International Journal of Economics and Financial Issues
Vol. 3, No. 2, 2013, pp.496-502
ISSN: 2146-4138
www.econjournals.com

Testing for the Fisher Hypothesis under Regime Shifts in Turkey: New Evidence from Time-Varying Parameters

Ibrahim Arısoy
Çukurova University, Department of Economics,
01330 Adana, TURKEY, E-mail: iarisoy@cu.edu.tr

ABSTRACT: This paper examines the validity of Fisher hypothesis in Turkey for the time period 1987Q1-2010Q3. For this purpose, we employ cointegration test with a structural break as well as time varying parameters approach (TVP) that takes into account the effects of regime or policy changes on the relation between interest rate and inflation rate. The empirical results show that weak form of the Fisher hypothesis holds in Turkish economy.

Keywords: Fisher Effect; Cointegration; Regime Shift; Time-Varying Parameters; Kalman Filter
JEL Classifications: C12; E40; E50

1. Introduction

In recent years, the relationship between inflation and nominal interest rates has been the subject of numerous studies in the empirical literature. This empirical relationship is a major part of monetary economics because whether monetary policy influences the real interest rate is one of the most important questions facing monetary authorities. A positive association between movements of the nominal interest and inflation rates, known as Fisher hypothesis, has been widely accepted as an empirical regularity in macroeconomics ever since Fisher (1930). Fisher hypothesis formulates real interest rate as the difference between nominal interest rate and expected inflation rate. In order for the strong form of Fisher hypothesis to hold, nominal interest rate moves one-to-one with expected inflation rate. If the nominal interest rate and the inflation rate are each integrated of order one, I(1), and the two variables should be cointegrated with a slope coefficient of unit value so that the real interest rate is covariance stationary. As known, cointegration concept is associated with the long run equilibrium relationship between two or more variables. This empirical relationship has important implications for macroeconomic policy because, if the hypothesis holds in the long run, the monetary policy does not affect the real interest rate, leaving the ex ante real interest rate unchanged. This would mean that real interest rates are not related to the expected inflation and are determined by the real factors in an economy, such as the capital productivity and the time preference (Payne and Ewing, 1997; Million, 2004).

This paper examines the validity of Fisher hypothesis in Turkey for the period 1987Q1-2010Q3. For this purpose, we employ cointegration test with structural breaks as well as time varying parameters approach (TVP) that takes into account the effects of regime or policy changes on the relation between interest rate and inflation rate. Given that the Turkish economy has witnessed some important policy changes during the analysis period, this method would yield more reliable results. The remainder of the study is outlined as follows. Following the introduction, Section 2 consists of a brief literature review. Section 3 is for the theoretical framework, while Section 4 devoted to the empirical methodology and results. Section 5 concludes.

2. A Brief Overview of the Previous Literature

Fisher hypothesis has been studied extensively by using different samples of countries, estimation methods and data sets since the seminal study of Rose (1988). Empirical results, however, do not reach a general consensus on the validity of Fisher effect because the conclusions differ depending on countries, time periods and estimation techniques. Rose (1988), for example, examines the validity of this hypothesis using time series data of the US and 17 OECD countries for the period 1901-1950 and finds that inflation rates in some of the countries are nonstationary and interest rate stationary, which contradicts the Fisher effect.

The results from cointegration tests of the Fisher hypothesis are mixed. Some studies, including Mishkin (1992), Crowder and Hoffman (1996), and Evans and Lewis (1995), found a long run relationship, but with a slope coefficient different from one, whereas McDonald and Murphy (1989), Bonham (1991), Sun and Phillips (2004) rejected the cointegration relation between inflation and nominal interest rates. Using quarterly data for 11 OECD countries over the period 1957-1995, Koustas and Serletis (1999) find no evidence of cointegration for any of the countries except Japan. Having a look at more recent studies, one can get more informative results regarding the validity of Fisher hypothesis. Christopoulos and Leon-Ledesma (2007), for example, argue that the failure of finding support for Fisher hypothesis may be due to nonlinearities in the relationship between inflation and interest rates. Berument et al. (2007) investigates the relationship between inflation uncertainty and interest rate to explore the validity of Fisher hypothesis for a large sample of countries, including G7 and 45 developing countries. Empirical results of this study show that the Fisher hypothesis holds in all G7 countries and in some developing countries. Hatemi-j and Irandoust (2007) attempt to test whether the Fisher hypothesis has empirical support for Australia, Japan, Malaysia and Singapore using cointegration and time varying parameters methods. The empirical results of this study show that full Fisher effect is generally rejected. Westerlund (2008) finds some evidence in favor of the Fisher hypothesis for 20 OECD countries by using a panel cointegration test with multiple structural breaks for the period 1980Q1-2004Q4. Hall et al. (2010) examine the validity of Fisher hypothesis for the US economy by using cointegration test and time-varying coefficients (TVC) method and find strong support for Fisher hypothesis over the period 1960Q1-2008Q1.

