Productivity and Real Exchange Rate Movements for the ASEAN and SAARC Countries: Revisiting the Balassa-Samuelson Hypothesis

I. Introduction

Exchange rate equilibrium is a longstanding notion which has always been imperative in explaining the mechanism of economic and financial stability of a region. The long run dynamics of exchange rate can be traced back to 1922 when Gustav Cassel first introduced the concept of Purchasing Power Parity (PPP) which is regarded to be the best manifestation of potentially equilibrium exchange rates. This theory states in a macroeconomic environment where exchange rates and commodity prices are perfectly flexible and cross-country trade is absolutely frictionless, the relative prices between countries are tend to be stable or stationary over time. This theory can be seen as a long term tendency of the equilibrium exchange rate.

Cross country price levels in connection with bilateral exchange rate movements do not only represent PPP-phenomenon but also undertake the discussion of relative sectoral prices (tradables and non-tradables). Balassa (1964) and Samuelson (1964) were the first ones who, in the context of exchange rate and relative sectoral price differentials, attributed these price differentials to differentials in economic development which are likely to persist for longer periods. One country being more productive than the other, the former's non-traded sector is most likely to face a sharper rise in price levels in comparison to the later one, resulting in a real appreciation of former country's exchange rate. In simpler words, Balassa and Samuelson (1964) provided the first realistic explanation of why the theory of absolute PPP is flawed in the perspective of equilibrium exchange rates.

As discussed earlier, the absolute version of PPP can be realized only by assuming spatial arbitrage in a well-connected and perfectly competitive, frictionless world economy, so that the relative prices of a common basket of goods across countries are equalized when quoted in a common currency. As an explanation to this, consider a situation where the price of *nth* good at home is given as p_n and in foreign the same good has a price p_n'. *E* is the bilateral exchange rate between home and foreign defined as units of home currency per unit of foreign currency. *P* and *P** are the aggregate price level indices for all the goods produced locally at home and abroad quoted in their local currencies. With the given specifications, absolute PPP can be validated if the two prices (in terms of domestic currency) for each good get equalize across countries, provided every type of market frictions and rigidities are absent. The common basket of goods across two countries, if comprising of exactly identical goods with commonly used weights, then the law of one price i.e. price equalization (between p_n and p_n') for *nth* good can be taken in a broader perspective of equalization of aggregate price indices (*P* and *P**) giving rise to well known absolute PPP formulation of $E = \frac{P}{P^*}$. Thus, absolute version of PPP states that assuming no market frictions and rigidities, the relative price of a common basket of goods across countries measured in a common currency will always be equal i.e. $\frac{P}{EP^*} = 1$

In their classical articles *The Purchasing Power Parity Doctrine: A Reappraisal* by *Bela Balassa* and *Theoretical Notes on Trade Problems* by *Paul A. Samuelson*, published in 1964, first time provided the most obvious reasoning in the form of productivity-exchange rate pass-through that why absolute version of PPP is unlike to hold in long run. The introduced the factor of cross country sectoral productivity growth differential between traded and non-traded sectors as an important factor responsible for bringing systematic biases into the relationship between cross country relative prices of tradables and exchange rate. They regarded this sectoral productivity growth bias, vital for bringing undesirable alternations in an economy's internal price mechanisms.

According to their model, an economically advanced country i.e. high income country is likely to be technologically more sound and advanced as compared to a low income economy. However, this technological advancement will not be uniform across all the sectors of economy. It is likely to be more pronounced for tradable sector of the economy in comparison to non-tradable one. Assuming purchasing power parity with no market friction or rigidities, the prices of tradables from various countries will be equalized as they are traded in international market. However, this will not be the situation for non-tradables for which law of one price does not hold. Thus if the home country is growing more in terms of traded sector productivity relative to its trading partner, it will cause the domestic wage rate of traded sector to increase. This wage rise will bring supply-side inflation for non-traded sector only pulling their prices upwards (prices of traded sector being determined internationally will not take up this influence), thus causing the domestic real exchange rate to appreciate relative to its trading partners. Hence long run cross country sectoral productivity differentials will make long run exchange rate to see trend deviations from PPP.

