NONLINEARITY IN THE REAL INTEREST PARITY HYPOTHESIS

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ABSTRACT

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This study examines Real Interest Parity (RIP) hypothesis for some old and present members of European Free Trade Area (EFTA). The analysis entails the application of nonlinear unit root tests proposed by Kapetanios, Shin and Snell (2003) and Kılıç (2011) for January 1967 and August 2012 period, which coincides with some stages of Balassa's (1961) economic integration classification. The results show that nonlinearity in real interest rate differentials is significant for most cases and more supportive evidence for RIP can be obtained when nonlinearity is taken into consideration. Moreover, countries with stronger economic ties are more prone to verify RIP.

Keywords: EFTA, nonlinear unit root tests, trade blocs.

ÖZ

REEL FAİZ PARİTESİNDEKİ DOĞRUSALSIZLIK

Kadakal, Zeynep Şeyma
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Bu çalışma Reel Faiz Paritesi hipotezini bazı eski ve mevcut Avrupa Serbest Ticaret Bölgesi (EFTA) üyesi ülkeler için incelemektedir. Analiz, Kapetanios, Shin ve Snell (2003) ile Kılıç (2011) tarafından önerilen doğrusal olmayan birim kök testlerinin, Balassa'nın (1961) ekonomik entegrasyon sınıflandırmasının bazı aşamalarıyla örtüşen Ocak 1967 ve Ağustos 2012 dönemi, için uygulamasını içermektedir. Sonuçlar, seçilen ülkelerin çoğu için reel faiz farklarında doğrusalsızlığın anlamlı olduğunu ve doğrusalsızlık göz önünde tutulduğunda Reel Faiz Paritesini destekleyen daha fazla kanıtın elde edilebileceğini göstermektedir. Ayrıca, daha güçlü ekonomik bağları olan ülkeler Reel Faiz Paritesini geçerli kılmakta daha eğilimlidir.

Anahtar Kelimeler: EFTA, doğrusal olmayan birim kök testleri, ticaret blokları.

To My Family

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CHAPTER 1

INTRODUCTION

For the last decades, many countries have made great effort to enable free movement of capital and goods between nations. Technological advances have lowered the information and trading costs dramatically. All these developments lead to the perception that economies are more dependent to each other and more integrated. Hence researchers have become more interested in the verification of this perception in last years through analysis of goods and/or capital market integration.

This study aims to analyze the Real Interest Parity (RIP) hypothesis which enlightens whether the real economic integration is achieved or not.RIP requires the real interest rates of countries to show convergent behavior and it is derived from the Uncovered Interest Parity (UIP), the Purchasing Power Parity (PPP) hypotheses and the Fisher relation. UIP and PPP examine the equilibrium relation in the assets and the commodity markets, respectively. Hence, when the real interest rates of countries satisfy the RIP, this means their capital and goods market are integrated, thus they are considered to acquire the real economic integration. Since real interest rates are important for investment and saving decisions, real interest rate convergence has crucial implications for the investors and monetary authorities.

The countries within a trade bloc are expected to be more integrated than the ones outside. Balassa (1961) defines a hierarchical relation for regional trade agreements by considering the restrictions to trade and the degree of economic cooperation. The free trade area includes no tariff for members, while common markets enable free movement of both commodities and factors of production. Moreover, monetary union requires harmonization of economic policies. The degree of economic integration can be considered to increase from free trade area to monetary union. This study aims to explore this idea by examining RIP for a sample of former and present European Free Trade Area (EFTA) members for January 1967 and August 2012 period. EFTA suits well for this purpose. Although EFTA was founded as a free trade area, it have evolved into a single market structure and even a monetary union owing to some old members entering to the European Union (EU) and some joining to Eurozone and present members' trade agreements with the EU.

Majority of the studies in the literature analyze RIP through linear unit root and cointegration tests and panel data equivalents of them. However, factors like transaction costs, the contractual arrangements, asymmetric monetary policies, downward rigidity of commodity prices, risk perception of investors, limits to speculation and heterogeneous beliefs of agents can cause nonlinearity in RIP. This situation has directed the researchers[1] to apply nonlinear models for the investigation of RIP. For the RIP analysis, unit root and cointegration tests based on nonlinear models like Threshold Autoregressive (TAR), Smooth Transition Autoregressive (STAR) models and Markov Regime Switching are conducted. Accounting for nonlinearity, they provide much stronger evidence in favor of RIP than the previous studies utilizing linear models for real economic integration.

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[1]Baharumshah, Liew and Hamzah (2008), Baharumshah, Liew and Haw (2009), Baharumshah, Liew and Mittelhammer (2010), Cooray (2009), Cuestas and Harrison (2010), Cuestas and Ordonez (2009), Ferreira and Leon-Ledesma (2007), Holmes, Dutu and Cui (2009), Holmes and Maghrebi (2006), Sarpota (2009), Sekioua (2008), Su, Shen, Chang and Liu (2012), Su, Chang and Liu (2012) and Yılancı and Bozoklu (2011).

Due to aforementioned reasons of possible nonlinearity in RIP, we apply the nonlinear unit root tests proposed by Kapetanios, Shin and Snell (2003) and Kılıç (2011), in addition to standard linear unit root tests of Dickey and Fuller (1979) and Said and Dickey (1984) and Phillips and Perron (1988).To ensure existence of nonlinearity, we further utilize the linearity test of Harvey and Leybourne (2007). These tests are utilized for RIP analysis of some old and present EFTA members which are Austria, Denmark, Finland, Norway, Sweden, Switzerland and UK over the period between January 1967 and August 2012. Empirical results show that linear unit root tests are generally unable to support RIP, because these tests may suffer from low power in the presence of nonlinearity. Findings of nonlinear unit root tests, especially Kılıç's (2011) test, prove this point by providing strong evidence in favor of RIP. Furthermore, linearity test verifies nonlinearity in RIP for majority of the cases. Moreover, RIP holds almost for all the countries for the time period coinciding with the emergence of the single market structure and the introduction of the Euro. This shows that higher real integration can be achieved through increasing degree of economic cooperation[2].

This study contributes to the RIP literature by use of Kılıç's (2011) test and Harvey and Leybourne (2007) linearity test, both of which have not been used before for the RIP analysis. The data covers an extended time period. This enables the investigation of how the real integration of old and present EFTA members affected when they engage in stronger trade agreements, which is the another contribution of our study. The organization of the study is as follows; Chapter 1 briefly introduces the study, Chapter 2 reviews the literature on RIP, Chapter 3 gives detailed information on the data, Chapter 4 describes the methodology used, Chapter 5 discusses the empirical results and finally Chapter 6 concludes the study.

[2]Results for Austria and Denmark versus Germany pairs in the third period contradict with this situation. Possible explanation to this is discussed in the empirical results part.

CHAPTER 2

LITERATURE REVIEW

Increasing efforts of eliminating the barriers to cross-border movement of capital and goods especially after 1970s pose the question of whether this trend resulted in economic integration of nations. Real Interest Parity (RIP), which answers this question, states that if investors have rational expectations and arbitrage forces are free to act, then real interest rates of the countries must be equal at least in the long run.

Verification of Uncovered Interest Parity (UIP), Purchasing Power Parity (PPP) and Fisher relation imply RIP hypothesis.UIP condition represents the integration in the assets markets, while PPP condition stands for the goods market integration. Hence, RIP is considered as a measure of overall economic integration and provides information on economic independence. If RIP condition is satisfied, then domestic real rates are strongly linked to the foreign or world real rate and cannot differentiate much from it. Therefore, monetary policies aiming to affect domestic savings through real interest rates are not able to create an impact on the rate of capital formation, in turn, on productivity (Feldstein, 1983). This means that policies have limited influence on the economy and monetary authority looses its power of stabilizing the economy through the real interest rate channel. Thus, RIP is an important concept for policy makers due to shedding light to autonomy issue. Moreover, comovement of real rates prevents making profit from portfolio diversification (Lewis, 2006). Hence, it becomes meaningless for international investors to search for arbitrage opportunities in international markets. Additionally, RIP has an important place in exchange rate models as studies like Frenkel (1976) and Mussa (1982) build their models on the validness of RIP condition.

Due to aforementioned points, there are various studies focusing on the RIP in the literature. The early studies[3] search for equalization of real rates between major developed countries by applying simple linear regression models for domestic and foreign real rates. Their findings are strongly against the RIP. Observed failures are considered to be resulted from the nonstationarity of real rates. Hence, Al-Awad and Goodwin (1998), Centeno and Mello (1999) and Yamada (2002) use basic cointegration methods for RIP analysis of leading economies, while Lee (2002a, 2002b) and Phylaktis (1999) pursue the same approach for emerging Asian economies. These studies provide some evidence for RIP hypothesis.