As for the analysis of Turkish case, Kasman et al. (2006) examine the Fisher hypothesis using data for 33 developed and developing economies including Turkey within the framework of cointegration and fractional cointegration tests and show that partial Fisher effect is valid for Turkey. Berument et al. (2007) indicates the existence of the weak Fisher effect in Turkey during 1985:1-2004:07. Using Johansen cointegration test for the period 1990:1-2003:12, Gul and Acıkalın (2008) scrutinizes the validity of Fisher hypothesis for Turkish economy and find that there is a strong Fisher effect. Kıran (2011) offers empirical results supporting the validity of Fisher hypothesis in Turkey over the period 1990:01-2010:3 by using conventional cointegration and fractional cointegration tests. Kose et al. (2012) test the validity of Fisher hypothesis for the Turkish economy during the inflation targeting period namely, 2002-2009. They find the validity of the weak Fisher effect for the Turkish economy.

This study, however, differs from the earlier studies in general and from the studies on Turkey in particular since the validity of Fisher hypothesis is examined by using both constant coefficient (cointegration tests with structural breaks) and time varying parameters (TVP) methods. In order to capture the effects of structural changes or regime shifts on the Fisher effect, this study employs TVP approach as it permits parameter estimates to respond differently under alternative policy regimes (see, Hatemi-j and Irandoust, 2008; Hall et al., 2010). Thus, the main contribution of this study is not only to consider the effects of regime shifts on Fisher effect, but also to see how the elasticity of interest rate with respect to inflation has evolved over time

3. Theoretical Underpinning of Empirical Analysis

It is a common practice in the empirical literature to begin with the theoretical framework. Fisher hypothesis states that the nominal interest rate (i_t) at time t is equal to the ex ante real interest rate (r^e_t) plus expected inflation rate (π^e_t) at time t, which could be expressed as follows:

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

Under the assumption of rational expectations, expected inflation is equal to actual inflation (π_t). The Fisher hypothesis is commonly investigated using the following regression equation:

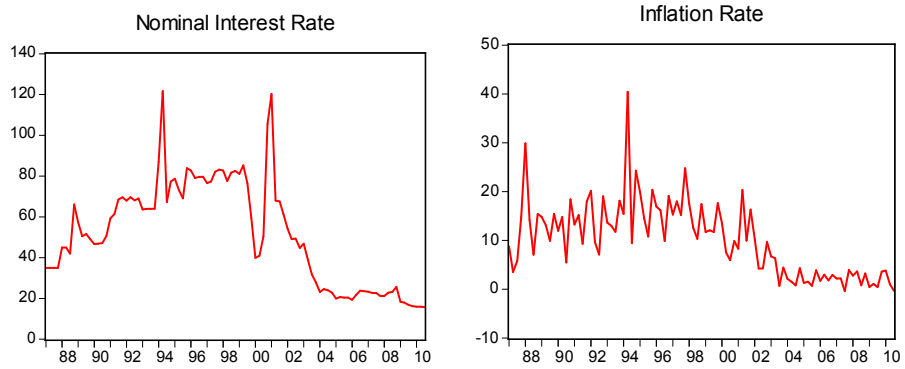
$$i_t = \beta_0 + \beta_1 \pi_t + \varepsilon_t \qquad (2)$$

where β_1 is the slope coefficient of interest. It should be kept in mind that inflation expectations and consequently the ex ante real interest rate could not be directly measured or observed. Thus, we have to rely on nominal interest rates measured at the beginning of time period and at the end of time period. Finding the slope coefficient, β_1, statistically significant and equal to one would imply the strong form of the Fisher hypothesis, and thus a one-to-one relationship between the nominal interest rate (i_t) and the inflation rate (π_t). The weak form of the hypothesis suggests that the slope coefficient, β_1, is positive and less than one.

