REVISITING THE FISHER EFFECT FOR DEVELOPED AND DEVELOPING COUNTRIES: A BOUNDS TEST APPROACH

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ABSTRACT

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This study investigates the Fisher Effect for a sample of ten developed countries and ten developing countries. The study examines whether the nominal interest rate adjusts to the expected inflation rate in the long run. The distinction between the developed countries and developing countries also enables to identify special conditions under which Fisher Effect is more likely to hold. To analyze the long run relationship between the nominal interest rate and expected inflation rate, Bounds test approach of Pesaran et. al. (2001) is utilized. Estimation results show that the adjustment of nominal interest rate to expected inflation is encountered mostly for the developing countries which have inflationary history in their economies.

Keywords: Fisher Effect, Bounds Test Approach, Developed and Developing Countries

ÖZ

GELİŞMİŞ VE GELİŞMEKTE OLAN ÜLKELER İÇİN FİSHER ETKİSİNİN ARAŞTIRILMASI: SINIR TESTİ YAKLAŞIMI

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Bu çalışmada, Fisher Etkisi on tane gelişmiş ve on tane gelişmekte olan ülkede incelenmiştir. Çalışmada, uzun dönemde, nominal faiz oranlarının beklenen enflasyonla uyumlu olup olmadığı incelemektedir. Gelişmiş ülke ve gelişmekte olan ülkeler açısından Fisher Etkisinin araştırılması, Fisher Etkisinin hangi koşullar altında geçerli olduğunu belirleme imkânı da tanır. Nominal faiz haddi ile beklenen enflasyon oranı arasındaki ilişkiyi incelemek için Pesaran vd. (2001) geliştirdiği Sınır testi yaklaşımından yararlanılmıştır. Tahmin sonuçları, daha çok enflasyonist geçmişleri olan gelişmekte olan ülkelerde nominal faiz oranını enflasyon beklentilerine uyum sağladığını göstermektedir.

Anahtar Kelimeler: Fisher Etkisi, Sınır Testi Yaklaşımı, Gelişmiş ve Gelişmekte Olan Ülkeler

To my parents…

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CHAPTER 1

INTRODUCTION

Understanding the origins of the fluctuations in interest rates has been critical not only for the theoretical macroeconomics but also for the monetary policy issues. Interest rate is an important variable for macroeconomists because it links the economy of the today and the economy of the future through its effects on saving and investment decisions. Fisher Effect explains why the interest rates rise and fall with the changes in the purchasing power of money. It states that the nominal interest rate consists of the real interest rate and compensation for expected inflation rate since savers or investors expect compensation for the reduction in value of nominal money (purchasing power) caused by inflation (Smant, 2004). To put it in a different way; interest rate reflects market information regarding expected change in the purchasing power of money or future inflation (Alkhazali, 1997).

Policy implications of the Fisher Effect can be demonstrated in many ways. Movements in interest rate primarily reflect fluctuations in expected inflation rate, so they become signals of the future inflation. Fisher relation would imply that interest rates are good indicators of inflationary expectations. Additionally, whenever the increases in the inflationary expectations do not get fully incorporated in nominal interest rates, the government may have motivation to run debt-financed fiscal deficits. Accordingly, in an economy where the Fisher Effect does not hold, the real cost of public sector debt will diminish. Finally in some central theoretical models of the economic literature, like the neoclassical growth model stationarity of the real interest rates is assumed. Therefore, testing the Fisher Effect is crucial in this respect as well. Absence of one-to-one adjustment of nominal interest rate to expected inflation rates, i.e. Fisher Effect will challenge some basic models of the economic theory.

The Fisher Effect has been the subject of a vast literature. Abundant empirical analyses have tested the Fisher hypothesis, especially for developed countries. From the beginning, tests of Fisher Effect yield conflicting results. Fisher's (1930) own research established that the theory fails in practice; he found that the nominal interest rate and inflation rate do not correlate well. However, studies in the 1970s support the Fisher Effect, concluding that the nominal interest rates accommodate changes in inflation rate. On the other hand, studies in the 80's like Mishkin (1981) and Rose (1988) contradict with this conclusion (Smant, 2004)[1]. Recent developments in the time series econometrics i.e. unit roots, and cointegration and the advancement of the rational expectations theory and efficient market theory provide new perspectives to the relationship between the nominal interest rate and expected inflation. Nevertheless, it remains to be a controversial issue. Whether the real interest rate moves with the expected inflation rate is an open question. In general, it appears that the conclusions regarding the Fisher Effect are sensitive to the time period, to the country and to the technique used.

In this study, we concentrate on the effect of the inflation rate on the nominal interest rate, as this is the crux of the Fisher Effect hypothesis. We test the Fisher Effect hypothesis by employing a recently popularized cointegration analysis; the Autoregressive Distributed Lag (ARDL) approach. With the help of this approach we will determine whether there is evidence of

[1] See Fama (1974), Fama & Gibbons (1982), Fama & Schwert (1976) and Levi and Makin (1979) for more details.

relationship between nominal interest rate and expected inflation rate in the long run for twenty countries. Ten of these countries are developed ones which are Canada, Denmark, Finland, France, Germany, Italy, Japan, Norway, the United Kingdom and the United States. The rest of countries are developing ones, which are Argentina, Brazil, Chile, India, Israel, Malaysia, Mexico, Singapore, South Korea and Turkey. The data are quarterly and span the period of 1985:01-2006:3.

This study makes a couple of contributions to the literature. First, the relationship between the nominal interest rate and expected inflation is tried to investigate by recently developed cointegration method, bounds testing approach suggested by Pesaran et. al. (2001). This testing approach is superior to the other methods for analyzing the long run relations when the variables are mixed order of integration. Secondly, this multi-country analysis enables us to differentiate the effects of the expected inflation rate on the nominal interest rate between the developed countries and developing countries which have relatively high and volatile inflation. In other words, another aim of this study is to see whether the monetary policy is able to affect the real side of the economy especially for the developing countries that have high inflation rates. Thirdly, this study updates the previous multi-country Fisher Effect studies in terms of the time span.

The rest of the paper is outlined as follows. Chapter 2 describes a brief summary of the literature on Fisher Effect from three perspectives: Importance and implications of Fisher Effect, empirical findings for developed countries and empirical findings for developing countries. Chapter 3 gives general information about the analytical framework of ARDL approach to cointegration. Chapter 4 discusses the properties of the data used. Chapter 5 displays empirical results and presents an analysis of the regression results. Finally, chapter 6 summarizes the study by generating some conclusions.

CHAPTER 2

THE LITERATURE ON FISHER EFFECT

In this chapter, first, the theory of Fisher Effect and its importance and implications will be discussed. Then, some empirical studies of the Fisher hypothesis will be presented. Studies on Fisher Effect can be classified into two; studies for developed countries that faced with low inflation and those for developing countries that faced with high inflation.

2.1 Fisher Effect: Theory, Importance and Implications

Nominal interest rates and inflation are two of the important variables of the monetary policy. The relationship between inflationary expectations and the nominal interest rate is explained by two effects. These effects are liquidity and Fisher effects. The first one, the liquidity effect, relies on the agents' preferences to hold cash balances in response to a rise in inflationary expectations. More explicitly, a rise in inflationary expectation increases the cost of holding cash balances and decreases agents' incentives for liquidity, and demand for financial assets increases. Subsequently, the increased supply of loanable funds decreases the price of credit, which is the real interest rate (Fahmy and Kandil, 2003). The second one, the Fisher Effect, determines the necessary inflationary premium to compensate investors for the cost of inflation. An inflation premium is added to the real interest rate to hedge against inflation which also guarantees investors that ex post inflation does not offset their return.

When we look at the liquidity and Fisher effects, at higher inflation rates as expected inflation increases, Fisher Effect dominates liquidity effect (Fisher, 1930). In addition, as the maturity of securities increases, Fahmy and Kandil (2003) argue that Fisher Effect dominates the relationship between inflationary expectations and nominal interest rate.[1]

Fisher (1930) states that in the long run equilibrium, a change in the rate of growth of money supply leads to a fully perceived change in inflation rate and an adjustment of the nominal interest rates. Therefore, changes in inflation will be absorbed in nominal interest rates, leaving real interest rate constant. But this constancy in real interest rate does not mean an “unconditional constancy” (Kesriyeli, 1994). In other words, Fisher Effect is the co-movement of the nominal interest rates and the expected inflation. In addition, there exists a one-to-one relationship between these variables. The important question is that whether there is any evidence that real interest rates move in response to expected inflation (Kesriyeli, 1994). This is an open question.

From the theoretical perspective, following Granville and Mallick (2004), the Fisher relation can be shown as follows;

i_t, is the nominal interest rate, $\prod_t$, is the inflation rate, and r_t, is the ex-post real interest rate, than we can write:

$$1+r_t=\frac{1+i_t}{1+\prod_t} \tag{1}$$

[1] Similar evidence on the vanishing liquidity effect is presented by Melvin (1983).

Solving for r_t:

$$r_t = \frac{i_t - \Pi_t}{1 + \Pi_t} \tag{2}$$

Ignoring the denominator and assuming constant real interest rates, an ex-ante definition that inflation expectations, Π_t^e, determine the nominal interest rate as :[2]

$$i_t = r + \Pi_t^e \tag{3}$$

In this equilibrium, right hand side variables are not observable; therefore this relation is not estimable. Assuming efficient markets (Fama, 1975), the observed inflation can be decomposed into its expected component and a forecast error, u_t, orthogonal to all information at t:

$$\Pi_t = \Pi_t^e + u_t \tag{4}$$

where, $E(u_t) = 0$, $E(u_t^2) = \delta_u^2$, $E(u_t u_s) = 0 \quad \forall s \neq t.$

Rewriting this in a regression framework:

$$i_t = \alpha + \beta \Pi_t + e_t \tag{5}$$

The nominal interest rate is decomposed into two parts: the expected inflation rate and the ex-ante real interest rate. In the equation (5), coefficient α should capture the average real interest rate and e_t is the error that is a linear combination of a "rational" forecast error accounting for the difference

[2] According to Garcia (1993) due to non-linearities intrinsic to the calculations of the real interest rate and the use of the linear expectation operator, the Fisher effect under uncertainty holds only as an approximation. The cross effect is assumed to be irrelevant.

between actual and expected inflation. A usual test of the Fisher Effect will test that α is constant and β is equal to one, which is also called the "Full Fisher Effect" by Mishkin (1991).

Estimation of the last equation by using OLS (or by any other methods) and finding significant coefficients, give intuitive results for the existence of Fisher relation. However as Granger and Newbold (1974) and Phillips (1986) draw attention, if there exist stochastic trends in the variables of a regression, the results may be spurious. Therefore, a cointegration test for a common trend in inflation and interest rates is needed to apply.

Before moving into the empirical literature, it is worth discussing the implications of Fisher Effect and implied stationarity of the real interest rates in macroeconomics.

Interest rates are important variables for macroeconomists because they link the economy of today and the economy of the future through their effects on saving and investment decisions.

According to monetary neutrality principle, an increase in the rate of money growth raises the rate of inflation but does not affect any real variable. In the application of this principle Fisher Effect hypothesis concerns the effect of money on interest rates. A Full Fisher Effect in the long run implies monetary super-neutrality and no money illusion. This statement means that the real interest rates are determined solely by the marginal productivity of capital, the rate of time preferences and the degree of risk aversion (Christopoulos and Leon-Ledasma, 2005). Main objective in testing the Fisher Effect is to determine whether the real rate of interest will be influenced by the monetary policy or not.

Another implication of the Fisher Effect is that, the movements in interest rates primarily reflect fluctuations in expected inflation, so they become signals of the future inflation. That is; Fisher relation would imply that interest rates are good indicators of inflationary expectations.

The conclusion of the test of Fisher Effect carries another policy implication: If increases in inflationary expectations do not get fully incorporated in nominal interest rates, the government may have motivation to run debt-financed fiscal deficits. That is in an economy where Fisher equation does not hold, the real cost of debt of the government sector will diminish. This issue is particularly relevant for highly inflationary economies.[3]

Economic theory generally assumes that real interest rates follow stationary processes. For instance, the canonical neoclassical growth model with explicitly optimizing, indefinitely lived agents, presumes a stationary real interest rate behavior. According to canonical growth model, the steady-state real interest rate is constant.

Following Barro (1981), Rapach and Weber (2004) give theoretical explanations about the requirement of stationary real interest rate:

> "…consider a permanent tax-financed increase in government purchases. Household experiences a permanent reduction in the present value of their lifetime wealth equal to present value of the permanent increase in government purchases. Households, thus, decrease their consumption in each period by an amount equal to the increase in government purchases each period, leaving the steady-state capital stock and real interest rate unchanged. While a temporary change in government purchases can affect the real interest rate in the canonical growth model, the effect will only be temporary, so that the steady- state real interest rate is still unchanged."

Moreover, stationarity of real interest rate is also a prediction of the standard asset pricing models and it is consistent with super neutrality that can be extended to the issue of inflation which is a monetary phenomenon (Caporale and Pittis, 2004). Hence, nonstationary of real interest rate creates

[3] For an application of this issue in Brazil data, see Garcia (1993).

important problems for some well-known theoretical models. Therefore, testing Full Fisher Effect is also crucial in this respect. Absence of one-to one adjustment of nominal interest rates to expected inflation rates, i.e. Full Fisher Effect will challenge some basic models of economics theory.

The significant issue is whether the ex-ante real interest rate is determined by the expected inflation rate. The consensus among economists is debatable. Although Fisher relation is not justified empirically, there is not agreement on the source of its fluctuations. Cooray (2003) identifies sources of these fluctuations as the following two effects: "wealth effect" is proposed by Mundell (1963) and Tobin (1965); and "tax effect" is suggested by Darby (1975) and Feldstein (1976). Wealth effect says that the nominal effect should rise by less than unity in reaction to a change in inflation through the impact inflation had on the real rate. This means that inflation leads to a fall in real money balances and resulting a fall in wealth which leads to augmented saving by bringing the pressure on real rates downwards (Cooray, 2003). On the other hand, tax effect explanation relies on the existence of taxation of interest income. Taxes are the reason for nominal interest rates would increase by more than unity in response to expected inflation for a given after-tax real interest rate. That implies more than complete adjustment of nominal interest rate to expected inflation. However, Tanzi's (1980) explanation contradicts with the importance of tax effect by way of fiscal illusion, tax evasion and tax exempt agents.

2.2 Applied Studies for Developed Countries

There is a vast literature that examines the validity of Fisher relationship between nominal interest rate and inflationary expectations. Most of the empirical studies on Fisher Effect have focused on the developed economies. Moreover, using US data is common exercise in finding any evidence of Fisher Effect relation. In general it appears that, the power of the Fisher Effect is sensitive to the time period, to the country and to the data frequency.

Absence of any direct measure of inflationary expectations creates the main problem in testing for the Fisher Effect. In order to solve this issue, the majority of early studies on the Fisher Effect used some form of distributed lag on past inflation rates as a proxy for inflationary expectations (Cooray, 2003). However, with the advancement of the theory of rational expectations which is pioneered by Muth (1961) and theory of efficient market advanced by Fama (1970), Fisher hypothesis is reinterpreted to incorporate these theories. Besides Muth and Fama's findings, recent developments, since the late 1980s, in the time series econometrics literature forced a reconsideration of the validity of the tests on the Fisher Effect. For instance, researchers have at their disposal various cointegration techniques due to, for example, Engle and Granger (1987), Johansen and others to test for the existence of a stationary long run relation between series, which are nonstationary, individually (Atkins and Coe, 2002). The possible examples are found in Rose (1988), Mishkin (1992), Wallace and Warner (1993), MacDonald and Murphy (1989), Rapach and Weber (2004).

Cointegration models are widely used in empirical studies of the Fisher Effect. One of the first examples of these studies is Rose (1988). Even though Rose (1988) does not directly use a cointegration method to investigate the constancy of the real interest rate, he sheds some light on the issue of stationarity and the level of integration that are significant in determining before proceeding with the testing of the Fisher Effect in a cointegration framework (Tierney, 2005). In his analysis of the nominal interest rate and inflation, Rose (1988) used annual, quarterly and monthly data for the US with the sample period ranging from 1892 to 1970 and from 1901 to 1950.[4] Using conventional Dickey and Fuller (1979) and Phillips and Perron (1988) unit root tests, Rose (1988) finds evidence for the presence of a unit root in the real interest rate, which contradicts the Fisher relationship.[5] For further verification of results, he also applied unit root tests to prices and nominal interest rates of eighteen OECD countries. The null hypothesis of a unit root was rejected for all eighteen countries, lending support to the results from US data. His conjecture that the ex ante real rate is nonstationary has encouraged a rapidly growing literature that analyses the stochastic properties of the variables in the Fisher identity (Chu et. al., 2003).

Mishkin (1991, 1995) studied the integration properties of inflation, nominal interest rate and real interest rate for the US over different sub-samples by accounting the shifts in the monetary regimes.[6] Contrary to the findings by Rose (1988), Mishkin (1991) concluded that there are unit roots in both the nominal interest rate and the inflation rate based on the augmented Dickey-Fuller tests, which take into consideration heteroscedasticity. Tests for cointegration along the lines of Engle and Granger (1987) to find a common trend in interest rates and inflation supported the evidence for a long run Fisher Effect in the post war U.S. data. Mishkin (1992), in an attempt to explain why there is strong evidence of Fisher effect for some cases but not for others pointed out that the solution is dependent on the existence of the stochastic trends in inflation and interest rate in some samples. When the two series exhibit the same trends, this result gives a strong correlation between

[4] GNP deflator, CPI, the implicit price deflator and wholesale price index variables with the log version were used for inflation. For the nominal interest rates, the one-month interest rate on finance paper, the Euro dollar deposit rate, the rate of one-month certificates of deposit and the one-month T-bill rate were employed.

[5] Rose (1988) found interest rate series to be I(1) series and inflation rate series to be I(0).

[6] Mishkin (1992) used monthly and quarterly data of the one month T-bill as nominal interest rate and CPI as inflation variable with the sample period being from January 1953 to December 1990 with different sub-periods taken into account.

them. Accordingly Mishkin (1992) concludes that when nominal interest rates and inflation exhibit trends, the Fisher Effect is strong.

Mishkin (1995) has another contribution to the literature; he warns about the potential problem of existence of moving average terms in the model. If the time series models of the variables do not show pure autoregressive progress, but rather include important moving average terms, the Dickey- Fuller for unit root can be misleading for small samples. In his paper for Australia, Mishkin concludes that inflation rate suffers from this problem.