$$\Delta RER_t = \Delta e_t + \frac{\tilde{\delta}}{\tilde{Y}}(1-\beta)\left[\left(\Delta\tilde{A}_t^{T*} - \Delta\tilde{A}_t^{N*}\right) - \left(\Delta\tilde{A}_t^{T} - \Delta\tilde{A}_t^{N}\right)\right] \quad \text{----------------------- (1)}$$

where

rer_t= Bilateral real exchange rate

$\widetilde{A_t^s}$= Average labor productivity, s = traded and non-traded sectors

$1-\beta$ = Share of non-tradables in consumption basket

* = trading partner (reference country)

The above equation represents that if a^T is found to be growing at a faster pace than a^{T*} the domestic wage rate will rise in comparison to the international one. If it is also a situation that a^T is growing faster than a^N the relative wage rate at home will rise giving a push to non-traded sector prices. Hence, despite the equality between international traded sector prices, domestic price index will rise (due to bidding up of non-tradables prices) in comparison to the foreign price index. This is how the imbalanced productivity growth in traded sector both at domestic as well as international level will cause the real exchange rate of transition Asian economies to appreciate.

Balassa and Samuelson also made an inter-country income comparison in the context of long run exchange rate deviations from PPP. Taking the real price structure of a large group of OECD member countries, Balassa empirically proved a methodical association between prices of non-tradables and per capita income. According to him, there is a positive relationship between per capita income and services prices i.e. lower will be the level of country's per capita income lower will be the prices of services. This notion of Balassa is altogether contradictory to absolute version of PPP according to which exchange rate conversion based upon PPP always yield impartial income comparisons.

Balassa and Samuelson findings brought two revolutionary explorations into the existing literature on international development economics. First one is the incorporation of the role of non-tradables into standard trade models. This mechanism serves as a mile stone in understanding the way long run exchange rate equilibrium is related to relative sectoral prices of a country. The second is the introduction of cross country sectoral productivity growth bias as more powerful and verifiable supply side explanation of why exchange rate diverges from its PPP position in long run. None of these explorations were new, however Balassa and Samuelson were the first one to identify the channels of sectoral productivity differentials as a lucid explanation of why long run exchange rate deviates from PPP. Besides, they revealed the implications of these sectoral productivity differentials for cross country income comparisons and extended strong empirical supports for their proposed idea.

The importance of investigating for more consistent and reliable estimates of productivity bias introduced by Balassa and Samuelson owes to a number of factors. Starting with the external balance of an economy, productivity bias is one of the core sources of explaining imbalances in net trade and current and capital accounts. As a consequence, this affects the long run growth and development of the economy. Similarly, internal balance is hampered when developing economies, in their urge for productivity gains, are least likely to maintain a good balance between their relative traded and non-traded sectors' growth rates. As a consequence, the policy targeted upon productivity gains are usually found to be inconsistent with maintaining moderate inflation rates and exchange rate stability. This dilemma is the key to understanding the long-term trend of real exchange rate, particularly for the developing economies. If this really happens, the catching up policies of transition and developing Asian economies may prove to be adverse rather than advantageous. On the other hand, the BS estimates have major implications for the interpretation of inflation and exchange rate criteria for those regions of the world that are getting increasingly globalized. In the hope of mutually shared regional economic gains, they are opening up their commodity, labour and capital markets for each other, thus getting deep into economic integration.