Lee and Tsong (2012), Moosa and Bhatti (1996a, 1996b) and Shi, Li and Alexiadis (2012) show that results are seriously affected by the power of the method applied. Hence, studies using more powerful techniques like panel unit root and cointegration tests are more supportive of RIP. This point is proven by Amornthum and Bonham (2011), Baharumshah, Haw and Fountas (2005), Baharumshah, Haw, Masih and Lau (2011), Holmes, Otero and Panagiotidis (2011) and Mohsin and Rivers (2011) for Asian countries, while in Camarero, Carrion-i-Silvestre and Tamarit (2010), Dreger (2010), Kim (2006) and Wu and Chen (1998) for major developed economies and in Holmes and Wang (2009) for EU accession countries. However; despite utilizing panel data methods, Jenkins and Madzharova (2008) and Singh and Banerjee (2006) fail to support RIP for European Union (EU) countries and emerging economies, respectively.

[3]Cumby and Mishkin (1986), Cumby and Obstfeld (1984), Frankel and McArthur (1988), Gaab, Granziol and Horner (1986), Modjtahedi (1988), Mark (1985), Mishkin (1984).

Bagdatoglou and Kontonikas (2011), Holmes (2002, 2005), Ji and Kim (2009) and O'Brien (2007), emphasize that RIP condition is only satisfied during some periods. This may point out that existence of structural breaks can inhibit the adjustment of real rates. Analysis of Arghyrou, Gregoriou and Kontanikas (2009), Bagdatoglou and Kontonikas (2011), Fountas and Wu (1999), Magonis and Tsopanakis (2013), Maveyraud-Tricoire and Raus (2009) and Wu and Fountas (2000) which deal with the issue through methods considering structural breaks, confirm RIP condition for a significant number of developed economies in their sample.

Studies assuming linear adjustment affirm RIP to a certain extent. However, researchers using nonlinear methods propose legitimate reasons for nonlinearity. Mancuso, Goodwin and Grennes (2003) mention that existence of transaction costs both in goods and assets markets create a neural band within which arbitrage does not occur due to being unprofitable. However, outside of the band, profit opportunities emerge and are quickly eliminated thorough arbitrage mechanism. This enables markets to reach equilibrium easily, while it is not possible within the neutral band. Thus, real rates can behave differently within and outside of the band. They also cite contractual arrangements necessitate assets to be held for a certain predetermined period. This requirement makes rapid elimination of profits costly and difficult, hence arbitrage may not take place for that period. Thus, both transaction costs and contracts can create asymmetry in RIP (Mancuso *et al.*, 2003). Moreover, monetary authorities may take a biased position towards the inflation rate or currency appreciation in case of inflation or exchange rate targeting. They can be either more tended to or reluctant to affect the interest rates or exchange rates and hence pursue asymmetric policies. In addition, downward rigidity of commodity prices can cause slower adjustment in goods markets in comparison to financial markets. This synchronization problem and asymmetric monetary policies might evoke nonlinear adjustment in real interest rate differentials (Holmes and Maghrebi, 2006). Besides, because of imperfect information, the changes in interest rates can alter the investors' risk perceptions. Markets can perceive huge interest rate increments negatively and hence, triggering a rapid adjustment. This can create an asymmetric financial market adjustment causing RIP to hold nonlinearly (Ferreira and Leon-Ledesma, 2007).

Additionally, nonlinearity in RIP can also be justified by the limits to speculation hypothesis. This hypothesis states that financial market players choose a strategy only if its expected excess return per unit of risk, i.e. expected Sharpe ratio, is higher than the Sharpe ratio of the alternative ones. The speculative capital invested in a certain strategy cannot be attracted by the others until a large enough excess return emerges. Hence, this can create a band of inaction in financial markets, in turn, asymmetric behavior in RIP (Sarno, Valente and Leon, 2006). Furthermore, nonlinear adjustment in PPP due to heterogeneous beliefs of agents in foreign exchange market might generate nonlinearity in RIP (Sekioua, 2008) as well. This heterogeneity forms a band around the equilibrium level of nominal exchange rate within which opinions of traders are diverse. While some of them think that the currency is overvalued or undervalued, others regard the current level as the appropriate point. However, higher exchange rate deviation from the equilibrium causes traders to reach a greater degree of consensus on the proper direction of exchange rate movement and to behave accordingly. Thus, adjustment towards equilibrium can occur rapidly outside of the band. On the other hand, nominal rate may be unstable within the band and adjustment may not occur (Taylor, 2003).

In light of the points stated above, studies focusing on nonlinearity provide supportive evidence for RIP through nonlinear cointegration and unit root tests. For example, Cooray (2009) and Holmes and Maghrebi (2006) analyze the issue for developed countries by using Enders and Siklos (2001) Threshold Autoregressive (TAR) cointegration tests. Ferreira and Leon-Ledesma (2007) apply Caner and

Hansen (2001) TAR unit root test for mixed sample of developed and emerging economies around the world, while Sekioua (2008) and Su, Shen, Chang and Liu (2012) utilize the same method for developed and East Asian economies, respectively. Kapetanios *et al.* (2003) unit root test is performed by Baharumshah, Liew and Hamzah (2008) for Association of South East Asian Nations (ASEAN), Baharumshah, Liew and Haw (2009) for some leading and Asian developing economies and, Cuestas and Harrison (2010) for Central and East European countries, Sarpota (2009) for industrialized nations and Cuestas and Ordonez (2009) for some Latin American countries constituting the Mercado Comun del Sur (MERCOSUR). Furthermore, Baharumshah, Liew and Mittelhammer (2010), Holmes, Dutu and Cui (2009), Su, Chang and Liu (2012) and Yılancı and Bozoklu (2011) prefer other nonlinear unit root tests based on Smooth Transition Autoregressive (STAR) and Markov regime switching models. These studies examine similar sample of countries used in the other studies with nonlinear perspective.

This study contributes to the existing literature in terms of the methodology used and sample selection. Firstly, we apply not only the nonlinear unit root test of Kapetanios *et al.* (2003) but also the one proposed by Kılıç (2011), the latter of which has not been utilized in the RIP literature before. Moreover, we also apply the linearity test of Harvey and Leybourne (2007), which has not been applied before for RIP analysis. Secondly; following Bachellerie, Héricourt, Mignon (2009), we examine a sample of former and present European Free Trade Agreement (EFTA) members. Bachellerie *et al.* (2009) try to show whether stronger economic cooperation creates higher real integration by examining RIP within outstanding economic blocs around the world. These blocs include free trade area, custom union, common market and monetary union which are four steps of Balassa's (1961) hierarchical economic integration classification. They use linear cointegration method of Gregory and Hansen (1996) and present stronger real integration within common market and monetary union groups. This study is also inspired by the idea of analyzing RIP within the Balassa's (1961) integration classification framework and search for integration within EFTA for which Bachellerie *et al.* (2009) provide little support. However, differing from the Bachellerie *et al.* (2009), it aims to see changes in the degree of integration within the same group of countries once they are in a stronger economic bloc. For this purpose, old and present EFTA members are examined for an extended time period such that it coincides with the evolution of free trade area relation to common market and monetary union relation for some members.

CHAPTER 3

DATA

RIP analysis is conducted for monthly data of some former and present EFTA members[4], which are Austria, Denmark, Finland, Norway, Sweden, Switzerland and UK. Long term government bond yield series are used for nominal interest rates, due to the studies of Fujii and Chinn (2001) and Fountas and Wu (1999), which provide empirical results in favor of the RIP hypothesis when the long term interest rates are utilized. Following many other RIP studies, consumer price index (CPI) series are used in calculation of inflation rates. Both series are obtained from International Financial Statistics database except for CPI series of UK and Germany, which is attained from OECD database, and long term government bond yield series of Austria and Finland, which is acquired from Global Financial Data. The data covers the period between January 1967 and August 2012 which is the available widest interval.