Cooray (2003) states that the studies by Bonham (1991), Jacques (1995) and Wallace and Warner (1993), covering a similar time period, confirm Mishkin's findings for the USA. Both of them show that inflation contained a unit root. Wallace and Warner (1993) used an expectations model of the term structure of interest rate and observed that inflation affects both long and short-term interest rates. Wallace and Warner (1993) are the first users of cointegration techniques as proposed by Johansen (1988) and Johansen and Juselius (1990). Quarterly data from the period 1948:1- 1990:4 to test for stable long run relationships between the 3-month inflation rate, 3-month Treasury bills and 10-year government bond rates provide support for existence of a Fisher Effect both in short and long term interest rates and for expectations theory of the term structure.

Bonham's (1991) findings were also consistent with those of Mishkin (1991) and Wallace and Warner (1993). Application of Dickey- Fuller tests to monthly data from 1955:1-1990:3 provided support for stationarity in the first differences of nominal interest rate and inflation.

More recent evidence using unit root and cointegration tests can be found in Rapach and Weber (2004). Their study can be regarded as the most extensive study in unit root and cointegration analysis of many countries in examining Fisher Effect. Rapach and Weber (2004) updated the Rose's

(1988) study in two ways: Firstly, they extended the quarterly data covering the period from 1957 to 2000 for sixteen OECD countries, and secondly, they applied Ng and Perron (2001) unit root tests with better size and power.[7] Generally, Rapach and Weber's findings overlap with Rose's (1988). Besides Engle and Granger (1987) and Phillips and Quliaris (1990) tests, they employed the recently developed cointegration tests of Perron and Rodriguez (2001). All of these tests' results present little robust evidence of a stationary real interest rate for most countries (Rapach and Weber, 2004). In their analysis, instead of Treasury bill rate, long term government bond rates were used as nominal interest rate measure and CPI as an inflation measure. For Australia, Norway and US, the results of unit root test match those of Rose (1988), with a nominal interest rate I(1) and inflation I(0). On the other hand, for two of the 16 countries, Germany and Switzerland, data verify stationary real interest rates-with both variables integrated at degree of zero. Further, for different reasons from Rose (1988), Austria had a nonstationary real interest rate, while nominal interest rate is I(0), the inflation rate is I(1). For the other ten countries both the nominal interest rate and the inflation rate are integrated at degree of one. However, Perron and Rodriguez (2001) cointegration test did not give robust evidence for cointegration for any of the ten countries.

As it was mentioned, empirical studies have focused on nonstationarities of the data and tested the Fisher Effect in a long run relationship using cointegration. A probable obscurity in assessing the time series properties of inflation and nominal interest rate results in structural breaks in the form of infrequent changes in the mean or the drift rate of the series due to distinct exogenous actions (Malliaropulos, 2000). Since standard stationarity tests misinterpret structural breaks as enduring stochastic disturbances, these tests are biased towards nonstationarity (Perron, 1989).

[7] These OECD countries are; Australia, Austria, Belgium, Canada, Denmark, France, Germany, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Switzerland, UK and US.

Recent findings reported by Garcia and Perron (1996), Bekdache (1999), Johansen and Garcia (2000), Malliaropulos (2000), Lai (2004) and Clemente, Montanes and Reyes (2002) indicate that the real interest rate process may have experienced some structural breaks.

Garcia and Johnson (1996) applied regression tree analysis to locate structural breaks in the stochastic process followed by the ex post real interest rate from early 1950s to the 1990s for the US data. One of the most important advantages of regression tree analysis is that it allows the data to determine the number of regime changes as well as their dates. Garcia and Johnson (1996) found changes in mean and variance of the real interest rate process in 1972:04, 1980:01 and 1986:02. Despite the changes in the mean of ex-post real interest rate, their finding is consistent with the Fisher Effect. However, when more detailed analysis is held, the samples overlap and the findings are similar to the regimes found by Garcia and Perron (1996). Garcia and Perron (1996) use the Markow switching method of Hamilton (1989) to locate shifts in the real interest rate.

Malliaropulos' (2000) findings are contradicting Garcia and Perron (1996) and Garcia and Johnson (1996) results. Malliaropulos (2000) investigates the univariate time series properties of the inflation and the nominal interest rate, allowing for structural breaks of unknown timing in the series, with the Zivot and Andrews test (1992). Using quarterly data for the US for the period 1960:01- 1995:03[8], he finds that inflation, nominal and real interest rates are trend-stationary with a structural break both in the mean and the deterministic trend in early 1980s. Using a VAR model, he finds that dynamic effects of inflation on nominal interest rates support results Fisher Effect in medium to long term. Malliaropulos (2000) explains this contradiction as adopting different hypothesis testing method. While these

[8] Nominal interest rates are three month Treasury bill rates. Inflation rate is the one quarter ahead change in the log of CPI.

authors test nonstationarity against the alternative of structural shifts in the mean, Malliaropulos (2000) tests nonstationarity against the joint hypothesis of structural shifts in both the mean and the drift rate of the series.

Lai (2004) paid attention to structural break properties of real interest rate of the US. In his study the expected inflation rate data are directly collected by the University of Michigan’s Survey of Consumers, covering the sample from 1978:01 to 2001:12. He found that the real interest rate may appear nonstationary when it is stationary and a process shift is responsible. The mean shift corresponds to the dramatic reversal of inflation around the late 1980 or the early 1981. Lai (2004) firstly tested the stationarity of real interest rate by augmented Dickey-Fuller tests and modified Dickey-Fuller test that finds no structural breaks. When unit root tests with either a mean shift or a trend shift are applied, significant evidence in favor of no-unit root is found, rejecting the absence of no long run reversion. The no unit root finding confirms the long run Fisher Effect.

Clemente et. al. (2002) study Fisher Effect for G7 countries by taking structural breaks into consideration. The consideration of breaks leads to change in the results of unit root statistics. Unlike most of the previous papers, they found that nominal interest rates and inflation rates of G7 countries are stationary rather than integrated. They also conducted the Bai and Perron procedure to analyze whether breaks in nominal interest rates and inflation rates affect the structural relationship or not. This procedure confirms their hypothesis of the existence of regime changes in the relationship between nominal interest rate and inflation rate. An ARDL polynomial with the addition of dummy variable in order to detect the breaks is used to test the Fisher Effect. According to Clemente et. al. (2002) while the Fisher Effect holds for the US and France certainly there is some possibility for Japan and Italy, the rest of the G7 countries do not show any Fisher Effect evidence (Clemente et. al., 2002).

Previous empirical studies show that the standard unit root tests have failed to reject the unit root hypothesis for postwar samples of developed countries. Additionally, introducing only a structural break was not sufficient for rejecting the presence of a unit root. A recent method called the fractional cointegration analysis deals with the deviations from long run relationship that takes a long time to dissipate before reaching the equilibrium level. If linear combination of inflation and interest rate is a long-memory stationary process, then two series are said to be fractionally co-integrated (Kasman, Kasman and Turgutlu, 2005). Sun and Phillips (2004) employed fractional cointegration process - both the exact Whittle and the log-periodogram approaches - for the US covering the data from 1934:1 through 1999:4. They argue that the empirical results obtained by Rose (1988) and Mishkin (1992, 1995) can be misleading since the ex post version of the Fisher equation appears unbalanced for three reasons: Firstly, the timing of the three components of the Fisher Effect, nominal interest rate, real interest rate and the inflation rate, is different. Secondly the short run dynamics of the three components are not same. The nominal interest rate is mostly less volatile than inflation and ex post real interest rate. Finally, the integration order of the real rate in small samples leads a possibly large forecasting error, which is the reason for false rejection of the null hypothesis of expected inflation containing a unit root. The artificial rejection, coupled with evidence that the nominal interest rate contains a unit root, can lead to the false result that ex ante real interest rate is an I(1) process. Sun and Phillips (2004) introduced the bivariate exact Whittle estimator that allows for the presence of additive perturbations or short memory noise in the data. This new estimator provided a support for the hypothesis that the nominal and real interest rates and inflation rate are integrated of the same order, however there is little support for the long run Fisher Effect (Sun and Phillips, 2004).

One of the recent studies of the literature on the Fisher Effect that uses the cointegration technique belongs to Atkins and Coe (2002). They examined the Fisher Effect for the US and Canadian case for the period of 1953-1999 using Pesaran, Shin and Smith (2001) method. The most important advantage of "Bounds Testing" method is the lack of need for the assumption regarding the integration levels of inflation or interest rate series. Atkins and Coe find positive evidence of Fisher Effect in post-war Canadian and the US data with a wide range of nominal interest rate.

2.3 Applied Studies for Developing Countries

As far as the Fisher Effect in emerging economies is concerned, there are not many studies; the developing countries did not attract much attention in the literature. Berument and Jelassi (2002) have conducted a multi-country analysis in which the Fisher Effect was investigated for both developed and developing countries.[9] Their results are in the line with the suggestion of Olekalns (1996); that is the Fisher Effect is more likely to hold for the developed countries than for the developing countries. Berument and Jelassi (2002) argue that:

> "…removing the restrictions on the free movement of financial asset prices, and allowing market deregulations of interest and exchange rate results in a steadier real rate, as nominal rates of return are free to adjust rapidly to expected inflation movements"

In their study for Brazil, Chile, Greece, Mexico, Turkey, Venezuela and Zambia, the strong version of Fisher Effect is not rejected (Berument and

[9] Fourteen of the twenty six countries were developing ones. They were Brazil, Chile, Costa Rica, Egypt, Greece, India, Kuwait, Mexico, Morocco, Philippines, Turkey, Uruguay, Venezuela, and Zambia.

Jelassi, 2002). Partial adjustment of nominal interest rate to expected inflation is found for Egypt, Morocco, Philippines and Uruguay. On the other hand, for Costa Rica, India and Kuwait no evidence of Fisher relation is found.

Another applied paper for less developed countries on the Fisher Effect is Payne and Ewing (1997). By utilizing the Johansen-Juselius cointegration procedure, their investigation reveals that only four of ten countries- Malaysia, Pakistan, Singapore and Sri Lanka- provide evidence to support the Full Fisher Effect.[10]

Besides Berument and Jelassi (2002) and Payne and Ewing (1997), both of which reach a consensus on the absence of any evidence of Fisher Effect for the Indian case, Paul (1984) finds out that Fisher's hypothesis of the positive relation between inflationary expectations and the nominal interest rate is supported for both short term and long term interest rates in India with some adjustment lag.

Empirical works on the Fisher Effect for the Latin American countries have been undertaken by Carneiro, Divino and Rocha (2002), Garcia (1993), Phylaktis and Blake (1993), Thornton (1996) and Maghyereh and Al-Zoubi (2006). Carneiro et. al. (2002) analyzed the validity of the Fisher Effect for Argentina, Brazil and Mexico, all of which have experienced chronic high inflation initially and reached a stage of relative macroeconomic stabilization, within the period from 1980 to 1997. The cointegration analysis (Johansen, 1988; and Johansen and Juselius, 1990) and exogeneity tests (Engle et. al., 1983; Johansen, 1992; Ericson et. al., 1998) give evidence for stationary real interest rate for the cases of Argentina and Brazil only. However, Phylaktis and Blake (1993) have investigated this hypothesis for these three countries and have confirmed the validity of Fisher Effect for Mexico as well. This contradiction was tried to be explained by Carneiro et. al. (2002)

[10] Other six countries are Argentina, Fiji, India, Niger, Singapore, and Thailand.

> "…they use quarterly data and their sample period is relatively short and does not cover the several stabilization attempts implemented in these countries also leaving out the recent stabilization observed in Latin America."

The Mexican case was also analyzed by Thornton (1996). His conclusion endorses the validity of a stable long-run relationship between nominal interest rate and inflation expectation from the period 1978 to 1994 using two-stage Engle and Granger (1987) method.

Brazilian experience is investigated by Garcia (1993) in a signal extraction framework. The aim is to detect noise that represents the validity of Fisher Effect. Fisher hypothesis seems to reasonably fit the Brazilian evidence, implying that the government cannot have the burden of financing its fiscal deficits ameliorated by issuing debt in periods when the inflation is increasing.

A recent study of Fisher Effect for the developing countries is Maghyereh and Al-Zoubi (2006). They analyze three Latin American countries, Argentina, Brazil and Mexico and three other developing countries which are Malaysia, South Korea and Turkey. They employed nonparametric test of Bierens (2000) which detects the existence of nonlinear cotrending among different macroeconomic time series. They found a linear combination between nominal interest rate and inflation rate for all countries. Furthermore, they conclude that the relationship between the nonlinear trend in the nominal interest rate and inflation rate for all countries is equal to unity, indicating the existence of Full Fisher Effect in the developing countries.

In another recent study by Berument, Ceylan and Olgun (2007), the validity of a positive relationship between the nominal interest rate and expected inflation and the inflation risk effect on the interest rate is checked in 54 developed and developing countries. The simple Fisher relation- without the impact of inflation risk- is tested using a version of the GARCH specification for G7 countries plus 47 developing countries. The Fisher

Effect holds for all the G7 countries and only for 23 developing countries. When the inflation risk is added to the regression, validity of the Fisher Effect is reduced; it holds only 6 of the G7 countries and 18 of the 47 developing countries.

CHAPTER 3

THE ANALYTICAL FRAMEWORK

In this chapter, the analytical framework of the basic model that is used in this study will be presented. In examining the existence of a long run relationship between the nominal interest rate (i_t) and the expected inflation rate ($\prod_{t+1}^{e}$), the autoregressive distributed lag (ARDL); bounds test approach of Pesaran, Shin and Smith (2001) has been adopted.

Testing the evidence of Fisher Effect by adopting the ARDL modeling has numerous advantages. These advantages can be enumerated as follows: Firstly, the OLS based ARDL approach can be applied irrespective of whether the variables are purely I(0), purely I(1) or a mixture of both (Pesaran et. al., 2001). It avoids pre-testing problem associated with the standard cointegration approaches that makes it easy to use. Secondly, the model takes sufficient numbers of lags to capture the data generating process in general-to-specific modeling framework (Launrenceson and Chai, 2003). This approach gives robust results in small sample size while the Johansen cointegration test requires large samples for validity purpose. Finally, dynamic error correction model (ECM) which can be derived from ARDL by a simple linear transformation, integrates the short run dynamics with the long run equilibrium without loss of long run information (Banerjee et. al., 1993). It is also argued that, problems which occur as a result of nonstationary time series data, can be get rid of by adopting ARDL approach (Laurenceson and Chai, 2003).

To illustrate the ARDL modeling approach, following by Atkins and Coe (2002), a general unrestricted VAR in levels is demonstrated as follows:

$$x_t = \mu + \sum_{j=1}^{p} \phi_j x_{t-j} + \varepsilon_t \tag{1}$$

where $x_t = [i_t \quad \Pi_{t+1}]'$; Hence, i_t is the nominal interest rate at time t and Π_{t+1} is the inflation rate at time t+1. These two series i_t and Π_{t+1} can be either I(0) or I(1). By invoking rational expectations, expected inflation rate is proxied by using one period ahead inflation rate. μ represents constant term vectors, $\mu = [\mu_i \quad \mu_\Pi]'$, and ϕ_j is the VAR parameters for lag j matrix. The error term vector is $\varepsilon_t = [\varepsilon_{i,t} \quad \varepsilon_{\Pi,t+1}]'$ ~ IN (0,Ω), where Ω is positive definite.

VAR model in Eq. (1) can be written as a vector error correction model (VECM) as follows:

$$\Delta x_t = \mu + \lambda x_{t-1} + \sum_{j=1}^{p-1} \gamma_j \Delta x_{t-j} + \varepsilon_t \tag{2}$$

where $\Delta = 1 - L$

$$\gamma_j = \begin{bmatrix} \gamma_{ii,j} & \gamma_{i\Pi,j} \\ \gamma_{\Pi i,j} & \gamma_{\Pi\Pi,j} \end{bmatrix} = -\sum_{k=j+1}^{p} \phi_k \tag{3}$$

λ is the long run multiplier matrix and it is demonstrated as:

$$\lambda = \begin{bmatrix} \lambda_{ii} & \lambda_{i\Pi} \\ \lambda_{\Pi i} & \lambda_{\Pi\Pi} \end{bmatrix} = -\left(I - \sum_{j=1}^{p} \phi_j \right) \tag{4}$$

I is a 2 x 2 identity matrix. To investigate only long run effect of the level of inflation rate on the level of the nominal interest rate and to eliminate the long run impact of nominal interest rate on the inflation rate, it is needed to impose the restriction of $\lambda_{\Pi i} = 0$. By this way, inflation rate become a *long-run force* for the nominal interest rate (Pesaran et. al., 2001). However, this restriction allows nominal interest rate to influence the inflation rate in the short run (Atkins and Coe, 2002).

Fisher Effect states that in the long run equilibrium a change in the rate of growth of money supply leads to a fully perceived change in inflation rates and adjustment of nominal interest rates. The Fisher equation is generally formulated as follows:

$$i_t = \theta_0 + \theta_1 \Pi_{t+1} + \upsilon_t \tag{5}$$

where, θ_1 is assumed to be equal to one.

By imposing this restriction ($\lambda_{\Pi i} = 0$), Fisher relation can be reinterpreted as an ARDL (p, q) as follows:

ARDL (p, q):

$$\Delta i_t = \alpha + \delta_1 i_{t-1} + \delta_2 \Pi_t + \sum_{j=1}^{p-1} \beta_{i,j} \Delta i_{t-j} + \sum_{j=1}^{q-1} \beta_{\Pi,j} \Delta \Pi_{t+1-j\ ,\ j} + u_t \tag{6}$$

"p" and "q" are the number of lagged differences of nominal interest rate and inflation rate, respectively. In Eq. (6) the parameters of $\beta_{i,j}$ and $\beta_{\Pi,j}$ are the short run dynamics of the model, whereas δ_1 and δ_2 represent long run relationship. In Eq. (6) the null hypothesis which indicates the nonexistence of a stable long run level relationship is demonstrated as follows with its alternative hypothesis:

H_o: $\delta_1 = \delta_2 = 0$

H_1: $\delta_1 \neq 0$ and $\delta_2 \neq 0$

Under the alternative hypothesis there is a single long run relationship between the two variables which is described by Eq. (5):

$$i_t = \theta_0 + \theta_1 \Pi_{t+1} + \upsilon_t$$

where $\theta_0 = -\alpha/\delta_1$ and $\theta_1 = -\delta_2/\delta_1$ and υ_t is a mean zero stationary process. When the long run parameter, θ_1 from Eq. (5), is equal to 1, the nominal interest rate adjusts one-for-one with movements in inflation rate as the Full Fisher Effect implies.

