INVESTIGATION OF SMOOTH BREAKS AND NONLINEAR MEAN REVERSION IN REAL INTEREST PARITY: EVIDENCE FROM ASIAN COUNTRIES

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ABSTRACT

INVESTIGATION OF SMOOTH BREAKS AND NONLINEAR MEAN REVERSION IN REAL INTEREST PARITY: EVIDENCE FROM ASIAN COUNTRIES

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This study explores the empirical validity of long run Real Interest Parity (RIP) for a set of Asian countries for the period of January 1984 and August 2016 by taking Japan as a base country. We apply unit root test of Christopoulos and Leon-Ledesma (2010) which enables us to measure infrequent smooth temporary breaks and nonlinear mean reversion in the real interest rate differential (rid) series simultaneously. We model the smooth breaks by Fourier function while nonlinearity in rids series are model by modified versions of the most recently developed exponential smooth transition autoregressive (ESTAR) models of Kapetanios et al. (2003) and Kılıç (2011). The results provide strong evidence in favor of RIP for Asian countries when smooth breaks are taken into consideration and nonlinearity in the rids series are correctly specified. Our findings also reveal that for most of the countries Fourier functions have one frequency which is associated with 1997 Asian Crisis.

Keywords: Real Interest Parity, Real interest rate differential, Asian countries, Nonlinearity, Smooth Breaks.

ÖZ

REEL FAİZ PARİTESİ'NDE YUMUŞAK KIRILMALARIN VE DOĞRUSALSIZ ORTALAMAYA DÖNÜŞÜN İNCELENMESİ: ASYA ÜLKELERİ ÖRNEĞİ

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Bu çalışma, Asya ülkeleri için uzun vade Reel Faiz Paritesi (RIP)' nin ampirik geçerliliğini Japonya baz ülke alınarak Ocak 1984 – Ağustos (2016) periodunda incelemektedir. Çalışmada, Reel Faiz Oranı Farkları (rids) serilerindeki yumuşak geçici kırılmaları ve doğrusalsız ortalamaya dönüşü eşzamanlı analiz eden Christopoulos ve Leon-Ledesma'nın (2010) birim kök testini uyguladık. Yumuşak kırılmaları Fourier fonksiyonları ile modellerken, serideki doğrusalsızlığı yakın zamanda geliştirilen Kapetanios, Shin ve Snell (2003) ile Kılıç (2011) ESTAR modellerinin Fourier fonksiyonları ile modifiye edilen birim kök testleri ile inceledik. Sonuçlar, Asya Ülkeleri'nin reel faiz oranı farkları serilerinde yumuşak kırılmalar modelde analiz edildiğinde ve doğrusalsızlık doğru olarak modellendiğinde, Reel Faiz Paritesi'ni destekleyen çok güçlü kanıtlar elde edilebileceğini göstermektedir. Sonuçlar ayrıca, çoğu ülke için Fourier fonksiyonlarındaki optimal frekansın, 1997 Asya Kriziyle bağlantılı olarak, bir olduğunu göstermektedir.

Anahtar Kelimeler: Reel Faiz Paritesi, Reel Faiz Oranı Farkları, Asya Ülkeleri, Doğrusalsızlık, Yumuşak Kırılmalar.

To My Family

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LIST OF ABBREVIATIONS

ADF	: Augmented Dickey-Fuller
ASEAN	: Association of Southeast Asian Nations
ESTAR	: Exponential Smooth Transition Autoregressive
IFS	: International Financial Statistics
IMF	: International Monetary Fund
MAIC	: Modified Akaike Information Criteria
PP	: Phillips-Perron
PPP	: Purchasing Power Parity
RIDS	: Real Interest Rate Differentials
RIP	: Real Interest Parity
STAR	: Smooth Transition Autoregressive
TAR	: Threshold Autoregression
UIP	: Uncovered Interest Parity
WTO	: World Trade Organization

CHAPTER 1

INTRODUCTION

Especially with the collapse of Bretton Wood Era, international connectedness of capital and goods markets has accelerated significantly. Countries have liberalized their both financial and real sectors by eliminating the barriers towards the movements of capital and goods across countries, deregulating their financial sectors and signing trade agreement to lower the transaction cost of the goods etc. In a fully liberalized market it is expected that assets with identical risks would bring same expected return across the world. That is, in such an environment investors expect that real interest rates of assets have to be same both in foreign and domestic countries. This idea postulates basic logic of real interest parity (RIP) hypothesis.

In this study we aim to analyze RIP hypothesis which is one of the core international macroeconomic topic exploring the long run characteristics of real and financial sector together. This hypothesis is derived from Uncovered Interest Parity (UIP), Purchasing Power Parity (PPP) and Fisher equation. While UIP and PPP indicates equilibrium relation in assets and goods markets respectively, Fisher equation states that expected real interest rate of an asset is equal to the difference between nominal interest rate and expected future rate of inflation. Due to its power in measuring the assets and goods market integration contemporaneously, there have been numerous studies testing the validity of RIP hypothesis since Mishkin (1984) but the results of these studies are rather mixed. These studies test the stationarity behavior of real interest rate differentials (rids) as an indicator of long run mean reversion of RIP. The majority of the studies test the mean reversion nature of RIP by using the conventional unit root tests and cointegration tests. However, they fail to find strong evidence in favor of stationarity in rids series and, hence, RIP due to the low power of these tests (for

instance, Meese and Rogoff, (1988) and Edison and Pauls, (1993)). The failure of these tests in finding the evidence of RIP hypothesis is mainly due to the ignorance of existence of structural breaks and nonlinearity in the data generating process of rids. Hence, recent studies on RIP use unit root tests considering either structural breaks or nonlinearity in the series. However, in our study we apply the most recently developed unit root test of Christopoulos and Leon-Ledesma (2010) which allows infrequent smooth breaks and non-linear adjustment simultaneously. As pointed out by Papell (2002), the policies or events may lead to appreciation (or depreciation) of real interest rate differentials giving rise to some breaks in data generating process of rids but at the same time due to the heterogeneous beliefs of investors, transaction and information costs, stickiness of prices of products, country specific risk premium and so on, the mean reversion of rids may follow a nonlinear path. That's why, using the model considering either structural break or nonlinearity in rids series may not provide sufficient evidence in favor of RIP. In Christopoulos and Leon-Ledesma (2010) unit root test, temporary smooth breaks are modeled by Fourier functions while nonlinearity is modeled by exponential smooth transition autoregressive (ESTAR) model. Nonlinearity is tested by most recently developed ESTAR unit root tests of Kapetanios et al. (2003) and Kılıç (2011). While the former associates the nonlinearity with the size of deviations from RIP, the latter associates the nonlinearity with the size of appreciation or depreciation of real interest rate differentials.

This study applies Christopoulos and Leon-Ledesma (2010) unit root test on Asian countries real interest rate differential series throughout their liberalization period between 1984(1) – 2016(8) by taking Japan as a based country. During the last few decades, Asian countries have taken important steps towards liberalizing their goods and capital market by gradually removing restrictions on the flow of goods and capital. These liberalization attempts strengthen the Asian countries' both financial sector and real sector so that their economies have performed sustain and rapid growth in the last three decades. Hence, this region become a popular area among the researchers who study on the empirical validity of RIP hypothesis but their findings are inconclusive.

Due to the lack of unanimity of the empirical studies investigating the validity of RIP for Asian countries, we apply more powerful unit root test of Christopoulos and Leon-Ledesma (2010). Our findings reveal strongest evidence of long run RIP when we apply modified version of Kılıç (2011) unit root test which considers smooth temporary breaks together with nonlinear mean reversion.

The rest of the study is organized as follows. Chapter 2 reviews the literature on RIP, Chapter 3 explains the data in detail, Chapter 4 describes the econometric methodology we implement. Chapter 5 provides the empirical results and Chapter 6 concludes the study.

CHAPTER 2

LITERATURE REVIEW

In the last few decades many countries including developed, developing and emerging countries have opened up both their capital and goods markets to the rest of the world in order to increase the degree of international integration. The initial attempts come from developed countries such as the US and some European countries after Bretton Woods era ended in mid-1970s and it has been spread to developing and emerging markets. They have deregulated the capital and goods sectors via relaxing the capital controls, reducing the information and transaction costs (Frankel, 1992). If full integration is achieved, both capital and goods will move across the countries freely and thus the real interest rates across countries will be equalized that implies real interest rate parity (RIP) hypothesis to be hold (Baharumshah et al., 2005).

RIP hypothesis is a useful condition to measure the degree of international integration since it is the combination of uncovered interest parity (UIP) condition and purchasing power parity (PPP) condition (together with Fisher equation and rational expectation theory). While UIP condition shows the degree of financial market integration, PPP hypothesis states goods market integration. That is, UIP represents the relation between nominal interest rates and expected change in exchange rates between domestic and foreign country while PPP shows inflation rates and change in exchange rates between those countries. Hence, testing for RIP hypothesis explicitly implies testing the degree of international integration in both goods and assets market simultaneously[1]. If RIP hypothesis is satisfied, domestic markets are perfectly linked to the foreign markets and the real interest rate cannot fluctuate much from the world

[1] For the empirical evidence of RIP hypothesis as a measure of international integration see Chinn and Frankel (1995), Awad and Goodwin (1998) and Obstfeld and Taylor (2002).

real interest rate. Hence, domestic authority's monetary and fiscal policies become highly dependent to the anchored country's actions during the liberalization process. Krugman (1999) draws attention to this point such that an economy cannot maintain perfect capital flows, independent domestic policies and fixed exchange rate system simultaneously. If there is a strong international linkage of real interest rates, then real interest rates are determined by international capital market and hence small economies lose their power to affect the domestic sector via applying monetary policies. Thus, the authorities' stabilization policies to the domestic market have little impact on saving and investment formation (Pipatchaipoom, 2005).

There are voluminous of studies testing RIP hypothesis due to its importance in explaining whether the countries are internationally integrated or autonomous. The earlier studies on RIP literature have focused on the equalization of the real interest rates between countries by applying simple regression method and they found the evidence against the RIP hypothesis (For example, Mishkin, 1984; Cumby and Obstfeld,1984; Mark,1985; Cumby and Mishkin, 1986; Frankel and McArthur, 1988 and Modjtahedi,1987). Since real interest rates are not equal across countries due to the transformation and information costs, country-specific risk premium, trade barriers and contractual agreements between countries, arbitrage forces etc., the latter studies focused on real interest rate differential(s) as a measure of RIP hypothesis. Early empirical studies use real interest rate differentials, *rids* and apply conventional linear unit root test such as Augmented Dickey Fuller, ADF, (1981) and Phillips and Perron, PP, (1988) unit root tests. However, they fail to reject nonstationary null hypothesis as these tests assume that cycle of series is symmetric and hence adjustment toward equilibrium follows a linear fashion. For instance, Meese and Rogoff (1988) apply ADF test on the series of rids of four developed countries using monthly data over the period 1974(1) – 1986(3) and fail to reject the null of unit root hypothesis. Similarly, Edison and Pauls (1993) fail to reject unit root null hypothesis on major developed and G-10 countries rids by using quarterly data for the period 1974(Q1)-1990(Q4). Due to the weak power of standard unit root tests, some studies carried out linear cointegration

tests and panel unit root tests to see the long run adjustment of domestic and foreign real interest rates. For instance, Chinn and Frankel (1995) test the RIP hypothesis using cointegration methodology of Johansen (1998) for Asian countries but they do not find evidence of RIP hypothesis expect 3 cases while Wu and Chen (1998) apply panel unit root test to euro money market zone for the period 1979(M1) – 1996(M9) and find evidence supporting for mean reversion in rids. However, panel unit root tests may cause some problems due to heterogeneity issue[2] as these tests ignores the country specific differences and implicitly assume that real interest rates have same dynamics for all countries which may result in an unreliable inferences on the validity of RIP. Additionally, rejection of unit root null hypothesis in panel data implies at least one of the series is stationary but not all of them so it does not give an answer on each specific country analysis.

