EMPIRICAL TEST OF THE LONG-RUN FISHER EFFECT: AN APPLICATION OF THE ARDL BOUNDS TECHNIQUE TO SAUDI ARABIA

Mansur Masih, King Fahd University of Petroleum & Minerals, Dhahran, Saudi Arabia
Mohsen Al-Hajji, King Fahd University of Petroleum & Minerals, Dhahran, Saudi Arabia
Yakubu Umar, King Fahd University of Petroleum & Minerals, Dhahran, Saudi Arabia

ABSTRACT

We tested the 'Fisher Effect' about the long run relation between the nominal interest rates and the expected inflation rates. We tried to advance the field by (i) applying a recent time-series technique called 'Auto-Regressive Distributed Lag' (ARDL) and (ii) testing the traditional closed-economy Fisher hypothesis and an augmented Fisher hypothesis by incorporating the foreign interest rate and/or nominal effective exchange rate variable in the context of a small open developing economy, such as, Saudi Arabia. The stability of the functions was also tested by CUSUM and CUSUMSQ. Our findings tend to suggest:(i) consistent with the Fisher hypothesis, the nominal interest rates and the expected inflation rate (generated by ARIMA) have a long-run relationship (ii) consistent with the international Fisher hypothesis, these domestic variables have a long run relationship with the international variables (iii) finally, in the closed-economy context, it is the nominal interest rate that contains information to predict the future inflation (rather than the other way round). But in the open economy context, the effective exchange rate is the driver and the two domestic Fisher-hypothesis variables (i.e., the interest rate and the expected inflation rate) bear the burden of short-run adjustment to bring about the long term equilibrium.

Keywords: Fisher Effect, Bounds Test, ARDL

1. INTRODUCTION: THE ISSUE MOTIVATING THE STUDY

According to Classical economic theory, once-and-for-all increase in nominal variables has no effect on real variables. For example, under monetary neutrality, a once-and-for-all increase in money supply has no impact on real income. One of the neutrality conditions says that a fully anticipated once-and-for-all increase in expected inflation has no effect on the real interest rate. This is known as the Fisher effect. Although most economists believe that these neutrality propositions may not hold in the short-run, there are controversies about their validity in the long run.

Since the late 1980s, there has been renewed academic interest in the empirical testing of long-run neutrality predictions. This renewed interest is partly due to (i) the fixed exchange rate targeting and/or inflation rate targeting in many countries of the world and also partly due to (ii) the advances in the time series techniques for studying non- stationary data with the help of various cointegration techniques. Atkins (1989), Atkins and Coe (2002), MacDonald and Murphy (1989), Dutt and Ghosh (1995), Crowder and Hoffman (1996) and Crowder (2003), amongst others, applied cointegrating techniques to test the long-run Fisher effect. While recent evidence tends to be more in favor of long-run monetary neutrality, the evidence on the long-run Fisher effect is mixed (for an excellent and comprehensive survey of recent evidence on long-run monetary neutrality and other long- run neutrality propositions, see Bullard (1999).

One of the weaknesses of cointegration techniques, however, is that the unit root and cointegration tests suffer from pre-test biases particularly in small samples and the variables are required to be I(1). This paper will investigate the empirical validity of the Fisher Effect by applying a new econometric technique developed by Pesaran, Shin and Smith (2001). This technique (ARDL) allows testing for the existence of a long-run relationship between economic time series without having to specify whether these series are individually I(1) or I(0). This represents a clear advantage over cointegration techniques that require the researcher to assume that the underlying inflation and nominal interest rate series are both I(1).

Moreover, there has been hardly any study of the Fisher's hypothesis in the context of an open developing economy with a free capital movement. We want to fill in the above two gaps (i.e., relating to methodology and the open developing economy context) and use Saudi Arabia as a case study.

The next section highlights the major focus of the study followed by the recent methodological discussion in section three. The major contributions of the paper are spelt out in section four followed by the literature review in section five. The theoretical underpinnings are given in section six followed by the data, empirical estimates and discussions in section seven. The study ends with the conclusions and policy implications in section 8.

2. THE OBJECTIVE OF THE STUDY

We intend to test empirically the traditional long-run Fisher hypothesis and also augmented by the foreign interest rate and foreign exchange rate variables in the context of a small open developing economy, such as, Saudi Arabia. We want to apply a very recent time series technique known as autoregressive distributed lag (ARDL) bounds test by Pesaran, Shin, and Smith (2001).

3. METHODOLOGY

The regression analysis that has been applied for many decades to estimate the long-run relationship among economic and social variables is now considered to have either estimated a spurious relationship (if the original 'level' form of the variables was non-stationary) or estimated a short-run relationship (if the variables were 'differenced' to make the original variables stationary). The damaging limitation of the traditional regression analysis (i.e., either spurious or not testing theory) has been addressed by the recent and ongoing cointegration time series techniques. The significant contributions made by the time series cointegration techniques starting with the publication of the seminal paper by Engle and Granger (1987) have been recognized through the recent award of the Nobel Prize in Economic Science to Engle and Granger in 2003.