Estimation of Eq. (6) by OLS and calculation of F-statistics for the null hypothesis give the evidence for Fisher Effect. However the F-test used for this procedure has a non-standard distribution, irrespective of whether the underlying explanatory variables are purely I(0) or I(1). Therefore Pesaran et. al. (2001) developed a table for the critical values of different combination of integrated series. There are two critical values: upper and lower critical values and there are three cases for decision:

(i) If the test statistic is above an upper critical value, the null hypothesis can be rejected irrespective of whether the nominal interest rate and inflation rate are integrated order of zero or one.

(ii) If the test statistic is between the upper and lower critical values, the conclusion is inconclusive.

(iii) If the test statistic falls below a lower critical value, the null hypothesis is accepted, Fisherian relation is disclaimed.

CHAPTER 4

THE DATA PROCESS

4.1 Characteristics of the Data

This study concerns with the multi-county analysis of Fisher Effect, specifically for ten developed countries and ten developing ones. The first step in the analysis is to determine which variables to use. Nominal interest rate data is composed of quarterly observations of mostly Treasury bill rate. When the Treasury bill rate is not available, lending rate, deposit rate, and saving deposit rates are used. Treasury bill rate is the rate that shows a short term debt obligation backed by government with a maturity of less than one year. On the other hand, lending rate is the rate at which short and medium term private sector's financing needs are met. Since lending rate is the most risk free measure of interest rates after the Treasury bill rate, it is chosen when the Treasury bill rate is not obtainable (Berument and Jelassi, 2002). When both of the two rates are not available, deposit rate, saving deposit rate or government bond yield rate are employed. The Consumer Price Index (CPI) is used to measure the inflation rate for each country.

In view of the fact that annual data may cause aggregation bias as suggested by Rosanna and Seater (1995), annual data is not used. Study period starts from 1985:Q1 and comes to 2006 for most of the countries. The two of the three exceptions are Denmark and Finland for which the most recent available observations are used. The third exception is Turkey for which data starts from 1991:Q4.

All the series examined in this study -nominal interest rates and inflation rates- are collected from the IMF's International Financial Statistics (IFS) tape, except for Turkey. Turkish nominal interest rate data are collected from the Istanbul Stock Exchange Market.

Table 4.1 reports the countries which are examined, the definitions of the nominal interest rates and the sample periods of each country.

Table 4.1 List of the Studied Countries in the Analysis of Fisher Effect

Country	**Interest Rate**	**Study Period**
Developed Countries		
Canada	Treasury bill rate	1985:Q1- 2006:Q2
Denmark	Lending rate	1985:Q1- 2002:Q4
Finland	Lending rate	1985:Q1- 2005:Q3
France	Government Bond Yield	1985:Q1- 2006:Q2
Germany	Treasury bill rate	1985:Q1- 2006:Q3
Italy	Treasury bill rate	1985:Q1- 2006:Q3
Japan	Lending rate	1985:Q1- 2006:Q2
Norway	Deposit rate	1985:Q1- 2006:Q3
United Kingdom	Treasury bill rate	1985:Q1- 2006:Q1
United States	Treasury bill rate	1985:Q1- 2006:Q3
Developing Countries		
Argentina	Deposit rate	1985:Q1- 2006:Q3
Brazil	Saving deposit rate	1985:Q1- 2006:Q3
Chile	Lending rate	1985:Q1- 2006:Q3
Malaysia	Treasury bill rate	1985:Q1- 2006:Q3
Mexico	Treasury bill rate	1985:Q1- 2006:Q3
India	Lending rate	1985:Q1- 2006:Q2

Israel	Treasury bill rate	1985:Q1- 2006:Q2
Singapore	Treasury bill rate	1985:Q1- 2006:Q3
South Korea	Lending rate	1985:Q1- 2006:Q2
Turkey	Treasury bill rate	1991:Q4- 2006:Q1

Abbreviations and explanations of the variables that are used in the Fisher Effect analysis are presented below:

CPI: Consumer price index. The serial codes of the CPI for each country are demonstrated in the appendix A. For Germany, two indexes are unified: Before 1991: Q1 West Germany series and after 1991: Q1 Unified Germany series exist. The combination of these two series is used in the analysis.

INF: Inflation rate, which is measured by the percentage change in the level of the quarterly observations of the CPI. It is calculated by the following formula:

$$\Pi_t = \left(\frac{CPI_t - CPI_{t-1}}{CPI_{t-1}} \right) * 100$$

TBR: Treasury bill rate. For Canada, Germany, Italy, Israel, Malaysia, Mexico, Singapore, Turkey, United Kingdom, and United States, Treasury bill rates are used as a proxy of nominal interest rate.

LR: Lending rate. For Denmark, Finland, France Japan, Chile, India, and South Korea lending rate is used as a proxy of nominal interest rate.

SDR: Saving deposit rate. Brazil's saving deposit rate is used as a proxy of nominal interest rate in the Fisher analysis.

DR: Deposit rate. It is used only for Argentina and Norway.

GBY: Government bond yield. It is used only for France.

Time series plots and descriptive statistics of the nominal interest rate and the inflation rate are given in Figure 4.1 and Figure 4.2, and Table 4.2, respectively.

<u>Figure 4.1: Time Series Plots of the Variables of the Developed Countries</u>

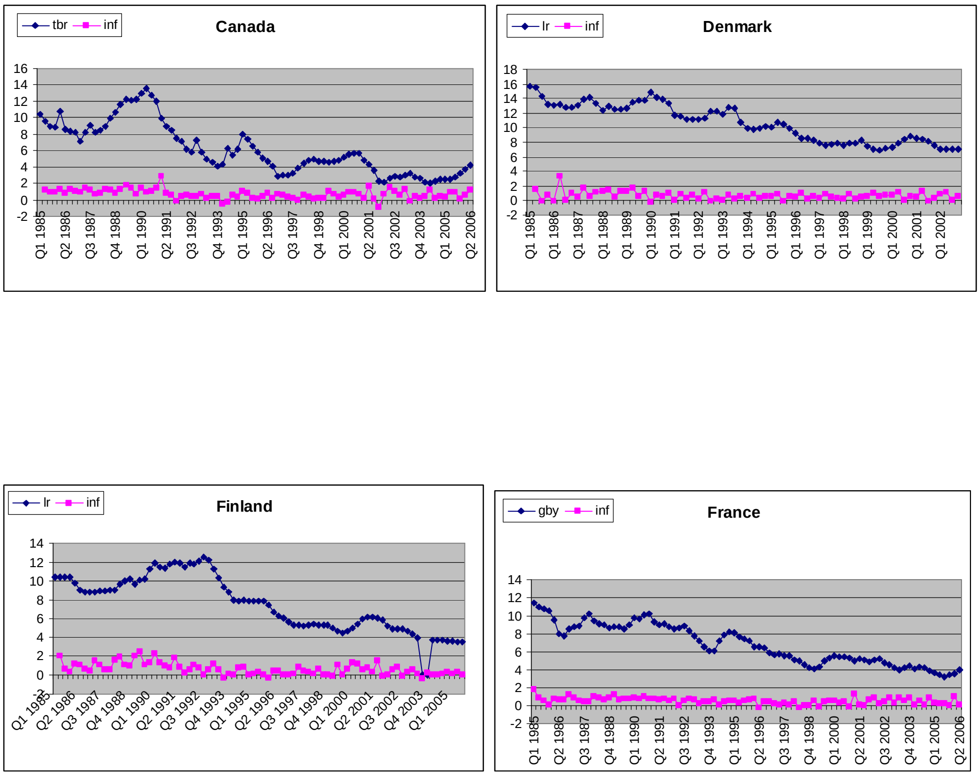


Figure 4.1 (cont’d)

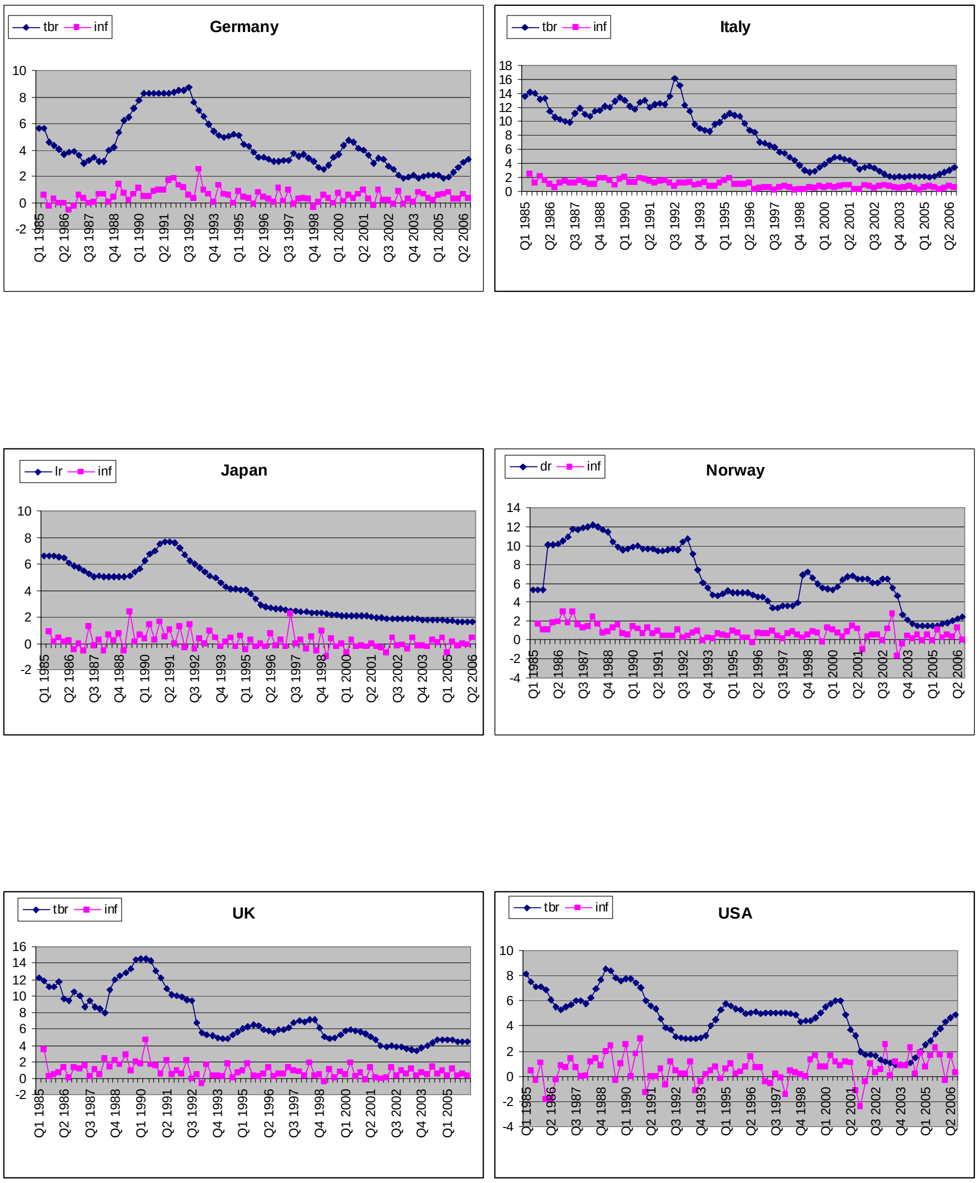
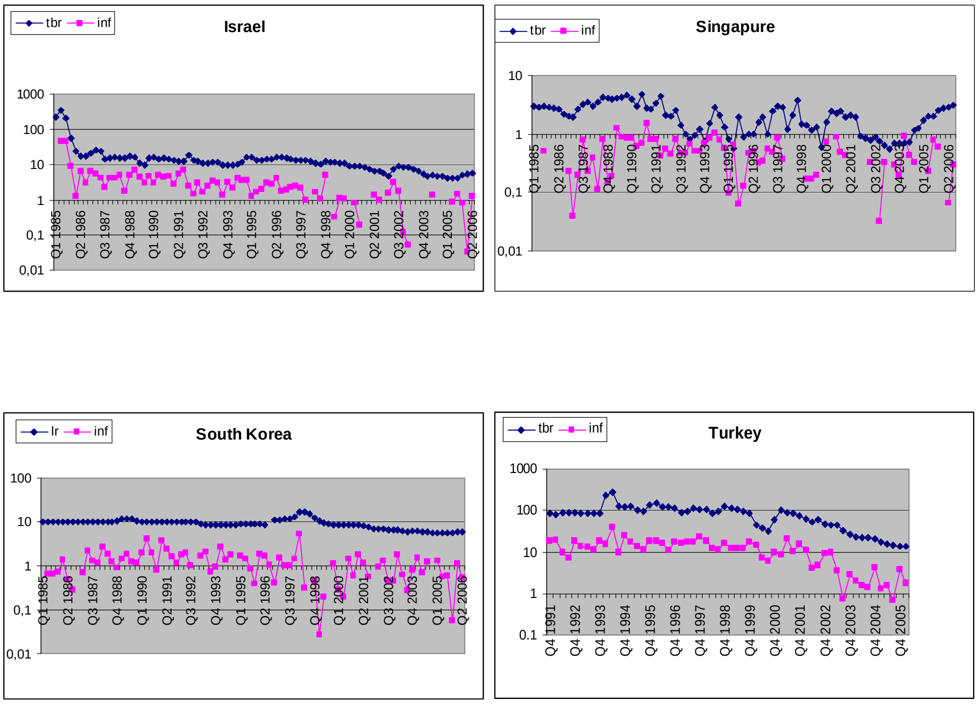


Figure 4.2: Time Series Plots of the Variables of the Developing Countries[1]

[1] The vertical axes of the graphs are in the logarithmic scale for developing countries. When the logarithmic scale is used, the fluctuations of the variables can be seen more obviously.

Figure 4.2 (cont'd)



Following facts can be observed from Figure 4.1 and Figure 4.2. Firstly, there is a tendency of decline in the nominal interest rate in most of the developed countries during the period of analysis. Secondly, inflation rates of the developed countries are relatively more stable than the interest rates. Finally, for Argentina, Brazil, Chile, Malaysia, Mexico and Turkey nominal interest rate and inflation rate series move in the same direction.

Table 4.2 Descriptive Statistics Table of Nominal Interest Rates

	Canada	Denmark	Finland	France	Germany	Italy	Japan	Norway	UK	USA
Mean	6.139733	10.64585	7.689519	6.820512	4.349184	7.926149	3.856012	6.703161	7.353453	4.724823
Median	5.305000	10.75000	7.853000	6.593500	3.677000	8.777000	3.130000	6.080000	5.998500	5.040000
Maximum	13.60000	15.63300	12.51000	11.43300	8.700000	16.12700	7.690000	18.41500	14.51000	8.533000
Minimum	2.001000	6.900000	3.495000	3.263000	1.817000	1.980000	1.613000	0.000000	3.410000	0.917000
Std. Dev.	3.114107	2.589890	2.785198	2.235084	1.972840	4.306932	1.973764	3.470571	3.185100	1.972850
Skewness	0.640014	0.066952	0.124713	0.167237	0.879771	-0.036827	0.404161	0.399925	0.770961	-0.223567
Kurtosis	2.400966	1.636136	1.643092	1.739866	2.695498	1.484496	1.679047	2.993654	2.349855	2.411255
Sum	528.0170	766.5010	622.8510	586.5640	378.3790	689.5750	331.6170	583.1750	632.3970	411.0596
Sum Sq. Dev.	824.3015	476.2348	620.5860	424.6259	334.7204	1595.271	331.1382	1035.858	862.3132	334.7237
Observations	86	72	81	86	87	87	86	87	86	87

Table 4.2 (cont'd)

	Argentina	Brazil	Chile	Malaysia	Mexico	India	Pakistan	Israel	S. Korea	Turkey
Mean	931.0783	563.7322	20.44329	4.535598	30.32838	14.55815	20.92945	2.102092	9.065023	82.33128
Median	10.67700	14.36800	17.22700	4.173000	18.69800	15.00000	12.10950	1.993000	9.191500	85.68500
Maximum	67666.40	10219.50	56.29500	8.879000	134.4730	20.00000	355.4670	4.827000	17.27700	278.3300
Minimum	2.330000	7.664000	4.991000	2.050000	4.583000	10.75000	4.038000	0.540000	0.000000	13.78000
Std. Dev.	7260.990	1615.419	12.04373	1.820560	28.30603	2.485313	48.14228	1.113522	2.459296	49.40124
Skewness	9.080599	4.297819	0.841206	0.421444	1.703867	-0.021670	5.507254	0.454277	0.150195	1.252557
Kurtosis	83.94013	23.25813	3.143987	1.852084	5.447439	1.895800	34.02484	2.301947	6.003594	6.509738
Sum	81003.81	37206.33	1778.566	394.5970	2608.241	1252.001	1799.933	182.8820	779.5920	4775.214
Sum Sq. Dev.	4.53E+09	1.70E+08	12474.43	285.0417	68104.65	525.0263	197002.7	106.6341	514.0915	139107.5
Observations	87	66	87	87	86	86	86	87	86	58

Table 4.3 Descriptive Statistics Table of Inflation Rates

	Canada	Denmark	Finland	France	Germany	Italy	Japan	Norway	UK	USA
Mean	0.672639	0.669279	0.620553	0.620553	0.545736	0.953771	0.164425	0.780114	0.897364	0.568979
Median	0.660679	0.597534	0.522949	0.522949	0.407009	0.852554	0.032638	0.675426	0.623653	0.638237
Maximum	2.904703	3.317838	2.482836	2.482836	26.71256	2.398639	2.383274	2.994428	4.680339	3.014131
Minimum	-0.882495	-0.208315	-0.415021	-0.415021	-21.11337	0.185625	-0.994785	-1.662344	-0.668317	-2.442469
Std. Dev.	0.553180	0.557710	0.620030	0.620042	3.718730	0.498677	0.618740	0.750458	0.856307	1.018112
Skewness	0.509372	1.568300	0.837264	0.837324	1.786393	0.710603	1.200344	0.382067	1.493301	-0.289369
Kurtosis	5.272279	8.480336	3.331624	3.331583	42.87937	2.933526	4.995261	5.009046	6.759520	3.475816
Sum	57.17429	47.51884	50.88535	50.88536	46.93333	82.02428	13.97616	67.08980	75.37857	48.93220
Sum Sq. Dev.	25.70465	21.77281	31.13946	31.14061	1175.461	21.13766	32.15850	47.87087	60.86077	88.10695
Observations	85	71	82	82	86	86	85	86	84	86

Table 4.3 (cont'd)

	Argentina	Brazil	Chile	Malaysia	Mexico	India	Pakistan	Israel	S. Korea	Turkey
Mean	23.94920	26.90093	2.484288	0.664975	5.923288	1.848171	1.849068	3.362102	1.134311	11.84274
Median	1.598871	2.182781	1.578618	0.631171	3.142731	1.960800	1.706381	1.939432	1.051105	11.97000
Maximum	566.9528	196.0022	12.24086	2.611815	38.90446	6.234253	5.394576	47.65840	5.257143	40.53000
Minimum	-1.044161	-0.354099	-0.355761	-0.606266	0.013785	-3.923185	-0.651631	-1.282063	-0.677075	0.707000
Std. Dev.	75.73816	46.93389	2.212614	0.540013	7.352359	1.712952	1.222142	7.167653	0.936697	7.401183
Skewness	5.437624	1.881701	1.496041	0.806069	2.253811	-0.135250	0.543331	5.487432	1.490082	0.789226
Kurtosis	35.52965	5.752303	6.216441	4.698916	8.098620	3.706659	3.150007	34.00712	7.280350	5.155946
Sum	2059.631	1775.462	213.6487	57.18788	509.4027	157.0946	159.0198	285.7787	96.41642	686.8790
Sum Sq. Dev.	487582.9	143181.3	416.1313	24.78720	4594.860	246.4731	126.9587	4315.521	73.70165	3122.318
Observations	86	66	86	86	86	85	86	85	85	58

When the Table 4.2 is examined, the following facts can be observed. While the standard deviations of nominal interest rates are low for developed countries, the same statistics for the developing countries are relatively high. Similarly, skewness statistics for developed countries vary around zero, implying a symmetric distribution; the same statistic indicates a high value for developing countries especially for Argentina and Brazil. The same observations apply for the kurtosis statistics.