The Balassa-Samuelson hypothesis is a supply-side explanation of exchange rate appreciation. Taking into account cross-country productivity differentials, bidding up of wages across sectors and appreciation of non-traded sector's prices, are the fundamental actors of the hypothesis which all are determined by real sector of an economy. The basic motivation of this study is to see if BS hypothesis serve as a plausible reason for persistent real exchange rate appreciation in Asian economies. Does it make any difference if we extend the original supply-side orientation of Balassa and Samuelson to include a number of demand-side factors of an economy like per capita income, biased concentration of government spending, diversifying export structure of transition economies, growth in capital demand, changing population demography or altering consumer preferences? Does the BS theory imply that the only explanation for rise in sectoral prices is the rise in wage rates across sectors? Do the transitional processes and structural changes occurring within Asian markets have something to do with non-traded sector price rise in the region? The answers to these questions will give a more comprehensive picture of the long term dynamics of real exchange rate. Thus the consequent framework will be a more generalized version of Balassa-Samuelson theory.

Apart from the theoretical arguments that need to be modified, the empirical literature is weak for the Asian economies. The Balassa-Samuelson hypothesis is less often empirically tested for these countries. Majority of the studies have been undertaken for the OECD member states and the CEE (Central and East European) countries, with a very few exceptions of South East Asian and Latin American states. It is interesting to investigate Asia, as it is getting itself integrated with global economy at a very fast pace. Moreover, in the presence of highly diversified consumer preferences, varying private and public spending patterns, mix of highly skilled and low skilled labour, within region rigorous labour migration, growing value-addition in exports and varying factor endowments and intensities from rest of the world, it is a natural curiosity to investigate the type of empirical evidences we obtain for Balassa-Samuelsson effect. In their transition processes, whether this unprecedented growth in traded sector of Asian economies is a good reason for explaining the real exchange rate misalignment will be the principal focus of the study.

In its simplest form, the BS hypothesis posits the following empirical relationship:

(1) $RER_t = \alpha + \beta \widetilde{A_t} + \varepsilon_t$,

where $\widetilde{A_t}$ = $(a_t^{T*} - a_t^{N*}) - (a_t^T - a_t^N)$ is the cross-sector and cross-country productivity growth differential, and $\beta > 0$.

Equation (1) is my starting point for investigating the determinants of RERs. This chapter estimates the relationship between RER_t and $\widetilde{A_t}$, and then tests to determine if the BS hypothesis can explain long-run deviations of RERs from purchasing power parity for a number of Asian economies. The role of exchange rate in the monetary policy framework for emerging Asian economies is not a new issue, but it remains a hot topic for academic research and debate. Over the last twenty years, East and South Asian Economies have been faced with substantial real exchange rate depreciation against major international currencies, particularly the U.S Dollar. With this in mind, my study will investigate RER behavior for each of the following member states of ASEAN+3 and SAARC territories (more discussion on the selection of these trading partners is given below).

TABLE 1.1
List of ASEAN and SAARC Countries

ASEAN	***North East Asian Dialogue Partners of ASEAN***	***SAARC***
Indonesia	China	Bangladesh
Malaysia	Japan	India
Philippines	Korea	Pakistan
Thailand		Sri Lanka
Singapore		

Estimation of the relationship between RER_t and $\widetilde{A_t}$ is complicated by the time series properties of these variables. I focus on two cases to determine if the simple version of the BS hypothesis above can explain the observed behavior of RERs

Case 1: RER and $\widetilde{\text{A}}$ are both stationary. If RER_t and $\widetilde{A_t}$ are both stationary, then one can estimate a long-run relationship between the RER and productivity differentials as per Equation (1). In this equation, β represents the BS coefficient. Accordingly, I will perform unit root tests for both RER_t and $\widetilde{A_t}$. If both are (trend) stationary, I will estimate the equation below

(2) $$RER_t = \alpha + \beta \widetilde{A_t} + \gamma t + \varepsilon_t ,$$

where a time-trend variable is added to Equation (1) to avoid omitted variable bias caused by other time-varying variables. A test of the BS hypothesis is that β is negative and significant.