Although the cointegrating procedure has made an important advance on regression analysis by focusing on the point that any regression analysis should start off, not mechanically, but by testing the stationarity and cointegration properties of the time series involved, the cointegrating estimates also are subject to a number of limitations. The estimates derived from the cointegrating tests (such as the Johansen test) and the unit root tests (such as, the augmented Dicky-Fuller and Phillips-Peron, etc. which precede the cointegrating tests), are found to be biased. The tests lack power and are biased in favour of accepting the null hypothesis. The cointegration tests require the variables to be I(1) but the order of integration of a variable, whether I(1) or I(0), may depend on the number of lags included or whether the intercept and/or the trend are included or excluded in the unit root tests. Moreover, the Johansen cointegrating tests have small sample bias and simultaneity bias among the regressors.

The Auto-Regressive Distributive Lag (ARDL) method (also known as the bounds testing approach) proposed by Pesaran, Shin and Smith (2001) that we have employed is free from the above limitations of the unit root and cointegration tests. The ARDL bounds testing approach does not require the restriction imposed by cointegration technique that the variables are I (1) or I (0). The ARDL technique involves two stages. At the first stage, the existence of a long-run relationship among the variables is investigated. This is done by constructing an unrestricted error correction model (UECM) with each variable in turn as a dependent variable and then testing whether or not the 'lagged levels of the variables' in each of the error correction equations are statistically significant. The test consists of computing an F-statistic testing the joint significance of the 'lagged levels of the variables' in each error-correction equation. The computed F-statistic is then compared to two asymptotic critical values. If the test statistic is above an upper critical value, the null hypothesis of no long-run relationship can be rejected regardless of whether the variables are I(0) or I(1). Alternatively, when the test statistic falls below a lower critical value, the null hypothesis of no long-run relationship is accepted regardless of whether the variables are I(0) or (1). Finally, if the test statistic falls between these two bounds, the result is inconclusive. It is only in this case that the researcher may have to carry out unit root tests on the variables. As regards the implications of the F-statistics, if all the F-statistics in all equations happen to be insignificant, then that implies the acceptance of the null of 'no long run relationship among the variables'. However, if at least one of the F-statistics is significant, then the null of 'no long-run relationship among the variables' is rejected. In that case, there is a long run relationship among the variables. When the F-statistic is significant, the corresponding dependent variable is endogenous and when the F-statistic is insignificant, the corresponding dependent variables are exogenous or called 'long-run forcing variables'.

Once the long run relationship has been demonstrated, the second stage of the analysis involves the estimation of the long run coefficients (after selecting the optimum order of the variables through AIC or SBC criteria) and then estimates the associated error correction model.

4. THE CONTRIBUTIONS OF THE PAPER

The study will depart from earlier works and also advance the field in the following ways:

(i) As far as our knowledge goes this study will be the first attempt in this region to investigate the issue as to whether there is any significant long-run relationship between the nominal interest rate and the expected inflation rate augmented by the dynamic interactions of the domestic variables with the international variables, such as, the foreign interest rate and nominal effective exchange rate in the context of a small open developing economy, such as, Saudi Arabia.

(ii) We believe that the application of the very recently developed 'ARDL Bounds testing' procedure (which is an alternative to and an improvement on the standard cointegrating techniques for testing long-run relationship) will also be the attempted first in this region.

(iii) Given the objective of the Saudi Government to maintain a fixed exchange rate with the US$, a rigorous examination of the long-run relationship as well as the direction of temporal causality among the nominal interest rate, the expected inflation rate, and the international variables is a topical issue of utmost importance. The findings of the study, therefore, will have distinct policy implications for Saudi Arabia.

5. LITERATURE REVIEW

The Fisher effect hypothesis introduced by the seminal work of Fisher (1930) affirms nominal interest rate as the sum of the constant real interest rate and expected decline in the Purchasing Power of money. Numerous empirical studies such as Granville and Mallick (2004), Carneiro et. al. (2002), Crowder and Hoffman (1996) maintain that this intuitive and simple hypothesis has limited empirical support. Mishkin and Simon (1995), and Evans and Lewis (1995), Dimand (1999), extend the Fisher effect hypothesis. However, Atkins and Coe (2002), Chung and Crowder (2002), Larson, Lyhagen and Lothgren (2001), Kao and Chiang (2000), Kao (1999), Daniels et. al. (1996), Dutt and Ghosh (1995), Moazzami (1991), Hoffman and Rasche (1991), Atkins (1989), MacDonald and Murphy (1989) have attempted to examine the role of the Fisher effect and how to determine nominal interest rates by testing for cointegration between nominal interest rates and inflation rates in various articles. These studies broadly conclude that there is evidence of cointegration by using times series data which include both the rising inflation periods of the 1960- 1970s and the declining inflation periods of the 1980-1990s.