4. Empirical Methodology and Results

As a preliminary step, the estimation procedure begins with the examination of unit root properties of the data under consideration. In the second step, the possible long run relationship between inflation and interest rates is investigated by means of cointegration tests with structural breaks. Finally, we utilize TVP approach based on Kalman filter to observe changes in the adjustment of nominal interest rate to inflation rate in Turkey over the time. All the estimation results reported below are based on quarterly Turkish data over the period 1987:Q1-2010:Q3. The nominal interest rate (i) is three-month deposit rate and inflation rate (π) is calculated as the difference of logarithmic consumer price index (CPI). All data are extracted from the electronic data delivery system of Central Bank of Turkey. Figure 1 illustrates the time series plots of the data.

Figure 1. Time Series Plot of Nominal Interest Rate and Inflation Rate



4.1. Unit Root Test Results

The stationarity properties of the variables are first examined prior to the empirical analysis. We employ, for this purpose, the Augmented Dickey-Fuller test with GLS de-trending (Elliot et al., 1996), the Ng and Perron (2001) test and the Lee and Strazicich (2003) test with structural breaks.

Table 1. Unit Root Test Results

Variables		Ng-Perron	KPSS	LS (2003)
π		-2.746 (3)	1.037 (6)	-2.829 (3)
$\Delta\pi$		-27.701 (0)	0.195 (18)	2001:02
r		-1.417 (5)	0.646 (7)	-3.269 (0)
Δr		-46.875 (0)	0.290 (15)	2001:01
Critical Values	%1	-13.800	0.739	-4.545
	%5	-8.100	0.463	-3.842
	%10	-5.700	0.347	-3.504

Notes: Figures in parenthesis indicate the optimal lag selected by modified AIC for the Ng-Perron test and LS (2003) and the truncation for the Bartlett Kernel in KPSS test**.** The values below the test statistics of LS (2003) test is break date. Δ shows the first difference of the respective variable.

The unit root results in Table 1 suggests that each of variable is integrated of order one (I(1)) irrespective of a structural break, thus the empirical analysis proceeds with the cointegration test to examine if there is a long run relationship between interest rate (i) and inflation rate (π).

4.2. Cointegration Tests

As the estimation model consists of two variables, one could examine if there is a long run relationship between the by applying Engle and Granger cointegration test. In the first step, the long run relationship is estimated by using an OLS regression and then, the residual series are obtained. In the second step, the stationarity of the residuals is tested by means of the unit root tests. If the residuals are stationary, cointegration could be established. However, a limitation of conventional Engle-Granger (1987) cointegration test is that it does not take into account the effect of a structural break in the cointegration relationship. Gregory and Hansen (1996) developed residual-based cointegration tests allow for an endogenous structural break in the cointegration relationship. The regime shift (C/S) model of Gregory and Hansen (1996) is considered since our aim is to capture the change both in the intercept and slope which takes the form:

$$i_t = \alpha_0 + \alpha_1 D_t + \beta_0 \pi_t + \beta_1 \pi_t D_t + \varepsilon_t \qquad (3)$$

Here D_t is a dummy variable indicating the time of the regime shift, $D_t = 1$ if t x [nτ] and 0 otherwise, τ is an unknown parameter denoting the relative timing of structural change. β_0 (α_0) is the slope (intercept) coefficient before the regime shift and β_1 (α_1) is the change in the slope (intercept) term due to the shift. The null hypothesis of Gregory and Hansen tests is that the residuals (ε_t) contain a unit root and hence, there is no cointegration with a break, whereas the alternative hypothesis is that residuals stationary and hence, there is a cointegration relationship between the variables. If the residuals are stationary, the two series are said to be cointegrated. Gregory and Hansen (1996) propose three test statistics to examine the null hypothesis of no cointegration. These statistics are the ADF test statistics and extensions of the Z test statistics (Z_t and Z_α). We choose a trimming region of 15%.

