisher (1930) analyzed the relation between short-term nominal treasury interest rates and inflation rates for US economy for the period of 1890-1927 and for the economy of England for the period of 1820-1924.

In Fisher hypothesis (1930) nominal interest rate i_t equals to the sum of real interest rate r_t and expected inflation rate π_t^e;

$$i_t = r_t + \pi_t^e \qquad (1)$$

Fama (1975), in Fisher hypothesis, inflation expectations depend on rational expectations theory $\pi_t^e = \pi_t + \varepsilon_t$,assuming residuals are normally distributed ε_t~WN(0, σ^2) regressed as;

$$i_t = \beta_0 + \beta_1 \pi_t + \varepsilon_t \qquad (2)$$

Fisher hypothesis is built on null hypothesis of $\beta_1 = 1$which means change in inflation rate makes a parallel change in nominal interest rates. Equation (2) shows that there is an interaction between nominal interest rates and inflation rate without affecting real interest rates. First studies on Fisher effect that were performed by Cagan (1956), Meiselman (1962), Sargent (1969), Fama (1970), because of difficulties in estimating inflation expectations and because of arguments against rational expectations and adaptive expectations, based on a proxy variable. With works of MacDonald and Murphy (1989), Dutt and Ghosh (1995), Payne and Ewing (1997) debates were concentrated on effects of exchange rate regime on Fisher effect. In Austrian economy, studies on validity of Fisher effect are generally made by panel data method. Among these studies, Janero and Tolantino (2013) for the period of 1997-2012, Coppock and Poitras (2000) for the period of 1976-1988 reached the result of weak Fisher effect in their studies.

2. Methodology

2.1. Linear Granger Causality Test

The standard Granger (1969) causality analysis requires estimating a VAR (*p*) model in which *p* is the optimal lag length(s). In the TY procedure, the following VAR (*p*+*d*) model is estimated that *d* is the maximum integration degree of the variables.

$$y_t = v + A_1 y_{t-1} + \cdots + A_p y_{t-p} + \cdots + A_{p+d} y_{t-(p+d)} + \mu_t . \qquad (3)$$

where y_t is vector of *k* variables, *v* is a vector of intercepts, μ_t is a vector of error terms and *A* is the matrix of parameters. The null hypothesis of no-Granger causality against the alternative hypothesis of Granger causality is tested by imposing zero restriction on the first *p* parameters. The so-called modified Wald (MWALD) statistic has asymptotic chi-square distribution with *p* degrees of freedom irrespective of the number of unit roots and of the co-integration relations.

Hacker and Hatemi-J (2006) investigate the size properties of the MWALD test and find that the test statistic with asymptotic distribution poorly performs in small samples. Monte Carlo simulation of Hacker and Hatemi-J (2006) shows that the MWALD test based on the bootstrap distribution has much smaller size distortions than those of the asymptotic distribution. Hacker and Hatemi-J (2006) extends the TY approach based on the bootstrapping method developed by Efron (1979)[1]. In this new approach that is so-called the leveraged bootstrap Granger causality test, the MWALD statistic is compared with the bootstrap critical value instead of the asymptotic critical value.

[1]See Hacker and Hatemi-J (2006:1492-1493) for the details of the bootstrap method.

2.2. Frequency domain causality test

To test for causality based on frequency domain, Geweke (1982) and Hosoya (1991) defined two-dimensional vector of time series $z_t = [x_t, y_t]'$ and z_t has a finite-order VAR;

$$\Theta(L) z_t = \varepsilon_t \qquad (4)$$

where $\Theta(L) = I - \Theta_1 L - ... - \Theta_p L^p$ and lag polynomial with $L^k z_t = z_{t-1}$. Then Granger causality at different frequencies is defined as;

$$M_{y \to x}(\omega) = \log \left[\frac{2\pi f_x(\omega)}{|\psi_{11}(e^{-i\omega})|^2} \right] = \log \left[1 + \frac{|\psi_{12}(e^{-i\omega})|^2}{|\psi_{11}(e^{-i\omega})|^2} \right] \qquad (5)$$