According to RIP hypothesis, real interest rates of countries should converge. As stated in the introduction part, UIP and PPP hypotheses require the equilibrium relation to be established in the assets and the commodity markets, respectively. These two conditions together with Fisher relation imply RIP condition as follows

[4]EFTA was found in 1960 by Austria, Denmark, Norway, Portugal, Sweden, Switzerland and UK. In 1961 Finland, in 1970 Iceland and in 19991 Liechtenstein joined EFTA. While, in 1973 UK and Denmark, in 1986 Portugal and in 1995 Austria and Finland left EFTA and entered EU. Hence currently EFTA entails Iceland, Liechtenstein, Norway and Switzerland. Iceland, Liechtenstein and Portugal are excluded from the analysis due to unavailability of Iceland and Portugal data for the study period and the nonexistence of data for Liechtenstein.

$$s_{t+1}^{e} - s_t = i_t - i_t^{*} \tag{1.1}$$

$$s_{t+1}^{e} - s_t = \pi_{t+1}^{e} - \pi_{t+1}^{e*} \tag{1.2}$$

$$r_t = i_t - \pi_{t+1}^{e} \tag{1.3}$$

where (1.1) stands for UIP, (1.2) for PPP and (1.3) for Fisher relation. i_t and i_t^{*} are the domestic and foreign nominal interest rates at time t. s_t is the exchange rate at t, while s_{t+1}^{e} and π_{t+1}^{e} are the expected exchange rate and inflation rate for the period ahead, respectively. Subtraction of (1.2) from (1.1) gives

$$i_t - \pi_{t+1}^{e} = i_t^{*} - \pi_{t+1}^{e*}. \tag{1.4}$$

Utilizing the Fisher relation for domestic and foreign real rates in equation (1.4), the following RIP condition is obtained

$$r_t = r_t^{*}. \tag{1.5}$$

Rational expectations hypothesis states that ex-post, i.e. realized, inflation rate equals ex-ante, i.e. expected, inflation rate plus a stationary random forecast error term. Hence realized and expected series have same time series properties. Thus rational expectations assumption justifies the use of ex-post real rates and enables to avoid the complicate procedure of inflation forecasting for derivation of expected inflation rate. Moreover, Camarero and Carrion-i-Silvestre (2010), Bagdatoglou and Kontonikas (2011), Fountas and Wu (1999) and Fujii and Chinn (2001) observe robust results when both approaches are used. Following these studies, we also pursue ex-post perspective and calculate real rates as $r_t = i_t - \pi_{t+12}$ [5]. Inflation rate is calculated yearly by subtracting natural logarithm of the current price level from the natural logarithm of the 12 month ahead price level as in the studies[6] using long term rates.

After 1973, the free trade area structure of EFTA has been partially replaced by a common market due to some countries entry to the EU and trade agreements of Norway and Switzerland with the EU.[7] Moreover, Austria and Finland have been part of the monetary union since the introduction of Euro in January 1999. Hence, during the sample period, the economic cooperation between the countries have strengthened, since monetary union is stronger than common market and common market is stronger than free trade area according to Balassa's (1961) hierarchical classification. In order to examine whether these changes resulted in higher real integration, the sample period is divided into three subperiods and RIP analysis is conducted separately for each period. In the first period, January 1967 – December 1972, all countries are EFTA members and only free trade area relation is the case. In the second period, January 1973 – December 1998, free trade area evolves to common market owing to entry of all countries except for Norway and Switzerland to EU and foundation of European Economic Area. In the final period, January 1999

[5]Many studies do not explicitly define their real interest rate calculation. However the majority of the ones giving detailed information calculates real rates like this, although Wu and Fountas (2000), O'Brien (2007) and Arghyrou *et al.* (2009) calculates current real rate by subtracting current inflation rate from the last period or lagged nominal rate. Analysis is also replicated for this approach, results do not differ much.

[6]Bachellerie *et al.* (2009), Fountas and Wu (1999), Sarpota (2009).

[7]In 1994 current EFTA members except for Switzerland formed a single market with the EU named as European Economic Area. Later Switzerland also obtained a similar status by signing a similar agreement with the EU.

– August 2012, Eurozone emerges. Hence, real interest rate differentials are calculated within each period with respect to both Germany and UK, since Germany is generally taken as the base country for analysis of real integration within the EU or Eurozone in studies like Maveyraud-Tricoire and Raus (2009), Holmes (2002, 2005) and Chang (2011); while UK is chosen as base for searching RIP within old and present EFTA members or outside the Eurozone in studies of Bachellerie *et al*. (2009) and Holmes and Wang (2009), respectively.

Figure 1 demonstrates both the real interest rates and the differentials where Germany and UK are taken as the base country, in other words the foreign rate. The whole sample is divided into the aforementioned three periods by the vertical dashed lines. At the initial period, interest rate differentials do not show sharp rise or falls, but the fluctuation patterns differ dramatically during the second period. After the introduction of Euro, the gap between the real rates is narrower and interest rate differentials generally fluctuate around a zero mean. Since the German and UK real rates are close to each other during the third period, interest rate differential series seem to behave similarly independent of the base country. The least fluctuation is observed for Austria and Switzerland versus Germany cases for all periods. Moreover, Swiss real rates are less than the rates of both base countries during the whole sample period. The highest real rate is observed for Denmark during the second period.

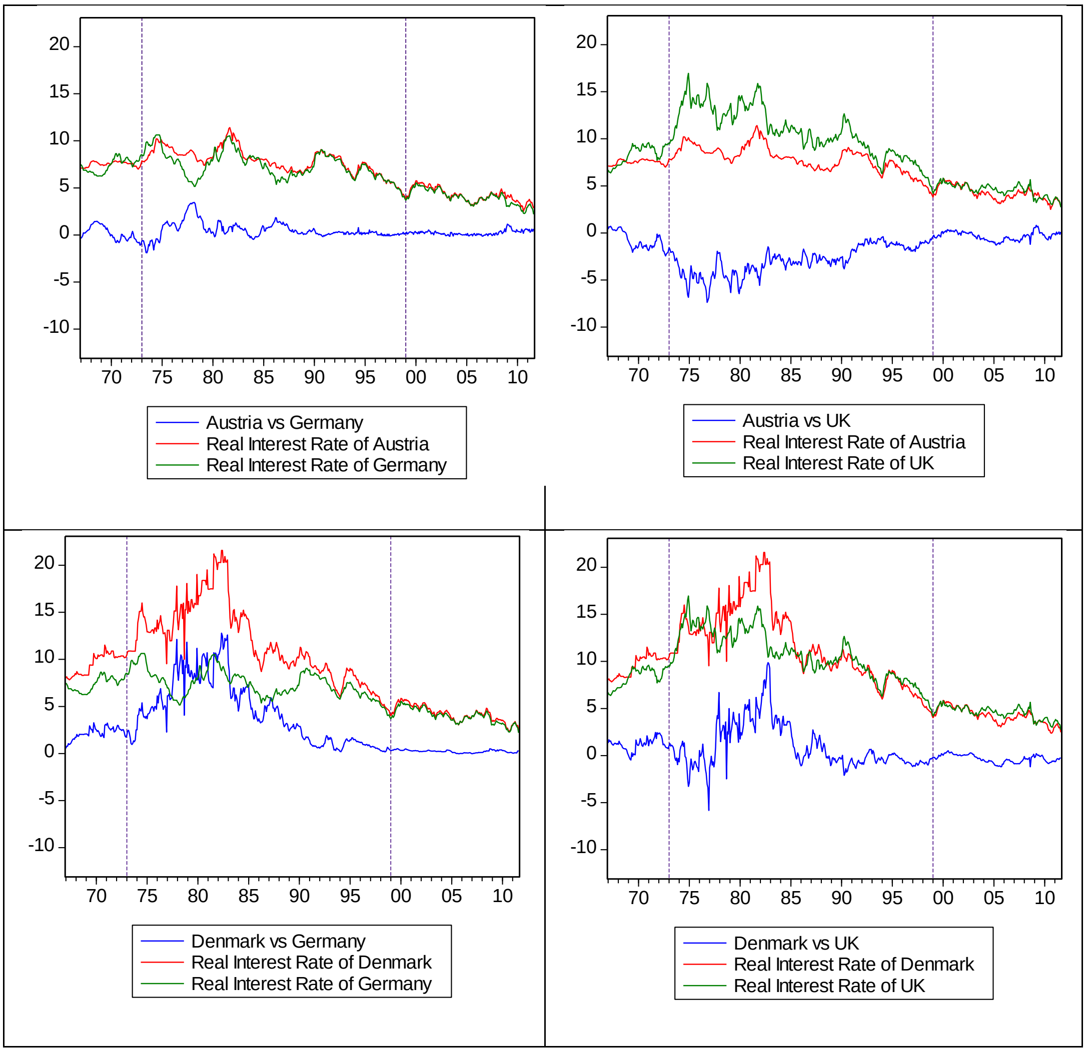
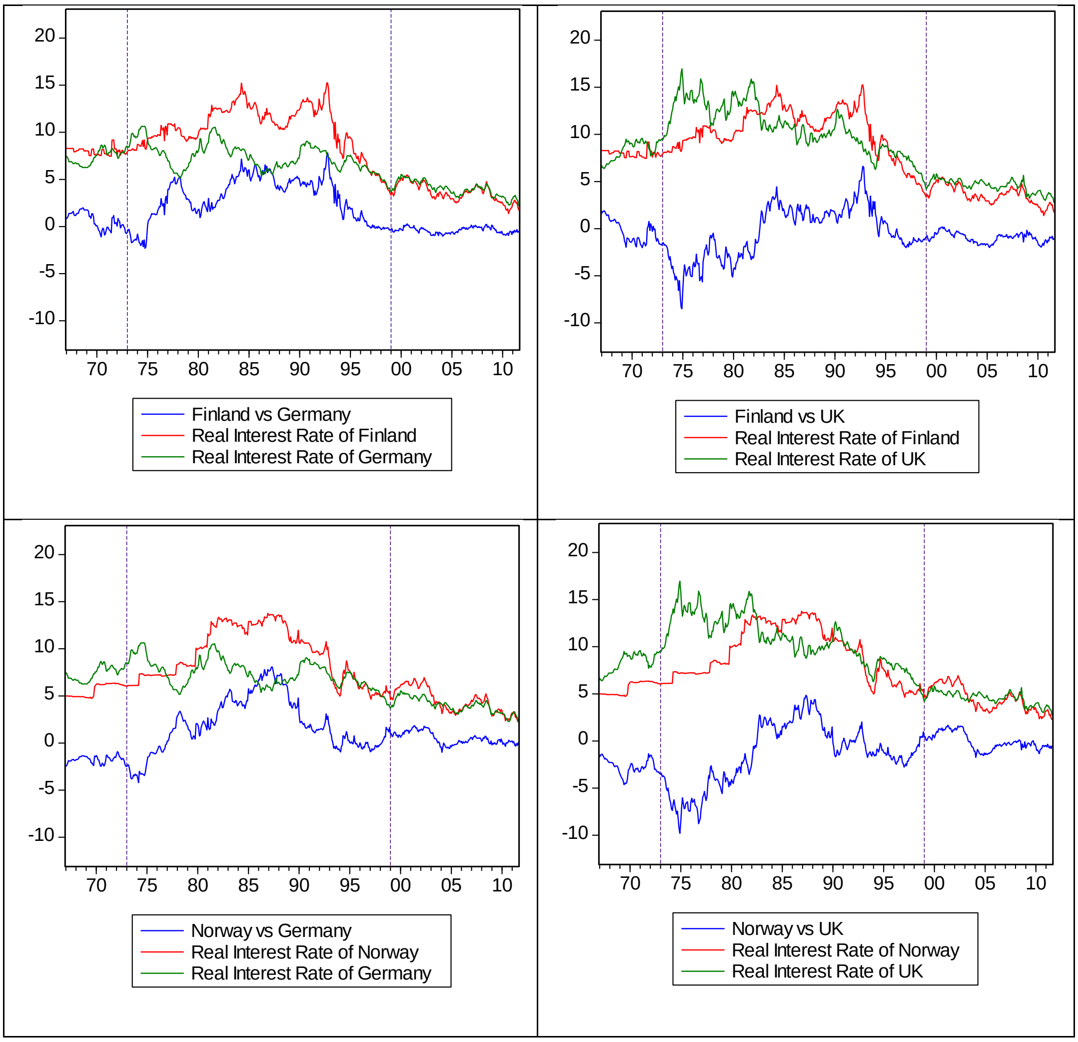