An obvious candidate, however, for cointegrating vector is the *ex post* real interest rate. Conventional growth theory shows that long-run real interest rates are determined in the steady state of the economy and hence stationarity has no implications for the accuracy of the Fisher effect. Stationarity is consistent with a host of theories of nominal interest rate behavior and therefore can be a necessary condition for the Fisher effect to hold. Rose (1988) argues that the finding of the unit root in the real interest rate is inconsistent with the Capital Asset Pricing Model. The sufficient condition for the Fisher effect to hold is that nominal interest rates embody an optimal inflation forecast, a condition that one can test using the signal extraction approach for testing expectations described in Durlauf and Hall (1988, 1989) models. Garcia (1993) applies this approach to Brazilian data for the period 1973-1990 and concludes that the

Fisher effect describes the data reasonably well. Johnson (1994a, 1994b) applies the approach to monthly US 1953-1979 data to find that, while one can reject the Fisher theory, it provides a reasonably good description of interest rate behavior. Johnson and Garcia (2000) relaxing the assumption of a constant *ex ante* real interest rate, test the Fisher theory and conclude that the 90-day US T-Bill rate over a period can be well described as the sum of a rational forecast of inflation and an infrequently changing *ex ante* real interest rate.

Mishkin (1992) was one of the first to suggest that due to the apparent non-stationarity of nominal interest rates and inflation, a possible source of the low Fisher effect estimates is the spurious regression problem discussed by Granger and Newbold (1974). He pointed out that the proper treatment of the Fisher relation is as a cointegrated system advocated by Engle and Granger (1987). Mishkin used the Engle-Granger OLS procedure to estimate the Fisher effect but was unable to make any strong conclusions due to the large standard errors of the estimated parameters. Subsequent studies used more efficient estimation procedures and generally found support for a longrun Fisher relation in the U.S. Evans and Lewis (1995) used the Stock and Watson procedure, and Crowder and Hoffman (1996) used the Johansen (1988) Gaussian Maximum Likelihood (MLE) estimator.

Lucas (1980) asserts that the relationship between inflation and interest rates represents one of the crucial tests of monetary neutrality. There is no consensus among economists with respect to this relationship. However, some studies find evidence favorable to a full adjustment of nominal rates of interest to changes in expected inflation resulting in no longrun effects on real interest rates consistent with longrun neutrality. Other studies find that the response of nominal interest rates to changes in inflation is insufficient to preclude effects on real interest rates and by extension other real variables.

The Fisher hypothesis research has generally been found to be strong in some countries over certain periods, for example, U.S., Canada, and the United Kingdom in post war period until 1979. However, it will certainly be of interest to find out whether nominal interest rates and inflation of emerging countries will also exhibit a longrun Fisher relation. For example, a necessary condition, but not sufficient, is for real interest rates to be equal internationally. In a seminal study Rose (1988) examined a group of industrialized Nations, Koustas (1998) and Koustas and Serletis (1999) examined eleven industrialized countries, but neither study found much evidence to support the Fisher hypothesis. The controversy on Fisher hypothesis still remains unresolved. In this study we will make an attempt to apply an alternative approach and test Fisher's theory in a small open developing economy. Saudi Arabia is taken as a case study.

6. THEORETICAL UNDERPINNINGS

The Fisher hypothesis states that the nominal interest rate and the expected inflation rate is a one-to-one relationship in the long run, given the real rate of interest. One way to examine this hypothesis is to test whether there is any significant long run relationship between nominal interest rate and expected (or anticipated) inflation rate. Depending on whether or not there is any significant long run relationship, one can infer whether the nominal interest rate contains information to predict the future inflation. For an open developing economy with free capital movement, however, it is important to augment the traditional closed-economy formulation of the Fisher hypothesis by introducing foreign interest rate and exchange rate variables consistent with the theoretical framework given by the international Fisher hypothesis/uncovered interest rate parity hypothesis. One would expect that in an open economy, the international factors would have significant long-term dynamic interactions with the domestic factors. If indeed there is any long-term relationship between the domestic and international variables, it would be interesting for the decision makers to know as to which variable drives the dynamic system and which variable responds in the short term to bring about long-term equilibrium among them. We intend to unfold that relationship by testing both the traditional closed economy Fisher hypothesis and the open economy international Fisher hypothesis.

7. DATA, EMPIRICAL RESULTS AND DISCUSSIONS

In line with the above theoretical framework, we need the following variables for testing the above hypotheses: nominal interest rate, expected inflation rate, foreign interest rate and exchange rates/nominal effective exchange rate. The source of all domestic variables is the Saudi Arabian Monetary Agency (SAMA) and the source of foreign interest rate and nominal effective exchange rate is International Financial Statistics published by the IMF. The period covered in the study (1986-2004) depended mainly on the availability of consistent data for all the variables.

We discussed earlier that because of the limitations of the tests involved in unit roots and cointegration, we applied the recently developed ARDL method to test first the closed economy Fisher hypothesis i.e., the long run relation between the nominal interest rate and the inflation rate **(Table 1)**.