if $|\psi_{12}(e^{-i\omega})|^2 = 0$ that y does not cause x at frequency ω. If components of z_t are I(1) and co-integrated, then the autoregressive polynomial $\Theta(L)$ has a unit root. The remaining roots are outside the unit circle. Extracting z_{t-1} from both sides of equation 1d gives;

$$\Delta z_t = (\Theta_1 - I) z_{t-1} + \Theta_2 z_{t-2} + ... + \Theta_p z_{t-p} + \varepsilon_t = \tilde{\Theta}(L) z_{t-1} + \varepsilon_t \qquad (6)$$

where $\tilde{\Theta}(L) = \Theta_1 - I + \Theta_2 L + ... + \Theta_p L^p$ (Breitung and Candelon, 2006). Geweke (1982) and Hosoya (1991) proposed a causality measure at a particular frequency based on a decomposition of the spectral density. Breitung and Candelon (2006) who has using a bivariate vector autoregressive model propose a simple test procedure that is based on a set of linear hypothesis on the autoregressive parameters. So that test procedure can be generalized to allow for co-integration relationships and higher-dimensional systems.

Breitung and Candelon (2006) assume that ε_t is white noise with $E(\varepsilon_t) = 0$ and $E(\varepsilon_t, \varepsilon_t') = \Sigma$, where Σ is positive definite. Let G be the lower triangular matrix of the Cholesky decomposition $G'G = \Sigma^{-1}$ such that $E(\eta_t \eta_t') = I$ and $\eta_t = G\varepsilon_t$. If the system is stationary, let $\phi(L) = \Theta(L)^{-1}$ and $\psi(L) = \phi(L) G^{-1}$ the MA representation;

$$z_t = \phi(L)\varepsilon_t = \begin{pmatrix} \phi_{11}(L) & \phi_{12}(L) \\ \phi_{21}(L) & \phi_{22}(L) \end{pmatrix} \begin{pmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{pmatrix} = \begin{pmatrix} \psi_{11}(L) & \psi_{12}(L) \\ \psi_{21}(L) & \psi_{22}(L) \end{pmatrix} \begin{pmatrix} \eta_{1t} \\ \eta_{2t} \end{pmatrix} \qquad (7)$$

Let we can use this representation for the spectral density of x_t;

$$f_x(\omega) = \frac{1}{2\pi} \{ |\psi_{11}(e^{-i\omega})|^2 + |\psi_{12}(e^{-i\omega})|^2 \} \qquad (8)$$

Breitung and Candelon (2006) investigate the causal effect of $M_{y\to x}(\omega)=0$ if $|\psi_{12}(e^{-i\omega})|^2=0$. The null hypothesis is equivalent to a linear restriction on the VAR coefficients. $\psi(L)=\Theta(L)^{-1}G^{-1}$ and $\psi_{12}(L)=-\dfrac{g^{22}\Theta_{12}(L)}{|\Theta(L)|}$, with g^{22} as the lower diagonal element of G^{-1} and $|\Theta(L)|$ as the determinant of $\Theta(L)$, it follows y does not cause at frequency ω if

$$|\Theta_{12}(e^{-i\omega})| = \left|\sum_{k=1}^{p}\theta_{12,k}\cos(k\omega)-\sum_{k=1}^{p}\theta_{12,k}\sin(k\omega)i\right| = 0 \qquad (9)$$

with $\theta_{12,k}$ denoting the (1,2) element of Θ_k. Thus for $|\Theta_{12}(e^{-i\omega})|=0$,

$$\sum_{k=1}^{p}\theta_{12,k}\cos(k\omega)=0 \qquad (10)$$

$$\sum_{k=1}^{p}\theta_{12,k}\sin(k\omega)=0 \qquad (11)$$

Breitung and Condelon's (2006) applied to linear restrictions (10) and (11) for $\alpha_j=\theta_{11,j}$ and $\beta_j=\theta_{12,j}$. Then the VAR equation for x_t can be implied as