The failure of earlier empirical studies finding evidence supporting RIP is due to the existence of some problems in conventional linear unit root tests. Firstly, if roots take values near the unit root, then the power of these tests detecting stationary nature of series will collapse and conclude that series is nonstationary even if it is not. Such consequences can arise when the sample size is small since in the short run, series can fluctuate away from equilibrium and the deviation can be persistent in a short period but the power of standard unit root test is low in capturing the short run behavior of series. Secondly, if there are structural changes in the series, the standard unit root tests could be biased towards the non-rejection of unit root (Perron, 1989). There are some theoretical papers modelling structural change in the series such as Zivot and Andrews (1992) that allows one endogenously determined structural break in the series, and Lumsdaine and Papell (1997) that allows two endogenously determined structural breaks in the series. Additionally, Perron (1997) develops a procedure to test for unit root by searching multiple structural breaks in the series endogenously. Studies of Fountas and Wu (1999), Wu and Fuantas (2000), Maveyraud – Tricoire and Raus

[2] See Taylor and Sarno (1998) and Taylor (2003) which illustrate the weakness of panel unit root test very clearly.

(2009) and Bagdatoglu and Kontonikas (2011) apply methods considering structural breaks and find some evidence in favor of RIP for developed countries.

All of the test statistics mentioned above assume a symmetric mean reversion of rids to positive and negative shocks under the alternative and ignore the possible nonlinearities in the series. Hence, the final weakness of conventional unit root tests is detecting the possible nonlinearities in the series. Sonora and Tika (2010) point out that application of linear unit root test in measuring real interest rate differentials is not appropriate if the true data generating process of real interest rate differential is stationary nonlinear process. There are various reasons that might lead to nonlinearity in rids such as transaction costs, sticky prices of goods, heterogeneous beliefs of investors during news come ahead, imperfect capital mobility, incomplete institutional reforms etc. Transaction costs might change real interest rate equalization even in a well-integrated markets. Goodwin and Grennes (1994) states that there exists neutral band, or inaction band, in RIP hypothesis due to transaction costs effect. That is, if transaction cost is higher than the difference between real interest rates, arbitrage opportunity will be removed as investment will not be profitable and transaction will not take place. On the other hand, as soon as real interest rate difference is higher than transaction cost, arbitrage will quickly remove a disparity between those rates. That's why, Balke and Wohar (1998) suggest nonlinear unit root models for RIP when the role of transaction costs is effective. Stickiness of good prices can be accounted as another reason of nonlinearity in RIP. As explained above, PPP condition indicates how easy goods are arbitrage across countries. However, due to the sticky prices in some tradable goods lead persistent deviation in PPP in the short run which might cause failure of linear stationarity hypothesis and low mean reversion in the long run. Hence, this causes of breakdown in RIP due to strong ties between PPP and RIP and this nonlinear adjustment in PPP will be observed in RIP as well. Additionally, investors' heterogeneous beliefs can be accounted as a possible reason of nonlinearity in RIP hypothesis. That is, investment decisions of agents are not same on a same news

because of their different risk profiles, learning skills, attitudes etc. Hence, effect of a news takes some time until the response of all agents are completed.

There has been a growing literature to model possible nonlinearity in the series due to the low power of conventional linear unit tests as we pointed out above. The first attempt comes by Tong (1978) who introduces threshold autoregressive (TAR) model and this model developed by Chan (1993), Chan and Tsay (1998) and Caner and Hansen (2001). Empirical studies based on TAR type of nonlinearity find some supportive evidence in favor of RIP hypothesis. For instance, Mancuso et al. (2003) construct TAR model for rids of developed countries and observe some evidence of nonlinearity while Ferreira and Ledesma (2003) apply momentum TAR framework of Caner and Hansen (2001) for both developed and emerging markets and find evidence of asymmetric adjustment toward equilibrium by emphasizing role of risk premium for emerging markets. Su, Chang and Shen (2012) also apply Caner and Hansen (2001) TAR model for twelve Central and Eastern European (CEE) countries and conclude that real interest rate convergence is mean reverting towards RIP equilibrium but rather in a nonlinear way. However, recent studies find that regime switching of real interest rate differentials may be smooth rather than sharp switching as stated in TAR model and they develop and use smooth transition autoregressive (STAR) model proposed first by Granger and Terasvirta (1993). They emphasis the importance of transaction cost and heterogeneity of agents' expectations in explaining the smoothness of real interest rate differentials. When rids series deviate around the equilibrium, arbitrage is not profitable for the agents which creates an inaction band where transaction will not occur such that rids may follow a unit root process inside of the band. Once the difference between real interest rates in absolute term increases, international transaction of goods and assets takes place so that real interest rate differentials will move back to its equilibrium which means that outside of the band rids follow a stationary process. This logic implies that real interest rate differentials may follow a globally stationary nonlinear process such that in the local area where deviation of real interest rate around equilibrium is small, RIP follows a (near) unit root process while

rids follows stationary process as size of the deviation increases and hits the band. Kapetanios et al. (2003) systematize this behavior of the series and proposed an improved version of ESTAR type unit root test. They apply this new test on eleven OECD countries' real interest rate and real exchange rate series and find valid evidence of globally stationary nonlinear mean reversion in some of those series. Several studies apply the method of Kapetanios et al. (2003) including Liew et al. (2004), Ceratto and Sarantis (2006), Wallace (2008), Cuentas and Gil-Alana (2009) and Telatar and Hasanov (2009). Recently, Kılıç (2011) improves the method proposed by Kapetanios et al. (2003) by using the lagged difference as a transition variable instead of using level form. He applies this modified ESTAR version, namely Kılıç (2011) method, together with Kapetanious (2003) method for comparison purpose on exchange rates of European countries and shows that his modified test provides stronger evidence in favor of stationarity in real exchange rate.

In this study we aim to investigate the empirical validity of RIP hypothesis for post liberalization period of ASEAN-5 countries including Indonesia, Malaysia, Philippines, Singapore and Thailand together with the industrialized economies which are China, Hong Kong and South Korea with respect to Japan as a based country. Since 1980s, Asian countries has taken some steps in favor of liberalizing both their real and capital market by progressively removing restrictions on flow of goods and capital. They generally follow same two stages throughout liberalization attempts but timing and intensity of those stages can differ in those countries. The first stage of liberalization is gradually removing foreign exchange controls, the ceiling on lending and deposit rates. In the mid- and late-1970s Hong Kong, Malaysia and Singapore liberalized their interest rate. Indonesia and Philippines followed this trend by applying full deregulations on interest rate in early 1980s. On the other hand, Japan deregulated its interest rate system more systematically so it took some time to complete this stage which has continued during the period 1979-1994. Thailand and South Korea removed interest rate ceilings in mid-1980s while China was the last country in this race and applies controlled deregulations and with being the member of World Trade

Organization, WTO, in 2001 its domination in this region accelerated. In the second stage of liberalization efforts, Asian countries opened up their capital accounts during late-1980s so that foreign investors were permitted to hold domestic assets and domestic investors were allowed to hold foreign assets. These relaxations in financial sector together with the external factors such as recessions in developed countries made the Asian region a secure port for the foreign investors during 1980s and early-1990s. However, due to the weak regulations and supervision of financial system together with pegged exchange rate system caused the destruction of the regional financial system and the region faced a crisis in 1997 known as Asian Crisis which started in Thailand and spread to the other countries within a very short period of time. Due to the destructive effects of uncontrolled liberalization in the region, authorities revised their financial policies and imposed more systematic regulations so that the consequences of uncontrolled liberalization before the crisis period would be eliminated. For instance, ASEAN countries issued Honoi Action Plan in 1998 in order to strengthen the macroeconomic and financial corporation between ASEAN countries. The other purposes of this plan are to facilitate regional integration, establish a common currency in the region and systematize liberalization of capital market. Moreover, in 2004 the Asian Development Bank emphasized the importance of common currency for a strongly integrated market across the Asian countries since this idea had already been applied by European countries and they became a successful pioneer for them. Additionally, in 2006 the most developed countries in Asian region namely Japan, South Korea and China applied some steps for the common currency purposes. These progressive liberalization attempts make Asian countries become an interesting group of countries which involve the same stages of financial liberalization process and arouse many researchers' interest who study RIP hypothesis as a measure of international integration. For instance, Baharumshah et al. (2005), Holmes et al. (2011) and Liu et al. (2013) apply panel unit root test on real interest rate differentials while Chang et al. (2012) and Baharumshah et al. (2013) test for the validity of the long run RIP hypothesis of Asian countries by endogenously determined structural breaks. Holmes and Maghrebi (2004) apply STAR models for ASEAN countries rids and find evidence of nonlinear behavior in rids. Baharumshah et al. (2008) and

Baharumshah et al. (2010) apply Kapetanios et al. (2003) ESTAR model for ASEAN, and G7 and 10 Asian countries respectively and conclude that RIP hypothesis holds for those countries if nonlinearity are accounted in the data generating process of rids.

In our study we contribute to the existing literature on RIP hypothesis in terms of methodology we used and our sample selection criteria. Firstly, we apply Christopoulos and Leon-Ledesma (2010) methodology which allows infrequent temporary smooth breaks and possible nonlinearity in the model simultaneously. Based on our knowledge on RIP literature, we have not seen any empirical study testing the validity of RIP hypothesis by using Christopoulos and Leon-Ledesma (2010) methodology. Thus, our study will be a pioneer empirical study using this methodology on RIP hypothesis. We apply this newly developed unit root test on Asian countries real interest rate differential series based on Japan which there is no study using this method on Asian countries. In Christopoulos and Leon-Ledesma (2010) methodology, nonlinearity is tested by means of modified version of ESTAR models of Kapetanios et al. (2003) and Kılıç (2011). KSS (2003) test has been applied on many RIP studies for Asian countries as we gave some examples above. However, we did not reach any empirical RIP study of Asian countries that uses Kılıç (2011) test which is stronger unit root test in detecting possible nonlinearity. We modify these two nonlinear tests by inserting Fourier functions into them so that these modified versions of KSS (2003) and Kılıç (2011) tests provides us to investigate smooth temporary breaks and nonlinearity simultaneously. In this content, our study will be the first study using these tests for Asian countries. Moreover, we examine the sample of ASEAN-5 countries (Indonesia, Malaysia, Philippines, Singapore and Thailand) together with developed countries in that region (China, Hong Kong and South Korea) throughout the post liberalization period. If we find an evidence in favor of RIP hypothesis, then we will be able to conclude that Asian countries achieve a high degree of cooperation during our sample period so that integration process provides positive impacts on these countries.

CHAPTER 3

DATA

We conduct RIP hypothesis for monthly data of ASEAN-5 countries (Association of Southeast Asian Nations) which are Indonesia, Malaysia, Philippines, Singapore and Thailand and industrialized economies namely China, Hong Kong and South Korea with respect to Japan as a base country. Although the primary aim of the ASEAN countries during the early period of the association is to ensure political sustainability of the region, they focus more on economic sustainability and interregional integration during the 1980s and beyond. Hence, this association become popular area among the researcher to analysis both international and interregional integration of this region. The reason why we choose Japan as a base country is that Japan has been the major trading partner and contributor of direct investment to the ASEAN countries and South Korea and Japan is a crucial source of capital intensive manufacturers for these countries since 1980s (Baharumshah, 2005). Moreover, stock markets connectedness of the countries in our sample have accelerated toward Japan especially after the Asian crisis.