TABLE 1: LONG RUN RELATIONSHIP BETWEEN INTEREST RATE AND CURRENT INFLATION; AND BETWEEN INTEREST RATE AND EXPECTED INFLATION

Model	Dependent Variable	'F' Statistic
with interest rate and current Inflation	Interest Rate (DTHREEM)	2.3 (0.143)
	Current Inflation (DWPI)	38.7 (0.000)*
with interest rate and expected Inflation	Interest Rate (DTHREEM)	1.33 (0.310)
	Expected Inflation (DEXPINF)	13.2 (0.002)*

*Significant at 1% level.

The above 'F' statistic relates to the 'variable addition test' i.e., whether the 'lagged level form' of the variables added to the equation is significant or not. The 'F' statistic tests the joint null hypothesis that the coefficients of these 'level' variables are zero. A significant 'F' implies the rejection of the null hypothesis that there is no long run relationship between the variables. Since at least one 'F' is significant in each model, it implies that long run relationship exists between current inflation and interest rate, and between expected inflation and interest rate.

TABLE 2a: ARIMA (1, 1, 1) MODEL FOR GENERATING 'EXPECTED INFLATION' RATE BASED ON WHOLESALE PRICES

Dependent Variable: D(WPI)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.909471	0.403774	2.252424	0.0397
AR(1)	0.633441	0.115159	5.500598	0.0001
MA(1)	-0.957013	0.032684	-29.28100	0.0000

R-squared	0.497852	Mean dependent var	2.138889
Adjusted R-squared	0.430899	S.D. dependent var	3.386850
S.E. of regression	2.554997	Akaike info criterion	4.864991
Sum squared resid	97.92017	Schwarz criterion	5.013387
Log likelihood	-40.78492	F-statistic	7.435848
Durbin-Watson stat	2.153911	Prob(F-statistic)	0.005705

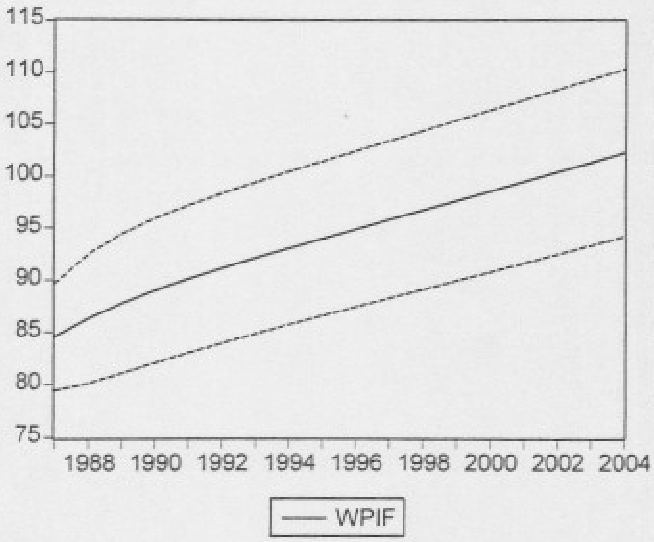
Inverted AR Roots	.63
Inverted MA Roots	.96

The 'expected' inflation rate in the above table was first proxied by the current inflation rate and then the expected inflation rate was also generated by the Box-Jenkins ARIMA (1, 1, 1,) method **(Tables 2a –2c)**. The 'forecasted' inflation rate had a good fit with AR1 and MA1 specifications with the original series differenced once. Hence, the final specification obtained is ARIMA (1, 1, 1) given in Table 2a.

TABLE 2b: ACTUAL AND FITTED VALUES FROM ARIMA (1, 1, 1) MODEL

obs	Actual	Fitted	Residual	Residual Plot
1987	5.90000	9.13467	-3.23467	| *. | . |
1988	11.8000	7.16630	4.63370	| . | . * |
1989	1.10000	3.37347	-2.27347	| .* | . |
1990	1.80000	3.20590	-1.40590	| . * | . |
1991	3.10000	2.81903	0.28097	| . |* . |
1992	1.40000	2.02815	-0.62815	| . *| . |
1993	0.60000	1.82134	-1.22134	| . * | . |
1994	1.90000	1.88228	0.01772	| . * . |
1995	8.00000	1.51995	6.48005	| . | . *|
1996	-0.30000	-0.80059	0.50059	| . |* . |
1997	0.00000	-0.33572	0.33572	| . |* . |
1998	-2.20000	0.01208	-2.21208	| .* | . |
1999	0.50000	1.05680	-0.55680	| . *| . |
2000	0.40000	1.18296	-0.78296	| . *| . |
2001	-0.10000	1.33605	-1.43605	| . * | . |
2002	0.00000	1.64435	-1.64435	| . * | . |
2003	1.00000	1.90704	-0.90704	| . * | . |
2004	3.60000	1.83486	1.76514	| . | *. |

TABLE 2c: FORECAST STATISTICS OF ARIMA (1,1,1) MODEL



Forecast: WPIF	
Actual: WPI	
Forecast sample: 1985 2004	
Adjusted sample: 1987 2004	
Included observations: 18	
Root Mean Squared Error	17.13549
Mean Absolute Error	16.60527
Mean Abs. Percent Error	14.80016
Theil Inequality Coefficient	0.083396
Bias Proportion	0.939073
Variance Proportion	0.033485
Covariance Proportion	0.027442

The error-correction representation of the above model indicated that the 't' ratio of the error-correction term is significant when the inflation rate variable is the dependent variable but not significant when the interest rate variable is the dependent variable. That tends to indicate that in the closed-economy context of the Fisher hypothesis, it is the nominal interest rate, which is exogenous, or the long-run forcing variable. In other words, the nominal interest rate contains information to predict the future inflation rate (rather than the other way around).