Table 2. Co-integration Test Results

Panel A				**Panel B**						
Engle-Granger (1987) Test				Gregory and Hansen (1996)Test						
β_0	β_1	R^2	ADF		C/S	TB	C/T	TB	C	TB
25.759 (8.745)	2.553 (10.954)	0.56	-5.830*	ADF*	-5.573	1990:Q3	-4.354	1990:Q2	-4.525	2007:Q1
				Zα	-112.50	1990:Q2	-113.852	1990:Q2	-113.825	1990:Q2
				Zt	-13.051	1990:Q2	-13.579	1990:Q2	-13.589	1990:Q2
Notes: Figures in brackets are t-statistics. (*) indicates the rejection of the null hypothesis. TB denotes break time. The critical values for the ADF test are from MacKinnon (1996).The critical values of Gregory and Hansen are for C/S, %1 -5.13 and %5 -4.61; C/T, %1 -5.45 and %5 -4.99; C, %1 -5.47 and %5 -4.95,										

The results of the cointegration tests are presented in the Panel A and B of Table 2, respectively. As seen from Table 2, the cointegration tests indicate a long run relationship between interest rate and inflation rate regardless of a structural break. Having found a long run equilibrium relationship between the real interest and inflation rates, the long run parameter estimations based on the dynamic OLS (DOLS, Stock and Watson (1993) and Canonical Cointegrating Regression (CCR, Park, 1992) are presented in Table 3.

Table 3. The Results of Long Run Parameter Estimation

$i_t = \alpha_0 + \alpha_1 D_t + \beta_0 \pi_t + \beta_1 \pi_t D_t + \varepsilon_t$					
	α_0	α_1	β_0	β_1	R^2
FMOLS	38.075 (0.004)	-13.417 (0.326)	0.684 (0.451)	2.185 (0.023)	0.64
CCR	38.121 (0.012)	-20.930 (0.183)	0.664 (0.544)	2.995 (0.010)	0.59
Notes: Figures in brackets are p-values. The CCR and FMOLS procedures were conducted with Bartlett kernel, Newey-West bandwidth.					

The estimated break date for the regime shift model, C/S, of Gregory and Hansen test was used to construct the level and slope dummy variables in the long run parameter estimation. The estimation results of the FMOLS and CCR procedures indicate that the Fisher hypothesis is not confirmed because the coefficient of the inflation rate (π_t) is not statistically significant. However, the slope and intercept dummy variables for the inflation rate are statistically significant, indicating the possibility of regime shifts. In order to test for parameter instability, Hansen (1992) proposes a stability test in cointegrated systems. The null hypothesis of Hansen (1992) test is that the parameters are stable, contrary to the alternative that indicates parameter instability. The test statistics, L_C, is 0.785 with p-value of 0.00. As the p-value is smaller than %5 level of significance, the null hypothesis (the parameters are stable) is rejected. As a result, the relationship between the nominal interest rate and the inflation rate seems to be unstable since the test statistics is highly significant. Given this result one can proceed with the TVP approach.

4.3. Time Varying Parameters Approach

The conventional cointegration models, which essentially tests whether the linear combination of two series is stationary, are based on the underlying assumption that the long run relationship between the series is time invariant and parameters are constant and thus the estimates of coefficients remain unchanged over time. In order to capture structural changes and their impact on the Fisher effect, I employ time varying parameters (TVP) approach that allows parameter estimates to respond

differently under alternative policy regimes. The TVP model considers the Lucas critique of econometric policy evaluation, which argues that macroeconomic parameter estimates are not invariant to changes in the policy regimes and thus are useless for forecasting the impact of the policy changes (Hatemi-j, 2002:434). Following Harvey (1991), Fisher equation could be rewritten in a general state-space representation as follows:

$$i_t = \beta_t Z' + \varepsilon_t \qquad \varepsilon_t \sim iid(0, \sigma^2)$$
$$\beta_t = \beta_{t-1} + u_t \qquad u_t \sim iid(0, Q)$$

Where $\beta_t = (\beta_0, \beta_1)$ and $Z_t = (1\ \pi)$ and Q is the diagonal variance-covariance matrix. ε_t and u_t are an N×1 vector of serially uncorrelated disturbances with zero mean. In this set up, the first equation is the Fisher equation with time-varying parameters (the measurement equation) and the second equation (the state equation) defines the evolution of parameters over time. Once the model has been put in state-space form, it is possible to apply Kalman filter, which is a recursive procedure for computing the state vector at time t, based on the information available at time t. As the Kalman filter is a recursive procedure, it needs to be set initial values. To do so, the parameters of the model was first estimated by means of OLS and these parameters and fitted values of the state variables obtained from the OLS estimation was specified as initial values.