$$x_t=\alpha_1 x_{t-1}+...+\alpha_p x_{t-p}+\beta_1 y_{t-1}+...+\beta_p y_{p-1}+\varepsilon_{1t} \qquad (12)$$

and the null hypothesis $M_{y\to x}(\omega)=0$ is equivalent to the linear restriction with $\beta=[\beta_1,...,\beta_p]'$

$$H_0:\quad \mathrm{R}(\omega)\beta=0 \qquad (13)$$

and

$$R(\omega)=\begin{bmatrix}\cos(\omega) & \cos(2\omega) & ... & \cos(\mathrm{p}\omega)\\ \sin(\omega) & \sin(2\omega) & ... & \sin(\mathrm{p}\omega)\end{bmatrix} \qquad (14)$$

The causality measure for $\omega\in(0,\pi)$ can be tested with the conventional F-test for the linear restrictions imposed by Eq.(10) and Eq. (11). The test procedure follows an F-distribution with (2, T-2p) degrees of freedom.

3. Data and Empirical Findings

The data set contains interest and inflation rates of the Austria. In this regard, inflation rate is proxied by quarterly changes in the consumer price index (CPI). Treasury bill rates are used as monetary policy interest rate. Data for variables are obtained from International Financial Statistics. We employ quarterly data from 1990:Q1 to 2013:Q4.

The descriptive statistics of variables are reported in table 1. First of all, as expected the mean of the interest rate are higher than inflation rate. According to the coefficients of variation of the inflation rate are higher than interest rate. However, kurtosis value of interest rate are higher than inflation rate.

Table 1: Descriptive Statistics

Variable	Mean	Std. Dev.	Coef. Of Var.	Skewness	Kurtosis
INF	2.235	0.991	0.443	-0.057	2.247
INT	5.09	1.853	0.364	0.44	2.374

Notes: Coefficient of variation is the ratio of standard deviation to mean. INT: long term interest rate (per cent per annum), INF: consumer price index for all items.

Prior to the identification of possible causality between variables, it is necessary to determine integration degree of them. In this respect, we employ a battery of the unit root tests developed by Dickey and Fuller (1979) (henceforth ADF), Phillips and Perron (1988) (henceforth PP) and Elliot et al. (1996) (henceforth DF-GLS).

Although ADF and PP test with constant and with constant and trend reject the null of unit root in level of interest rate. All the unit root tests show that inflation rate has not a unit root in levels. When the unit root tests are applied to first differences of the variables, tests statistics reject the null of a unit root in first difference in different significance levels. Accordingly, the maximum integration order (d) of the variables equal to one in the TY procedure and so the series in the first difference will be used in frequency domain causality test.

Table 2: Results for Unit Root Test

		ADF	DF-GLS	PP
Levels				
Intercept	INT	-1.555 (1)	0.133 (1)	-1.112 (1)
	INF	-3.117 (1)**	-2.625 (1)**	-2.845 (3)*
Intercept and Trend	INT	-3.358 (1)	-3.218 (1)	-2.659 (2)
	INF	-3.26 (1)*	-3.264 (1)**	-2.960 (3)
First-differences				
Intercept	INT	-7.192 (0)***	-4.926 (0)***	-7.122 (2)***
	INF	-7.332 (0)***	-7.272 (0)***	-7.349 (2)***
Intercept and	INT	-7.168 (0)***	-6.221 (0)***	-7.095 (2)

Trend	INF	-7.291 (0)***	-7.347 (0)***	-7.308 (2)***

Notes: The figures which is ***, **, * show 1 %, 5 % and 10 % levels, respectively

For the DF-GLS test: The asymptotic critical values for without trend -2.591, -1.944 at the %1 and %5 levels and with trend -3.602, -3.1772 at the %1 and %5 levels. The figures in parenthesis denote the number of lags in the tests that ensure white noise residuals. The Schwarz criterion was used.