For the purpose of real interest calculation, we use short term nominal interest rates as regards of the choice of maturity since they facilitate to capture impact of monetary policies. Moreover, short term interest rates provide strong forecast ability of future expected inflation as stated in Byun and Chen (1996). Interest rate also increases more risk as maturity increases. Hence, we use three-month deposit rates for Indonesia, Malaysia, Thailand, China and Japan, money market rates for South Korea, Philippines and Singapore and three-month treasury bill rate for Hong Kong. For the calculation of rids, we convert the annualized monthly interest rate into a compounded quarterly interest rate since interest rate series we use have three-month maturities. The rate of

Consumer Price Index (CPI) growth is chosen as an indicator of inflation rate and again it is transformed into quarterly rate. All nominal interest rates and inflation rates are converted into logarithmic form. Our determination of nominal interest and inflation rates are in accordance with the existing literature on RIP and UIP studies. We obtain both interest rate and CPI series from IMF's International Financial Statistic (IFS) database. Our monthly data cover the period between 1984(1) – 2016(11). Because the liberalization attempts of the countries are diversified in terms of timing we choose 1984(1) as the starting period where the countries in our sample completed at least its partial liberalization process[3] so that this will allow us to see the synchronize movements of countries real interest rate differential series. Due to the availability of data our starting period for China is 1987(1) and for Hong Kong is 1995(1).

As we mentioned in literature review part, RIP hypothesis will hold if both goods and assets markets are fully integrated to the world market. When equilibrium conditions of assets and goods market which refer to UIP and PPP hypothesis respectively are satisfied together with Fisher Equation and expectation hypothesis, RIP hypothesis will be formed as follows:

$$i_t - i_t^* = s_{t+1}^e - s_t^e \tag{3.1}$$

$$s_{t+1} - s_t = \pi_t - \pi_t^* \tag{3.2}$$

$$s_{t+1}^e - s_t^e = s_{t+1} - s_t + \varepsilon_t \tag{3.3}$$

$$i_t = r_t - \pi_{t+1}^e \tag{3.4}$$

[3] Kaminsky and Schmukler (2003) study on the partial and full liberalization periods of countries' domestic, stock and capital market and they give an excellent chronological review of each sector's liberalization stages.

where equation (3.1), (3.2), (3.3) and (3.4) stand for UIP, PPP, rational exchange rate expectation hypothesis and Fisher equation respectively. i_t, i_t^* , s_t and π_t are the domestic and foreign nominal interest rates, exchange rate and inflation rate at time t while s_{t+1}^e and π_{t+1}^e are expected exchange rate and inflation rate at time t+1. $\varepsilon_t \sim N(0, \sigma^2)$ indicates the random measurement erros. When we substitute equation (3.1) into equation (3.3) and the result into equation (3.2) we obtain

$$i_t - i_t^* = \pi_t - \pi_t^* + \varepsilon_t \tag{3.5}$$

which indicates that nominal interest rate differentials are equal to inflation rate differentials between domestic and foreign country and some disturbance term. By Fisher equation stated in (3.4), RIP hypothesis can be obtained by rewriting equation (3.5) as

$$r_t - r_t^* = \varepsilon_t = rids_t \tag{3.6}$$

For the time being we assume that a highly integrated world so that real interest rate convergence is sustained with real interest rate differentials, rids, which follows a stationary process with zero mean, i.e., $rids_t \sim iid$. We compute real interest rate by using ex post form of Fisher equation which is in accordance with the existing literature since Cumby and Mishkin (1986). However, we take the importance of maturity into account so that our real interest rate in Fisher equation becomes

$$r_t = i_t - \pi_{t+3} \tag{3.7}$$

where r_t is the ex post real interest rate at time t earned by holding an asset for three months and π_{t+3} is the inflation rate at time t+3. This implies that agents shape their investment decisions according to the maturity date.

CHAPTER 4

METHODOLOGY

In this section we first describe the nonlinear unit root test methodology of Kapetanios et al. (2003) test and Kılıç (2011) test within the RIP context. Then, we describe unit root methodology of Christopoulos and Leon-Ledesma (2010) which tests the smooth breaks and nonlinearity in the series simultaneously and again it will be described within the RIP context.

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

Kapetanios et al. (2003) develop a procedure to test of the null of a linear unit root process against an alternative of a globally stationary nonlinear exponential smooth transition autoregressive (ESTAR) process defined as follows:

$$rids_t = \beta rids_{t-1} + \theta rids_{t-1} F_E(rids_{t-1};\, \gamma) + \varepsilon_t \quad , \qquad t= 1, .., T \tag{4.1}$$

where $rids_t$ is real interest rate differentials, ε_t ensures iid structure and β, θ and γ are unknown parameters. F_E is the transition function which has an exponential form as

$$F_E(rids_{t-1};\, \gamma) = 1 - \exp(-\gamma rids_{t-1}^2) \tag{4.2}$$

In representation (4.2) it is assumed that the speed of adjustment parameter, $\gamma \geq 0$ and transition variable is $rids_{t-1}$ with delay parameter is 1. The exponential transition

function is bounded between 0 and 1. Hence, $F_E(rids_{t-1};\ \gamma)$ is symmetrically U-shaped exponential transition function.

Combining (4.1) and (4.2) we obtain the ESTAR model as

$$rids_t = \beta rids_{t-1} + \theta rids_{t-1}[1 - \exp(-\gamma rids_{t-1}^2)] + \varepsilon_t \quad (4.3)$$

We reparametrize (4.3) by subtracting $rids_{t-1}$ from both sides of the regression and obtain:

$$\Delta rids_t = \rho rids_{t-1} + \theta rids_{t-1}[1 - \exp(-\gamma rids_{t-1}^2)] + \varepsilon_t \quad (4.4)$$

where $\rho = \beta - 1$ and θ and γ are unknown parameters. Representation (4.4) implies that the larger the deviation from RIP is, the faster the adjustment towards long run RIP equilibrium will be. For the small value of transition variable where deviation form equilibrium is small, however, rids will behave nonstationary process in this middle regime. This emphasis the importance of the size of the deviation in real interest rate differentials.

It is proposed $\rho = 0$ in (4.4) which implies that $rids_{t-1}$ follows a unit root process in the middle regime. Under the null hypothesis $\rho = 0$ and $\gamma = 0$, $rids_{t-1}$ follows a linear unit root process while under the alternative where $\rho = 0$ but $\gamma > 0$, rids follow a nonlinear but globally stationary process where $-2 < \theta < 0$ must hold. Under the null hypothesis of $\rho = 0$ model (4.4) becomes:

$$\Delta rids_t = \theta rids_{t-1}[1 - \exp(-\gamma rids_{t-1}^2)] + u_t \quad (4.5)$$

Because θ is undefined under the null hypothesis, Kapetanios et al. (2003) derive a t – type test statistic by taking a first–order Taylor series approximation to the ESTAR model in (4.5) under the null hypothesis $\gamma = 0$ and they obtain following auxilary regression :

$$\Delta rids_t = \alpha rids_{t-1}^3 + u_t \tag{4.6}$$

Here the null hypothesis $\gamma = 0$ turns to the null of $\alpha = 0$ with the alternative of $\alpha < 0$. The t-type test statistic derived by Kapetanios et al. (2003) is:

$$KSS = \frac{\hat{\alpha}}{s.e.(\hat{\alpha})} \tag{4.7}$$

where $\hat{\alpha}$ estimated parameter is obtained by OLS and $s.e.(\hat{\alpha})$ is standard error of estimated parameter $\hat{\alpha}$. Because KSS does not have an asymptotic standard normal distribution in testing linear unit root against nonlinear stationary process, Kapetanios et al. (2003) tabulates the asymptotic critical values of KSS statistic by stochastic simulations.

Consider the more general case where disturbance terms in (4.5) are serially correlated. In order to ensure iid structure of disturbance term optimal lag must be determined. Kapetanios et al. (2003) uses Dickey and Fuller (1979) and Said and Dickey (1984) proposed linear approach for obtaining serially uncorrelated disturbance terms. Hence, representation in (4.5) becomes:

$$\Delta rids_t = \sum_{i=1}^{p} \rho_i \Delta rids_{t-i} + \theta rids_{t-1}[1 - \exp(-\gamma rids_{t-1}^2)] + \varepsilon_t \tag{4.8}$$

Where $\varepsilon_t \sim iid(0, \sigma^2)$. After correcting the serially correlated disturbance terms, the auxiliary regression in (4.6) turns to:

$$\Delta rids_t = \sum_{i=1}^{p} \rho_i \Delta rids_{t-i} + \alpha rids_{t-1}^3 + \varepsilon_t \quad (4.9)$$

Where the asymptotic distribution in (4.9) is same with that in (4.6) and p is the optimal lag determined by MAIC proposed by Ng and Perron (2001).

4.2 Nonlinear Unit Root Test of Kılıç (2011)

Kılıç (2011) develops a new unit root test which is similar to that of Kapetanios et al. (2003). The differences of the unit root test of Kılıç (2011) from Kapetanios et al. (2003) are using the stationary lagged difference term rather than level form as a transition variable under the alternative hypothesis and the way dealing with nuisance parameter problem.

Kılıç (2011) reformulates the model (4.8) where nonlinearities in real interest rate is due to the size of appreciation or depreciation of real interest rate differential. He reformulates model (4.8) by replacing the transition variable $rids_{t-1}$ with $\Delta rids_{t-1}$ and the model becomes as

$$\Delta rids_t = \sum_{i=1}^{p} \rho_i \Delta rids_{t-i} + \theta rids_{t-1}[1 - \exp(-\gamma \Delta rids_{t-1}^2)] + \varepsilon_t \quad (4.9)$$

Reforming the lagged difference term as a transition variable provides that large changes (appreciations or depreciations) in real interest rate differential are long run mean reverting towards zero equilibrium as it will provide arbitrage gains between domestic and base country. However, small changes will be persistent and rids will act as a unit root process since the small size in appreciation or deprecation between two countries real interest rates will not motivate the investors to invest either of the countries so they will not make any action in such small changes in real interest rates.

Testing the null of a unit root, H_0: $\theta = 0$, against a globally stationary ESTAR process, H_A: $\theta < 0$, the test suffers from a nuisance parameter problem since the speed of adjustment parameter, γ, is unknown and so unidentified under the unit root null hypothesis as in Kapetanios et al. (2003). Kılıç (2011) overcomes this problem by using the lowest possible t-value on $\theta = 0$, $Sup - t_{iN}$, over a fixed parameter space of γ values that are normalized by the sample standard deviation of the transition variable $\Delta rids_{t-1}$ as

$$Sup - t_{iN} = inf_{\gamma \epsilon \Gamma_T} \; t_{\theta=0}(\gamma) = inf_{\gamma \epsilon \Gamma_T} \frac{\hat{\theta}(\gamma)}{s.e.(\theta(\gamma))} \tag{4.10}$$

Where $\Gamma_T = \left[\underline{\gamma}, \overline{\gamma}\right] = \left[\frac{1}{100 s_{\Delta rids_{t-1}} T}, \frac{100}{s_{\Delta rids_{t-1}} T}\right] \in \mathbb{R}$ and $s_{\Delta rids_{t-1} T}$ is the sample standard deviation of $\Delta rids_{t-1}$, $\hat{\theta}(\gamma)$ and s.e. $(\hat{\theta}(\gamma))$, respectively, are the parameters and standard errors of the model (4.9) obtained by OLS. In implementing the test , $Sup - t_{iN}$, Kılıç (2011) suggests to use a grid size of $\frac{1}{100 s_{\Delta rids_{t-1}} T}$. The asymptotic critical values of $Sup - t_{iN}$ statistic have non-standard asymptotic distribution, so t-test statistic is obtained through Monte Carlo simulation.

4.3 Christopoulos and Leon-Ledesma (2010) Unit Root Test

Christopoulos and Leon-Ledesma (2010) develop a new unit root test that considers both smooth breaks and non-linear adjustment in the series simultaneously. The smooth breaks are modeled by Fourier function which allows for infrequent smooth temporary mean changes and hence it illustrates the long run behavior of the series while the non-linear adjustment is modeled by means of ESTAR model.