Then we tested the augmented Fisher hypothesis by adding the international variables, such as, foreign interest rate / the nominal effective exchange rate / foreign exchange rate to the domestic variables (**Table 3**).

TABLE 3: LONG RUN RELATIONSHIP BETWEEN INTEREST RATE, EXPECTED INFLATION RATE, AND FOREIGN INTEREST RATE/ NOMINAL EFFECTIVE EXCHANGE RATE/ FOREIGN EXCHANGE RATE

Model	Dependent Variable	'F' Statistic
with interest rate, expected inflation and foreign interest rate	Expected inflation	18.3 (0.002)*
with interest rate, expected inflation and nominal effective exchange Rate	Expected inflation	10.5 (0.008)*
with interest rate, expected inflation and foreign exchange rate	Expected inflation	7.1 (0.021)*

* significant at 1%.

In three different models above, we find that the 'F' statistic is significant in the equations with the expected inflation rate as the corresponding dependent variable. A significant 'F' statistic implies the rejection of the null hypothesis that there is 'no long run relationship among the three variables' (in each model). In other words, it implies that long run relationship exists among interest rate, expected inflation rate, and foreign interest rate/ nominal effective exchange rate/ foreign exchange rate. Being an open economy one would expect a long-term co-movement of the above three variables in Saudi Arabia.

Finally, we estimated the error correction representation of the selected ARDL models **(Table 4).**

TABLE 4: ERROR CORRECTION REPRESENTATIONS FOR THE SELECTED ARDL MODELS

Dependent Variable = dEXPINF with ARDL(2,1,1) based on Akaike Information Criteria (AIC)

Regressor	Coefficient	Std Error	t-Ratio
ECT(-1)	-1.9404	.49045	-3.9565[.003]*

Dependent Variable = dTHREEM with ARDL(2,2,1) based on Akaike Information Criteria (AIC)

Regressor	Coefficient	Std Error	t-Ratio
ECT(-1)	-.33316	.12639	-2.6360[.025]*

Dependent Variable = dNOMIEX with ARDL(2,0,0) based on Akaike Information Criteria (AIC)

Regressor	Coefficient	Std Error	t-Ratio
ECT(-1)	-.21328	.18932	-1.1265[.282]

* indicates significant at 1%

The above results show the three error correction models with the expected inflation rate, interest rate, and nominal effective exchange rate as dependent variables respectively. The 't' ratios of the error-correction term are significant at 1% level when the expected inflation rate and the interest rate are the dependent variables but not significant when the nominal effective exchange rate is the dependent variable. That tends to indicate that the nominal effective exchange rate is the exogenous variable and the other two variables are endogenous. That implies that in the open economy context of the Fisher hypothesis, the effective exchange rate is the driver or the leading variable and the other two domestic variables (the interest rate and the expected inflation rate) bear the burden of short-run adjustment to bring about long-term equilibrium.

The above results are quite plausible in the context of an open developing economy like Saudi Arabia which is heavily dependent on the external sector for its annual growth and development. Its domestic policies such as, the interest rate and inflation rate are driven markedly by the health of the external sector which is influenced heavily, among others, by the effective exchange rate.

We then tested the 'stability' of the coefficients of the final equations with the help of CUSUM and CUSUMSQ tests **(Figures 1-3)** and we find that the coefficients are all stable since they are all within the 5% critical bounds.

FIGURE 1a: CUSUM AND CUSUMSQ TESTS WITH EXPECTED INFLATION AS THE DEPENDENT VARIABLE FOLLOWED BY NOMINAL INTEREST RATE AND NOMINAL EFFECTIVE EXCHANGE RATE