Case 2: RER and $\widetilde{\text{A}}$ are both non-stationary but co-integrated. When RER and $\widetilde{A_t}$ are co-integrated, the relationship between *RER* and $\widetilde{A_t}$ can be represented by an Error Correction Model (ECM):

The estimation and testing of a co-integrating relationship can be performed in a single-equation framework (Engle-Granger procedure) or in a VAR framework (Johansen-Juselius procedure). The main advantages of using the Johansen-Juselius approach is that (i) the model does not necessitate the pre-discrimination between dependent and explanatory variables; (ii) it provides a convenient framework for estimating the presence and number of cointegrating relationships; and, most importantly, (iii) it allows direct testing of the statistical significance of key variables.

The Johansen-Juselius model uses a maximum likelihood procedure to simultaneously estimate the following two-equation system:

(3) $$\Delta RER_t = \gamma_1 + \theta_1\left(RER_{t-1} - \alpha_1 - \beta \tilde{A}_{t-1}\right) + \sum_{i=1}^{k} \lambda_{1i} \Delta \tilde{A}_{t-k} + \sum_{i=1}^{k} \mu_{1i} \Delta RER_{t-k} + \nu_{1t} \quad ,$$

(4) $\Delta\tilde{A}_t = \gamma_2 + \theta_2(RER_{t-1} - \alpha_1 - \beta\,\tilde{A}_{t-1}) + \sum_{i=1}^{k}\lambda_{2i}\,\Delta\tilde{A}_{\,t-k} + \sum_{i=1}^{k}\mu_{2i}\,\Delta RER_{t-k} + \nu_{2t}$.

If my unit root tests indicate that both RER_t and $\widetilde{A_t}$ are nonstationary, I will use the Johansen ML procedure to test for cointegration.

If I determine that the series are not cointegrated, that will imply that there does not exist a long-run relationship between RER_t and $\widetilde{A_t}$, and I will take that as evidence against the BS hypothesis. On the other hand, if I conclude that there exists a cointegrating relationship, I will use the framework of Equations (3) and (4) to estimate the long-run relationship between RER_t and $\widetilde{A_t}$. In this case, evidence in favor of the BS hypothesis is given by the following

$-1 < \theta_1 < 0$ and statistically significant,

θ_2 is insignificant, and

β is negative and statistically significant.

Condition (iii) is the essence of the BS hypothesis and states that RERs decreases in the long-run due to increase in the productivity differential between the traded and non-traded sectors. Condition (i) states that short-run deviations from the long-run equilibrium relationship between RER_t and $\widetilde{A_t}$ cause RERs to return to their long-run value. And condition (ii) is consistent with the behaviour that the productivity variable $\widetilde{A_t}$ is unaffected by temporary shocks to RERs. The last condition is necessary to establish that causation in the long-run relationship runs from $\widetilde{A_t}$ to RER_t and not vice versa.

<u>Selection of major trading partners of ASEAN and SAARC countries</u>. Keeping in view geographical immediacy, historic trade relations, complementary composition of economic needs and convergence of economic objectives and agendas, the table below highlights the 12 most prominent ex-regional trading partners of the ASEAN. All of these ASEAN ex-regional trading and dialogue partners share multi-dimensional economic ties with ASEAN member states

undertaking the areas of agriculture, manufacturing, industry, services, energy, defense and security, and livestock.

For this study, I will focus on bilateral RERs between each of the Asian countries and one of three major trading partners: the United States, Japan, and Korea. I choose these three countries because they are the ASEAN region's most prominent major trading partners. This can be well seen from TABLE 1.2. Due to non-availability of data, I have excluded the EU-27 territory, noting, however, that the region plays a highly influential role in commodity trade with the ASEAN.