Figure 1: Real interest rates and real interest rate differentials with respect to Germany and UK over the period January 1961 – June 2012 (Source: International Financial Statistics database)



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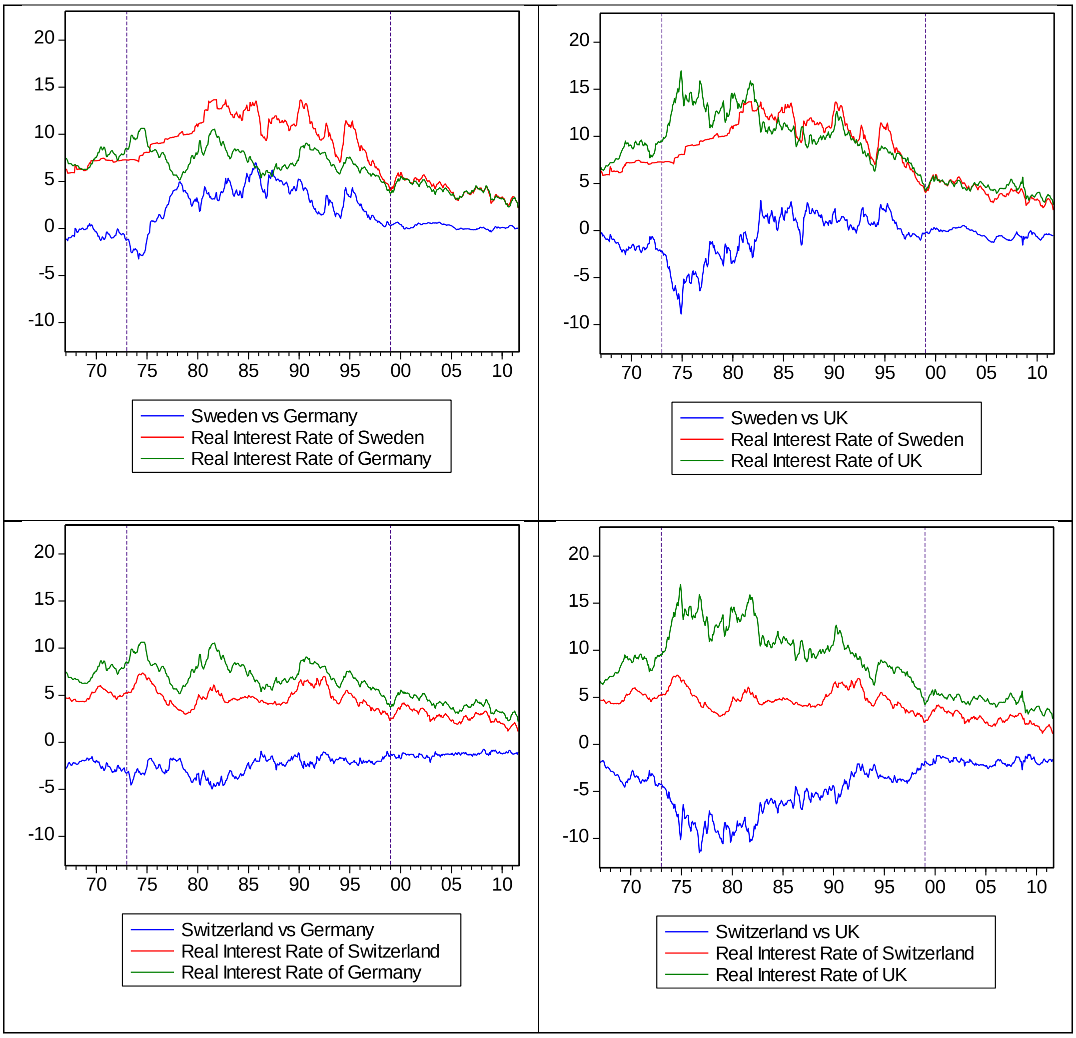

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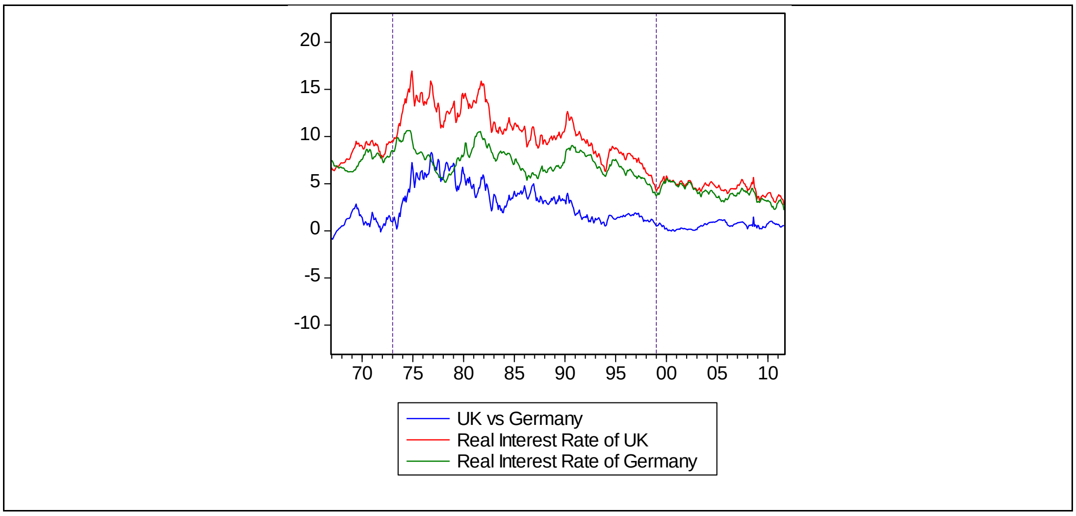