In the proposed model such breaks are captured by using the trigonometric variables so that deviations in the mean are temporary and the starting and the end values are built to be the same.

Consider the following real interest rate differential model:

$$rids_{t-1} = \delta(t) + u_t \tag{4.11}$$

Where $rids_{t-1}$ is the real interest rate differentials, $\delta(t)$ is time-varying deterministic component and $u_t \sim N(0, \sigma^2)$. Christopoulos and Leon-Ledesma (2010) use the Fourier series expansion proposed by Becker et al. (2004) to determine the unknown number of breaks of unknown form of $\delta(t)$ which is defined as

$$\delta(t) = \delta_0 + \sum_{k=1}^{H} \delta_1^k \sin(\frac{2\pi kt}{T}) + \sum_{k=1}^{H} \delta_2^k \cos(\frac{2\pi kt}{T}) \tag{4.12}$$

where k is the number of frequencies of Fourier function, T is the sample size, t is time trend and π = 3,14. For the purpose of determination of the appropriate number of frequencies (H) to be included in the fitted model to overcome the specification problem in the model (4.12), they follow Ludlow and Enders (2000) method which is

shown that a single frequency is enough to approximate Fourier expansion in applications. The model (4.12), hence, turns to

$$\delta(t) = \delta_0 + \delta_1 \sin\left(\frac{2\pi kt}{T}\right) + \delta_2 \cos\left(\frac{2\pi kt}{T}\right) \quad (4.13)$$

Under the single frequency restriction, the test ensures that the breaks are captured endogenously and the form of breaks do not have to be pre-determined so that the over-fitting of the series and the size distortion problems can be eliminated. Since the true value of k is unknown, the procedure to detect the most appropriate frequency k is to estimate the model (4.11) under the restriction of model (4.13) for each integer value of k $\in$ [1,5]. The value of k is chosen as the one gives the smallest sum of square residuals.

Testing the null hypothesis H_0: $\delta_1 = \delta_2 = 0$ against the alternative of H_1: $\delta_1 = \delta_2 \neq 0$ can be carried out by tesiting the unknown breaks in DGP of $rids_t$. An F-statistic, $F(\tilde{k})$, is suggested to test the null hypothesis and the critical values are obtained via Monte Carlo simulation and are tabulated in Becker et al. (2006).

As model (4.13) is plugged into model (4.11), the model becomes

$$rids_t = \delta_0 + \delta_1 \sin\left(\frac{2\pi kt}{T}\right) + \delta_2 \cos\left(\frac{2\pi kt}{T}\right) + u_t \quad (4.14)$$

The calculation of the test statistic of model (4.14) follows three steps procedure. The first step is to find the optimal frequency k^* by estimating non-linear deterministic component in model (4.14) through OLS by choosing value k $\in$ [1,5] and to select the optimal k^* which gives the minimum sum of square residuals. The OLS residuals are then computed as

$$\hat{u}_t = rids_t - \hat{\delta}_0 - \hat{\delta}_1 \sin\left(\frac{2\pi k^* t}{T}\right) - \hat{\delta}_2 \cos\left(\frac{2\pi k^* t}{T}\right) \quad (4.15)$$

In the second step, a unit root on the OLS residuals of first step is tested. In testing the unit root for real interest rate differentials, three models are constructed as

$$\Delta u_t = \beta_1 u_{t-1} + \sum_{j=1}^{p} \alpha_j \Delta u_{t-j} + v_t \quad (4.16)$$

$$\Delta u_t = \rho_1 u_{t-1}^3 + \sum_{j=1}^{p} \alpha_j \Delta u_{t-j} + v_t \quad (4.17)$$

$$\Delta u_t = \theta u_{t-1}(1 - \exp(-\gamma \Delta u_{t-1}^2)) + \sum_{j=1}^{p} \alpha_j \Delta u_{t-j} + v_t \quad (4.18)$$

where $\gamma > 0$ and $v_t \sim WN(0, \sigma^2)$. The model (4.16) is standard ADF regression defined as Fourier-ADF (FADF) test where the null hypothesis $H_0: \beta_1 = 0$ is tested against the alternative $H_1: \beta_1 < 0$. This model assumes that adjustment towards equilibrium is symmetric. The model (4.17) is the auxiliary regression developed by Kapetanios et al. (2003) which follows an ESTAR process with transition variable is $rids_{t-1}$. The detail of the model explained in section 4.1. Testing the null hypothesis $H_0: \rho_1 = 0$ against a globally stationary ESTAR process $H_1: \rho_1 < 0$ is obtained by the following t-statistic:

$$FKSS = \frac{\hat{\rho}_1}{s.e(\hat{\rho}_1)}$$

The model (4.18) is developed by Kılıç (2011) assuming that the speed of adjustment is non-linear and follows ESTAR process as Kapetanios et al. (2003) with the difference being due to the transition function $F(\gamma, \Delta u_{t-1})$. Testing the null of a unit root hypothesis of Kılıç (2011), the following t-statistic is used:

$$F - Sup - t_{iN} = \sup_{(\gamma)\epsilon\Theta} \left\{ \frac{\hat{\theta}(\gamma)}{s.e.(\hat{\theta}(\gamma))} \right\}_{\theta=0}$$

where $\hat{\theta}(\gamma)$ and $s.e.(\hat{\theta}(\gamma))$,respectively, are the estimated parameters and standard errors for the null hypothesis $H_0: \theta = 0$ for the range of γ defined as $\Theta = \left[\underline{\gamma}, \overline{\gamma}\right]$and $0 < \underline{\gamma} < \gamma < \overline{\gamma}$.

The asymptotic distributions of these three test statistics depend on only the frequency of Fourier series. The critical values are tabulated through stochastic simulations under the null of unit root for values $k\epsilon[1,5]$.

The final step is that if the null of a unit root in second step is rejected, then the null hypothesis $H_0: \delta_1 = \delta_1 = 0$ is tested against the alternative $H_1: \delta_1 = \delta_2 \neq 0$ in the model (4.14) by using F-statistic, $F(\tilde{k})$. If the null hypothesis is rejected, then $rids_t$ is stationary around a breaking deterministic function. Briefly, in the first step we determined the number of smooth breaks, then in the second step true form of rids is tested, i.e., whether rids series follow linear or nonlinear process and in final step the model selected in first two steps is tested.

CHAPTER 5

EMPIRICAL RESULTS

We start our empirical investigation by applying standard linear unit root tests; Augmented Dickey Fuller (ADF) and Ng and Perron (2001) on real interest rate differentials, rids, of Asian countries with respect to Japan. We select the lag order for these unit root tests by the modified AIC (MAIC) information criteria which is more valid criteria in a way dealing with power and size distortion suggested by Ng and Perron (2001) with the maximum autoregressive order of 12 due to the usage of monthly data. Table 1 shows the results obtained by conventional linear unit root tests. The second column in Table 1 indicates ADF results and we find evidence of RIP only in three cases which are for Philippines at 1% and for Indonesia and Malaysia at 5% significance level. When we look at the results of the modified version of the standard linear unit root test Ng and Perron (2001) in columns between third and sixth, we obtained even worse evidence of stationarity in real interest rate differential series. That is, Ng and Perron (2001) test provides stationarity of rids in only one case, i.e., for China at 5% significance level. The reason why they are unable to find long run evidence of RIP is obvious since these tests have low power when the true data generating process of real interest rate differential series includes some breaks and/or nonlinearity in itself.

Now, we apply the method of Christopoulos and Leon-Ledesma (2010) who use Fourier functions together with the nonlinear models in order to capture the possible structural breaks and nonlinearities in the rids series simultaneously. As we mentioned in methodology part, structural breaks are modeled by Fourier functions which are formulated by trigonometric functions and these Fourier functions allow us to capture infrequent temporary smooth mean changes in rids series. Moreover, in order to find the evidence of possible nonlinear mean reversion in the series we apply KSS (2003)

Table 5.1: Standard Linear Unit Root Tests Results

	Period	*ADF*	MZ_{α}^{GLS}	MZ_{t}^{GLS}	MSB^{GLS}	MP_{T}^{GLS}
Base Country: Japan						
Indonesia	1984(1)-2016(8)	-3.47[b]	-4.88	-1.52	0.31	5.12
Korea	1984(1)-2016(8)	-2.01	-2.85	-1.04	0.36	8.21
Malaysia	1984(1)-2016(8)	-3.34[b]	-7.92	-1.97	0.25	3.14[b]
Philippines	1984(1)-2016(8)	-6.79[a]	-2.15	-0.97	0.45	10.76
Singapore	1984(1)-2016(8)	-2.41	-5.29	-1.60	0.30	4.71
Thailand	1984(1)-2016(8)	-2.51	-0.69	-0.43	0.63	22.67
Hong Kong	1995(1)-2016(8)	-1.38	-1.82	-0.92	0.50	12.98
China	1987(1)-2016(8)	-2.58	-12.45[b]	-2.49[b]	0.20[b]	1.98[b]
Critical Values						
1%		-3.47	-13.80	-2.58	0.17	1.78
5%		-2.87	-8.10	-1.98	0.23	3.17

Notes: The lag order for ADF and Ng and Perron (2001) unit root tests are chosen using the modified AIC (MAIC) with a maximum autoregressive order of 12 as suggested by Ng and Perron (2001). [a] and [b] denote rejection of the null hypothesis of a unit root at 1 percent and 5 percent significance levels, respectively.

and Kılıç (2011) unit root tests which are modeled by means of ESTAR process. The optimal lag is selected again by MAIC by allowing maximum lag 12 due to usage of monthly data.

Christopoulos and Leon-Ledesma (2010) methodology includes three steps. In the first step we estimate a Fourier function in equation (4.14) for each rids series in order to determine the optimal number of frequencies, k^{*}, which minimizes the residual sum of squares. The rids series together with Fourier functions are illustrated in Figure 1. We find only one frequency for most of the countries except two frequencies for Singapore and five frequencies for China. Figure 1 indicates that especially Asian Crisis in 1997-1998 shapes some of the countries Fourier waves such as Indonesia, Korea and Thailand. The destructive effect of the crisis is seen much on Indonesia. Before Asian Crisis, Indonesian economy enjoyed with moderate interest rate and inflation rate together with stable exchange rate. Figure 1 reflects this positive scenario for Indonesia

since we observe positive and relatively moderate real interest rate till 1996. However, these indicators reflect artificial phenomena as uncontrolled liberalization causes massive capital inflows to the country which increases the volatility of speculative actions and huge amount of short term external debts. These lead Indonesia to be more inclined to the crisis. The sharp decrease in rids of Indonesia is due to hyperinflation period during 1997-1998 when inflation climbs to 60% - 70%. After 1998, the Indonesia government implement a serial number of economic reforms. The reforms which positively affected the business cycles were supported by all the agents so that economy quickly eliminated the downside of the crisis as we see in the Figure 1. The same situation can be observed in Korea and Thailand as well. Graph of Philippines rids shows that it is not affected from Asian crisis. Prudential policies, late opening up capital sector to the world, limited accession to the external debt instruments strengthen its financial sector. Hence, we see a smooth Fourier wave in its rids series. Compared to the developing countries in Asian region, Malaysia has a more developed and powerful financial sector as its financial liberalization period began in 1960s. That's why we observe rather smooth fluctuations in the rids series. The last country having one frequency in rids series is Hong Kong. The starting date for Hong Kong rids data is 1995 when the country completed its liberalization process with removing all ceilings in time deposits. End of the 1990s and early 2000s, Hong Kong economy displays a significant economic growth with low inflation rate so that we can observe positive real interest rate. On the other hand, during the 2008-2012 we can observe downside effects of global financial crisis with negative real interest rate. The effect of 2008 crisis can also be seen in other developed economies such as Singapore, Korea and China. Singapore economy is the one of the strong economy in Asian region with powerful financial sector, low inflation, low country-specific risk premium, and sustained economic growth so that we observe slight fluctuations in the rids series (it is fluctuated around 2 and -2). We find 2 frequencies in Singapore rids series, the first one is due to 1985 recession and the other is due to 2008 financial crisis. The last country in our investigation is China which has 5 frequencies in its rids series since China's liberalization process differs from rest of the countries in the region. Unlike the other countries in the region, China applied controlled liberalization in both capital