My empirical strategy is to take each of the twelve countries identified in TABLE 1.1 and estimate the relationship between *RER* and $\tilde{A}$, sequentially using the United States, Japan, and Korea as its respective trading partner. By examining such a large set of relationships, I will be undertaking the most thorough investigation of the BS hypothesis to date. The remainder of the chapter is devoted to individual country analyses. The first country that I examine is Pakistan. I will do this in great detail so that the reader will understand the many steps that are involved in testing the BS hypothesis. Once I have established the protocol, I will then proceed to the other countries, but provide only a summary report of my findings.

TABLE 1.2
ASEAN Ex-Regional Major Trading Partners (% share in Total Trade Volume)

Trading Partners	**1993**	**1997**	**2001**	**2005**	**2006**	**2007**	**2008**	**2009**
EU-27	23.80	21.71	22.60	19.31	19.67	19.79	19.23	18.84
USA	28.51	28.99	25.43	21.20	19.77	18.98	17.19	16.40
Japan	32.63	24.93	23.84	21.19	19.84	18.34	19.79	17.64
Korea	4.99	5.61	6.61	6.60	6.86	6.48	7.22	8.19
Hong Kong	-	6.32	2.31	6.22	6.32	7.23	5.93	7.45
China	3.33	4.98	10.67	15.62	17.17	18.13	18.17	19.54
Australia	3.42	3.16	4.23	4.30	4.46	4.44	4.85	4.81
India	1.09	1.95	2.31	3.16	3.52	3.94	4.50	4.29
Canada	1.32	0.97	1.14	0.82	0.84	1.00	0.99	0.99
New Zealand	0.48	0.45	0.52	0.56	0.55	0.61	0.72	0.58
Pakistan	0.38	0.44	0.29	0.31	0.40	0.43	0.45	0.47
Russia	-	0.43	0.52	0.64	0.54	0.57	0.90	0.74

SOURCE: ASEAN Statistical Year Book (Various Years).

II. COUNTRY STUDY: Pakistan

This section begins by testing the orders of integration of the Pakistan/US real exchange rate and the bilateral sectoral productivity differential series. I will use four unit root tests; the Augmented Dickey-fuller test, the Dickey-Fuller GLS test, the ERS point Optimal test and the KPSS test. It is well known that different tests can produce different results. For this reason, it is a wise idea to see how consistent my results are across tests.

The general form of the Augmented Dickey-Fuller (ADF) test is:

(5) $$\Delta y_t = c + \delta t + \phi y_{t-1} + \sum_{i=1}^{p} \beta_i \Delta y_{t-i} + \varepsilon_t \ ,$$

where c and t are deterministic regressors that allow for either a constant term and a time trend if the series is trend stationary, or a drift term and a quadratic time trend if the series is difference stationary. In addition, lagged differences are added to control for the effects of serial correlation, which can invalidate hypothesis testing.

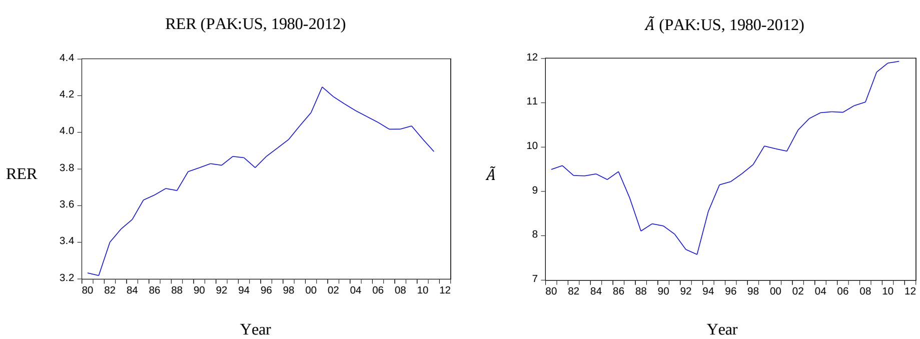
The inclusion of a time trend in the equation has a tradeoff. While it makes allowance for trending behavoiur if the variable is trend stationary, it results in a loss of power in the unit root test if the test is difference stationary. Enders (2010) suggests testing to determine if the time trend belongs in the ADF specification. If the appropriate test indicates that the time trend does not belong in the equatoin, he suggests estimating the ADF specification with just a constant/drift term. Unfortunately, this strategy has problems when used with the software package Eviews. The null hypothesis for the “Intercept only” version of the ADF test in Eviews assumes that the data generating process for the series is a random walk without drift. If the series has a drift term, the resulting critical values produced by Eviews will be invalid.