Figure 1 (Continued)

CHAPTER 4

METHODOLOGY

This study analyses RIP by conducting linear and nonlinear unit root tests for real interest rate differentials. For linear perspective, standard Augmented Dickey Fuller (Dickey and Fuller, 1979; Said and Dickey, 1984) unit root test and Phillips and Perron (1988) unit root test are used. Studies of Balke and Fomby (1997), Pippenger and Goering (1993) and Taylor (2001) demonstrate that standard linear unit root tests have low power in case of nonlinearity. Moreover, Cuestas and Harrison (2010), Baharumshah *et al.* (2009), Holmes and Maghrebi (2008) and Baharumshah *et al*. (2008) conclude that nonlinear unit root tests provide more supportive evidence for RIP. Due to the low power problem of linear tests and reasons of nonlinearity in RIP discussed in literature review part, nonlinear unit root tests proposed by Kapetanios *et al.* (2003) and Kılıç (2011) are utilized. Both tests are more powerful than conventional unit root tests. Monte Carlo experiment results show that Kılıç's (2011) test has better size and power properties than the test proposed by Kapetanios *et al.* (2003)[8]. Moreover, the linearity test proposed by Harvey and Leybourne (2007), which is robust to order of the integration of the data, is also conducted as part of the analysis. In the following discussion, nonlinear unit root tests and linearity test are described in detail and rid_t stands for the real interest rate differentials.

[8]Additionally, Kılıç compares the power of his test with nonlinear unit root tests proposed by Park and Shintani (2005) and Bec, Guay and Guerre (2008) and overall his test outweighs the others.

4.1 Nonlinear Unit Root Test of Kapetanios, Shin and Snell (2003):

Kapetanios *et al.* (2003) develops a procedure to test for nonstationarity against nonlinear globally stationary exponential smooth transition autoregressive (ESTAR) process as,

$$rid_t = \beta rid_{t-1} + \phi rid_{t-1}\left[1-\exp(-\gamma rid_{t-1}^2)\right] + \varepsilon_t, \qquad t = 1,....,T \qquad (4.1)$$

which can be reparameterized by subtracting rid_{t-1} from both sides as

$$\Delta rid_t = \theta rid_{t-1} + \phi rid_{t-1}\left[1-\exp(-\gamma rid_{t-d}^2)\right] + \varepsilon_t, \qquad (4.2)$$

where $\varepsilon_t \sim iid(0,\sigma^2)$, $\theta = \beta - 1$ and β, ϕ, γ and θ are unknown parameters. The speed of transition parameter γ is assumed to satisfy $\gamma \geq 0$. Small values of γ means slower transition, while for large values transition is sharper. In addition, following Micheal, Nobay and Peel (1997), they take $\theta = 0$. Hence model (4.2) becomes

$$\Delta rid_t = \phi rid_{t-1}\left[1-\exp(-\gamma rid_{t-1}^2)\right] + \varepsilon_t. \qquad (4.3)$$

Under the null hypothesis of $H_0 : \gamma = 0$, rid_t is a unit root process, while under the alternative hypothesis of $H_1 : \gamma > 0$, rid_t is a nonlinear but globally stationary process assuming that $-2 < \phi < 0$. For small values of real interest rate differentials, the process show unit root behavior, in other words a neutral band emerges within which RIP fails to hold. While for large differentials either positive or negative, real interest rate differentials adjust to equilibrium and RIP holds. The transition between these two regimes is sharper for larger γ values. The model in (4.3) describes well the behavior of real interest rate differentials, since Micheal, Nobay and Peel (1997) emphasize that the existence of transaction costs creates a neutral band around the PPP equilibrium. Outside of the band, deviations from PPP are eliminated, while within the band PPP condition does not hold. This adjustment process occurs gradually rather than abruptly. Hence, STAR model is more suitable than the Threshold Autoregressive (TAR) model in which the regime changes discretely. Moreover, outside of the neutral band both negative and positive deviations from PPP adjust in a similar way. This validates the use of the ESTAR model instead of the LSTAR model for PPP analysis. Due to these reasons, the behavior of real interest rate differentials also should be considered within the ESTAR model framework. Hence, unit root tests of Kapetanios *et al.* (2003) and Kılıç (2011) are preferred for the examination of RIP in this study, since both tests are based on the ESTAR model.

The problem in testing this hypothesis is that ϕ is unknown under H_0 (see Davies, 1987). To solve this, Kapetanios *et al.* (2003) derive a t-type test statistic through use of a first order Taylor series approximation for ESTAR model under H_0 following

Luukkonen, Saikkonen and Terasvirta (1988). The auxiliary regression obtained by approximation is

$$\Delta rid_t = \delta rid_{t-1}^3 + error. \quad (4.4)$$

Aforementioned hypothesis can be replaced by $H_0 : \delta = 0$ and $H_1 : \delta < 0$ and t-statistic for testing it is

$$t_{NL} = \hat{\delta} / s.e.(\hat{\delta}), \quad (4.5)$$

where $\hat{\delta}$ is the Ordinary Least Squares (OLS) estimate of δ and $s.e.(\hat{\delta})$ is the standard error of δ. t_{NL} does not have an asymptotic standard normal distribution. Hence the critical values for the test are obtained through Monte Carlo simulations.

If rid_t has a nonzero mean, then the testing procedure is applied to demeaned data which is obtained by subtracting the sample mean from rid_t. If the series has a nonzero mean and nonzero linear trend, then demeaned and detrended data, i.e. the residuals from regressing rid_t on a constant and trend term through OLS estimation, is used. Asymptotic critical values for raw data and these cases are provided by stochastic simulation.

In case of autocorrelated errors in model (4.3), the corrections of Dickey and Fuller (1979) and Said and Dickey (1984) are utilized assuming that errors are linearly correlated. The model becomes

$$\Delta rid_t = \sum_{j=1}^{p} \Delta rid_{t-j} + \phi rid_{t-1}\left[1-\exp(-\gamma rid_{t-1}^2)\right] + \varepsilon_t, \qquad (4.6)$$

where $\varepsilon_t \sim iid(0,\sigma^2)$. Similarly, equation (4.4) is extended as

$$\Delta rid_t = \sum_{j=1}^{p} \Delta rid_{t-j} + \delta rid_{t-1}^3 + error. \qquad (4.7)$$

t_{NL} is computed using equation (4.5) and OLS estimation of (4.7) as before. This modification does not affect the asymptotic distribution of the test statistics and same critical values can be used. The number of augmentations p is determined by standard model selection procedure. It is identified prior to test and under the null hypothesis.

4.2 Nonlinear Unit Root Test of Kılıç (2011):

The unit root test proposed by Kılıç (2011) is similar to that of Kapetanios *et al.* (2003), with the differences being due to the choice of the transition variable and the way dealing with the nuisance parameter problem. Kılıç reforms model (4.3) by replacing the transition variable rid_{t-1} with Δrid_{t-1}. Utilization of the difference term in the model enables to examine whether larger changes in real interest rate differentials are mean reverting while smaller ones are persistent. To test for a linear unit root process, i.e. $H_0 : \phi = 0,$ against a stationary ESTAR process, i.e. $H_1 : \phi < 0,$ t-statistic is used as in Kapatenios *et al*. (2003). The problem of γ being unidentified under the null hypothesis is solved by calculating t-statistics for a fixed parameter space of γ values and taking the minimum t-value as the test statistic. That is

$$t_{ESTAR} = \inf_{\gamma \in \Gamma_T} \hat{t}_{\phi=0}(\gamma) = \inf_{\gamma \in \Gamma_T} \frac{\hat{\phi}(\gamma)}{s.e.(\hat{\phi}(\gamma))}, \tag{4.8}$$

where $\Gamma_T = \left[\underline{\gamma}_T, \overline{\gamma}_T\right] = \left[\frac{1}{100 s_{\Delta rid_{t-1}T}}, \frac{100}{s_{\Delta rid_{t-1}T}}\right] \in \mathbb{R}$, and $s_{\Delta rid_{t-1}T}$ is the sample standard deviation of Δrid_{t-1t}. $\hat{\phi}(\gamma)$ and $s.e.(\hat{\phi}(\gamma))$ are obtained by least squares estimation of model (4.3) where Δrid_{t-1} is the transition variable. It is advised to take the grid size as $\frac{1}{100 s_{\Delta rid_{t-1}T}}$.