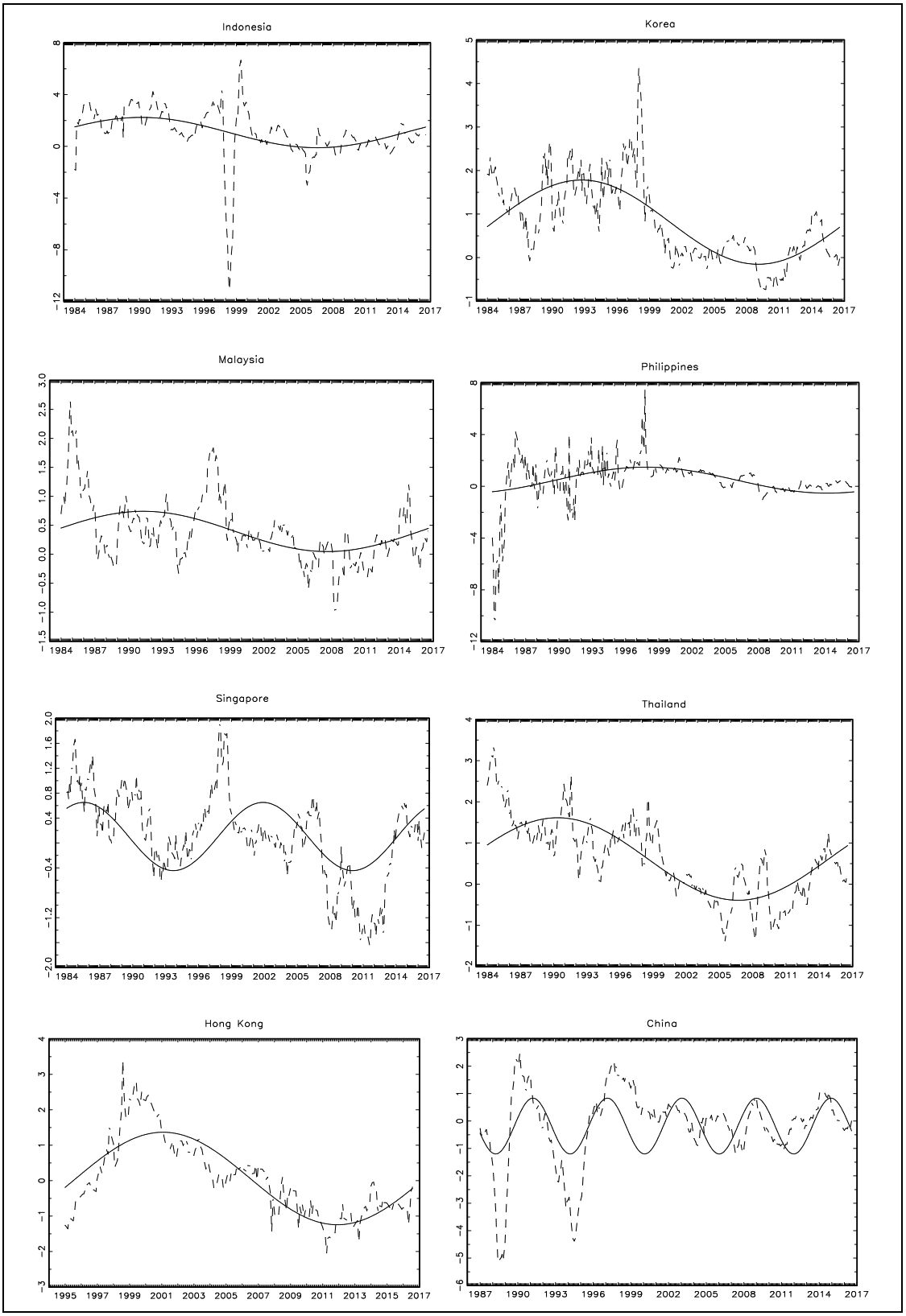

Figure 5.1: Real Interest Rate Differentials with Fourier Functions

and goods sector. Due to the regulations in capital accounts, allowing only medium and long term external debts, and control over banking system are the primary reasons why Asian crisis does not jump to China. We observe two crucial downturns in Chinese rids series during 1988-1989 and 1993-1995 which are the high inflation periods due to the political and economic turmoil in China. During 2000s especially involvement to WTO in 2001 China becomes a global economy so that not only goods market but also capital market attract the foreign investors and size of capital inflows rise significantly.

After finding the optimal frequencies of Fourier functions for each rids series, we now apply three unit root tests on the OLS residuals obtained from the first step. The first test is the Fourier ADF (FADF) test and it implies linear mean reversion in rids series. We estimate model (4.16) for FADF test and the third column in Table 2 shows the results of FADF test. The result illustrates that we reject the unit root null hypothesis at 1% significance level for Indonesia and Philippines and at 5% significance level for Thailand. Compared to ADF results in Table 1 we can observe that taking smooth breaks into account the rejection of null hypothesis improves with the exception of Malaysia case. That is, while in standard ADF test we reject the unit root null hypothesis at 5% significance level for Malaysia, in FADF test we fail to reject the null. However, in FADF test we do not find sufficient evidence in favor of RIP hypothesis because FADF test implies linearity assumption in rids series and it has low power in nonlinear series. We also estimate Fourier series with nonlinear models namely Fourier KSS test, $FKSS$, and Fourier Kılıç test, $F-Sup-t_{iN}$. We report the results of the Fourier functions with nonlinear models in the forth and fifth columns of Table 2. The forth column of Table 2 represents the $FKSS$ statistics obtained from the regression (4.17) and the fifth column of Table 2 represents the $F-Sup-t_{iN}$ statistics obtained from the regression (4.18). According to the results of FKSS we reject unit root null hypothesis in three cases which are Philippines and China at 1% significance level, and Indonesia at 5% significance level. Compared to the results of FADF test, FKSS test does not provide more supportive evidence in favor of RIP

Table 5.2: Unit Root Test Results Based on Fourier Function

	Period	$\tilde{k}$	$F(\tilde{k})$	*FDAF*	*FKSS*	$F-Sup-t_{iN}$
Base Country: Japan						
Indonesia	1984(1)-2016(8)	1	39.786[a]	-5.722[a]	-3.881[b]	-5.449[a]
Korea	1984(1)-2016(8)	1	230.143[a]	-3.577	-2.091	-3.909[b]
Malaysia	1984(1)-2016(8)	1	46.343[a]	-3.757	-3.191	-4.904[a]
Philippines	1984(1)-2016(8)	1	42.219[a]	-6.556[a]	-5.462[a]	-7.282[a]
Singapore	1984(1)-2016(8)	2	81.409[a]	-2.566	-3.063	-3.409[b]
Thailand	1984(1)-2016(8)	1	249.702[a]	-3.929[b]	-2.982	-3.872[b]
Hong Kong	1995(1)-2016(8)	1	341.253[a]	-2.762	-3.467	-4.946[a]
China	1987(1)-2016(8)	5	63.133[a]	-2.397	-3.656[a]	-3.463[b]

Notes: In all tests, the augmentation order is chosen according to MAIC with a maximum autoregressive order of 12. The critical values for the unit root tests FADF, FKSS and $F-Sup-t_{iN}$ depend on the frequency $\tilde{k}$ of the Fourier series and they are taken from Tables 1-3 of Christopoulos and León-Ledesma (2010). The critical values for the *F*-test $F(\tilde{k})$ are obtained from Table 1 of Becker et al. (2006). [a] and [b] denote rejection of the null hypothesis of a unit root at 1 percent and 5 percent significance levels, respectively.

hypothesis since both testing approach detect stationarity of rids in three cases, i.e., both unit root test provides the same result for Philippines at 1% significance level while for Indonesia the $FKSS$ test gives less evidence of stationarity and for Thailand $FKSS$ test find no evidence of RIP but FADF does. However, the $FKSS$ test find stronger evidence of stationarity of RIP for China at 1% significance level which the FADF test fail to reject the unit root null. When we analyze the results of $F-Sup-t_{iN}$ test indicated in the last column of Table 2, we find the strongest evidence in favor of RIP. We reject the unit root null hypothesis in all the cases, i.e., at 1% significance level for Indonesia, Malaysia, Philippines and Hong Kong, and at 5% significance level for the rest of the countries. The result is not surprising and shows the power of the $F-Sup-t_{iN}$ test over the other two tests.

In the final step of Christopoulos and Leon-Ledesma (2010) methodology, we test the significance of the breaks by using $F(\tilde{k})$ statistics and report in the second column of

Table 2. We reject the null hypothesis for all cases which state that real interest rate differential series are stationary around a breaking deterministic function.

Our empirical results on real interest rate differentials emphasis mainly the importance of correctly specifying the model. As we show above that including Fourier functions to allow detecting possible temporary smooth breaks improve empirical validity of real interest rate differentials. In order to find a strong evidence of long run mean reversion of RIP, the nonlinearity in real interest rate differentials should also be correctly specified. Our findings provide strong evidence of stationarity in RIP through the unit root test of Kılıç (2011) together with Fourier function indicated as $F - Sup - t_{iN}$ since this test states that the nonlinearity is detected by the size of real interest rate appreciation or depreciation. On the other hand, FKSS test allows nonlinearity trough the size of deviation in real interest rate differential which is not a correct specification of nonlinearity in rids as size of appreciation or depreciation (symmetric response) in rids shapes the agents' actions both in real and capital markets. Hence, using lagged difference of rids as a transition variable perfectly reflects agents' positons in international market.

In order to illustrate the nonlinearity in real interest rate differentials, in Figure 2 we plot the estimated transition functions of model (4.18) against the transition variable. The transition parameter, γ, is standardized by the standard error of the transition variable, Δu_{t-1}. According to Figure 2, the transition functions are symmetrically U-shaped around zero for most of the cases as expected in ESTAR models. Due to the symmetric shape of transition function, almost same number of observation is plotted below and above the equilibrium. Figure 2, also, illustrates that the speed of the mean reversion from the outer regime is same in both appreciation or depreciation cases in rids. However, while speed of adjustment is very fast in China and Thailand cases, it is relatively slow in Hong Kong case.