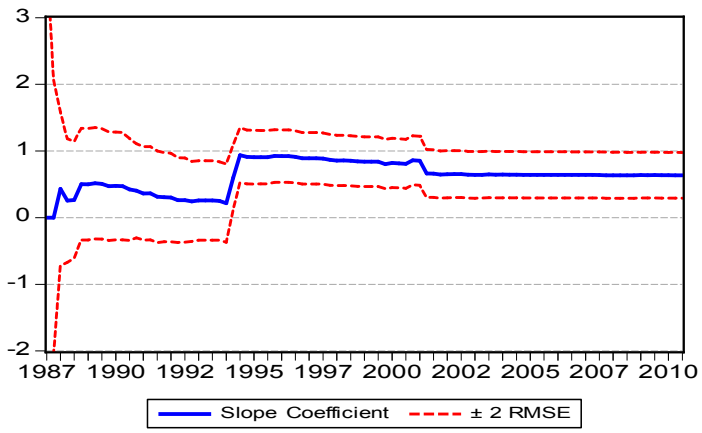
The estimation results of TVP approach based on Kalman filter is presented in Table 4. In view of the results, it can be concluded that the weak Fisher hypothesis holds in Turkey since the coefficient of inflation rate (π_t) is less than one (0.634) with a positive sign and statistically significant. It should be noted that a positive but less than unit value of the estimated coefficient suggests the Fisher hypothesis holds in its weak form and lends support to Tobin (1965) as Berument et al. (2007:56) argued.

Table 4. Time Varying Parameter Estimation Results

	Final State	Root MSE	z-Statistic	Prob.
β_0 (Intercept)	15.89556	10.52305	1.510547	0.1309
β_1 (Slope Coefficient)	0.634888	0.171630	3.699175	0.0002
Log likelihood	-380.9342	Akaike info criterion		8.082826
Parameters	3	Schwarz criterion		8.163475
Diffuse priors	2	Hannan-Quinn criter.		8.115414
Note: Convergence achieved after 53 iterations				

The final step is to show the time path of the slope coefficient, which is depicted in Figure 1. What we are interested in is the adjustment of interest rate to inflation rate over time. As can be seen from the Figure 2, the time-varying slope coefficient indicates that interest rates fail to fully adjust to inflation during the analysis period. Moreover, the impact of inflation on interest rate was limited until the financial 1994 crisis, but became noticeably stronger after the crisis until the early of 2001.

Figure 2. The Time Varying Estimation of Slope Coefficient



5. Conclusion

The aim of this paper is to shed light into the relationship between inflation and interest rate in Turkey since the Turkish economy has experienced relatively high inflation during the last three decades. This study examines the validity of Fisher hypothesis for Turkish economy during the period 1987Q1-2010Q3. To carry out the analysis, the conventional methods such as unit root and cointegration tests with a structural break and TVP method are utilized. The main motivation of using TVP approach stems from empirical evidence that the relationship between interest rates and inflation rates have time-varying dynamics as well as the presence of regime shift. The empirical results show that weak form of Fisher hypothesis holds in Turkish economy. This finding has an important policy implication for policy makers. The monetary policy does not affect the real interest rate because any change in inflation partially cancels out a change in the nominal interest rate.

References

Berument, H., Jelassi, M.M. (2002), *The Fisher hypothesis: A cross-country analysis*, Applied Economics, 34, 1645-1655.

Berument, H., Ceylan, N.B., Olgun, H. (2007), *Inflation Uncertainty and Interest Rates: Is the Fisher Hypothesis Universal?*, Applied Economics, 39(1), 53-68.

Bonham, C.S. (1991), *Correct Cointegration Test of the Long Run Relationship Between Nominal Interest and Inflation*, Applied Economics, 23, 1487-1492.

Christopoulos, D.K., Leon-Ledesma, M.A. (2007), *A long-run nonlinear approach to the Fisher effect*, Journal of Money, Credit, and Banking, 39, 543-559.

Crowder, W., Hoffman, D. (1996), *The long-run relation between nominal interest rates and inflation: The Fisher equation revisited*. Journal of Money, Credit and Banking, 28, 102-118.

Dickey, D.A., Fuller, W.A. (1979), *Distribution of the Estimators for Autoregressive Time Series with a Unit Root*, Journal of the American Statistical Association. 74, 427-431.

Elliott, G., Rothenberg, T.J., Stock, J.H. (1996), *Efficient Tests for an Autoregressive Unit Root*, Econometrica. 64, 813–836.