The Table 4.3 shows the descriptive statistics of inflation rates. The standard deviations of the inflation rates are low for developed countries; then again, the same statistics are relatively high especially for Argentina, Brazil, Mexico, Israel and Turkey in developing countries. The similar pattern can be observed for skewness and kurtosis statistics between the developed and developing countries.

CHAPTER 5

THE EMPIRICAL ANALYSIS

It is canonical to assume that the data series are stationary in time series econometrics. The classical regression model requires that all the variables- both dependent and independent variables- in a regression need to be stationary, otherwise “spurious regression” problem as Granger and Newbold (1974) suggested occurs. Nevertheless, one of the advantages of the Ordinary Least Squares (OLS) estimation based on the Autoregressive Distributed Lag (ARDL) framework is that it avoids pre-testing problem associated with standard cointegration analysis. Broadly speaking, this procedure can be applied irrespective of whether the variables are purely I(0), purely I(1) or a mixture of both. However, it seems convenient to investigate the unit root properties of the data because, this approach fails in the presence of I(2) series. Existence of I(2) variables will lead spurious results, the computed F-statistic provided by Pesaran et. al. (2001) for the bounds test is not going to be valid.

Before we carry on the ARDL bounds test, we will examine the stationarity of all variables to eliminate the possibility of I(2) variables. After that the results of the bounds test are presented which will inquire the existence of a long run relationship between the nominal interest rate and inflation rate. Thirdly, the results of the analysis will be compared with the previous multi-country analyses.

5.1 Unit Root Tests:

Firstly, stationarity of nominal interest rates and inflation rates is tested using the familiar augmented Dickey-Fuller (ADF) tests (Dickey and Fuller, 1979). The ADF test is based on the OLS t-statistic corresponding to β_0 in the regression model:

$$\Delta y_t = b_0 + \beta_0 y_{t-1} + \sum_{j=1}^{k} \beta_i \Delta y_{t-j} + e_{tk} \qquad (1)$$

where t = 1,…..,T. the null hypothesis of $\beta_0 = 0$, corresponding to a unit root in y_t is tested against the one-sided alternative hypothesis of $\beta_0<0$, corresponding to the stationary of y_t . In addition to the conventional unit root test of ADF, we use Phillips and Perron (1988) unit root test, hereafter referred to as P-P. By employing the P-P unit root test, we can be more confident that rejections of the null hypothesis of nonstationarity are not due to size distortions. By this way, the probability of nonrejection of a false null hypothesis declines.

ADF and PP test statistics for each country are reported in Table 5.1 and 5.2. Lag length for the ADF tests are selected by looking at the Akaike Information Criteria (AIC). The results in Table 5.1 and 5.2 indicate the existence of a mixture of I(1) and I(0) variables and therefore guarantees that the ARDL testing could be proceeded.

The regressions on which the unit root tests are based include a constant with no trend for both levels and first differences of the variables. The critical values for rejection of a unit root are from MacKinnon (1991). The critical values of ADF test statistic at the 1%, 5%, and 10% significance levels are -3.513, -2.897 and -2.586 respectively. Similarly, the critical values of P-P unit root test statistic at 1%, 5%, and 10% significance levels are -3.509, -2.895, and -2.585, respectively.

Table 5.1: Unit Root Test Results of the Nominal Interest Rate Variables

	A. Levels				B. First Differences				
	Test Statistics		p-values		Test Statistics		p-values		
Country	ADF	P-P	ADF	P-P	ADF	P-P	ADF	P-P	Decision
Argentina	-9.193	-9.193	0.000	0.000	-	-	-	-	I (0)
Brazil	-3.829	-3.824	0.004	0.004	-	-	-	-	I (0)
Canada	-2.032	-1.668	0.272	0.443	-3.870	-7.865	0.003	0.000	I (1)
Chile	-0.831	-2.922	0.804	0.046	-5.806	-15.063	0.000	0.001	I (1)
Denmark	-0.595	-1.504	0.863	0.528	-6.480	-6.421	0.000	0.000	I (1)
Finland	-0.550	-0.550	0.828	0.874	-4.720	-4.692	0.002	0.000	I (1)
France	-0.264	-1.729	0.924	0.412	-7.529	-5.950	0.000	0.000	I (1)
Germany	-2.178	-1.569	0.215	0.493	-5.440	-5.615	0.000	0.000	I (1)
India	-1.067	-0.770	0.724	0.822	-5.839	-5.899	0.000	0.000	I (1)
Israel	-1.190	-10.61	0.674	0.000	-6.453	-	0.000	-	I (0)
Italy	-1.060	-1.122	0.727	0.703	-5.002	-6.517	0.000	0.000	I (1)
Japan	-1.150	-1.086	0.691	0.718	-3.599	-3.257	0.007	0.020	I (1)
Malaysia	-1.652	-12.87	0.451	0.341	-8.816	-8.859	0.000	0.000	I (1)
Mexico	-2.451	-2.281	0.131	0.180	-5.075	-9.894	0.000	0.000	I (1)
Norway	-1.451	-948	0.553	0.308	-8.368	-14.070	0.000	0.000	I (1)
Singapore	-1.854	-3.032	0.352	0.030	-4.089	-	0.001	-	I (0)
S.Korea	-2.351	-2.975	0.158	0.041	-12.256	-	0.000	-	I (0)
Turkey	-0.947	-2.225	0.765	0.199	-4.890	-9.164	0.000	0.000	I (1)
UK	-1.576	-1.587	0.490	0.484	-6.614	-6.582	0.000	0.000	I (1)
USA	-1.972	-2.201	0.298	0.207	-3.510	-4.397	0.01	0.000	I (1)

Table 5.2: Unit Root Test Results of the Inflation Rate Variables

	A. Levels				B. First Differences				
	Test Statistics		p-values		Test Statistics		p-values		
Country	ADF	P-P	ADF	P-P	ADF	P-P	ADF	P-P	Decision
Argentina	-3.425	-6.472	0.012	0.000	-	-	-	-	I (0)
Brazil	-2.338	-2.007	0.163	0.283	-5.538	-8.148	0.000	0.000	I (1)
Canada	-6.259	-6.207	0.000	0.000	-	-	-	-	I (0)
Chile	-1.388	-5.495	0.583	0.000	-5.481	-	0.000	-	I (0)
Denmark	-1.965	-10.81	0.310	0.000	-5.473	-	0.000	-	I (0)
Finland	-1.404	-5.436	0.576	0.000	-6.059	-	0.000	-	I (0)
France	-1.507	-7.911	0.524	0.000	-5.496	-	0.000	-	I (0)
Germany	-12.815	-24.57	0.001	0.000	-	-	-	-	I (0)
India	-2.830	-7.794	0.057	0.000	-6.337	-	0.000	-	I (0)
Israel	-2.03	-10.93	0.272	0.000	-10.395	-	0.000	-	I (0)
Italy	-1.484	-4.603	0.536	0.003	-4.027	-	0.002	-	I (0)
Japan	-2.135	-11.56	0.231	0.000	-12.085	-	0.000	-	I (0)
Malaysia	-2.694	-7.298	0.073	0.000	-11.014	-	0.000	-	I (0)
Mexico	-2.636	-2.476	0.089	0.124	-4.123	-10.603	0.001	0.000	I (1)
Norway	-3.241	-6.748	0.021	0.000	-	-	-	-	I (0)
Singapore	-3.851	-5.641	0.003	0.000	-	-	-	-	I (0)
S. Korea	-2.641	-7.794	0.088	0.000	-6.119	-	0.000	-	I(0)
Turkey	-2.177	-4.124	0.216	0.001	-14.292	-	0.000	-	I (0)
UK	-1.984	-8.975	0.292	0.000	-3.247	-	0.021	-	I (0)
USA	-3.704	-7.438	0.005	0.000	-	-	-	-	I (0)

ADF and PP tests for levels and first differences of nominal interest rate are presented in panel A and B of Table 5.1, respectively. When we look at the Table 5.1, we notice that the nominal interest rate variables are stationary after differencing once for most of the countries. The five exceptions are Argentina, Brazil, Israel, Singapore and S. Korea for which nominal interest rate variables are stationary in levels. PP unit root test results confirm ADF results for most of the countries.

Table 5.2 which present the unit root test results for inflation rates in levels and first differences show that, P-P unit root test results contradict with the ADF statistics. ADF test can not reject the null hypothesis of unit root for inflation rate in levels for 13 countries. However, P-P test rejects the null of unit root for 18 countries. Considering the fact that P-P is more dependable in small samples, we based our decision mainly on the P-P test. Combining the test results of the unit root hypothesis that are reported in panel A and B of Table 5.2, we conclude that all the inflation rates are stationary processes in levels, except for Brazil and Mexico. Brazil's and Mexico's inflation rates are I(1).

5.2 Bounds Tests for Cointegration

To test the effect of inflation rate on nominal interest rates, the following relationship is examined:

ARDL (p, q):

$$\Delta i_t = \alpha + \delta_1 i_{t-1} + \delta_2 \prod_t + \sum_{j=1}^{p-1} \beta_{i,j} \Delta i_{t-j} + \sum_{j=1}^{q-1} \beta_{\Pi,j} \Delta \prod_{t+1-j\ ,\ j} + u_t \qquad (2)$$

where i_t is the nominal interest rate, and $\prod_t$ represents the inflation rate[1]. In order to estimate equation (2), the optimum number of lags included must be decided on. For this purpose, the ARDL method estimates $(p_{max} + 1)^k$ number of regressions, where "p_{max}" is the maximum lag length and "k" is the number of variables in the equation. Next, we have started from a general model in which all variables have five lags.

Considering the length and frequency of our data set, "5" lags are selected as the maximum lag (p_{max})[2]. Then, the optimal orders of lags with an optimal functional form are determined not only by minimizing the AIC or SIC criteria, but also by taking into account the autocorrelation and by omitting the insignificant variables. AIC and SIC indicate the same number of lags, approximately. Once the optimal lag length is determined, equation (2) is estimated via OLS method for each country.

After that, the F-test will be conducted for the joint significance of the coefficients of the lagged levels of variables (for δ_1 and δ_2) in order to test for the existence of long run relationship among the variables. Broadly speaking, the validity of the Fisher Effect is checked by testing the null hypothesis that there exists no relationship between the variables of the model, corresponding to nonexistence of Fisher relationship, against the alternative of the existence a long run relationship. The stable long run level relationship between the nominal interest rate and the inflation rate, formulation of the Fisher Effect, is also described as follows[3]:

$$i_t = \theta_0 + \theta_1 \prod_{t+1} + \upsilon_t \tag{3}$$

[1] See chapter 3 for detailed information about equation 2.

[2] Since the models for Canada and France do not provide a good fit, we enlarge the maximum lag length to eight only for these countries.

[3] See chapter 3 for detailed information about equation 3.

These regressions are carried out separately for twenty countries. All the estimated models are given in Table 5.3. To denote first differences of the variables, "D" prefix is used. "Dvariable (i)" denotes i-period lagged form of the variable in first differences.

Table 5.3: Estimation Results from ARDL Models

Argentina:

(1) Argentina: ARDL (4, 2), Dependent Variable: DDR

Regressors	Coefficients	Standard Error	T-Ratio
C	-691.8671	424.5251	-1.629744
DR(-1)	-2.559489	0.410569	-6.234008
INF	132.2688	24.20069	5.465496
DDR(-1)	-0.171026	0.335937	-0.509102
DDR(-2)	0.757075	0.142106	5.327537
DDR(-3)	-0.346810	0.124713	-2.780862
DINF	128.0819	26.32375	4.865639

Key Regression statistics:
$R^2 = 0.907$
Durbin-Watson Statistic: 2.251
$F_{(3,83)} = 106.04$ (0.000)

Diagnostic Test Statistics:
Autocorrelation $F_{(4, 72)} = 2.497$ (0.051)
Heteroscedasticity $F_{(12, 70)} = 18.75$ (0.000)

Table 5.3 (cont'd)

Brazil:

(2) Brazil: ARDL (5, 4) , Dependent Variable: DSDR			
Regressor	Coefficients	Standard Error	T-Ratio
C	22.60872	53.77333	0.420445
SDR(-1)	1.134696	0.161437	7.028703
INF	-24.89286	4.140898	-6.011466
DSDR(-1)	-1.327966	0.176363	-7.529728
DSDR(-2)	-0.496951	0.148765	-3.340503
DSDR(-3)	-0.067469	0.050057	-1.347858
DSDR(-4)	-0.008256	0.033987	-0.242929
DINF	106.8672	7.094548	15.06328
DINF(-1)	47.06677	8.174104	5.758034
DINF(-2)	16.53546	7.349448	2.249892

Key Regression Statistics:
$R^2 = 0.952$
D-W Statistic: 1.874
$F_{(4, 81)} = 102.43$ (0.000)

Diagnostic Test Statistics:
Autocorrelation $F_{(4,47)} = 1.519$ (0.211)
Heteroscedasticity $F_{(9,75)} = 236.32$ (0.000)

Table 5.3 (cont'd)

Canada:

(3) Canada: ARDL (6, 8), Dependent Variable. DTBR			
Regressor	Coefficient	Standard Error	T-Ratio
C	0.177558	0.188829	0.940308
TBR(-1)	-0.068635	0.043899	-1.563471
INF	0.332631	0.397538	0.836727
DTBR(-1)	0.428802	0.124053	3.456597
DTBR(-2)	-0.112104	0.125223	-0.895237
DTBR(-3)	0.382692	0.116408	3.287512
DTBR(-4)	-0.227400	0.112196	-2.026806
DTBR(-5)	0.148749	0.113447	1.311183
DINF	-0.336802	0.396016	-0.850474
DINF(-1)	-0.277672	0.370736	-0.748974
DINF(-2)	-0.378963	0.344949	-1.098605
DINF(-3)	-0.310992	0.315333	-0.986234
DINF(-4)	-0.369246	0.270538	-1.364860
DINF(-5)	-0.222031	0.217880	-1.019048
DINF(-6)	-0.297067	0.169593	-1.751644

Key Regressions:
R^2= 0.296
D-W Statistic: 1.98
$F_{(15,63)}$ = 1.794 (0.050)

Diagnostic Test Statistic
Autocorrelation $F_{(4, 59)}$ = 0.816 (0.519)
Heteroscedasticity $F_{(18, 49)}$ = 1.989 (0.017)

Table 5.3 (cont'd)

Chile:

(4) Chile: ARDL (3, 2), Dependent Variable. DLR			
Regressor	Coefficients	Standard Error	T-Ratio
C	1.811308	0.741741	2.441968
LR(-1)	-0.309746	0.081275	-3.811070
INF	1.801410	0.488266	3.689404
DLR(-1)	-0.028830	0.054164	-0.532281
DLR(-2)	0.067603	0.048546	1.392563
DINF	2.834978	0.480477	5.900339

Key Regressions:
$R^2 = 0.854$
D-W Statistic: 2.08
$F_{(6,78)} = 76.25$ (0.000)

Diagnostic Test Statistic
Autocorrelation $F_{(4,74)} = 0.704$ (0.591)
Heteroscedasticity $F_{(10,73)} = 1.66$ (0.106)

Denmark:

(5) Denmark: ARDL (2, 5), Dependent variable: DLR			
Regressor	Coefficients	Standard Error	T-Ratio
C	0.103744	0.272867	0.380201
LR(-1)	-0.077239	0.028091	-2.749633
INF	0.944672	0.279670	3.377805
DLR(-1)	0.175566	0.114859	1.528536
DINF	-1.073877	0.289589	-3.708285
DINF(-1)	-0.810321	0.252996	-3.202906
DINF(-2)	-0.755419	0.213729	-3.534462
DINF(-3)	-0.592743	0.153643	-3.857920

Key Regressions:
$R^2 = 0.309$
D-W Statistic: 2.00
$F_{(8,59)} = 3.59$ (0.001)

Diagnostic Test Statistic
Autocorrelation $F_{(4, 55)} = 0.974$ (0.429)
Heteroscedasticity $F_{(14.52)} = 1.508$ (0.141)

Table 5.3 (cont'd)

Finland:

(3) Finland: ARDL (2, 3), Dependent Variable. DLR			
Regressor	Coefficients	Standard Error	T-Ratio
C	0.061514	0.106180	0.579334
LR(-1)	-0.048468	0.015878	-3.052468
INF	0.399092	0.101425	3.934855
DLR(-1)	0.372761	0.101886	3.658618
DINF	-0.238717	0.086387	-2.763350
DINF(-1)	-0.188997	0.069503	-2.719251

Key Regressions:
R^2= 0.424
D-W Statistic: 1.89
$F_{(6, 70)}$ = 9.709 (0.000)

Diagnostic Test Statistic
Autocorrelation $F_{(4, 66)}$ = 0.918 (0.458)
Heteroscedasticity $F_{(10, 65)}$ = 3.31 (0.001)

France:

(7) France: ARDL (5, 3) , Dependent Variable: DGBY			
Regressor	Coefficients	Standard Error	T-Ratio
C	0.064707	0.155376	0.416450
GBY(-1)	-0.063603	0.028358	-2.242838
INF	0.597215	0.241408	2.473883
DGBY(-1)	0.603106	0.107127	5.629823
DGBY(-2)	-0.452099	0.123331	-3.665725
DGBY(-3)	0.362886	0.121826	2.978721
DGBY(-4)	-0.360593	0.106910	-3.372868
DINF	-0.309088	0.196955	-1.569332
DINF(-1)	-0.247599	0.141454	-1.750388