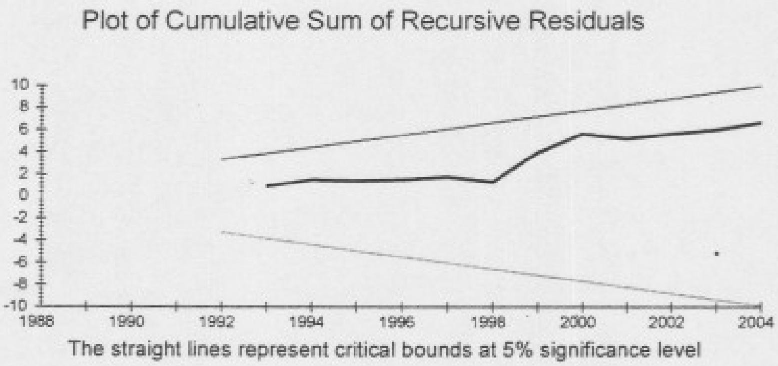


FIGURE 1b

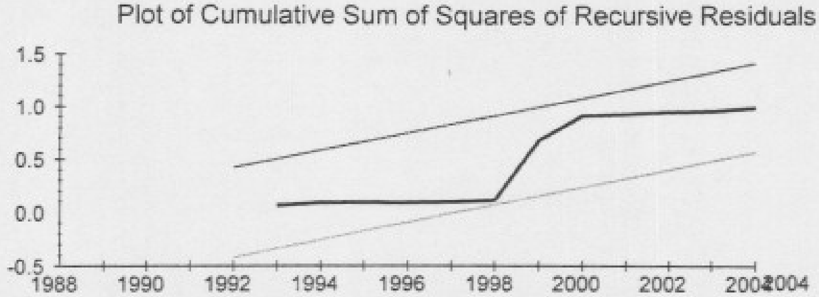
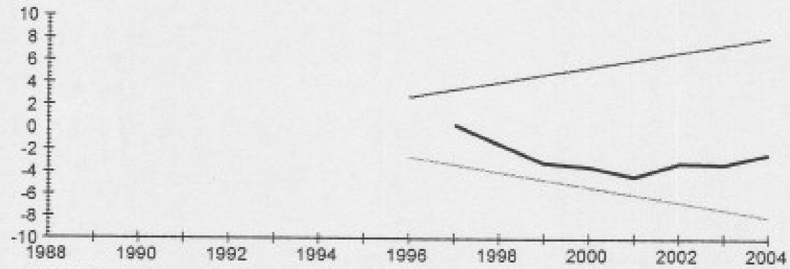


FIGURE 2a: CUSUM AND CUSUMSQ TESTS WITH NOMINAL INTEREST RATE AS THE DEPENDENT VARIABLE FOLLOWED BY EXPECTED INFLATION AND NOMINAL EFFECTIVE EXCHANGE RATE

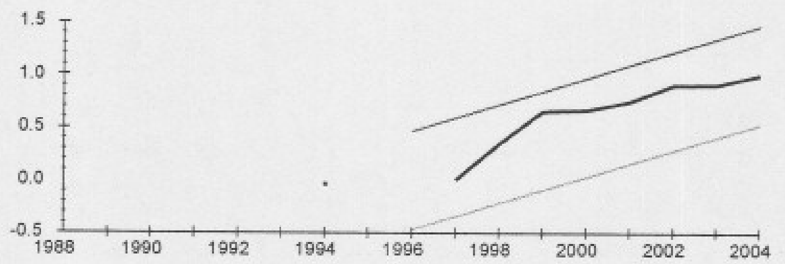
Plot of Cumulative Sum of Recursive Residuals



The straight lines represent critical bounds at 5% significance level

FIGURE 2b

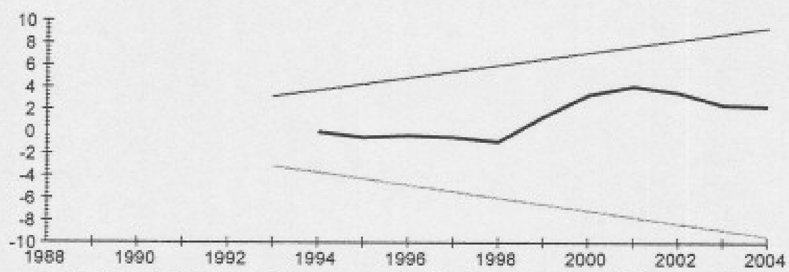
Plot of Cumulative Sum of Squares of Recursive Residuals



The straight lines represent critical bounds at 5% significance level

FIGURE 3a: CUSUM AND CUSUMSQ TESTS WITH NOMINAL EFFECTIVE EXCHANGE RATE AS THE DEPENDENT VARIABLE FOLLOWED BY EXPECTED INFLATION AND NOMINAL INTEREST RATE

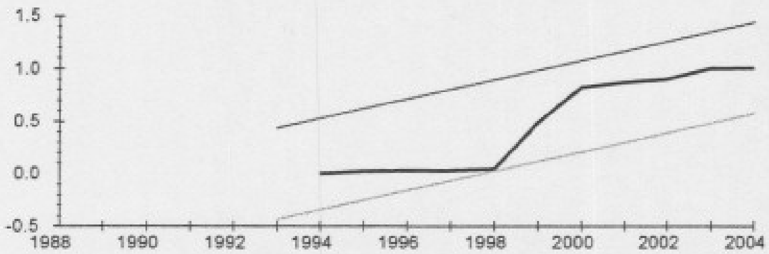
Plot of Cumulative Sum of Recursive Residuals



The straight lines represent critical bounds at 5% significance level

FIGURE 3b

Plot of Cumulative Sum of Squares of Recursive Residuals



The straight lines represent critical bounds at 5% significance level

8. CONCLUSIONS AND POLICY IMPLICATIONS

There have been many empirical studies of the traditional closed-economy specification of the Fisher hypothesis. However, unlike other studies, we tested the Fisher hypothesis in both the closed-economy context and the open economy context of a developing economy, such as, Saudi Arabia. We have applied a recently developed time series technique called ARDL by Pesaran, Shin, and Smith (2001) which has taken care of a major limitation of the conventional cointegrating tests in that they suffer from the pre-test biases. The Box-Jenkins ARIMA (1, 1, 1) generated the 'expected inflation' variable and the stability of the functions was tested by the CUSUM and CUSUMSQ tests. Our findings tend to suggest:

(i) consistent with the Fisher hypothesis, the nominal interest rates and the expected inflation rate have a long-run relationship (ii) consistent with the international Fisher hypothesis, these domestic variables have a long run relationship with the international variables.(iii) in the closed-economy context, it is the nominal interest rate that contains information to predict the future inflation rate (rather than the other way around). But in the open economy context, the nominal effective exchange rate is the driver or the leading variable. In other words, the nominal effective exchange rate variable initially receives the exogenous shocks leading to the disturbance of the long term equilibrium existing among the variables and the two domestic Fisher-hypothesis variables (i.e., the interest rate and the expected inflation rate) then bear the burden of short-run adjustment to restore the long term equilibrium. These findings are quite plausible and intuitive and also contain strong policy implications for an open developing economy, such as, Saudi Arabia which is heavily dependent on the health of the external sector for its growth and development.

REFERENCES

Atkins, Frank J., "Co-integration, Error Correction and the Fisher Effect", *Applied Economics*, Vol. 21, 1989, 1611-1620.

Atkins, Frank J. and Coe, Patrick J. "An ARDL Bounds Test of the Long-Run Fisher Effect in the United States and Canada", *Journal of Macroeconomics*, Vol.24, 2002, 255- 266.

Bullard, J, "Testing long-run monetary neutrality propositions: lessons from the recent research", *Federal Reserve Bank of St. Louis Review*, Vol. 81, 1999, 57-77.

Carneiro, F G., Divino, J. Â. C. A.and Rocha, C. H., "Revisiting the Fisher hypothesis for the Cases of Argentina, Brazil and Mexico", *Applied Economics Letters*, Vol.9, 2002, 95-98.

Chung, S. Young and Crowder, William J. "Why Are Real Interest Rates Not Equalized Internationally?", Mimeo: University of Texas at Arlington, 2002.

Crowder, William J. (2003), "Panel Estimates of the Fisher Effect", Department of Economics, University of Texas at Arlington, TX, crowder@uta.edu , (January 18, 2003).

Crowder, W. J. and Hoffman, D. L., "The Long-Run Relationship between Nominal Interest Rates and Inflation: the Fisher Equation Revisited", *Journal of Money, Credit and Banking*, Vol. 28, 1996, 102-118.

Daniels, J. P., F. Nourzad, and Toutkoushian, R. K., "Testing the Fisher Effect as a Long-Run Equilibrium Relation", *Applied Financial Economics*, Vol. 6, 1996, 115-120.

Dimand, Robert W, (1999), *"Irving Fisher and the Fisher Relation: Setting the Record Straight"*, *Canadian Journal of Economics* Vol. 32, 1999, 744-750.

Durlauf, S. N., and Hall, R. E., "Bounds on the Variances of Specification Errors in Models with Expectations", Mimeo, Stanford University, 1988.

Durlauf, S. N., and Hall, R. E. "A Signal Extraction Approach to Recovering Noise in Expectations Based Models", Mimeo, Stanford University, 1989.

Dutt, S. D. and Ghosh, D. "The Fisher Hypothesis: Examining the Canadian Experience", *Applied Economics*, Vol. 27, 1995, 1025-1030.

Engle, Robert F., and Granger, Clive W.J. "Co-integration and Error Correction Representation, Estimation and Testing", *Econometrica*, Vol. 55, 1987, 251-276.

Evans, Martin and Lewis, Karen "Do Expected Shifts in Inflation Affect Estimates of the Longrun Fisher Relation?", *Journal of Finance*, Vol 50, March 1995, 25-53.

Fisher, Irving, The Theory of Interest, Macmillan Publishing Company, 1930.

Garcia, Márcio G. P., "The Fisher Effect in a Signal Extraction Framework: The Recent Brazilian Experience," *Journal of Development Economics*, Vol. 41, 1993, 71-93.

Granger, C.W.J. and Newbold, P. (1974), "Spurious Regressions in Econometrics", *Journal of Econometrics*, Vol. 2, 197, 111-120,

Granville, B., and Mallick, S. "Fisher hypothesis: UK Evidence over a Century", *Applied Economics Letters*, Vol 11, 2004, 87-90.

Hoffman, Dennis L. and Rasche, Robert H. "Longrun Income and Interest Elasticities of Money Demand in the United States", *Review of Economics and Statistics*, Vol. 78, 1991, 665-674.

Johansen, Søren, "Statistical Analysis of Cointegrating Vectors", *Journal of Economic Dynamics and Control*, Vol. 12(2/3), June/September 1988, 231-254,

Johansen, Søren, "Estimation and Hypothesis Testing of Cointegration Vectors in Gaussian Vector Autoregressive Models", *Econometrica*, Vol. 59(6) November 1991, 1551-1580.