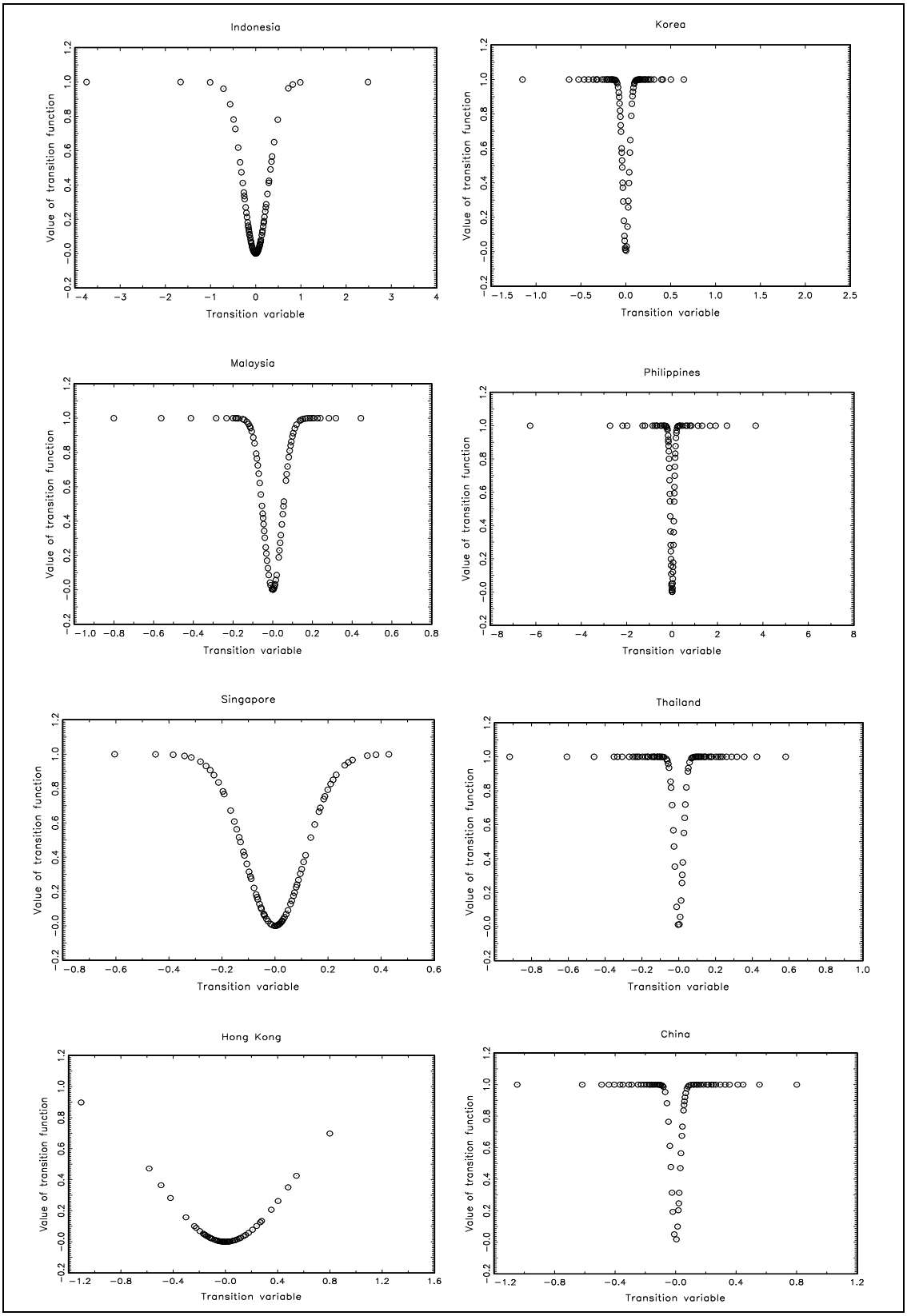

Figure 5.2: Scatter Plots of Estimated Transition Functions

CHAPTER 6

CONCLUSION

This study proposes the empirical validity of RIP hypothesis for Asian countries including ASEAN-5 together with China, Hong Kong and South Korea with respect to Japan for the liberalization period, 1984(1) – 2016(8). Due to the power of RIP as a measure of international integration of domestic country's real and financial market, there are voluminous literature testing the validity of long-run RIP but the findings do not offer a conclusive picture. The recent studies investigate the validity of RIP hypothesis by using the unit root tests which take either structural breaks or possible nonlinearity into account. However, the findings of those studies show us the fact that using the model considering either breaks or nonlinearity in rids series may not provide a sufficient evidence in favor of RIP. That is, some policies or contractual agreements in financial or/and real market lead to some breaks in the real interest rate differential series while the heterogeneous beliefs of agents, transaction and information costs, stickiness of product prices in the short run etc. may cause of the mean reversion of rids to follow a nonlinear path (Papell, 2002).

In this study we investigate the validity of the RIP hypothesis by applying the most recently developed unit root test of Christopoulos and Leon-Ledesma (2010) which allows infrequent smooth breaks and nonlinear adjustment in the series simultaneously. In Christopoulos and Leon-Ledesma (2010) unit root test, temporary smooth breaks are modeled by Fourier function and we observe a single frequency for six countries and two frequencies for Singapore and five frequencies for China. The breaks in the rids series generally are associated with 1997 Asian Crisis and 2008 Global Financial Crisis. To investigate the nonlinear adjustment in rids series we apply modified version of newly developed ESTAR models of Kapetanios et al. (2003) and Kılıç (2011). We modify these unit root test by inserting Fourier functions into the

models. Although unit root test of Kapetanios et al. (2003) is a popular test among the researchers, we observe that it offers no further evidence for stationarity of real interest rate differentials compared to the conventional unit root tests. That is, both FADF and FKSS tests reject the unit root null hypothesis for three cases. $F - Sup - t_{iN}$ results, on the other hand, find the strongest evidence of RIP with rejecting the unit root null hypothesis in all cases. The reason why $F - Sup - t_{iN}$ test provides strongest results is that it allows smooth breaks in rids series and associates the nonlinearity with the size of appreciation or depreciation in real interest rate differential series, which perfectly reflects the agents investment decisions.

Our finding reveals that breaks and nonlinear adjustments together are decisive in deriving the behavior of real interest rate differential series. We show that allowing smooth breaks improves even the results of linear unit root test since FADF test provides better results when compared to ADF test results. Our results further reveal the importance of correctly specifying nonlinearity in rids series of Asian countries throughout their liberalization period.

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APPENDICES

A. TURKISH SUMMARY/ TÜRKÇE ÖZET

Son 30 yılda, gelişmiş ve gelişmekte olan ülkeler uluslararası bütünleşme derecesini artırmak için hem sermaye hem de mal piyasalarını dünyanın geri kalanına açtı. İlk girişimler, Bretton Woods döneminin 1970'lerin ortalarında sona ermesinin ardından ABD ve bazı Avrupa ülkeleri gibi gelişmiş ülkelerden gelmiş ve gelişmekte olan ülkelere yayılmıştır. Ülkeler, sermaye kontrollerini esneterek ve bilgi ve işlem maliyetlerini düşürerek, sermaye ve mal sektörlerini deregülasyona tabi tutmuşlardır (Frankel, 1992). Eğer tam entegrasyon sağlanırsa, hem sermaye hem de mallar ülkeler arasında serbestçe dolaşacak ve böylece ülkeler arasında reel faiz oranları eşitlenecek ve böylece reel faiz oranı paritesi (RIP) hipotezi gerçekleşecektir (Baharumshah vd, 2005).

RIP hipotezi, açık faiz paritesi (UIP) ile satın alma gücü paritesinin (PPP) (Fisher denklemi ve rasyonel beklenti teorisi ile birlikte) sağlanmasıyla, uluslararası bütünleşmenin derecesini ölçmek için yararlı bir koşuldur. UIP finansal piyasa bütünleşmesinin derecesini gösterirken, PPP hipotezi mal piyasası entegrasyonunu belirtir. Yani, UIP, nominal faiz oranları ile iç ve dış ülke arasındaki döviz kurlarındaki beklenen değişim arasındaki ilişkiyi gösterirken, PPP enflasyon oranlarını ve bu ülkeler arasındaki döviz kurlarındaki değişimi göstermektedir. Dolayısıyla, RIP hipotezinin test edilmesi açıkça hem malların hem de varlıkların uluslararası entegrasyon derecesinin aynı anda piyasada test edilmesini gerektirir. RIP hipotezi sağlanırsa, iç pazar dış pazara mükemmel şekilde bağlanır ve reel faiz oranı, dünya reel faiz oranından çok fazla dalgalanamaz. Dolayısıyla, yerel otoritenin para ve maliye politikaları, liberalleşme sürecinde baz alınan ülkenin politikalarına oldukça bağımlı hale gelir. Krugman (1999) bu noktaya dikkat çekerek bir ekonominin mükemmel sermaye akışlarını, bağımsız iç politikaları ve sabit döviz kuru sistemini eş

zamanlı olarak koruyamayacağına dikkat çekmektedir. Reel faiz oranlarının güçlü bir uluslararası bağlantısı varsa, o zaman reel faiz oranları uluslararası sermaye piyasası tarafından belirlenir ve bu nedenle küçük ekonomiler para politikalarını uygulayarak yerel sektörü etkileme gücünü kaybeder. Dolayısıyla, yetkililerin iç piyasaya yönelik istikrar politikalarının tasarruf ve yatırım oluşumunda etkisi çok az olacaktır (Pipatchaipoom, 2005).

Ülkelerin uluslararası düzeyde entegre veya özerk olup olmadığının açıklanmasındaki önemi nedeniyle RIP hipotezini test eden çok sayıda çalışma bulunmaktadır. RIP literatürü ile ilgili ilk çalışmalar, basit regresyon metodu uygulayarak reel faiz oranlarının ülkeler arasında eşitlenmesine odaklanmış ve RIP hipotezine karşı kanıt bulmuştur (örneğin; Mishkin, 1984; Cumby ve Obstfeld, 1984; Mark, 1985; Cumby ve Mishkin, 1986; Frankel ve McArthur, 1988 ve Modjtahedi, 1987). İşlem ve bilgi maliyetleri, ülkelere özgü risk primleri, ticaret engelleri ve ülkeler arasındaki anlaşmalar, arbitraj güçleri vb. nedeniyle reel faiz oranları ülkeler arasında eşit olmadığından, daha sonraki araştırmalar, reel faiz oranı farklarına (rids) odaklanmıştır. Reel faiz farklarını (rids) RIP'nin göstergesi olarak kullanan geçmiş çalışmalar, Augmented Dickey Fuller, ADF (1981) ve Phillips and Perron, PP (1988) birim kök testleri gibi geleneksel doğrusal birim kök testleri kullanmışlar. Geleneksel lineer birim kök testleri, serilerdeki döngünün simetrik olduğunu ve bu yüzden dengeye doğru dönüşün doğrusal bir yapıya sahip olduğunu varsaydıkları için, durağan olmayan boş hipotezi reddetmeyi başaramamışlardır. Örneğin, Meese ve Rogoff (1988) gelişmiş dört ülkenin rids serilerini, 1974 (1) - 1986 (3) dönemi için aylık veriler kullanarak ADF testini uygumışlar ve birim kök boş hipotezini reddedememişler. Benzer şekilde, Edison ve Pauls (1993), 1974 (Q1) -1990 (Q4) dönemi için üç aylık verileri kullanarak, aynı lineer birim kök testini uygulayarak gelişmiş ve G-10 ülkeleri için birim kök boş hipotezini reddedememişler. Standart birim kök testlerinin güçsüzlüğü nedeniyle, bazı çalışmalar, iç ve dış reel faiz oranlarının uzun dönemli yapısını görmek için doğrusal eş entegrasyon testleri ve panel birim kök testleri kullandılar. Örneğin, Chinn ve Frankel (1995) Asya

ülkelerinde Johansen'in (1998) eş entegrasyon metodolojisini kullanarak RIP hipotezini test ettiler ancak RIP hipotezi için 3 vaka dışında kanıt bulamadılar. Diğer yandan, Wu ve Chen (1998) panel birimi kökü testini, 1979 (M1) - 1996 (M9) dönemi için euro para piyasası bölgesinde uygulamışlar ve ridlerin ortalamaya geri dönüşünü destekleyici kanıtlar bulmuşlardır. Bununla birlikte, panel birimi kök testleri, heterojenite problemi nedeniyle bazı sorunlara neden olabilir; çünkü bu testler, ülkeye özgü farklılıkları göz ardı eder ve gerçek faiz oranlarının, tüm ülkeler için aynı dinamiklere sahip olduğunu varsayar ve bu da, RIP'nin geçerliliği üzerinde güvenilir olmayan çıkarımlara neden olabilir. Ek olarak, panel serilerinde birim kök boş hipotezin reddedilmesi, serilerden en az birinin durağan olduğunu, hepsini değil, göstermekte ve panel grubundaki her bir ülkeye özgü analiz yapılmamaktadır.