For nonzero mean and nonzero linear trend cases, the same approach in Kapetanios *et al*. (2003) is utilized. If rid_t has a nonzero mean, then the testing procedure is applied to demeaned data. If the series has nonzero mean and nonzero linear trend, then demeaned and detrended data is used. Asymptotic critical values for raw data and these cases are obtained by Monte Carlo simulations.

Autocorrelated errors problem is dealt as in Kapetanios *et al.* (2003). The model (4.6), where Δrid_{t-1t} is used instead of rid_{t-1}, is estimated t_{ESTAR} is calculated for equation (4.8) same as before. This modification does not affect the asymptotic distribution of the test statistics and same critical values can be used. The number of augmentations p is determined by standard model selection procedure. It is identified prior to test and under the null hypothesis.

4.3 Linearity Test of Harvey and Leybourne (2007):

Harvey and Leybourne (2007) develop a test procedure to test for linearity of a series. Their test does not make any prior assumption for the order of the integration of the series. This robustness to the integration order is the advantage of this test over other linearity tests. They use a nonlinear Autoregressive order of 1 (AR(1)) model for a stationary rid_t ,

$$rid_t = \mu + v_t \tag{4.10}$$

$$v_t = \rho v_{t-1} + \rho f(v_{t-1}, \theta) v_{t-1} + \varepsilon_t \tag{4.11}$$

where $\varepsilon_t \sim iid(0, \sigma^2)$ v_t is globally stationary and $f(.,\theta)$ is either ESTAR or LSTAR model. For the possibility of rid_t being a nonstationary nonlinear AR(1) model, instead of equation (4.11) the following is considered,

$$\Delta v_t = \phi \Delta v_{t-1} + \lambda f(\Delta v_{t-1}, \theta) \Delta v_{t-1} + \varepsilon_t \tag{4.12}$$

where Δv_t is globally stationary. Equations (4.11) and (4.12) are approximated to the second order due to the assumption of $f(.,\theta)$ can be approximated by a Taylor series expansion around $\theta = 0$ and the following hybrid DGP is considered,

$$rid_t = \mu + v_t$$

$$v_t = \delta_0 v_{t-1} + \delta_1 v_{t-1}^2 + \delta_2 v_{t-1}^3 + \lambda_0 \Delta v_{t-1} + \lambda_1 (\Delta v_{t-1})^2 + \lambda_2 (\Delta v_{t-1})^3 + \varepsilon_t \qquad (4.13)$$

When the two equations in (4.13) are combined the following equation is obtained,

$$\begin{aligned} rid_t = {} & \beta_0 + \beta_1 rid_{t-1} + \beta_2 rid_{t-1}^2 + \beta_3 rid_{t-1}^3 + \beta_4 \Delta rid_{t-1} + \beta_5 (\Delta rid_{t-1})^2 \\ & + \beta_6 (\Delta rid_{t-1})^3 + \varepsilon_t. \end{aligned} \qquad (4.14)$$

The equation (4.14) is used to test the linearity of a series for the null hypothesis of linearity versus alternative hypothesis of nonlinearity which is stated as,

$$\begin{aligned} & H_0 : \beta_2, \beta_3, \beta_5, \beta_6 = 0 \\ & H_1 : \text{At least one differs from zero.} \end{aligned} \qquad (4.15)$$

The test statistic of the this linearity test is,

$$W_T^* = \exp(-b|DF_T|^{-1})W_T \qquad (4.16)$$

where $W_T = \frac{RSS_1 - RSS_0}{RSS_0 / T}$, in which T is the sample size, RSS_0 and RSS_1 stand for the residual sum of squares from OLS estimation of unrestricted equation (4.14) and the below restricted equation (4.17), respectively

$$rid_t = \pi_0 + \pi_1 rid_{t-1} + \gamma \Delta rid_{t-1} + \varepsilon_t. \tag{4.17}$$

Moreover, DF_T is the Dickey-Fuller test result for testing the existence of nonstationarity in the restricted equation (4.17) and b is obtained from the response surface methodology, which gives 0.2406, 0.2272 and 0.2034 values for 10%, 5% and 1% significance levels, respectively. The test statistics in (4.16) has $\chi^2_{(4)}$ distribution.

For the serial correlation situation the same approach used in Kapetanios *et al.* (2003) and Kılıç (2011) is utilized. The corresponding unrestricted and restricted equations are stated as

$$\begin{aligned} rid_t = \beta_0 + \beta_1 rid_{t-1} + \beta_2 rid_{t-1}^2 + \beta_3 rid_{t-1}^3 + \beta_4 \Delta rid_{t-1} + \beta_5 (\Delta rid_{t-1})^2 + \beta_6 (\Delta rid_{t-1})^3 \\ + \sum_{j=1}^{p} \beta_{4,j} \Delta rid_{t-j} + \varepsilon_t, \end{aligned} \tag{4.18}$$

$$rid_t = \pi_0 + \pi_1 rid_{t-1} + \sum_{j=1}^{p} \gamma_j \Delta rid_{t-j} + \varepsilon_t, \tag{4.19}$$

respectively. The augmentation term p is determined by the application of general-to-specific approach for the equation (4.18) and it is substituted in both equations above. The same test statistics (4.16) is used, but the Dickey-Fuller test is replaced by ADF_T, which is the result of the unit root test for (4.19).

CHAPTER 5

EMPRICAL RESULTS

This study aims to test the RIP hypothesis for some former and present EFTA member countries over the period between January 1967 and August 2012. For this purpose, the real interest rate differentials of Austria, Denmark, Finland, Norway, Sweden and Switzerland with respect to UK and Germany are tested for the existence of unit root by using linear and nonlinear unit root tests, in addition to the linearity test. The data period is divided into three parts: The first period as January 1967 – December 1972, the second period as January 1973 – December 1998 and the third period as January 1999 – August 2012.

During the whole sample period, EFTA have experienced drastic changes. The second period entails departures of Austria, Denmark, Finland, Sweden and UK from EFTA to join the EU and the integration of Norway and Switzerland to the single market structure of EU through sign of trade agreements. After January 1999, the monetary unification is attained between Austria, Finland and Germany with the introduction of the Euro. Hence aforementioned division of the sample period enables to compare the degree of real integration between countries when only free trade area relation exists during the first period and when single market structure formed during the second period and when common currency is the case for the third period. According to Balassa (1961), free trade area relation is weaker than the single market structure which is also weaker than the monetary union. The countries within a monetary union like Eurozone are expected to be more supportive of the RIP condition than the countries within a common market. Moreover, members of a single market are expected to provide stronger evidence for real integration than the countries within a free trade area do. Thus, real interest rate differentials (RIDs) are computed with respect to both UK and Germany. UK is used as the base country to examine the real rate integration within old and present EFTA members, since UK is the leading economy within the group. Germany is also taken as reference in RID computations, since it is the biggest economy in the EU and the Eurozone thus represents the integration within the EU, i.e. the single market, and Eurozone, i.e. the monetary union.

For the analysis of RIP; firstly, Augmented Dickey Fuller (ADF) (Dickey and Fuller, 1979; Said and Dickey, 1984) and Phillips and Perron (PP) (1988) unit root tests are applied to real interest rate differentials (RIDs) computed with respect to both UK and Germany. The lag selection for the ADF test is determined through the general to specific approach for which the maximum lag is taken as 12 due to use of monthly data. When the graphs of RIDs are examined, it seems series have nonzero mean, but it is difficult to conclude for the existence of linear trend. Hence tests are conducted for both the constant term and the linear trend together with constant term cases.

Secondly, nonlinear unit root tests of Kapetanios *et al.* (2003) and Kılıç (2011) are applied to RIDs, since in case of nonlinearity linear unit root tests have low power and can fail to provide evidence for RIP. For Kapetanios *et al.*'s (2003) test, the equation (4.7) is estimated and the test statistic in (4.5) is computed. Kılıç's (2011) test is applied by estimating (4.7) in which the transition variable is Δy_{t-1}, then computing the test statistic in (4.8) through the grid search approach as described before. The lag length p used for ADF test is utilized for both tests, since p is required to be determined under the null hypothesis before the application of the tests. Tests are conducted for demeaned and detrended data as described in the methodology chapter. Kılıç's (2011) test has an important place for this study, since it has not been applied before for RIP and it is powerful compared to other nonlinear unit root tests.