For the ADF test: The figures in parenthesis denote the results of Dickey Fuller test in the case of zero lag length and lag length chosen due to SIC criteria. For the ADF test, the Mac Kinnon (1996) critical values for with constant -.3.485, -2.885, -2.579 at the 1 %, 5 % and 10 % levels. The critical values for with constant and trend -4.035, -3.447 and -3.148 at the 1 %, 5 % and 10 % levels, respectively.

For the PP test: Values in the parenthesis show bandwidths obtained according to Newey-West using Bartlett Kernel criteria. For the PP test Mac Kinnon(1996) critical values for with constant -3.483, -2.884, -2.579 at the 1 %, 5 % and 10 % levels. The critical values for with constant and trend -4.033, -3.446 and -3.148 at the 1 % 5 % and 10 % levels, respectively.

The results obtained from the linear causality analysis are presented in table 3. The causality statistics show that there is no causal relationship between the variables in Austria. So it is possible to imply that Fisher effect is not valid in economy. In that respect, it is not possible to monitor inflationary expectations by using interest rates. Unlike, it is not useful to follow interest rate movements in order to monitor inflationary expectations in Austria.

Table 3: Linear TY Granger causality test

		Bootstrap critical values		
	Statistic	1%	5%	10%
Inflation Rate to Interest Rate	3.229 [0.35]	12.472	8.328	6.652
		Bootstrap critical values		
	Statistic	1%	5%	10%
Interest Rate to Inflation Rate	4.277 [0.232]	12.472	8.328	6.652

Notes: Brackets denotes results of asymptotic TY. * denote statistical significance at the 10% level of significance. The SBC was used to determine the optimal lag lengths for VAR (p+d) models. Bootstrap critical values are obtained from 10,000 replications.

Finally, we employ Breitung and Candelon's (2006) causality analysis which permits to decompose the causality test statistic into different frequencies. We calculate the test statistics at a high frequency of $\omega_i = 2.5$ and $\omega_i = 2.00$ to examine short term causality, $\omega_i = 1.00$ and ω_i =1.50 to examine medium term causality and finally ω_i = .1 and ω_i =.5 to investigate long term causality. The results are presented in table 4. According to results, there is a bi-directional causality between interest rate and inflation rate.

There is a causality running from interest rate to inflation rate and it appears in the short term. Analysis results support the short run Fisher hypothesis. Instead, the validity of causality running from inflation to interest rate in the long run implies the validity of Fisher effect in the short run.

Table 4: Results for Frequency Domain Causality

	Inflation Rate to Interest Rates						Interest Rates to Inflation Rates					
	Long Term		**Med Term**		**Short Term**		**Long Term**		**Med Term**		**Short Term**	
ω_i	**0.01**	**0.05**	**1.00**	**1.50**	**2.0**	**2.50**	**0.01**	**0.05**	**1.00**	**1.50**	**2.00**	**2.50**
	4.015*	4.042*	0.208	1.311	2.593	0.177	0.896	0.877	2.317	0.240	3.245*	3.727*

Notes: The lag lengths for the VAR models are determined by SIC. F- distribution with (2, T-2p) degrees of freedom equals 3.11. For every ω_i (frequency) between 0 and π, $\omega \in (0, \pi)$

6. Conclusions

This paper investigates the Fisher effect in Austria by employing quarterly data from 1990:Q1 to 2013:3. In order to determine the causal linkage among the variables in question, we employ bootstrap process based Toda Yamamoto (1995) linear causality test approach. We also employ frequency domain causality methodology developed by Breitung and Candelon (2006) to distinguish short and long run impacts of variables on each other and to get more appropriate results. Test results imply a number of key findings. First, according to linear Granger causality test, there is no causal relationship between the variables in Austria. So the time domain causality analyses imply that Fisher's hypothesis is not valid in Austria. Forth, frequency domain causality test results imply bi-directional causality while the Fisher effect is valid in the short run. Also the causality runs from inflation rate to interest rate in the long run.

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