Key Regressions:
R^2= 0.426
D-W Statistic: 2.155
$F_{(9, 65)}$ = 5.738 (0.000)

Diagnostic Test Statistic
Autocorrelation $F_{(4, 61)}$ = 2.413(0.058)
Heteroscedasticity $F_{(16, 57)}$ = 0.599 (0.871)

Table 5.3 (cont'd)

Germany:

(8) Germany: ARDL (4, 2) , Dependent Variable: DTBR

Regressor	Coefficients	Standard Error	T-Ratio
C	0.174740	0.089564	1.951003
TBR(-1)	-0.042798	0.018759	-2.281505
INF	0.028284	0.019508	1.449904
DTBR(-1)	0.423413	0.108886	3.888589
DTBR(-2)	0.080576	0.115800	0.695820
DTBR(-3)	0.201003	0.110686	1.815977
DINF	-0.017579	0.011043	-1.591814

Key Regressions:
R^2= 0.349
D-W Statistic: 1.99
$F_{(7,76)}$ = 5.857 (0.000)

Diagnostic Test Statistic
Autocorrelation $F_{(4, 72)}$ = 0.780 (0.541)
Heteroscedasticity $F_{(12, 70)}$ = 0.724 (0.722)

India:

(9) India: ARDL (2, 1), Dependent Variable: DLR

Regressor	Coefficients	Standard Error	T-Ratio
C	0.256356	0.278251	0.921312
LR(-1)	-0.020596	0.019457	-1.058534
INF	0.004134	0.028615	0.144480
DLR(-1)	0.412695	0.106230	3.884940

Key Regressions:
R^2= 0.169
D-W Statistic: 1.96
$F_{(4,80)}$ = 5.599 (0.002)

Diagnostic Test Statistic
Autocorrelation $F_{(4, 76)}$ = 0.157 (0.959)
Heteroscedasticity $F_{(6,77)}$ = 3.611 (0.003)

Table 5.3 (cont'd)

Israel:

(10) Israel: ARDL (2, 4), Dependent Variable: DTBR

Regressor	Coefficients	Standard Error	T-Ratio
C	1.854164	0.621365	2.984019
TBR(-1)	-0.312808	0.074895	-4.176631
INF	0.752762	0.197005	3.821022
DTBR(-1)	0.116802	0.041166	2.837365
DINF	-0.259549	0.214575	-1.209592
DINF(-1)	0.040317	0.166369	0.242333
DINF(-2)	-0.000462	0.056882	-0.008130

Key Regressions:
R^2= 0.81
D-W Statistic: 1.91
$F_{(7,75)}$ = 48.55 (0.000)

Diagnostic Test Statistic
Autocorrelation $F_{(4, 71)}$ = 1.622 (0.177)
Heteroscedasticity $F_{(12,69)}$ = 3.64 (0.000)

Italy:

(11) Italy: ARDL (2,4) , Dependent Variable: DTBR

Regressor	Coefficients	Standard Error	T-Ratio
C	-0.248917	0.194583	-1.279230
TBR(-1)	-0.133779	0.040206	-3.327320
INF	1.286171	0.419016	3.069502
DTBR(-1)	0.317308	0.105848	2.997763
DINF	-0.839706	0.381984	-2.198276
DINF(-1)	-0.684371	0.309834	-2.208832
DINF(-2)	-0.424236	0.249194	-1.702437

Key Regressions:
R^2= 0.232
D-W Statistic: 1.82
$F_{(7,76)}$ = 3.655 (0.001)

Diagnostic Test Statistic
Autocorrelation $F_{(4, 72)}$ = 2.227 (0.074
Heteroscedasticity $F_{(12, 70)}$ = 4.120 (0.000)

Table 5.3 (cont'd)

Japan:

(12) Japan: ARDL (2, 1) , Dependent Variable: DLR

Regressor	Coefficients	Standard Error	T-Ratio
C	0.033716	0.028314	1.190805
LR(-1)	-0.013508	0.006787	-1.990341
INF	0.032990	0.021818	1.512045
DLR(-1)	0.777329	0.067103	11.58411

Key Regressions:
R^2= 0.650
D-W Statistic: 1.93
$F_{(4,80)}$ = 42.89 (0.000)

Diagnostic Test Statistic
Autocorrelation $F_{(4, 76)}$ = 1.825 (0.132)
Heteroscedasticity $F_{(6,77)}$ = 4.138 (0.001)

Malaysia:

(13) Malaysia: ARDL (2, 2) , Dependent Variable: DTBR

Regressor	Coefficients	Standard Error	T-Ratio
C	0.230816	0.193356	1.193734
TBR(-1)	-0.121277	0.044583	-2.720287
INF	0.456238	0.190209	2.398610
DTBR(-1)	0.085439	0.107245	0.796674
DINF	-0.367063	0.140892	-2.605275

Key Regressions:
R^2= 0.118
D-W Statistic: 2.03
$F_{(5,80)}$ = 2.169 (0.065)

Diagnostic Test Statistic
Autocorrelation $F_{(4, 76)}$ = 1.196 (0.319)
Heteroscedasticity $F_{(8,76)}$ = 3.559 (0.001)

Table 5.3 (cont'd)

Mexico:

(14) Mexico: ARDL (3, 2) , Dependent Variable: DTBR

Regressors	Coefficients	Standard Error	T-Ratio
C	1.718713	0.970391	1.771154
TBR(-1)	-0.287271	0.075512	-3.804309
INF	1.044261	0.301848	3.459560
DTBR(-1)	-0.176748	0.052132	-3.390398
DTBR(-2)	-0.113083	0.053673	-2.106895
DINF	1.526646	0.270210	5.649855

Key Regressions:
R^2= 0.80
D-W Statistic: 1.94
$F_{(6, 74)}$ = 52.93 (0.000)

Diagnostic Test Statistic
Autocorrelation $F_{(4,70)}$ = 0.312 (0.868)
Heteroscedasticity $F_{(10,69)}$ = 2.656 (0.008)

Norway:

(1,5) Norway: ARDL (2, 4) , Dependent Variable: DDR

Regressor	Coefficients	Standard Error	T-Ratio
C	0.226255	0.430701	0.525318
DR(-1)	-0.222115	0.078811	-2.818325
INF	1.511898	0.493648	3.062702
DDR(-1)	-0.310804	0.100819	-3.082785
DINF	-0.715766	0.485103	-1.475492
DINF(-1)	-0.149055	0.405716	-0.367387
DINF(-2)	0.047738	0.297508	0.160461

Key Regressions:
R^2= 0.316
D-W Statistic: 2.09
$F_{(7,76)}$ = 5.100 (0.000)

Diagnostic Test Statistic
Autocorrelation $F_{(4, 72)}$ = 0.670 (0.614)
Heteroscedasticity $F_{(12,70)}$ = 0.564 (0.862)

Table 5.3 (cont'd)

Singapore:

(16) Singapore: ARDL (3, 1), Dependent Variable: DTBR			
Regressor	Coefficients	Standard Error	T-Ratio
C	0.253520	0.171684	1.476661
TBR(-1)	-0.149184	0.074412	-2.004827
INF	0.173641	0.165895	1.046693
DTBR(-1)	-0.232141	0.112207	-2.068866
DTBR(-2)	-0.268201	0.107731	-2.489546

Key Regressions:
R^2= 0.202
D-W Statistic: 2.02
$F_{(5, 79)}$ = 4.02 (0.002)

Diagnostic Test Statistic
Autocorrelation $F_{(4, 75)}$ = 1.679 (0.163)
Heteroscedasticity $F_{(8, 75)}$ = 4.044 (0.000)

South Korea:

(17) South Korea: ARDL (2, 1), Dependent Variable: DLR			
Regressor	Coefficients	Standard Error	T-Ratio
C	1.276941	0.710693	1.796754
LR(-1)	-0.197446	0.074781	-2.640326
INF	0.401778	0.184790	2.174240
DLR(-1)	-0.228242	0.108175	-2.109932

Key Regressions:
R^2= 0.193
D-W Statistic: 2.06
$F_{(3, 80)}$ = 3.551 (0.018)

Diagnostic Test Statistic
Autocorrelation $F_{(4, 76)}$ = 0.395 (0.811)
Heteroscedasticity $F_{(6, 77)}$ = 6.172 (0.000)

Table 5.3 (cont'd)

Turkey:

(18) Turkey: ARDL (2, 1), Dependent Variable: DTBR

Regressor	Coefficients	Standard Error	T-Ratio
C	9.308388	7.184439	1.295632
TBR(-1)	-0.628509	0.101496	-6.192462
INF	3.640690	0.656397	5.546479
DTBR(-1)	0.156252	0.110758	1.410757

Key Regressions:
R^2= 0.44
D-W Statistic: 2.02
$F_{(4, 52)}$ = 10.384 (0.000)

Diagnostic Test Statistic
Autocorrelation $F_{(4, 48)}$ = 0.542 (0.705)
Heteroscedasticity $F_{(6, 49)}$ = 0.426 (0.857)

UK:

(19) UK: ARDL (3, 5), Dependent Variable: DTBR

Regressor	Coefficients	Standard Error	T-Ratio
C	0.141438	0.162474	0.870528
TBR(-1)	-0.112263	0.044063	-2.547808
INF	0.661132	0.285339	2.317004
DTBR(-1)	0.081211	0.103262	0.786460
DTBR(-2)	-0.163751	0.100937	-1.622313
DINF	-0.027510	0.269737	-0.101990
DINF(-1)	0.262041	0.208145	1.258936
DINF(-2)	0.324910	0.161098	2.016851
DINF(-3)	0.469611	0.117516	3.996157

Key Regressions:
R^2= 0.44
D-W Statistic: 1.85
$F_{(9, 71)}$ = 6.563 (0.000)

Diagnostic Test Statistic
Autocorrelation $F_{(4, 67)}$ = 1.080 (0.369)
Heteroscedasticity $F_{(16, 63)}$ = 3.373 (0.000)

Table 5.3 (cont'd)

USA:

(20) USA: ARDL (2, 1), Dependent Variable: DTBR			
Regressor	Coefficients	Standard Error	T-Ratio
C	0.145662	0.094916	1.534630
TBR(-1)	-0.041023	0.018038	-2.274226
INF	0.070390	0.036513	1.927812
DTBR(-1)	0.594078	0.084104	7.063619

Key Regressions:
R^2= 0.47
D-W Statistic: 1.96
$F_{(4, 81)}$ = 18.82 (0.000)

Diagnostic Test Statistic
Autocorrelation $F_{(4, 77)}$ = 0.911 (0.444)
Heteroscedasticity $F_{(6, 78)}$ = 1.000 (0.430)

Table 5.4 Results from Bounds Tests on Equation (2)

Country	Optimal lags (p*, q*)	F-statistic value	Outcome
Argentina	(4,2)	21.99	Cointegration
Brazil	(5,4)	28.15	Cointegration
Canada	(2,1)	1.72	No Cointegration
Chile	(3,2)	7.31	Cointegration
Denmark	(2,5)	6.58	Cointegration
Finland	(2,3)	16.38	Cointegration
France	(1,1)	1.04	No Cointegration
Germany	(4,2)	3.36	No Cointegration
India	(2,1)	0.57	No Cointegration
Israel	(2,4)	9.09	Cointegration
Italy	(2,4)	5.55	No Cointegration*
Japan	(2,1)	2.39	No Cointegration
Malaysia	(2,2)	4.46	No Cointegration
Mexico	(3,2)	7.34	Cointegration
Norway	(2,4)	5.15	No Cointegration*
Singapore	(3,1)	2.27	No Cointegration
South Korea	(2,1)	5.25	No Cointegration*
Turkey	(2,1)	20.65	Cointegration
UK	(3,5)	3.25	No Cointegration
USA	(2,1)	4.61	No Cointegration

Notes: Asymptotic critical value bounds are obtained from Table C1. iii in Appendix B, Case III: unrestricted intercept and no trend with one regressor (Pesaran, Shin and Smith, 2001, p. T2).
Lower bound I(0) = 6.84and Upper bound I(1) = 7.84 at 1 % significance level.
Lower bound I(0) = 4.94 and Upper bound I(1) = 5.73 at 5 % significance level.
Lower bound I(0) = 4.04 and Upper bound I(1) = 4.78 at 10 % significance level.
* Sign represents that the F-statistic is significant at 10 % level.

In the Argentian case, all the variables enter in the equation are statistically significant, except for one period lagged deposit rate in first difference, DDR(-1). The coefficients of one period lagged deposit rate DR(-1) and the inflation rate, INF are -2.55 and 132.26, respectively. These coefficients are the coefficients of the cointegrating relationship. Both DR(-1) and INF are significant at 1% level. Joint significance of all the variables in the equation is assured strongly with high value of F-statistic. On the other hand the CUSUM stability test result plotted against the critical bound of 5 % significance level shows the model is unstable over time.[4] In detecting the autocorrelation, the Durbin-Watson statistic is reported. Moreover, the Breusch-Godfrey Serial Correlation LM test is employed which test for more general forms of serial correlation than the Durbin-Watson statistic. The Durbin-Watson statistic rejects the serial correlation with 2.251 value. Furthermore, the Breusch-Godfrey Serial Correlation LM test strengthens the absence of serial correlation in the case of Argentina. However, there exists heteroscedasticity problem. As Shrestra and Chowdhury (2005) specify, since the time series used are of mixed order of integration, i.e., I(0) and I(1), it is natural to detect heteroscedasticity. As it is reported in the Table 5.4, F-test for the null hypothesis of no Fisher relationship strongly confirms the existence of cointegration between the nominal interest rate and inflation rate. The calculated F-statistic $F_{76}^{2} = 21.99$ is higher than the upper critical value 7.84 at 1% level. Broadly speaking, there is strong evidence of Fisher Effect for Argentina, when the deposit rate is employed as a proxy of nominal interest rate and consumer price index is utilized to measure the inflation rate.

Analysis of the Brazilian data shows that all the variables enter in the equation are statistically significant with two exceptions; three and four period lagged saving deposit rate in first difference, DSDR(-3) and DSDR(-4).

[4] Plots of the CUSUM tests for each country are reported in the Appendix B.

Additionally, the joint significance of all the variables in the equation is assured strongly with F-statistics. The coefficients of the one period lagged saving deposit rate, SDR(-1) and the inflation rate, INF which represent the long run relationship are 1.13 and -24.89, respectively. Both the one period lagged deposit rate and the inflation rate are significant at the 1% level. The CUSUM stability test result plotted against the critical bound of 5% significance level validates stability of the model over time. Both D-W test statistic and the Breusch-Godfrey Serial Correlation LM test statistic reject the null hypothesis, implying no autocorrelation. The calculated F-statistic $F_{51}^{2} = 28.15$ falls above the upper bound critical value 7.84 at the 1% level. Thus, the null hypothesis of no cointegration is rejected, implying a long run relationship between the inflation rate and saving deposit rate. Thus we conclude that Brazilian data validates the Fisher relationship.

Canadian case indicates that only three variables, one, three and four period lagged Treasury bill rate in difference, DTBR(-1), DTBR(-3) and DTBR(-4) in the model are statistically significant. F-statistics measuring the joint significance of all the variables shows that the model is overall significant. Autocorrelation problem is rejected by the D-W test and the Breusch-Godfrey Serial Correlation LM test. However heteroscedasticity problem occurs. CUSUM stability test illustrates that the model is stable. Regarding the bounds test F-statistic, $F_{63}^{2} = 1.43$, falls below the lower critical value of lower bound even at 10 % level. From here we conclude that the Fisher Effect does not hold for Canada.

When the model for Chile is investigated, all the variables enter in the model are statistically significant, except for the one and two-period lagged lending rate in first differences. The coefficients of one period lagged lending rate, LR(-1) and inflation rate, INF are -0.309 and 1.801. Joint significance of all the variables is assured strongly with the high value of F-statistic. The high value of R^2, which is 0.85, shows that the overall goodness of fit of the model is satisfactory. The CUSUM stability test result ratifies the stability of the model over time. Both the autocorrelation and heteroscedasticity problems do not exist in the Chile case. As reported in the Table 5.4, bounds test confirms cointegration between nominal interest rate and inflation rate. The calculated F-statistic $F_{78}^{2} = 7.31$ is higher than the upper critical value 5.73 at 5 % level. Broadly speaking, Fisher Effect holds for Chile.

In the examination of Fisher Effect for Denmark, with an exception of one period lagged lending rate in differences, DLR(-1), all the coefficients of the variables are statistically significant. Not only individual t-test but also joint significance of F-test for all variables confirms this result. And the CUSUM test results justify the stability of the model over time. Diagnostic test results reports that the autocorrelation and heteroscedasticity problems do not exist. Bounds test for cointegration signifies the rejection of null hypothesis of no long run relationship between the nominal interest rate and inflation rate. The F-statistic $F_{59}^{2} = 6.58$ is more than the upper critical value of 5.73 at 5% significance level. This reveals evidence for Fisher Effect for Denmark.

In the case of Finland, all the variables enter into the equation are statistically significant. The coefficients of the one period lagged lending rate, LR(-1) and the inflation rate, INF are -0.048 and 0.39, respectively. Both the one period lagged lending rate and the inflation rate are significant at the 1 % level. The F-statistic measuring the joint significance of all regressors in the model is statistically significant. The CUSUM stability test result plotted against the critical bound of 5% significance level shows the model is stable over time. While the autocorrelation problem does not arise, the heteroscedasticity problem occurs. As mentioned before, Shrestra and Chowdhury's (2005) attention about this issue gives a sufficient explanation why it is natural to detect heteroscedasticity. We have tested whether the long run dynamics of the model are zero jointly, i.e. the coefficients of LR(-1) and

INF are zero. This null hypothesis is not rejected at 1% level. This result can be taken evidence for the cointegration between the lending rate and inflation rate for the Finland case.

When the model for France is investigated, all the variables in the model are significant, except for inflation in first differences, DINF, and one period lagged inflation in first differences, DINF(-1). Additionally, F-statistic measuring the joint significance of all the regressors is assured strongly with the F-statistics. The model passes the stability test, the autocorrelation and heteroscedasticity. Plus, the inflation rate has a positive sign; a change in the inflation rate affects the government bond yield rate at the same direction. The bounds test for France could not reject the null hypothesis of no Fisher Effect. The F-statistic $F_{65}^{2} = 3.37$ falls below the lower critical value of 4.94 at 5 % level. Broadly speaking, the Fisher Effect does not hold for France, when the government bond yield is used as a proxy of nominal interest rate.