Daha önceki ampirik çalışmaların RIP'yi destekleyen kanıt bulamaması, konvansiyonel doğrusal birim kök testlerinde bazı problemlerin varlığına bağlıdır. Öncelikle, kökler birim kökün yakınında değerler alırsa, serilerin sabit doğasını tespit eden bu testlerin gücü çökecek ve seri durağan olsa bile durağan olmadığı sonucuna varacaktır. Çünkü, kısa vadede seriler dengeden dalgalanabilir ve sapma kısa bir süre kalıcı olabilir, ancak standart birim kök testinin gücü, serilerin kısa dönem davranışlarını yakalayamaz. İkinci olarak, eğer seride yapısal değişiklikler varsa, standart birim kök testleri birim kök boş hipotezini reddetme yönünde bias olabilir (Perron, 1989). Zivot ve Andrews (1992) seride endojen olarak belirlenmiş bir yapısal kırılmaya izin verip ve böylece yapısal değişmeyi modellerken, Lumsdaine ve Papell (1997) seride iki adet endojen olarak belirlenmiş yapısal kopmalara izin veren teorik bir çalışma yaparak bu sorunu çözmeye çalışmışlardır. Ek olarak, Perron (1997) seride birden fazla yapısal kırılmayı endojen olarak araştırarak birim kök testi için bir prosedür geliştirmiştir. Fountas ve Wu (1999), Wu ve Fuantas (2000), Maveyraud - Tricoire ve Raus (2009) ve Bağdatoğlu ve Kontonikas (2011) çalışmalarında yapısal kırılmaları göz önüne alındığı metodlar uygulanmışlar ve gelişmiş ülkeler için RIP lehine bazı kanıtlar bulmuşlardır.

Yukarıda bahsedilen test istatistiklerinin tümü, alternatif hipotez altında rids serilerinin pozitif ve negatif şoklara simetrik bir şekilde yanıt verdiğini varsayar ve serideki olası doğrusalsızlığı gözardı eder. Dolayısıyla, konvansiyonel birim kök testlerinin son zayıflığı, serideki olası doğrusalsızlık yapıyı saptayamamasıdır. Sonora ve Tika (2010), rids serilerinin yapılarında doğrusalsızlık varsa standard birim kök teslerinin bu doğruslsızlığı yakalamada zayıf olduğunu vurgulamıştır. İşlem maliyetleri, esnek olmayan fiyatlar, gelecek haberlere yatırımcıların verdiği heterojen tepkiler, sermaye hareketliliğinin tam olmaması, eksik kurumsal reformlar gibi rids serilerinde doğrusalsızlığa neden olabilecek çeşitli etkenler vardır. Goodwin ve Grennes (1994), işlem maliyeti etkisinden dolayı RIP hipotezinde nötr bir period bulunduğunu belirtmektedir. Yani, işlem maliyeti reel faiz oranları arasındaki farktan daha yüksek olursa, arbitraj fırsatı ortadan kalkar; yatırımlar karlı olmaz ve işlem gerçekleşmez. Öte yandan, reel faiz farkı işlem maliyetinden yüksek olduğunda, arbitraj hızla bu oranlar arasındaki farkı kaldıracaktır. Bu nedenle, Balke ve Wohar (1998), işlem maliyetlerinin rolü etkili olduğunda RIP için doğrusal olmayan birim kök modelleri önermektedir. Ayrıca fiyatların yapışkanlığı, RIP'de doğrusalsızlığa bir başka sebep olarak açıklanabilir. Yukarıda açıklandığı gibi PPP, malların ülkeler arasında ne kadar kolay hareket ettiğini gösterir. Bununla birlikte, bazı ticari mallardaki yapışkan fiyatların kısa vadede PPP'de kalıcı sapmalara neden olması, bunun da doğrusal istikrar hipotezinde başarısızlığa ve uzun vadede düşük ortalama geri dönüşüme neden olabileceği düşünülmektedir. Dolayısıyla, PPP ile RIP arasındaki güçlü bağlardan dolayı PPP'de bu doğrusalsızlık RIP'de de gözlemlenecektir. Buna ek olarak, yatırımcıların heterojen inançları RIP hipotezinde doğrusalsızlığın olası bir başka nedeni olarak açıklanabilir. Yani, ajansların farklı risk profilleri, öğrenme becerileri, tutumlar vb. nedeniyle yatırım karaları da aynı değildir. Dolayısıyla, haberlerin etkisi, tüm ajanların yatırım kararlarını tamamlayana kadar biraz zaman alır.

Önceden belirttiğimiz gibi standart lineer birim kök testleri serilerdeki olası doğrusalsızlığı yakalayamadığı için, serilerdeki doğrusalsızlığı modelleyen çalışmalar giderek yaygınlaşmaktadır. Doğrusalsızlık ilk olarak Tong (1978) makalesinde Eşik

Otoregresyon (TAR) modeli ile incelenmiştir. Bu modelde doğrusalsızlığın yapısının ani olduğu varsayılmıştır. Bununla birlikte, son çalışmalar, TAR modelinde belirtildiği üzere, reel faiz oranı farklarını Granger ve Terasvirta'nın (1993) modellediği Yumuşak Geçişli Otoregresyon (STAR) modeli ile analiz etmişlerdir. Bu çalışmalar, reel faiz oranı farkındaki yumuşak geçişleri açıklamada işlem maliyetinin ve ajanların heterojen beklentilerinin önemini vurgulamışlar. Rids serileri dengenin etrafından çok az saptığında reel faiz farkı çok az olacaktır. Böyle bir durumda yatırımcılar için işlem yapmak karlı olmayacağı için, dengenin etrafında işlemlerin görülmediği bir alan oluşacak ve böylece bu alanda birim kök süreci görülecektir. Reel faiz farkı dengeden çok fazla uzaklaştığında ise yatırım karlı olduğu dışsal bölgeye ulaşacak ve sapmalar hızlı bir şekilde azalıp dengeye geri dönüş olacaktır. Böylece band dışında durağan bir süreç olacaktır. Kapetanios vd. (2003) dizinin bu davranışını sistemleştirdi ve ESTAR tipi birim kök testinin geliştirilmiş bir versiyonunu önerdi. Bu yeni testi on bir OECD ülkesinin reel faiz oranı ve reel döviz kuru serileri üzerinde uyguladılar ve bu serilerin bazılarında geçerli olan küresel sabit duran doğrusalsız geri dönüş yönünde deliller buldular. Birçok çalışma Kapetanios vd. (2003) doğrusalsız ama küresel anlamda durağan ESTAR modelini kullanarak serilerde doğrusalsız durağanlığa deliller buldular örneğin, Liew vd. (2004), Ceratto and Sarantis (2006), Wallace (2008), Cuentas ve Gil-Alana (2009) ve Telatar ve Hasanov (2009). Son zamanlarda, Kılıç (2011) Kapetanios vd. (2003) tarafından önerilen yöntemi geliştirdiler. Bu modifiye edilmiş ESTAR versiyonunu yani Kılıç (2011) metodunu Kapetanious (2003) metoduyla karşılaştırmalı olarak Avrupa ülkeleri döviz kurlarına uyguladılar ve modifiye edilmiş testin, Kılıç (2011) birim kök testi, reel döviz kurundaki durağanlık lehine daha güçlü kanıtlar sunduğunu gösterdiler.

Bu çalışmada, ASEAN-5 ülkelerinin (Endonezya, Malezya, Filipinler, Singapur ve Tayland) ve Çin, Hong Kong ve Güney Kore gibi daha sanayileşmiş ülkelerin liberalizasyon sonrası dönemi için RIP hipotezinin ampirik geçerliliğini test etmeyi amaçladık. Baz ülke olarak Japanya'yı seçtik çünkü Japonya ASEAN-5 ülkelerine ve Güney Kore'ye doğrudan yatırımın en fazla olduğu ülkedir ayrıca özellikle 1997 Asya

krizinden sonra bu ülkeler Japonya'nın finans sektörüne çok hızlı bir şekilde entegre olmuştur. 1980'lerden beri Asya ülkeleri, malların ve sermayenin akışına ilişkin kısıtlamaları kademeli olarak kaldırarak hem reel piyasayı hem de sermaye piyasalarını liberalleştirmeye yönelik bazı adımlar attı. Genellikle serbestleştirme girişimleri boyunca aynı aşamayı izlemekle birlikte, bu ülkelerdeki liberalleşme sürecinin zamanlaması ve yoğunluğu farklılık gösterebilir. Serbestleşmenin ilk aşamasında, döviz kontrolleri, borç verme ve mevduat faiz oranları sistemli bir şekilde kaldırdı. Serbestleşme çabalarının ikinci aşamasında, Asya ülkeleri 1980'lerin sonlarında finans sektörlerini yabancı sermayeye açtılar; böylece yabancı yatırımcılara yurtiçi varlıklara ve yerli yatırımcıların da yabancı varlıklara erişim imkanı sağlandı. Bu aşamalı liberalizasyon girişimleri, finansal liberalizasyon süreçlerini aynı aşamalarda izleyen Asya ülkelerini, RIP hipotezi üzerine ampirik çalışmalar yapan ülkeler için popüler böle haline getirerek bu bölgelerdeki ülkeler üzerine bir çok RIP çalışması yapılmaktadır. Örneğin, Baharumshah vd. (2005), Holmes vd. (2011) ve Liu vd. (2013), reel faiz oranı farklılıklarına ilişkin panel birimi kök testi uygularken Chang vd. (2012) ve Baharumshah vd. (2013), uzun vadede Asya ülkelerinin RIP hipotezinin geçerliliğini endojen olarak belirlenen yapısal bozulmaları modelleyerek test etmişler. Holmes ve Maghrebi (2004), ASEAN ülkeleri için STAR modellerini uygulamışlar ve rids serilerinde doğrusalsızlık yönünde kanıtlar bulmuşlar. Baharumshah vd. (2008) ve Baharumshah vd. (2010), Kapetanios vd. (2003) ESTAR modelini sırasıyla ASEAN, G7 ve 10 Asya ülkesi için uygulamışlar ve veri generasyon sürecinde doğrusalsızlığın önemini vurgulamışlardır.

Çalışmamızda, kullanılan metodoloji ve örnek seçim kriterlerimiz açısından RIP hipotezi ile ilgili mevcut literatüre katkıda bulunmaktayız. Öncelikle, nadir geçici yumuşak kırımları ve modeldeki olası doğrusalsızlığa eşzamanlı olarak izin veren Christopoulos ve Leon-Ledesma (2010) metodolojisini uyguluyoruz. RIP literatürü hakkındaki bilgilerimize dayanarak, Christopoulos ve Leon-Ledesma (2010) metodolojisini kullanarak RIP hipotezinin geçerliliğini sınayan ampirik bir çalışma görmedik. Bu nedenle, çalışmamız bu metodolojiyi RIP hipotezinde kullanan öncü bir

ampirik çalışma olacaktır. Bu yeni geliştirilen birim kök testini, Asya ülkelerinin rids serilerine Japonya'yı baz ülke alarak uyguladık. Christopoulos ve Leon-Ledesma (2010) metodolojisinde doğrusalsızlık, Kapetanios vd. (2003) 'nın ve Kılıç (2011) ESTAR modellerinin modifiye edilmiş versiyonu ile test edilmiştir.Yukarıda bazı örnekler verdiğimiz Asya ülkeleri için yapılan birçok RIP çalışmasında KSS (2003) testi uygulanmıştır. Ancak Kılıç (2011) birim kök metodunu uygulayan herhangi bir çalışma ile karşılaşmadık. Bu iki doğrusalsızlık birim kök testlerini, KSS (2003) ve Kılıç (2011) testlerinin bu değiştirilmiş versiyonlarını yumuşak geçici kırılmaları ve doğrusalsızlığı aynı anda araştırmamızı sağlayacak şekilde Fourier fonksiyonlarını ekleyerek değiştirdik. Bu bağlamda, çalışmamız Asya ülkelerinde bu testleri kullanan ilk çalışma olacaktır. Ayrıca, serbestleşme sonrası liberalleşme döneminde ASEAN-5 ülkeleri (Endonezya, Malezya, Filipinler, Singapur ve Tayland) ile daha gelişmiş ülkeler (Çin, Hong Kong ve Güney Kore) birlikte incelendi.