Both Kapetanios *et al*. (2003) and Kılıç (2011) test the existence of unit root in case of nonlinearity. They do not give information about the validness of nonlinearity. Hence, the linearity test of Harvey and Leybourne (2007) is also utilized to verify the nonlinearity in RIP resulting from the reasons described in the literature review part. For this purpose, the models (4.18) and (4.19) are estimated. The lag length p is determined as in the other tests, but the only difference is that p is allowed to take 1 as the minimum value. Then, the test statistic (4.16) is computed. Since computation of the test statistic is independent of whether the series has a constant and/or linear trend term, results are valid for both cases contrary to unit root tests.

As seen from Table 1, the results of ADF and PP unit root tests generally indicate existence of unit root behavior in RIDs, in turn, RIP failure for all periods independent of the base country choice. This shows that real integration between the sample countries is not achieved for most of the RIDs. However, there are exceptions of Norway versus Germany case in the first period and Switzerland versus UK case in the third period for which RIP holds. Moreover, Denmark seems to be integrated with Germany in the first period and with UK in the second period, and Austria, Finland and Switzerland seem to be integrated with Germany in the third period according to PP test, while ADF test does not support the real integration for these situations. In the third period, ADF test presents evidence for RIP in RID between UK and Germany, but PP test says the reverse.

Kapetanios *et al.*'s (2003) test findings are more supportive of RIP than the ADF and PP tests. RIDs of Norway with respect to Germany and RIDs of Denmark and Sweden with respect to UK seem to be stationary in the first period. During the second period, the real interest rates of Austria and Finland appear to converge to the real interest rate of UK, while Denmark and Switzerland show convergent behavior towards Germany. The RIP relation is proven for Denmark, Sweden and Switzerland versus UK and; Finland and UK versus Germany cases in the third period. Overall, nonlinear unit root test proposed by Kapetanios *et al.* (2003) provide limited evidence for RIP condition. Moreover, it does not present supportive evidence for the idea of increasing economic cooperation causing higher level of real integration.

Kılıç's (2011) unit root test proves both points that this study interested in. First, this study aims to show that the inability of previous studies to present strong evidence for real integration can result from nonlinearity. Second, the real interest rate differentials of the countries with closer economic ties by forming stronger trade blocs should be more successful in verification of the RIP condition. The results in Table 1 figure out that Kılıç's (2011) test is much more supportive of RIP for all periods than the other unit root tests, due to being more powerful. During the first period, RIP holds for Norway and Sweden independent of the base country choice, while it holds for Austria and UK versus Germany, and Finland and Switzerland versus UK cases. The second period records a high degree of success. RIP is supported for all cases except for UK and German real interest rate differentials. This shows that the single market structure has increased the real integration dramatically. The results for the third period also support RIP strongly especially for UK based RIDs. Only RIDs of Austria, Denmark, Finland and Switzerland with respect to Germany result in failure.

As stated previously, the analyses are also done for the linear trend case and similar results are obtained. Again, linear unit root tests generally signal the existence of unit root in RIDs, while the test of Kapetonios *et al.* (2003) provides weak but relatively stronger evidence for RIP. Kılıç's (2011) test strongly supports the RIP especially for the second and the third periods. Trend term is significant for Austria, Finland and Switzerland versus Germany cases in the first period and for Austria and Switzerland versus UK and Denmark, Switzerland and UK versus Germany cases in the second period and Switzerland versus Germany case in the third period. For these cases differing from without trend case; results of linear unit root tests support RIP for Austria and Switzerland versus UK and UK versus Germany in the second period and for Switzerland versus Germany in the third period. Moreover, Kapetanios *et al.*'s (2003) test results support RIP for Switzerland versus UK cases in the second period and Switzerland versus Germany cases in the third period, while Kılıç's (2011) test verifies real integration for Finland and Switzerland versus Germany pairs in the first period. However, evidence of real integration for Denmark in the second period disappears. Due to significant trend term, these results should be taken into consideration rather than the results for without trend case.

The linearity test of Harvey and Leybourne (2007) concludes for nonlinearity in most of the RIDs for which nonlinear unit root test results provide evidence for RIP. This proves our point that RIP should be analyzed within nonlinear model framework. However, for Austria versus UK and Denmark versus Germany pairs, RIP still cannot be verified during the first period, while RIP holds in other periods for which nonlinearity is significant. This is probably due to the free trade area relation being weaker than the other two trade blocs according to the Balassa's (1961) classification.[9] On the other hand, it is interesting that Kılıç's (2011) test verifies real integration for RIDs of Austria, Sweden and UK with respect to Germany in the first

[9]There is exception of Austria versus Germany in the third period where RIP still fails despite significant nonlinearity.

period and Switzerland versus Germany with trend case both in the first and third period, while linearity is supported and linear unit root tests shows nonstationarity for these pairs. Similarly, the test of Kapetanios *et al.* (2003) results in stationarity of RIDs for Denmark versus UK in the first period and Finland and Switzerland versus Germany in the third period. This situation may be linked to the power of linearity test, in other words a more powerful linearity test may verify nonlinearity for these cases, too.

Aforementioned failures of Kılıç's (2011) test for Austria, Denmark and Finland versus Germany pairs in after Euro period are quite surprising, since RIP holds for these cases in the second period. Moreover, Austria and Finland cases imply that Eurozone membership seems to have negative impact on the real integration contrary to our expectation. However, when the linearity test results are examined, it is seen that null hypothesis of linearity for Finland versus Germany pairs in the third period cannot be rejected. Additionally, linear unit root test results conclude for validness of RIP. This implies that RIP also holds for Finnish RIDs with respect to Germany in the third period. On the other hand, the failures of Austria and Denmark still need explanation due to nonlinearity being significant according to Harvey and Leybourne (2007) test results. Chang (2011) and Canarella, Miller and Pollard (2011) also provide evidence against RIP for RID between Austria and Germany after the Euro period despite considering nonlinearity. The study of Zhou, Bahmani-Oskoee and Kutan (2008) shows that nonlinear unit root test fails to verify PPP in post-Euro period for Austria and Denmark versus Germany pairs. Besides, Holmes and Maghrebi (2008) propose the violation of PPP as the reason of RIP violation in the Eurozone. Hence, PPP failure may be the reason of RIP failure also for our study.

Table 1: UnitRoot Test ResultsForRIDs (WithOnlyConstantTerm)

	1st Period					**2nd Period**					**3rd Period**				
	ADF	**PP**	$\mathbf{t_{NL}}$	$\mathbf{t_{ESTAR}}$	$\mathbf{W^*}$	**ADF**	**PP**	$\mathbf{t_{NL}}$	$\mathbf{t_{ESTAR}}$	$\mathbf{W^*}$	**ADF**	**PP**	$\mathbf{t_{NL}}$	$\mathbf{t_{ESTAR}}$	$\mathbf{W^*}$
Austria vs Ger	-1.89	-0.93	-1.94	-2.32[b]	4,16	-2.79	-2.81	-1.62	-3.23[a]	10,98[a]	-2.18	-3.69[a]	-0.61	-1.63	18,37[a]
Austria vs UK	-1.09	-1.36	-1.07	-1.26	9,06[b]	-2.46	-2.18	-3.47[a]	-2.90[a]	8,76[b]	-2.17	-2.46	-2.59	-3.29[a]	36,09[a]
Denmark vs Ger	-2.71	-2.96[a]	-1.31	-1.65	8,86[b]	-1.42	-1.74	-2.89[b]	-4.86[a]	21,79[a]	-2.19	-2.40	-2.28	-1.42	3,43
Denmark vs UK	-2.33	-2.03	-2.71[b]	-1.59	3,56	-2.57	-3.08[a]	-2.50	-6.83[a]	15,13[a]	-2.55	-2.12	-3.42[a]	-6.82[a]	41,13[a]
Finland vs Ger	-1.28	-1.41	-2.51	-1.73	21,96[a]	-1.87	-1.78	-2.02	-4.73[a]	14,29[a]	-2.15	-3.02[a]	-2.84[b]	-2.04	6,45
Finland vs UK	-1.84	-1.60	-2.51	-2.24[b]	16,74[a]	-1.91	-1.83	-3.04[a]	-2.52[a]	7,56[b]	-2.39	-2.39	-1.85	-2.62[a]	8,55[b]
Norway vs Ger	-3.46[a]	-2.98[a]	-3.96[a]	-3.28[a]	13,63[a]	-1.67	-1.69	-1.41	-2.72[a]	16,21[a]	-1.86	-1.69	-2.52	-2.96[a]	7,80[b]
Norway vs UK	-2.13	-1.93	-1.98	-3.30[a]	7,76[b]	-1.29	-1.37	-2.08	-2.53[a]	8,10[b]	-1.83	-1.43	-2.02	-3.49[a]	12,46[a]
Sweden vs Ger	-1.79	-1.79	-1.78	-2.10[b]	4,04	-2.50	-2.08	-1.68	-2.75[a]	9,77[a]	-1.79	-1.94	-2.47	-2.79[a]	7,62[b]
Sweden vs UK	-2.18	-2.16	-2.79[b]	-2.43[a]	10,26[a]	-2.14	-1.88	-2.29	-2.72[a]	9,20[b]	-1.58	-1.99	-3.49[a]	-5.48[a]	43,36[a]
Switzerland vs Ger	-1.29	-1.25	-1.88	-1.34	4,63	-2.69	-2.43	-3.21[a]	-2.84[a]	10,40[a]	-2.04	-4.17[a]	-1.76	-1.99	2,43
Switzerland vs UK	-2.53	-1.89	-2.21	-2.16[b]	11,60[a]	-1.09	-1.15	-2.25	-2.48[a]	7,67[b]	-3.58[a]	-3.78[a]	-4.01[a]	-4.46[a]	14,50[a]
UK vs Ger	-2.14	-2.33	-1.42	-2.46[a]	7,34	-1.72	-1.71	-2.59	-1.89	11,20[a]	-2.94[a]	-2.48	-5.06[a]	-6.73[a]	38,23[a]