In the examination of the German case, it is observed that most of the coefficients of the variables in the model are not statistically significant. Conversely, F-statistics measuring the joint significance of all regressors shows that the model is overall significant. And the CUSUM test shows that the model is stable over time. Diagnostic test results do not detect any autocorrelation and heteroscedasticity. Bounds test for cointegration signifies the acceptance of null hypothesis of no Fisher Effect. The calculated F-statistic F_{79}^{2} = 3.36 falls below the critical value of 3.79 at 5% significance level. This reveals the fact that there is no evidence of Fisher Effect for Germany.

Similar to Germany, the t-test indicates that most of the variables do not play a significant role in the model for India. However, joint significance is not rejected. The null hypothesis of no long run relationship between the nominal interest rate and inflation rate is strongly consented by the small value of bounds test. The F-statistics $F_{80}^{2} = 0.57$ is under the lower critical value of 4.94 at 5 % level. Therefore we conclude that the Fisher Effect does not hold for the Indian case.

The analysis for Israel shows that the coefficients of the long run variables of the model, TBR(-1) and INF are statistically significant. The Treasury bill rate is used to measure the nominal interest rate. F-statistics measuring the joint significance of all the variables supports the model overall. The model passes the tests for autocorrelation and stability. When the null hypothesis of no Fisher Effect is tested, result supports that the Fisher Effect holds for the Israeli case.

The long run coefficients of the model for Italian data are the one period lagged Treasury bill rate TBR(-1) and the inflation rate INF, which are statistically significant. No autocorrelation is detected and the stability of the model is ensured by the relevant test results. The calculated F-statistic, $F_{76}^{2} = 5.55$, is greater than the critical value of 4.78 only at 10 % significance level, which provides weak support for the Fisher Effect. We conclude that there is not enough evidence of Fisherian relationship for Italy.

In the model for Japan, most of the variables play a significant role. Moreover, goodness of fit indicator of the model seems relatively successful, $R^2 = 0.65$. In addition, no autocorrelation problem is found and the CUSUM indicates a stable model. Nevertheless, the model in which the lending rate is employed as a proxy of the nominal interest rate does not capture a relationship between nominal interest rate and inflation rate in the long run. Existence of cointegration is rejected at 5% significance level. $F_{80}^{2} = 2.39$ is less than the critical value of 4.94 at 5 % level. Examination of the Japanese data provides no indication for the long run relationship among the variables.

When the model for Malaysia is investigated, the coefficients of the one period lagged Treasury bill rate TBR(-1) and inflation INF are found negative and positive, respectively. The CUSUM plots the evidence of a stable model and the model has no autocorrelation problem. The null hypothesis of no long run relationship i.e. the coefficients of TBR(-1) and CPI are zero is not rejected with a F-value of F_{80}^{2} = 4.46. This result shows that there is no support for the Fisher Effect in Malaysia.

In the model for Mexico, estimated coefficients for the long run variables are -0.28 and 1.04. The negative sign is opposite to the theoretical explanation. The relatively high value of R^2 indicates the goodness of fit of the model is satisfactory. The model passes the test for autocorrelation and stability over time. The bounds test results show that the null hypothesis of no cointegration is rejected at 5 % level with a value of F_{74}^{2} = 7.34. Thus, Fisher Effect holds for the Mexican case.

In the analysis for Norway, the estimated coefficients of the long run variables, which correspond to DR(-1) and INF, are statistically significant in the model. The CUSUM test approves the stability of the model over time. Diagnostic test results show no autocorrelation and heteroscedasticity. Bounds test for cointegration signifies the rejection of null hypothesis of no long run relationship among the nominal interest rate and inflation rate. Therefore, Fisher Effect holds for Norway.

The case of Singapore demonstrates that except for the inflation variable, INF, all the variables are statistically significant in the model. The F-statistic measuring the joint significance of all the regressors is also significant. Bounds test for cointegration reveals the fact that the Fisher Effect does not hold for Singapore case. The calculated F-statistic, $F_{79}^{2} = 2.27$ falls under the lower critical value of 4.94 at 5 % significance level.

In the analysis of South Korea, long run variables of the model, LR(-1) and INF are significant. Test for the joint significance of all variables shows that the model is significant overall. An increase in the inflation rate variable, INF, leads a positive change in nominal interest rate, as expected theoretically. The model passes the autocorrelation and stability tests. The bounds test shows that there is evidence for cointegration at 10 % significance level. F^{2}_{80} = 5.25 is bigger than the critical value of 4.78 at 10 % level. However, 10 % significance level does not provide a strong evidence for the Fisher Effect. We conclude that the Fisher Effect does not hold for South Korea.

In the model for Turkey in which the Treasury bill rate is employed as a proxy of the nominal interest rate, both the long run variables, TBR(-1) and INF are statistically significant.[5] F-statistic measuring the joint significance of all the variables supports the model overall. In addition, the model passes the autocorrelation, heteroscedasticity and stability tests. The bounds test result shows that the null hypothesis of no long run relationship between the nominal interest rate and inflation rate is strongly rejected at 1 % level with a value of $F^{2}_{52} = 20.65$. Thus, Fisher Effect holds for the Turkish case.

In the Fisher Effect assessment for UK, long run variables of the model have a statistically significant contribution in examining the dependent variable. In addition, the F-statistic is statistically significant at 1 % level. The CUSUM plotted against the critical bound of 5 % significance level shows a stable model for UK. The Breusch-Godfrey Serial Correlation LM test indicates that there is no autocorrelation. Testing the joint significance of long run variables does not present evidence for cointegration between the nominal

[5] When we investigate the Turkish case by using interbank money market rate, both long run variables, INTERR(-1) and INF, are statistically significant. The model passes the diagnostic tests and the CUSUM stability test result plotted against the critical bound of 5 % significance level validates stability of the model over time. An increase in the inflation rate variable, INF, leads a positive change in nominal interest rate, as expected theoretically. When the interbank money market rate is proxied for the nominal interest rate, the bounds test for cointegration signifies the rejection of null hypothesis of no long run relationship between the nominal interest rate and inflation rate. The calculated F-statistic, $F^{2}_{74} = 15.86$, is higher than the upper critical value 7.84 at 1% level. This reveals the evidence for Fisher Effect for Turkey. The test results for this model are presented in the Appendix D.

interest rate and inflation rate. The calculated F-statistic, which is 3.25, is below the critical value of lower bound even at 10 % level. The bounds test result does not support the existence of Fisher Effect for the UK data.

The long run variables of the model for USA are one period lagged Treasury bill rate, TBR(-1), and inflation rate, INF. The model passes the stability, autocorrelation and heteroscedasticity tests successfully. An increase in the inflation rate variable INF, leads a positive change in nominal interest rate, as the theoretical explanation suggests. Bounds test for cointegration denotes no long run relationship between the nominal interest rate and inflation rate. The calculated F-statistic, $F_{81}^{2} = 4.61$ falls under the lower critical value of 4.94 at 5 % significance level. This reveals the fact that the Fisher Effect does not hold for the USA case.

As a conclusion, our findings are generally supportive of the existence of a long run relationship between the nominal interest rate and inflation rate in Argentina, Brazil, Chile, Denmark, Finland, Mexico and Turkey. However, our estimation results imply that the coefficients of the one period ahead inflation rate are positive but greater than one for all of these countries. The positive sign is consistent with the theoretical explanations of the analytical model. This result shows that "Full Fisher Effect" implying one-for-one adjustment of the nominal interest rate to inflation rate does not hold for any of these countries.

5.3 Discussion:

In this section, we briefly compare our results to those reported in the other multi-country analysis. The test results of our study for Fisher Effect contradicts with some of the previous empirical findings, especially in several respects from those of Berument and Jelassi (2002). Using monthly CPI index and either Treasury bill rate or lending rate covering the period from 1957:01 until 1998:05, Berument and Jelassi (2002) investigate the Fisherian link among the twenty six countries using an error correction modeling approach suggested by Moazzami (1989) which allows for direct estimates of the long run coefficients. In their study there is a tendency to confirm the Fisher Effect for most of the countries, especially in developed countries. They find that Fisher Effect tends to hold for 67 % of the developed countries; on the other hand the same ratio is 50 % for the developing countries. Moreover they interpret this result by referring to Olekalns (1996) who suggests that the Fisher Effect tends to hold in a financially deregulated economy.

Contrary to this finding, our analysis illustrates that the Fisher Effect does not have a tendency to hold in developed countries. Fisher hypothesis is rejected for seven of the ten developed countries which are Canada, France, Germany, Italy, Japan, UK and USA. Furthermore, we did not find any evidence to reject the Fisher hypothesis for six of the ten developing countries, which are Argentina, Brazil, Chile, Israel, Mexico, and Turkey. Our analysis shows that the adjustment of nominal interest rate to expected inflation rate is encountered mostly for the developing countries which have inflationary history in their economies. Most of these countries are experienced diverse economic situations like deep recessions, high-inflation rates, currency crises, macroeconomic stability plans and deregulations during the study period. As mentioned in chapter 2, the liquidity effect and Fisher Effect are the two effects to determine the relationship between inflationary expectations and nominal interest rate. Fisher (1930) states that at higher inflation rates, when the expected inflation increases, Fisher Effect dominates liquidity effect. Our findings corroborate his statement.

Consistent with the findings of our analysis, Maghyreh and Al-Zoubi (2006) examine the existence of Fisherian link for Argentina, Brazil, Malaysia, Mexico and Turkey using the nonlinear cotrending test. They applied a nonparametric test suggested by Bierens (2000) to the data of these six developing countries. Their findings support the idea that there is a linear combination between the expected inflation rate and nominal interest rate in these six countries. Moreover, their result indicates the existence of a Full Fisher Effect, meaning presence of a money illusion in these developing countries.

In the recent study of Berument, Ceylan and Olgun (2007), the validity of a positive relationship between the nominal interest rate and expected inflation and the inflation risk effect on the interest rate is checked in 54 developed and developing countries. The simple Fisherian link- without the impact of inflation risk- is tested using the GARCH specification for G7 countries plus 47 developing countries. The Fisher Effect holds for all the G7 countries and only for 23 developing countries. When the inflation risk is added to the regression, validity of the Fisher Effect diminishes to 6 of the G7 countries and 18 of the 47 developing countries. When the inflation risk added version of the analysis is considered, the adjustment of nominal interest rate to expect inflation is not encountered only for Italy among the developed countries which is consistent with our finding about Italy. However, the conflicting results for the developing country findings persist.

CHAPTER 6

CONCLUSION

The interest rate plays a crucial role in determining saving, investment and in fact almost all intertemporal decisions. Explanations about why the interest rates rise and fall with the changes in the purchasing power of money are attributed to the Fisher Effect. Fisher Effect emphasizes a long run relationship between the nominal interest rate and inflation rate implying an adjustment of nominal interest rate to the movements in inflation rate.

This thesis aimed to accomplish two distinct objectives. Firstly, we investigate the existence of Fisher Effect for twenty countries; ten of which are developed and the rest are developing countries. This way, we analyze the distinction of Fisher relation between the developed and developing countries which have different macroeconomic backgrounds, especially in terms of their inflation history.

Secondly, we test the Fisher Effect by employing a recently popularized cointegration analysis; i.e. this study used the Bounds test based on the Autoregressive Distributed Lag (ARDL) approach to determine whether there is a relationship between nominal interest rate and expected inflation rate in the long run. Using the ARDL approach to detect the Fisher Effect has numerous advantages: Firstly, the OLS based ARDL approach to testing of a relationship between variables in levels can be applied irrespective of whether the variables are purely I (0), purely I(1) or a mixture of both

(Pesaran et. al., 2001). It avoids pre-testing problem associated with standard cointegration techniques that makes it easy to use. Secondly, the model takes sufficient numbers of lags to capture the data generating process in general-to-specific modeling framework (Launrenceson and Chai, 2003). This approach gives robust results in small sample size while the Johansen cointegration test requires large samples for validity purpose. Finally, dynamic error correction model (ECM) which can be derived from ARDL by a simple linear transformation, integrates the short run dynamics with the long run equilibrium without lack of long run information (Banerjee et. al., 1993).

The study is conducted for Argentina, Brazil, Canada, Chile, Denmark, Finland, France, Germany, India, Israel, Italy, Japan, Malaysia, Mexico, Norway, Singapore, South Korea, Turkey, the United Kingdom and the United States. The data are quarterly and span the period of 1985:01-2006:3.

Measuring the expected inflation creates the main problem in studying the Fisher Effect. In our analysis, we follow Atkins and Coe (2002) and we measure expected inflation by using one period ahead inflation rate, by invoking rational expectations. When the stationarity status of the nominal interest rate and inflation rate is examined, another justification of employing the bounds testing approach appears. With the exclusion of Argentina and Mexico cases, for all countries the order of integration of the variables- nominal interest rate and inflation rate- are mixed. The residual based Engle-Granger (1987) and the maximum likelihood based Johansen (1988) and Johansen-Juselius (1990) methods fail to capture the cointegration relationship between variables under this condition.

Our analysis illustrates that the Fisher Effect have a tendency of not holding for developed countries. For seven of the ten countries, which are Canada, France, Germany, Italy, Japan, UK and USA, Fisher hypothesis is rejected. Furthermore, we do not find any significant evidence to reject the Fisher hypothesis for six of the ten developing countries, which are Argentina, Brazil, Chile, Israel, Mexico, and Turkey. The adjustment of nominal interest rate to the expected inflation is encountered mostly for the developing countries which have inflationary history in their economies.

Results of our analysis detect some indications about under which conditions Fisher Effect tends to hold. The liquidity effect and Fisher Effect are the two effects to determine the relationship between inflationary expectations and nominal interest rate. Fisher (1930) states that at higher inflation rates, when the expected inflation increases, Fisher Effect dominates the liquidity effect. Our findings corroborate his statement.

In the analysis of Canada and USA, we did not find cointegration between the nominal interest rate and expected inflation rate. However, in the literature, when the structural shifts in the data set are taken into account, investigation of Fisher hypothesis for these countries is mostly verified.[1] In our study the possible reason for the rejection of the Fisher Effect for Canada and USA can be the structural change in the time series data.

When the estimates of the parameter describing the long run response of nominal interest rate to changes in the inflation rate are investigated for the countries which the null of no long run relationship is rejected, our results are consistent with the Fisher Effect. On the other hand, these long run parameters are different from 1.0, thus we do not capture the one-for-one relationship between the nominal interest rate and inflation rate. That is we do not find any evidence of the Full Fisher Effect.

[1] See Bekdache (1999), Garcia and Johansen (2000), Garcia and Perron (1996), Malliaropulas (2000), Lai (2004) and Clemente, Montanes and Reyes (2002).

REFERENCES

Alkhazali, O. M. (1997). An Empirical Analysis of Stock Returns, Inflation, and Interest Rates in the Pasific-Basin Countries. A Dissertation submitted in partial satisfaction of the requirements for the degree of doctor of philosophy in economics, University of Memphis.

Al-Zoubi, H. & Maghyereh, A. (2006). Does Fisher Effect Apply in Developing Countries: Evidence from a Nonlinear Cotrending Test Applied to Argentina, Brazil, Malaysia, Mexico, South Korea and Turkey? *Applied Econometrics and International Development, 6*, 31-46.

Atkins, F. J. (1989). Cointegration, Error Correction and the Fisher Effect. *Applied Economics, 21*, 1611-20.

Atkins, F. J. & Coe, P. J. (2002). An ARDL Bounds Test of the Long Run Fisher Effect in the United States and Canada. *Journal of Macroeconomics, 24,* 255- 266.

Barro, R. J. (1981). Output Effects of Government Purchases. *Journal of Political Economy, 89-6,*1086-1121.

Bekdache, B. & Baum, C. (2000). A Re-Evaluation of Empirical Tests of the Fisher Hypothesis. Boston College Working Papers in Economics from Boston College Department of Economics, No: 472.

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

Berument, H. & Jelassi, M. M. (2002). The Fisher Hypothesis: A Multi-Country Analysis. *Applied Economics, 34,* 1645-1655.

Berument, H. & Malatyalı, K. (2001). Determinants of Interest Rates in Turkey. *Russian and East European Finance and Trade 37, 1,* 5-16.

Bierens, H. J. (2000). Nonparametric Nonlinear Cotrending Analysis, with an Application to Interest and Inflation in the US. *Journal of Business and Economic Statistics*, *18*, 323-337.

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

Cagan, P. (1956). The Monetary Dynamics of Hyper-Inflation. In M. Friedman (ed.), *Studies in the Quantity Theory of Money*, University of Chicago Press, Chicago.

Carneiro, F. , Divino, C. A., & Rocha, C. (2002). Revisiting the Fisher Hypothesis for the Cases of Argentina, Brazil and Mexico. *Applied Economic Letters*, 9, 95-98.

Chu, Q.C., Pittman, D. N., & Yu, L. Q. (2003). Real Rates, Nominal Rates, and the Fisherian Link. *International Review of Financial Analysis, 12,* 189-205.

Clemente, J., Montanes, A., & Reyes, M. (2002). Structural Breaks, Inflation and Interest Rates: Evidence for the G7 Countries. Retrieved September 25, 2006, from Web site:
http://129.3.20.41/eps/em/papers/0401/0401005.pdf

Cooray, A. (2003). The Fisher Effect: A Survey. *The Singapore Economic Revie, 48* , 135-150.

Crowder, W. & Wohar, M. (1999). Are Tax Effects Important in the Long Run Fisher Relationship? Evidence From the Municipal Bond Market. *The Journal of Finance, 54-1.*

Daniels, J., Nourzad, F., & R. Toutkoushan (1996). “Testing the Fisher Effect as a Long Run Equilibrium Relation” *Applied Financial Economics,* no.6 pp: 115-120

Darby, M. R. (1975). The Financial and Tax Effects of Monetary Policy on Interest Rates. *Economic Inquiry, 13*, 266-276.

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

Durlauf, S. & Hall, R. E. (1989). A Signal Extraction Approach to Recovering Noise in Expectations Based Models, mimeo, Stanford University.

Dutt, S. & Ghosh, D. (1995). The Fisher Hypothesis: Examining the Canadian Experience, *Applied Economics, 27*, 1025-1030.

Evans, M. & Lewis, K. (1995). Do Expected Shifts in Inflation Affect Estimates of the Long Run Fisher Relation?. *Journal of Finance, 50,* 225-253.

Fahmy, A.F. & Kandil, M. (2003). The Fisher Effect: New Evidence and Implications. *International Review of Economics and Finance, 12,* 451-465.

Fama, E. F. (1970). Efficient Capital Markets: A Review of Theory and Empirical Work. *Journal of Finance*, 25, 383-417.

Fama, E. F. (1975). Short Term Interest Rates as Predictors of Inflation. *American Economic Review, 65,* 269-282.