Johnson, P. A., "Estimation of the Spęcification Error in the Fisher Equation," *Applied Economics*, Vol. 26, 1994a, 519-526.

Johnson, P. A. "On the Number of Common Unit Roots in the Term Structure of Interest Rates," *Applied Economics*, Vol. 26, 1994b, 815-820.

Johnson, P. A., and Garcia, M. G. P. "A Regression Tree Analysis of Real Interest Rate Regime Changes", *Applied Financial Economics*, Vol. 10, 2000, 171-176.

Kao, Chihwa, "Spurious Regression and Residual-Based Tests for Cointegration in Panel Data", *Journal of Econometrics*, Vol. 90(1), May 1999, 1-44,

Kao, Chihwa and Chiang, Min-Hsien, "On the Estimation and Inference of a Cointegrated Regression in Panel Data", *Advances in Econometrics*, Vol. 15, 2000, 179-222

Koustas, Zisimos, "Canadian Evidence on Long-run Neutrality Propositions", *Journal of Macroeconomics*, Vol. 20, 1998, 397-411.

Koustas, Zisimos and Serletis, Apostolos,"On the Fisher Effect", *Journal of Monetary Economics* Vol. 44, 1999, 105-130.

Larsson, Rolf, Lyhagen, Johan and Lothgren, Mickael "Likelihood-Based Cointegration Tests in Heterogeneous Panels", *Econometrics Journal*, Vol. 4(1), 2001, 109-142.

Lucas, Robert J, "Two Illustrations of the Quantity Theory of Money", *American Economic Review*, Vol.70, December 1980, 1005–1014.

MacDonald, Ronald and Murphy, Phillip D. "Testing the Long-run Relationship between Nominal Interest Rates and Inflation using Co-integration Techniques", *Applied Economics*, Vol. 21, 1989, 439-447.

Mishkin, Frederic. S., "Is the Fisher Effect for Real? A Reexamination of the Relationship between in Inflation and Interest Rates", *Journal of Monetary Economics*, Vol.30, 1992, 195-215.

Mishkin, Frederic S. and Simon, John (1995) "An Empirical Examination of the Fisher Effect in Australia", *Economic Record*, Vol. 71, 1995, 217-229.

Moazzami, B., "The Fisher Equation Controversy Re-examined", *Applied Financial Economics*, Vol. 1, 1991, 129-33.

Pesaran, M.H., Shin, Y., and Smith, R, J., "Bounds testing approaches to the analysis of long-run relationships", *Journal of Applied Econometrics, Vol.*16, 2001, 289-326.
Rose, Andrew K., "Is the Real Interest Rate Stable?" *Journal of Finance*, Vol. 43, 1988, 1095-1112.
Stock, James H. and Watson, Mark W., "A Simple Estimator of Cointegrating Vectors in Higher-Order Integrated Systems", *Econometrica*, Vol. 61, July 1993, 783–820.
Wallace, Myles S., and Warner, Johns T., "The Fisher Effect and the Term Structure of Interest Rates: Tests of Cointegration," *The Review of Economics and Statistics*, Vol. 75, 1993, 320-324.

ACKNOWLEDGEMENTS

The authors are grateful to Professor Bhavesh Patel (Managing Editor, JIFE), anonymous referees, and King Fahd University of Petroleum & Minerals, Dhahran, Saudi Arabia for their support. The corresponding author, Dr Mansur Masih (masih@kfupm.edu.sa) is also grateful to Saudi Aramco for sponsoring the Chair in Energy Economics. We are also grateful to Mr Lurion DeMello for his excellent research assistance.

AUTHOR PROFILES:

Dr Mansur Masih got his Ph.D. from Leeds University, UK in 1974. Currently he is the Saudi Aramco Chair Professor of Energy Economics, King Fahd University, Dhahran, Saudi Arabia. He was also the Tun Ismail Ali Distinguished Chair Professor of Finance & Investment, National University of Malaysia in 2004 (June- August) and the Bumiputra Commerce Bank Chair Professor of Finance & Banking, Northern University of Malaysia, 2005-2007 (June –August). He has now got seventy articles in refereed journals.

Dr. Mohsen Ahmed Al-Hajji earned his Ph.D at the University of Colorado at Boulder, Colorado, U.S.A. in 1987. Currently he is an assistant professor of Economics at King Fahd University of Petroleum & Minerals, Dhahran, Saudi Arabia. He participated as a team member for some projects sponsored by Saudi Aramco and Saudi Agricultural bank. He has some publications in well known journals. He received the distinguished teacher award of the College of Industrial Managèment in 1996 and 2005.

Dr. Yakubu A. Umar earned his Ph.D. at the Victoria University of Manchester, UK in 1989. Currently, he is an assistant professor of finance at King Fahd University of Petroleum and Minerals, Dhahran, Saudi Arabia. He co-authored a book, 'The Saudi Business Cases in Managerial Economics' has publications in several reputable International journals and he is a board member of the Journal of Knowledge Globalization.