Engle, R.F., Granger, C.W.J. (1987), *Co-integration and error correction representation, estimation and testing*, Econometrica, 55, 251-76.

Evans M., Lewis, K. (1995), *Do expected shifts in inflation affect estimates of the long-run Fisher relation?*, Journal of Finance, 50, 225-253.

Fisher, I. (1930). The Theory of Interest. Macmillan, New York.

Gregory, A. and Hansen, B. (1996), *Residual Based Tests for Co-Integration in Models with Regime Shifts*, Journal of Econometrics, 70(1), 99-126.

Gul, E., Acıkalın, S. (2008), *An examination of the Fisher hypothesis: The case of Turkey*, Applied Economics, 40, 3227-3231

Hall, S.G., Hondroyiannis, G., Swamy, P.V.A.B., Tavlas, G.S. (2010), *The Fisher Effect Puzzle: A Case of Non-Linear Relationship?*, Open Economics Review, 21(1), 91-103.

Hansen, B.E. (1992), *Tests for Parameter Instability in Regressions with I(1) Processes*, Journal of Business and Economic Statistics, 10, 321–335.

Harvey, A.C. (1991), Forecasting Structural Time Series Models and the Kalman Filter. Cambridge University Press.

Hatemi-J, A. (2002), *Is the Government's Intertemporal Budget Constraint Fulfilled in Sweden? An Application of the Kalman Filter*, Applied Economics Letters, 9(7), 433-440.

Hatemi-J, A. and Irandoust, M.(2008),*The Fisher Effect: A Kalman Filter Approach to Detecting Structural change*, Applied Economics Letters,15, 619-624.

Ito, T.(2009), *Fisher Hypothesis in Japan: Analysis of long-term interest rates under different Monetary Policy Regimes*, The World Economy,32(7), 1019-1035.

Kasman, S., Kasman, A., Turgutlu, E. (2006), *Fisher Hypothesis Revisited: A Fractional Cointegration Analysis*, Emerging Markets Finance and Trade, 42(6), 59-76.

Kıran, B. (2011), *A fractional cointegration analysis of Fisher hypothesis: Evidence from Turkey*, Quality & Quantity, 47(2): 1077-1084.

Kose, N., Emirmahmutoglu, F., Aksoy, S. (2012). *The Interest Rate-Inflation Relationship under an Inflation Targeting Regime: The case of Turkey*, Journal of Asian Economics, 23,476-485.

Koustas, Z., Serletis, A. (1999), *On the Fisher Effect*, Journal of Monetary Economics, 44, 105-130.

Kwiatkowski, D., Phillips, P.C.B., Schmidt, P., Shin, Y. (1992), *Testing the null hypothesis of stationary against the alternative of a unit root. How sure are we that economic time series have a unit root?* Journal of Econometrics, 54, 159-178.

Lee, J., Strazicich, M.C. (2003), *Minimum LM Unit Root Test with Two Structural Breaks*, Review of Economics and Statistics. 85(4), 1082–1089.

MacDonald. R., Murphy, P.O. (1989), *Testing for the Long Run Relationship between Interest Rates and Inflation Using Cointegralion Techniques*, Applied Economics, 21, 439-447.

Million, N. (2004), *Central banks interventions and the Fisher hypothesis: A threshold cointegration analysis*. Economic Modelling, 21, 1051-1064.

Mishkin, F.S. (1992), *Is the Fisher effect for real? A reexamination of the relationship between inflation and interest rates*. Journal of Monetary Economics, 30, 195-215.

Payne, J.E., Ewing, B.T. (1997), *Evidence from Lesser Developed Countries on the Fisher Hypothesis: A Cointegration Analysis,* Applied Economics Letters, 4, 683-687.

Rose, A. (1988), *Is the Real Interest Rate Stable?*, Journal of Finance, 43(5), 1095-1112.

Stock, J., Watson, M.W. (1993), *A simple estimator of cointegrating vectors in higher order integrated systems*, Econometrica, 61(4), 783-820.

Sun, Y., Phillips, P.C.B. (2004), *Understanding the Fisher equation*, Journal of Applied Econometrics, 19, 869-886.

Tobin, J. (1965). *Money and Economic Growth*, Econometrica, 33, 671-84.

Westerlund, J. (2008), *Panel cointegration tests of the Fisher effect*, Journal of Applied Econometrics, 23(2), 193-233.