Notes: a and b represents the rejection of the null hypothesis at 5% and 10% significance levels, respectively. Ger stands for Germany. t_{NL}, t_{ESTAR} and W^* are the test statistics proposed by Kapetanios *et al.* (2003), Kılıç (2011) and Harvey and Leybourne (2007), respectively.

Table 2: UnitRoot Test ResultsForRIDs (WithConstantandLinear Trend Term)

	1st Period					2nd Period					3rd Period				
	ADF	**PP**	t_{NL}	t_{ESTAR}	W^*	**ADF**	**PP**	t_{NL}	t_{ESTAR}	W^*	**ADF**	**PP**	t_{NL}	t_{ESTAR}	W^*
Austria vs Ger	-3.33	-2.54	-2.71	-2.96^{a}	4,16	-3.03	-3.04	-2.05	-3.32^{a}	10,98^{a}	-2.51	-4.15^{a}	-0.65	-1.73	18,37^{a}
Austria vs UK	-1.59	-2.02	-1.96	-1.65	9,06^{b}	-4.85^{a}	-4.69^{a}	-3.63^{a}	-4.13^{a}	8,76^{b}	-2.16	-2.44	-2.29	-2.89^{a}	36,09^{a}
Denmark vs Ger	-1.37	-2.74	-1.27	-1.36	8,86^{b}	-2.79	-3.13	-2.67	-6.55^{a}	21,79^{a}	-2.11	-2.47	-2.23	-1.51	3,43
Denmark vs UK	-2.48	-2.09	-2.79	-2.01	3,56	-2.78	-3.34	-2.77	-7.12^{a}	15,13^{a}	-2.88	-2.24	-2.77	-6.26^{a}	41,13^{a}
Finland vs Ger	-3.39	-2.62	-2.31	-3.04^{a}	21,96^{a}	-1.57	-1.59	-1.81	-4.24^{a}	14,29^{a}	-2.19	-3.03	-2.77	-2.09	6,45
Finland vs UK	-2.05	-1.92	-4.83^{a}	-2.63^{a}	16,74^{a}	-2.14	-2.11	-2.98	-2.72^{a}	7,56^{b}	-2.67	-2.54	-2.03	-2.79^{a}	8,55^{b}
Norway vs Ger	-3.28	-2.76	-3.93^{a}	-3.21^{a}	13,63^{a}	-1.51	-1.54	-1.41	-2.52^{b}	16,21^{a}	-2.36	-2.21	-2.69	-3.65^{a}	7,80^{b}
Norway vs UK	-2.08	-1.93	-2.00	-3.19^{a}	7,76^{b}	-1.59	-1.72	-2.22	-1.82	8,10^{b}	-2.26	-1.93	-2.04	-3.96^{a}	12,46^{a}
Sweden vs Ger	-2.00	-2.07	-1.96	-2.44^{b}	4,04	-1.90	-1.78	-1.58	-2.99^{a}	9,77^{a}	-2.28	-2.45	-3.02	-2.77^{a}	7,62^{b}
Sweden vs UK	-2.29	-2.28	-2.55	-2.59^{a}	10,26^{a}	-2.78	-2.41	-3.46^{a}	-3.35^{a}	9,20^{b}	-1.17	-2.61	-2.54	-6.37^{a}	43,36^{a}
Switzerland vs Ger	-2.76	-2.70	-2.68	-2.56^{b}	4,63	-3.36	-3.13	-3.17^{b}	-3.28^{a}	10,40^{a}	-5.81^{a}	-5.82^{a}	-3.54^{a}	-5.43^{a}	2,43
Switzerland vs UK	-2.02	-2.19	-2.05	-1.91	11,60^{a}	-4.02^{a}	-3.79^{a}	-3.15^{b}	-3.81^{a}	7,67^{b}	-3.57^{a}	-3.77^{a}	-3.99^{a}	-4.46^{a}	14,50^{a}
UK vs Ger	-2.17	-2.05	-1.34	-1.98	7,34	-4.25^{a}	-3.82^{a}	-2.50	-4.15^{a}	11,20^{a}	-3.54^{a}	-2.72	-4.53^{a}	-6.81^{a}	38,23^{a}

Notes: a and b represents the rejection of the null hypothesis at 5% and 10% significance levels, respectively. Ger stands for Germany. t_{NL}, t_{ESTAR} and W^* are the test statistics proposed by Kapetanios *et al.* (2003), Kılıç (2011) and Harvey and Leybourne (2007), respectively.

CHAPTER 6

CONCLUSION

This study investigates the real interest parity (RIP) hypothesis for former and present European Free Trade Agreement (EFTA) members for an extended time period from the perspective of Balassa's (1961) economic integration classification. This classification entails hierarchical ordering of trade agreements like free trade area, common market and monetary union. It states that monetary union is the strongest form while free trade area is the weakest. Hence support for RIP is expected to increase from the free trade area to the monetary union. The selection of EFTA gives the opportunity to test this point. Since only free trade relation exists between the countries for the first part of the sample period, later this relation has evolved into single market structure in the following years and after emergence of Euro, some countries has become part of a monetary union. The division of the sample into subperiods according to these stages and analysis of RIP for each period enable us to see how the real integration between the sample countries is affected by increasing economic cooperation.

The previous literature on RIP proposes legitimate reasons for nonlinearity. Following this, real interest rate differentials are tested for stationarity by linear and nonlinear unit root tests. While linear tests provide poor evidence for real interest rate convergence, nonlinear test of Kapetanios *et al.* (2003) give more supportive results. Application of the nonlinear unit root test suggested in Kılıç (2011), which is more powerful, proves RIP for most of the countries especially for the time period coinciding with the formation of single market. In addition, the linearity test proposed by Harvey and Leybourne (2007) verifies nonlinearity for most of RIDs. Hence it can be concluded that due to the nonlinearity, the power of the method used may be the reason of RIP failure. Moreover, stronger economic cooperation brings about higher real integration.

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APPENDIX

TEZ FOTOKOPİ İZİN FORMU

ENSTİTÜ

Fen Bilimleri Enstitüsü ☐

Sosyal Bilimler Enstitüsü ☒ x

Uygulamalı Matematik Enstitüsü ☐

Enformatik Enstitüsü ☐

Deniz Bilimleri Enstitüsü ☐

YAZARIN

Soyadı : KADAKAL
Adı : ZEYNEP ŞEYMA
Bölümü : İKTİSAT

TEZİN ADI (İngilizce) : ANALYSIS OF NONLINEARITY IN REAL INTEREST PARITY HYPOTHESIS

TEZİN TÜRÜ : Yüksek Lisans ☒ x Doktora ☐

1. Tezimin tamamı dünya çapında erişime açılsın ve kaynak gösterilmek şartıyla tezimin bir kısmı veya tamamının fotokopisi alınsın. ☐
2. Tezimin tamamı yalnızca Orta Doğu Teknik Üniversitesi kullanıcılarının erişimine açılsın. (Bu seçenekle tezinizin fotokopisi ya da elektronik kopyası Kütüphane aracılığı ile ODTÜ dışına dağıtılmayacaktır.) ☐
3. Tezim bir (1) yıl süreyle erişime kapalı olsun. (Bu seçenekle tezinizin fotokopisi ya da elektronik kopyası Kütüphane aracılığı ile ODTÜ dışına dağıtılmayacaktır.) ☒ x

Yazarın imzası ……………… Tarih………………..