Ampirik araştırmamıza standart doğrusal birim kök testleri olan ADF ve Ng ve Perron birim kök testlerini uygulayarak başladık. Bu birim kök testleri için optimal gecikmeyi, Ng ve Perron (2001) tarafından öne sürülen MAIC ile belirledik. Maksimum gecikmeyi aylık veri kullandığımız için 12 olarak belirledik. Tablo 1, geleneksel doğrusal birim kök testleri ile elde edilen sonuçları göstermektedir. Tablo 1'deki ikinci sütun ADF sonuçlarını göstermektedir ve sadece% 1'lik Filipinler için ve Endonezya ve Malezya için% 5 anlamlılık düzeyinde olan üç vakada RIP bulgusu buluyoruz. Üçüncü ile altıncı sütunlar arasında ise standart doğrusal birim kök testinin modifiye edilmiş versiyonu olan Ng ve Perron (2001) birim kök sonuçlarına baktığımızda, reel faiz oranı farkı serilerinde daha zayıf durağanlık kanıtı elde ettik. Diğer bir deyişle, Ng ve Perron (2001) testi, tek bir durumda yani Çin için %5 anlamlılık seviyesinde durağanlık delili sağlamaktadır. Reel faiz oranı farkı serilerinin veri genere etme süreçlerinde serilerin yapısında olası kırımlar ve/ veya doğrusalsızlık varsa bu testlerin gücü azalacaktır ve RIP hold etmeyecektir.

Standard lineer birim kök testlerinin sonuçlarının zayıflığını gösterdikten sonra bu aşamada Christopoulos ve Leon-Ledesma (2010) metedunu kullanarak sonuçlarını analiz edeceğiz. Christopoulos ve Leon-Ledesma (2010) metodolojisi üç aşamadan oluşmaktadır. İlk aşamada, artık kareler toplamını minimum yapan optimum frekans sayısını, k *, belirlemek için Fourier fonksiyonunu her ülke için test ettik. Sonuçları Tablo 2'de listeledik. Sonuçlara göre altı ülke için optimum frekans sayısı bir çıkarken, Singapur için optimum frekans sayısı 2 ve Çin için 5 bulduk. Şekil 1, özellikle 1997-1998'deki Asya Krizinin Endonezya, Güney Kore ve Tayland'ın Fourier dalgalarını şekillendirdiğini göstermektedir. Krizin yıkıcı etkisi, en çok Endonezya'da görülüyor. Asya Krizi öncesinde Endonezya ekonomisi, stabil döviz kuru ile birlikte dengeli faiz ve enflasyon oranı ile iyi bir seneryo çiziyor. Şekil 1, 1996 yılına kadar pozitif ve nispeten ılımlı bir reel faiz oranını gözlemlediğimizden Endonezya için bu olumlu senaryoyu yansıtmaktadır. Ancak bu göstergeler ekonominin durumunu çok da iyi yansıtmıyor. Çünkü, liberalizasyon süreci ile ülkeye büyük sermaye girişleri olmuş ve bu da spekülatif eylemlerin varlığını artırmıştır. Ayrıca kriz öncesi dönemde kıza vadeli borç miktarı çok ciddi boyutlara ulaşmıştı. Tüm bunlar Endonezya ekonomisini krize daha eğimli hale getirmiştir. Endonezya'nın rids serisindeki keskin düşüş, enflasyonun %60-%70' e kadar yükseldiği 1997-1998 döneminde görülen hiperinflasyon döneminden kaynaklanmaktadır. 1998'den sonra Endonezya hükümeti bir dizi ekonomik reform uyguluyor. İş çevrelerini olumlu yönde etkileyen reformlar tüm ajanlar tarafından desteklendi; böylece ekonomi, Şekil 1'de görüldüğü gibi krizin olumsuz taraflarını hızlı bir şekilde ortadan kaldırdı. Aynı durum Kore ve Tayland'da da gözlemlenebilir. Filipinlerin rids dalgalarına baktığımızda, Asya krizinden etkilenmediğini görüyoruz. İhtiyatlı politikalar, sermaye sektörünün dünyaya açılması, dış borçlanma araçlarına sınırlı katılım gibi olumlu hamleler Filipinler'in finansal sektörünü güçlendirmiştir. Bu nedenle, rids serilerinde yumuşak bir Fourier dalgası görüyoruz. Asya bölgesindeki gelişmekte olan ülkelere kıyasla Malezya, 1960'lı yıllarda finansal serbestleşme dönemi başladığı için daha gelişmiş ve güçlü bir finansal sektöre sahiptir. Bu nedenle rids serilerinde yumuşak dalgalanmalar görüyoruz. Hong Kong rids verilerinin başlama tarihi olan 1995 yılında ülke, mevduatta tüm tavan faizlerin kaldırılmasıyla serbestleştirme sürecini tamamladı. 1990'ların sonunda ve

2000'lerin başında, Hong Kong ekonomisi düşük enflasyon süreci ile önemli bir ekonomi büyüme gerçekleştirdi ve böylece grafiğe baktığımızda düşük reel faiz gözlemlemekteyiz. Öte yandan, Hong Kong için 2008-2012 döneminde Küresel Finansal Krizin aşağı yönlü etkilerini negatif reel faiz oranı ile gözlemliyoruz. 2008 krizinin etkisi Singapur, Kore ve Çin gibi gelişmiş ekonomilerde de görülmektedir. Singapur ekonomisi, güçlü finansal sektör, düşük enflasyon, düşük risk primi ve devamlı ekonomik büyüme ile Asya bölgesinde güçlü ekonomilerin başında gelmektedir ve böylece serilerde hafif dalgalanmalar gözlemlenmektedir (2 ve -2 civarında dalgalanmaktadır). Singapore rids serisinde 2 frekans görülmektedir, ilki 1985 durağanlık döneminden, diğeri 2008 mali krizinden kaynaklanıyor. Araştırmamızın son ülkesi, Çin'in liberalizasyon süreci bölgedeki diğer ülkelerden farklı olduğu için, rides serisinde 5 frekans gözlemlemekteyiz. Bölgedeki diğer ülkelerden farklı olarak Çin, hem sermaye hem de mal sektöründe kontrollü liberalleşmeyi uyguladı. Asya krizinin Çin'e sıçramamasının başlıca nedenleri, sermaye hesaplarındaki düzenlemeler nedeniyle sadece orta ve uzun vadeli dış borçlanmaya izin verilmesi ve devletin bankacılık sistemi üzerindeki kontrolü şeklinde açıklanabilir. 1988-1989 ve 1993-1995 yılları arasında, Çin'deki siyasi ve ekonomik karışıklığa bağlı olarak yüksek enflasyon dönemleri Çin'in rids serisinde yaşanan önemli iki düşüşe neden olmuştur. 2000'li yıllarda özellikle 2001'de Dünya Ticaret Örgütü'ne dahil olan Çin, sadece mal pazarının değil aynı zamanda sermaye piyasasının da yabancı yatırımcıları cezbetmesi ve büyük sermaye girişlerinin önemli ölçüde artması ile küresel bir ekonomi haline geldi.

Her rids serisi için optimum Fourier frekanslarını bulduktan sonra, metodoloji bölümünde de açıklandığı gibi ilk adımda elde ettiğimiz OLS artıklarıyla açıklanan üç birim kök testi uyguluyoruz. Tablo 2' de fourier fonksiyonları ile modiye edilmiş ADF, KSS ve Kılıç testlerinin sonuçlarını gösterdik. Sonuçlara göre Fourier ADF (FADF) ve fourier KSS (FKSS) birim kökleri 3 ülke için boş hipotezi reddederken, Fourier Kılıç ($F - Sup - t_{iN}$) birim kök testi bütün ülkeler için boş hipotezi reddermektedir.

Reel faiz oranı farklılıklarına ilişkin ampirik sonuçlarımız modelin doğru bir şekilde belirlenmesinin önemine vurgu yapmaktadır. Olası geçici yumuşak kırılmalara izin veren Fourier fonksiyonlarını modele kattığımızda, RIP hipotezinin geçerliliği arttı. Ayrıca, RIP'nin uzun vadeli ortalama geri dönüşüne ilişkin güçlü bir kanıt bulmak için, rids serilerinde doğrusalsızlık doğru bir şekilde belirtilmelidir. Bulgularımız, Fourier fonksiyonları ile modifiye edilen Kılıç (2011) birim kök testinin, $F - Sup - t_{iN}$, RIP hipotezide durağanlığına yönelik çok güçlü kanıtlar sundu. Modifiye edilen Kılıç birim kök testinin FKSS birim kök testine kıyasla çok daha güçlü sonuçlar vermesinin nedeni, $F - Sup - t_{iN}$ testi doğrusalsızlığı reel faiz farkındaki değişim hızıyla açıklarken, FKSS birim kök tesi doğrusalsızlığı reel faiz farkındaki değişim ile açıklamaktadır. Yani, $F - Sup - t_{iN}$ birim kök testinde doğrusalsızlığa neden olan geçiş değişkeni olarak rids serilerinin ilk gecikmesi alınırken, FKSS birim kök testinde ise rids serisi düzey olarak alınmaktadır. Dolayısıyla, geçiş değişkenleri olarak gecikmiş rids serilerini kullanmak, ajanların uluslararası pazardaki konumlarını çok daha iyi yansıtmaktadır.

Reel faiz oranı farklarındaki doğrusalsızlığı göstermek için, Şekil 2'de (4.18)'deki modelindeki tahmini geçiş fonksiyonlarını geçiş değişkeni ile grafikte gösterdik. Geçiş parametresi γ, geçiş değişkeni Δu_{t-1} nin standart hatası ile standartlaştırılmıştır. Şekil 2'ye göre, geçiş fonksiyonları, ESTAR modellerinde beklendiği gibi olguların çoğunda sıfıra yakın simetrik U-şeklindedir. Geçiş fonksiyonunun simetrik şekli nedeniyle, hemen hemen aynı sayıda gözlem denge altında ve denge üstünde çizilmiştir. Şekil 2, aynı zamanda, dış rejimden ortalama geri dönüş hızının hem değer artışı durumunda hem de azalışı durumunda aynı olduğunu göstermektedir. Bununla birlikte, Çin ve Tayland'da dengeye doğru düzenleme hızı çok yüksek iken, Hong Kong rids serilerinde göreceli olarak yavaştır.

Sonuç olarak, bulgularımız göstemektedir ki, yumuşak kırılmalar ve doğrusalsızlık birlikte reel faiz oranı farkı serilerindeki dalgasal davranışları açıklamaktadır. Çalışmamız doğrusal birim kök testi olan ADF modeline bile Fourier fonksiyonu

koyduğumuzda boş hipotezi reddetme gücünün arttığını ampirik olarak gösteredik. Ayrıca bulgularımız doğrusalsızlığın rids serilerinde doğru bir şekilde modellenmesinin önemini de göstermiştir. Daha açık bir ifade ile, Asya ülkelerinin liberalleşme sürecinde RIP hipotezi, FKSS birim kök testi kullanılarak lineer boş hipotezi 3 ülke için reddederken, $F - Sup - t_{iN}$ birim kök testi kullanarak bütün ülkeler için boş hipotezi reddettik.

B. TEZ FOTOKOPİSİ İZİN FORMU

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YAZARIN

Soyadı : Gülcü
Adı : Abdullah
Bölümü : İktisat

TEZİN ADI (İngilizce) : Investigation of Smooth Breaks and Nonlinear Mean Reversion in Real Interest Parity: Evidence from Asian Countries

TEZİN TÜRÜ : Yüksek Lisans [X] Doktora [ ]

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