Feldstein, M. (1980a). Tax Rules and Mismanagement of Monetary Policy. *American Economic Review, 70,* Supplement, 182-209.

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

Garcia, M. G. P. (1993). The Fisher Effect in a Signal Extraction Framework. *Journal of Development Economics, 41,* 71-93.

Garcia, M. G. P. & Johnson, P. (1996). A Regression Tree Analysis of Real Interest Rate Regime Changes. Preliminary and incomplete- not for circulation paper.

Garcia, R. & Perron, P. (1996). An Analysis of the Real Interest Rate under Regime Shifts. *The Review of Economics and Statistics, 78-1,* 111-125.

Ghazali, N. A. & Ramlee, S. (2003). A Long Memory Test of Long Run Fisher Effect in the G7 Countries. *Applied Financial Economics,* 13, 763-769.

Gibson, W. E. (1970). Price Expectations Effects on Interest Rates. *Journal of Finance, 25,* 19- 34.

Granville B. & Mallick, S. (2004). Fisher Hypothesis: UK Evidence over a Century. *Applied Economics Letters, .11,* 87-90.

Hamilton, J. D. (1989). A New Approach to Economic Analysis of Nostationary Time Series and Business Cycles. *Econometrica* ,57, 357-384.

Jacques, K. (1995). Unit Roots, Interest Rates spreads and Inflation Forecasts. *Applied Economics, 27,* 605-608.

Johansen, S. & Juselius, K. (1990). Maximum likelihood estimation and inference on cointegration- with application to the demand for money. *Oxford Bullein of Economics and Statistics, 52-2,* 169-210.

Johnson, P. (1994). Estimation of the Specification Error in the Fisher Equation. *Applied Economics, 26,* 519-526.

Johnson, P. (2006). Is It Really the Fisher Effect?. *Applied Economics Letters, 13,* 201-203.

Kesriyeli M. (1994). Policy Regime Changes and Testing for the Fisher and UIP Hypothesis: The Turkish Evidence. *Discussion Paper No. 9411,* The Central Bank of the Republic of Turkey, Research Department.

Kasman, S., Kasman, A., & Turgutlu, E. (2005). Fisher Hypothesis Revised: A Fractional Cointegration Analysis. *Discussion Paper Series, Dokuz Eylül University,* 05/04.

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

Kutan, A. & Aksoy, T. (2003). Public Information Arrival and the Fisher Effect in Emerging Markets: Evidence from Stock and Bond Markets in Turkey. *Journal of Financial Services Research, 23-3,* 225-229.

Lai, K. S. (2004). On Structural Shifts and Stationary of the Ex ante Real Interest Rate. *International Review of Economics and Finance*, 13, 217-228.

Lardic, S. & Mignon, V. (2003). Fractional Cointegration between Nominal Interest Rates and Inflation: A Re-examination of the Fisher Relationship in the G7 Countries. *Economics Bulletin, 3,* 1-10.

Laurenceson, J. & Chai, J. C. H. (2003). Financial Reform and Economic Development in China, Cheltenham, UK, Edward Elgar.

Lungu, L. (1998). Is There Evidence of the Fisher Effect?. Dissertation of the Ma in Economics, Department of Economics and Accounting, University of Liverpool.

MacDonald, R. & Murphy, P. D. (1989). Testing for the Long Run Relationship between Nominal Interest rates and Inflation using Cointegration Techniques. *Applied Economics, 21,* 439-447.

MacKinnon, J. (1991). Critical Values for Cointegration Test. In R. Engle and C. Granger (ed.), *Long-run Economic Relationships: Readings in Cointegration*, Oxford: Oxford University Press.

Malliaropulos, D. (2000). A Note on Nonstationarity, Structural Breaks, and Fisher Effect. *Journal of Banking and Finance, 24,* 695-707.

Melvin, M. (1983). The Vanishing Liquidity Effect of Money on Interest: Analysis and Implication Policy. *Economic Inquiry*, 21.

Mishkin F. (1984). Are Real Interest Rates Equal Across Countries? An Empirical Investigation of International Parity Conditions. *Journal of Finance*, 39, 1345-1357.

Mishkin, F. (1991). Is the Fisher Effect for Real? A Reexamination of the Relationship between Inflation and Interest rates. *NBRE Working Papers* no.3632.

Mishkin, F. & Simon, J. (1995). An Empirical Examination of the Fisher Effect in Australia. *The Economic Record, 71*-214, 217-229.

Moazzami, B. (1989) Interest Rates and Inflationary Expectations: Long Run Equilibrium and Short Run Adjustment. *Journal of Banking and Finance, 14,* 1163-1170.

Mundell, R. (1963). Inflation and Real Interest. *Journal of Political Economy*, 71, 208- 283.

Muth, J. F. (1961). Rational Expectations and the Theory of Price Movements. *Econometrica*, 29, 315-335.

Ng, S.Perron, P. (2001). Lag Length Selection and the Construction of Unit Root Tests with Good Size and Power. *Econometrica*, *69-6*, 53-81.

Olekalns, N. (1996). Further Evidence on the Fisher Effect. *Applied Economics*, *28,*851-856.

Owen, P.D. (1993). Cointegration Analysis of the Fisher Hypothesis: The Role of the Real Rate and the Fisher Identity. *Applied Financial Economics*, 3, 21-6.

Paul, M. T. (1984). Interest Rates and the Fisher Effect in India. *Economics Letters, 14,* 17-22.

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

Pelaez, R. F. (1995). Fisher Effect: Reprise. *Journal of Macroeconomics, 17,* 333-346.

Perron, P. & Rodriguez, G. (2001). Residual Based Tests for Cointegration with GLS detrended Data. Manuscript, Boston University.

Phillips, P. C. & Perron, P. (1988). Testing for a Unit Root in Time Series Regression. *Biometrica*, 75, 335-346.

Pesaran, H. M., Shin, Y. & Smith, R. J. (2001). Bounds Testing Approaches to the Analysis of Long Run Relationship. *Journal of Applied Econometrics, 16,* 289-326.

Phylaktis, K. & Blake, D. (1993). The Fisher Hypothesis: Evidence from Three High Inflation Economies. *Weltwirtschaftliches Archiv, 129,* 591–599.

Rapach, D. E. & Weber, C. E. (2004). Are Real Interest Rates Really Nonstationary? New Evidence from Tests with Good Size and Power. *Journal of Macroeconomics, 26,* 409-430.

Rapach, D. & Wohar, M. (2005). Regime Changes in International Real Interest Rates: Are They a Monetary Phenomenon?. *Journal of Money, Credit and Banking, 37-5,* 888-906.

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

Sargent, T. J. (1969). Commodity Price Expectations and Interest Rate.in: W.E. Gibson, and G. G. Kaufman, (ed.), *Monetary Economics* : Reading on Current Issues, Mc Graw Hill Book Co, NY.

Shrestha, M. B. (2005). ARDL Modeling Approach to Cointegration Test. Retrieved November 12, 2006 from Web Site:
http://www.nzae.org.nz/conferences/ 2005/13-SHRESTRA.PDF.pdf

Shrestra, M. B. & Chowdhury, K. (2005, forthcoming). A sequential Procedure for Testing Unit Roots in the Presence of Structural Breaks in Time Series Data: An Application to Nepalese Quarterely Data 1970-2003. *International Journal of Applied Econometrics and Quantitative Studies 2.*

Smant, D. J. C. (2004). Lecture Notes on Interest Rates and Stock Market. Retrieved December 15, 2006 from Web Site:
www.few.eur.nl/few/people/**smant**/a7149/**notes**/2b_fishereff.pdf -

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

Tanzi, V. (1980). Inflationary expectations, economic activity, taxes and interest rates. *American Economic Review, 70,* 12-21.

Thornton, J. (1996), The Adjustment Interest Rates in Mexico: A Study of the Fisher Effect. *Applied Economics Letters*, 3, 255-257.

Tierney, H.L.R. (2005). Essays on Inflation and Nominal Interest Rates. A Dissertation Submitted in Partial Satisfaction of the Requirements for the degree of Doctor of Philosophy in Economics, University of California Riverside.

Tobin, J. (1965). Money and Economic Growth. *Econometrica,33,* 671-684.

Wallace S. M. & Warner, J. (1993). The Fisher Effect and the Term Structure of Interest Rates: Tests of Cointegration. *The Review of Economics and Statistics,* 75-2, 320-324.

Zivot, E. & Andrews D. W. K. (1992). Further Evidence on the Great Crash, the Oil-Price Shock and the Unit Root Hypothesis. *Journal of Business and Economic Statistics*, 10-3, 251-270.

APPENDICES

APPENDIX A

Explanations with serial codes of the nominal interest rate and inflation rates for each country:

Serial Codes

Country	**Nominal Interest Rate**	**Inflation Rate**
Argentina	21360L..ZF…	21364…ZF…
Brazil	22360K..ZF…	22364. B.ZF…
Canada	15660K..ZF…	15664…ZF…
Chile	22860P.FZF…	22864…ZF…
Denmark	12860P…ZF…	12864…ZF…
Finland	17260P…ZF	17264…ZF
France	13260C..ZF…	13264…ZF…
Germany	13460C…ZF	13464. D.ZF… 13464…ZF…
India	53460P..ZF…	53464…ZF…
Israel	43660C..ZF…	43660P…ZF…
Italy	13660C..ZF…	13664…ZF…
Japan	15860P..ZF…	15864…ZF…

Malaysia	54860C…ZF…	54864…ZF…
Mexico	27360C..ZF…	27364…ZF…
Norway	14260L..ZF…	14264…ZF…
Singapore	57660C..ZF…	57664…ZF…
South Korea	54260P..ZF…	54264…ZF…
Turkey*	18660B..ZF…	18664…ZF…
UK	11260C..ZF…	11264…ZF…
USA	11160C..ZF…	11163BA.ZF…

* This serial code represents the interbank money market rate for Turkey. Treasury bill rate data for Turkey is collected from the Istanbul Stock Exchange Market.

APPENDIX B

Explicit equation form of regressions for each country:

Argentina
DDR = - 691.867 – 2.559 DR(-1) + 132.268 INF - 0.17DDR(-1) + 0.757 DDR(-2) - 0.346 DDR(-3) + 128.081 DINF

Brazil
DSDR = 22.608 + 1.136 SDR(-1) - 24.892 INF - 1.327 DSDR(-1) - 0.496 DSDR(-2) - 0.067 DSDR(-3) - 0.008 DSDR(-4) + 106.867 DINF + 47.066 DINF(-1) + 16.535 DINF(-2)

Canada
DTBR = 0.177 - 0.068 TBR(-1) + 0.332 INF + 0.428 DTBR(-1) - 0.11 DTBR(-2) + 0.382 DTBR(-3) - 0.227 DTBR(-4) + 0.148 DTBR(-5) - 0.336 DINF - 0.277 DINF(-1) - 0.378 DINF(-2) - 0.310 DINF(-3) - 0.369 DINF(-4) - 0.222 DINF(-5) - 0.297 DINF(-6)

Chile
DLR = 1.811- 0.309 LR(-1) + 1.801 INF - 0.028 DLR(-1) + 0.066 DLR(-2) + 2.834 DINF

Denmark
DLR = 0.103 - 0.077 LR(-1) + 0.944 INF + 0.175 DLR(-1) - 1.073 DINF - 0.810 DINF(-1) - 0.755 DINF(-2) - 0.592 DINF(-3)

Finland
DLR = 0.061 - 0.048 LR(-1) + 0.399 INF + 0.372 DLR(-1) - 0.238 DINF - 0.188 DINF(-1)

France
DGBY = 0.064 - 0.063 GBY(-1) + 0.59 INF + 0.603 DGBY(-1) - 0.45 DGBY(-2) + 0.362 DGBY(-3) - 0.360 DGBY(-4) - 0.309 DINF - 0.247 DINF(-1)

Germany
DTBR = 0.174- 0.042 TBR(-1) + 0.028 INF + 0.423 DTBR(-1) + 0.08 DTBR(-2) + 0.201 DTBR(-3) - 0.017 DINF

India
DLR = 0.256 - 0.020 LR(-1) + 0.004 INF + 0.412 DLR(-1)

Israel
DTBR = 1.854- 0.312 TBR(-1) + 0.752 INF + 0.116 DTBR(-1) - 0.250 DINF + 0.040 DINF(-1) - 0.0004 DINF(-2)

Italy
DTBR = -0.248 - 0.133 TBR(-1) + 1.286 INF + 0.3173 DTBR(-1) - 0.839 DINF - 0.684 DINF(-1) - 0.424 DINF(-2)

Japan
DLR = 0.033 - 0.013 LR(-1) + 0.032 INF + 0.777 DLR(-1)

Malaysia
DTBR = 0.230 - 0.121 TBR(-1) + 0.456 INF + 0.0854 DTBR(-1) - 0.367 DINF

Mexico
DTBR = 1.718 - 0.287 TBR(-1) + 1.044 INF - 0.176 DTBR(-1) - 0.113 DTBR(-2) + 1.526 DINF

Norway
DDR = 0.226 - 0.222 DR(-1) + 1.511 INF - 0.310 DDR(-1) - 0.715 DINF - 0.149 DINF(-1) + 0.047 DINF(-2)

Singapore
DTBR = 0.253 - 0.149 TBR(-1) + 0.173 INF - 0.232 DTBR(-1) - 0.268 DTBR(-2)

South Korea
DLR = 1.276 - 0.197 LR(-1) + 0.401 INF - 0.228 DLR(-1)

Turkey
DTBR = 9.308 – 0.628 TBR(-1) + 3.640 INF + 0.156 DTBR(-1)

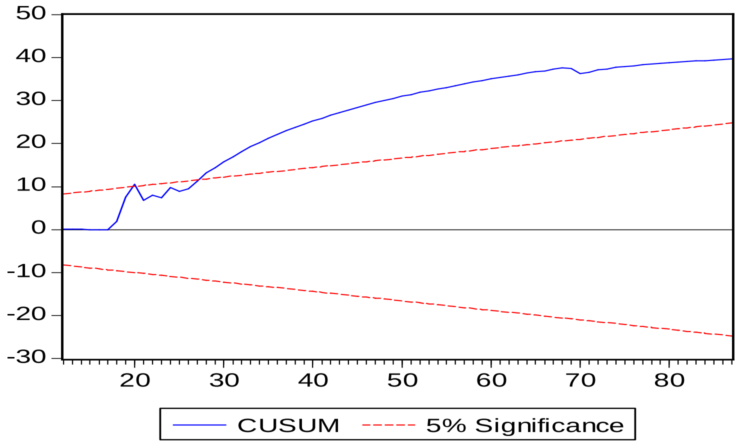
UK
DTBR = 0.141 - 0.112 TBR(-1) + 0.66 INF + 0.081 DTBR(-1) - 0.163 DTBR(-2) - 0.027 DINF + 0.262 DINF(-1) + 0.324 DINF(-2) + 0.469 DINF(-3)

USA
DTBR = 0.145 - 0.041 TBR(-1) + 0.070 INF + 0.594 DTBR(-1)

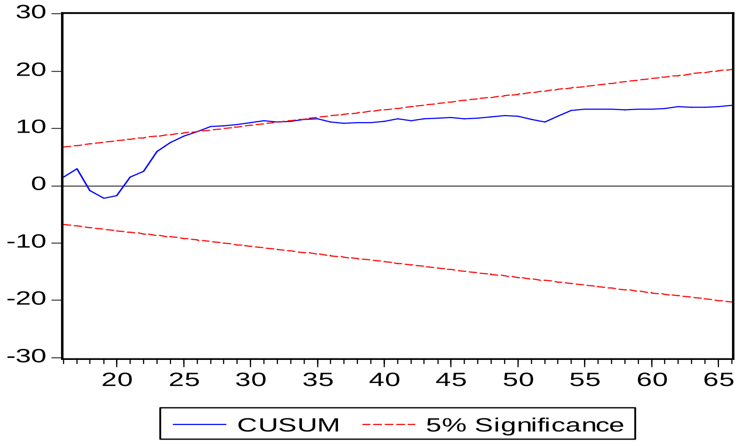
APPENDIX C

The plots of the stability test results: Cumulative sum of recursive residuals (CUSUM)

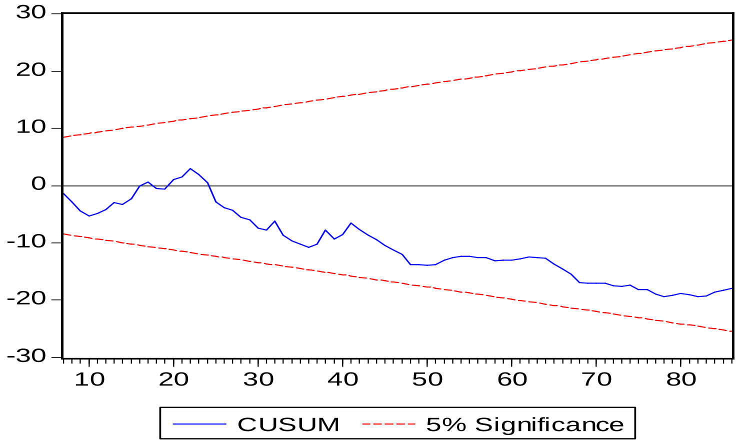
(1) Argentina: Stability Test Result, CUSUM



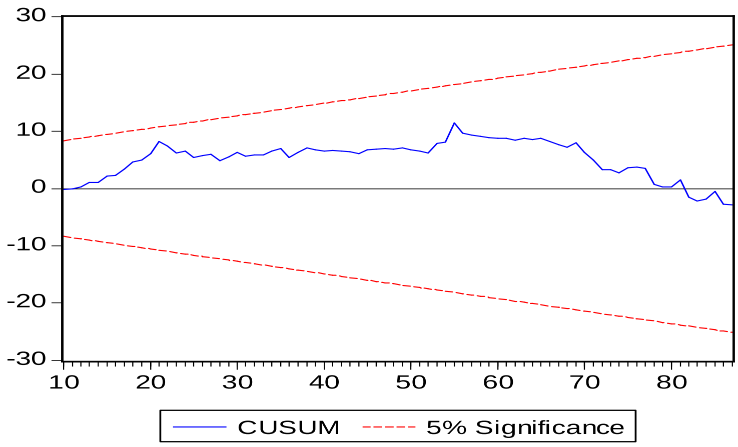
(2) Brazil: Stability Test Result, CUSUM



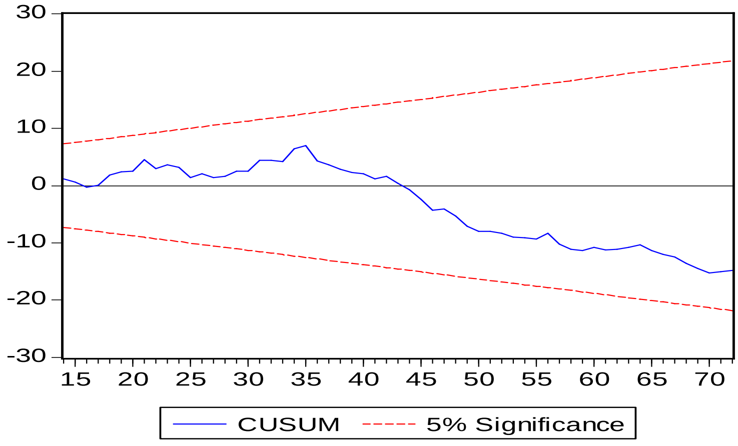
(3) Canada: Stability Test Result, CUSUM



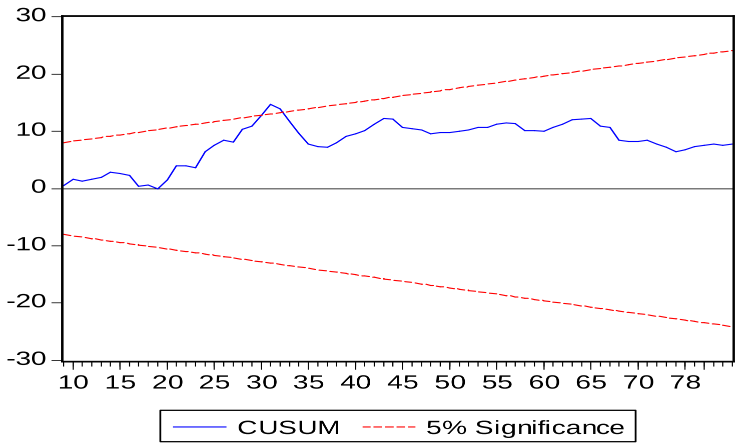
(4) Chile: Stability Test Result, CUSUM



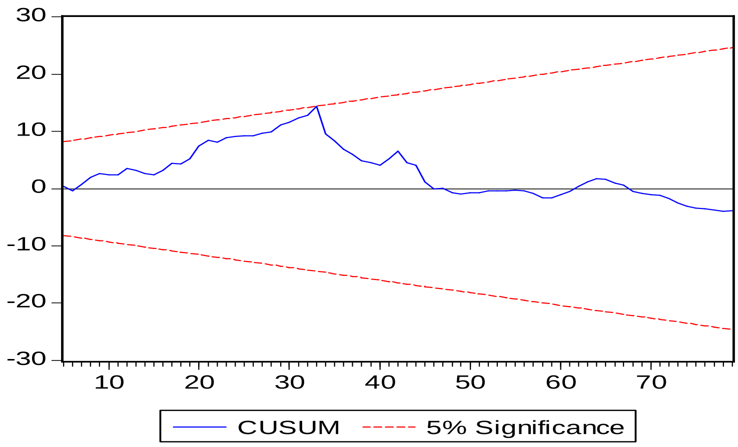
(5) Denmark: Stability Test Result, CUSUM



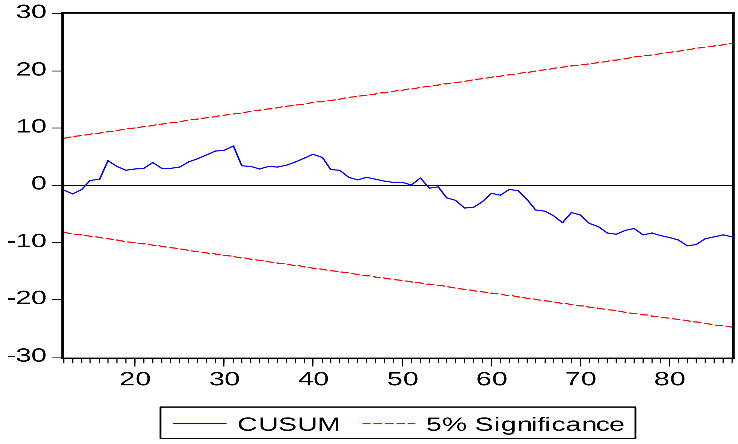
(6) Finland: Stability Test Result, CUSUM



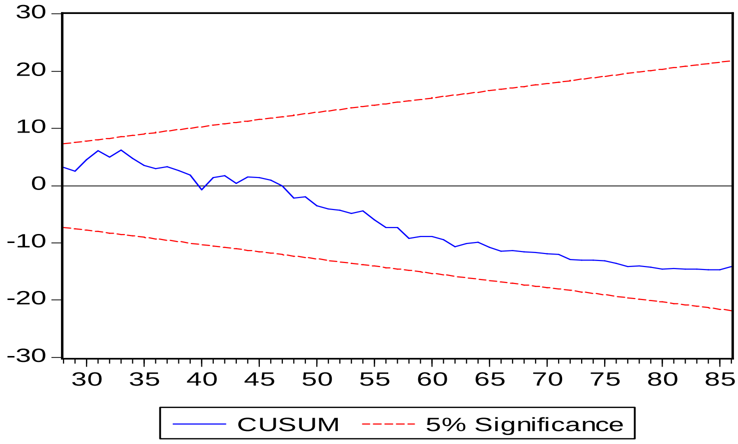
(7) France: Stability Test Result, CUSUM



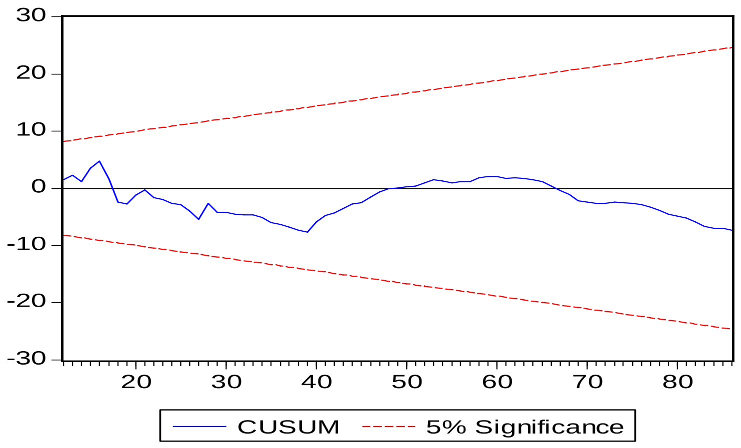
(8) Germany: Stability Test Result, CUSUM



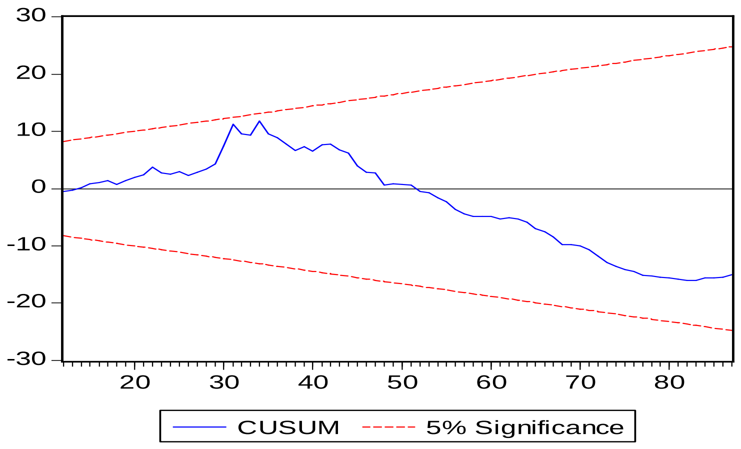
(9) India: Stability Test Result, CUSUM



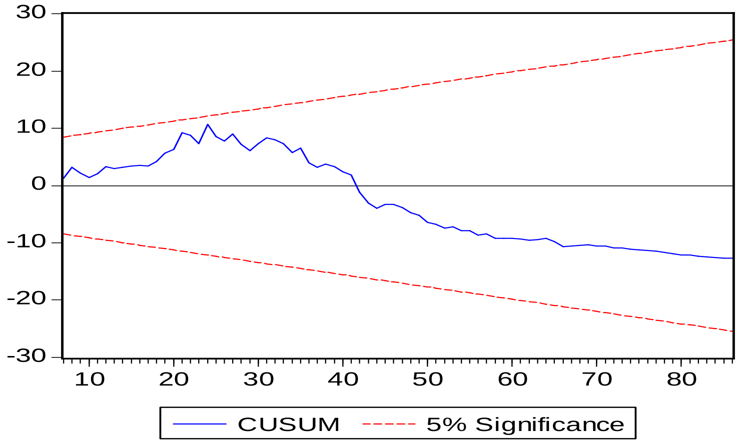
(10) Israel: Stability Test Result, CUSUM



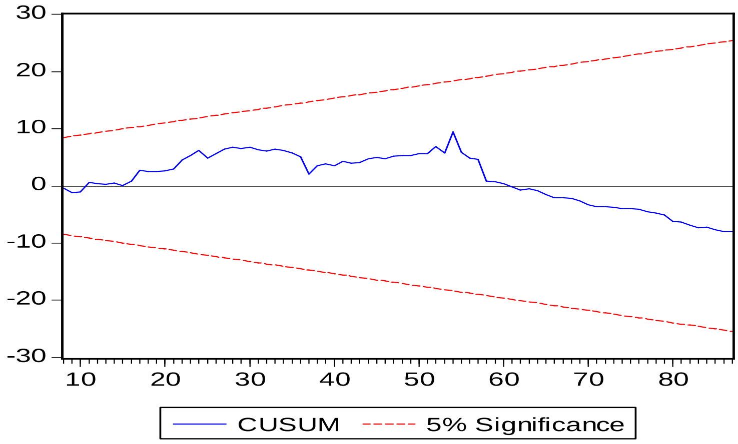
(11) Italy: Stability Test Result, CUSUM



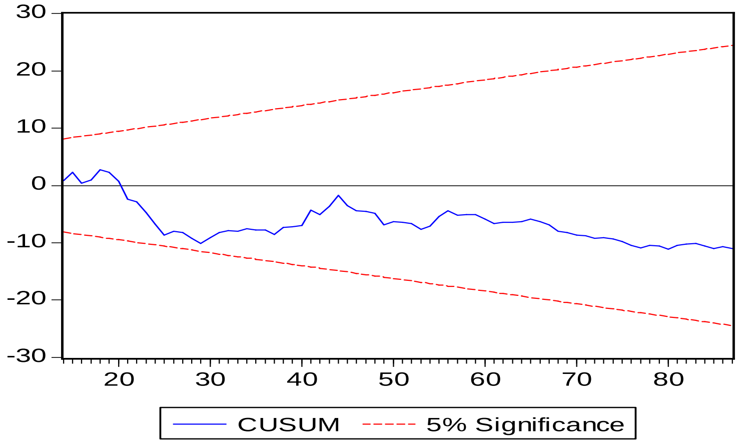
(12) Japan: Stability Test Result, CUSUM



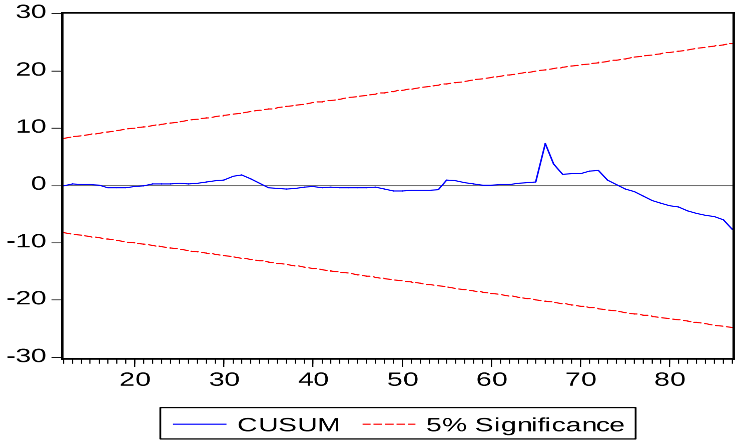
(13) Malaysia: Stability Test Result, CUSUM



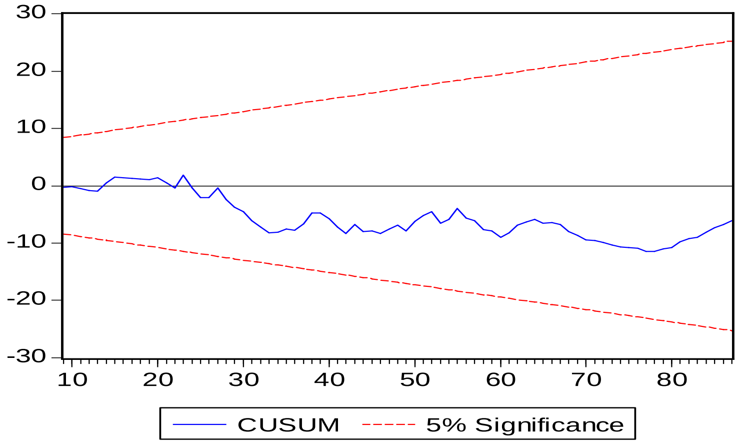
(14) Mexico: Stability Test Result, CUSUM



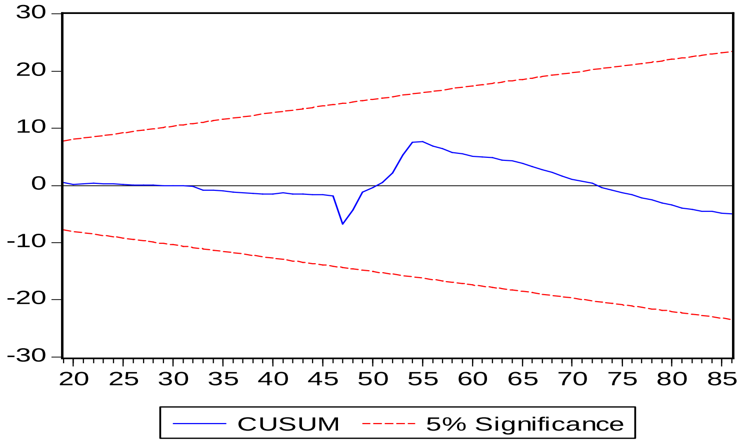
(15) Norway: Stability Test Result, CUSUM



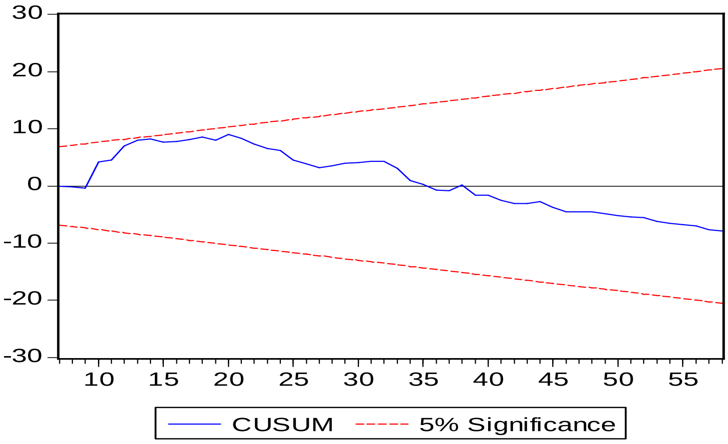
(16) Singapore: Stability Test Result, CUSUM



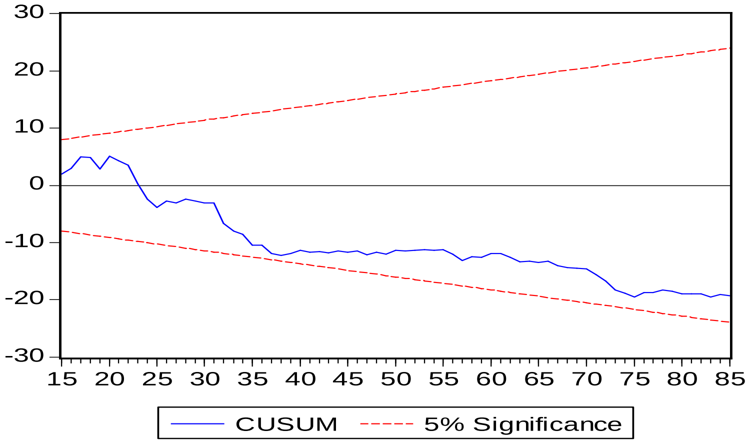
(17) South Korea: Stability Test Result, CUSUM



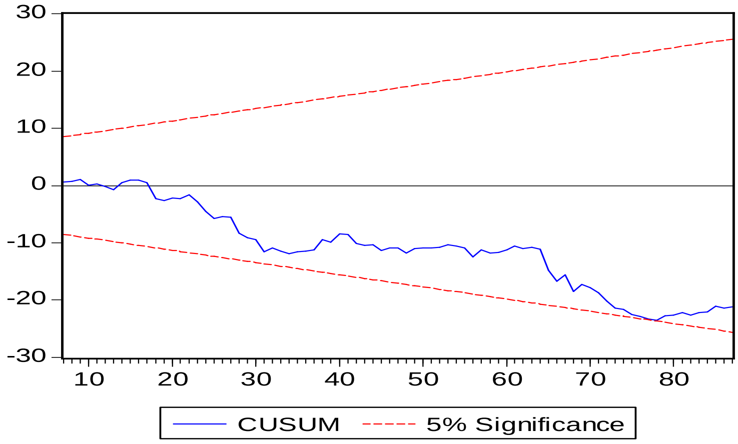
(18) Turkey: Stability Test Result, CUSUM



(19) UK: Stability Test Result, CUSUM



(20) USA: Stability Test Result, CUSUM



APPENDIX D

The test results for Turkey: Interbank money market rate is proxied as a nominal interest rate

Turkey:

Turkey: ARDL (2, 1), Dependent Variable: DINTERR			
Regressor	Coefficients	Standard Error	T-Ratio
C	18.27832	6.645914	2.750309
INTERR(-1)	-0.634500	0.112627	-5.633620
INF	1.665164	0.511140	3.257746
DINTERR(-1)	0.198252	0.107930	1.836858

Key Regressions:
$R^2 = 0.30$
D-W Statistic: 1.99
$F_{(4, 74)} = 7.959$ (0.000)

Diagnostic Test Statistic
Autocorrelation $F_{(4, 70)} = 1.099$ (0.363)
Heteroscedasticity $F_{(6, 71)} = 1.481$ (0.196)

Explicit equation form of regressions:

DINTERR = 18.27 – 0.63 INTERR(-1) + 1.66 INF + 0.19 DINTERR(-1)

Turkey: Stability Test Result, CUSUM, Dependent Variable: DINTERR