Accordingly, my strategy is to undertake a visual inspection of a plot of the time series. If the series demonstrates trending behavoiur, I will use the ADF unit root procedure that allows for both intercept and trend. If there is no evident trending behaviour, I will use the "intercept only" specification. When in doubt, I will include the time trend.

Determining the orders of integration for RER and $\tilde{A}$. In this section, I will elaborate my procedure in detail to explain how I determined the order of integration for the two variables. In later country studies, I will summarize the results of my testing, rather than giving full details. I note that all my results can be obtained by running the Eviews programs attached as an Appendix to this chapter.

One of the most popular, informal tests for stationarity is a graphical analysis of the series. A visual plot of the series is usually the first step in the analysis of any time series before pursuing any formal tests. In addition to the reasons given above, preliminary examination of the data is important as it allows the detection of data errors, and helps to identify structural breaks. FIGURE 1 plots the natural log of RER and $\tilde{A}$ against time.

FIGURE 2.1
Plots of RER and $\tilde{A}$ (1980-2012)



It is clear from FIGURE 2.1 that both variables have a positive trend and, as such, initial unit root testing should include both an intercept and a time trend in the testing specification. I also note that the two upward trends are consistent with the BS hypothesis that increases in $\tilde{A}$ contribute to increases in the RER.

The four stationarity tests that are employed in this study are the Augmented Dickey-fuller (ADF) test, the Dickey-Fuller GLS test, the ERS point Optimal test and the KPSS test. The first three have the null hypothesis that a series has a unit root. In contrast, the null hypothesis for the KPSS test is that the series do not have a unit root. My analysis begins with the ADF unit root test procedure.

Following the ADF test specification of Equation (5) (inclusive of an intercept and linear time trend), I can re-write the ADF equation for RER and $\tilde{A}$ as:

(6) $$\Delta RER_t = c_{RER} + \delta_{RER} t + \emptyset_{RER} RER_{t-1} + \sum_{i=1}^{p} \beta_i \, \Delta RER_{t-i} + \varepsilon_t^{RER} ,$$

(7) $$\Delta \tilde{A}_t = c_{\tilde{A}} + \delta_{\tilde{A}} t + \emptyset_{\tilde{A}} \tilde{A}_{t-1} + \sum_{i=1}^{p} \gamma_i \, \Delta \tilde{A}_{t-i} + \varepsilon_t^{\tilde{A}} ,$$

The p lagged differenced terms RER and $\tilde{A}$ are used to "soak up" any serial correlation in the error term that would otherwise invalidate hypothesis testing. Both error terms are assumed to be homoskedastic.

I first report the results of my ADF test, and then explain how I obtained my results. The first three columns of TABLE 2.1 below report (i) the series, (ii) the deterministic regressors, and (iii) the number of lags included in the respective specification. Before proceeding to the unit root tests, I check whether the residuals from the respective ADF equations are serially correlated.

TABLE 2.1
ADF Test Statistics for RER and $\tilde{A}$

Variables	***Deterministic Regressors***	***Lag Length***	***Residuals White Noise?***	***Sample Statistic***	***5% Critical Value***
RER	Intercept + Trend	0	Yes	-0.448	-3.562
$\tilde{A}$	Intercept + Trend	2	Yes	-1.521	-3.574

NOTE: Lag length is determined by automatic selection based on the SIC, subsequently adjusted to produce white noise in the residuals, if necessary.

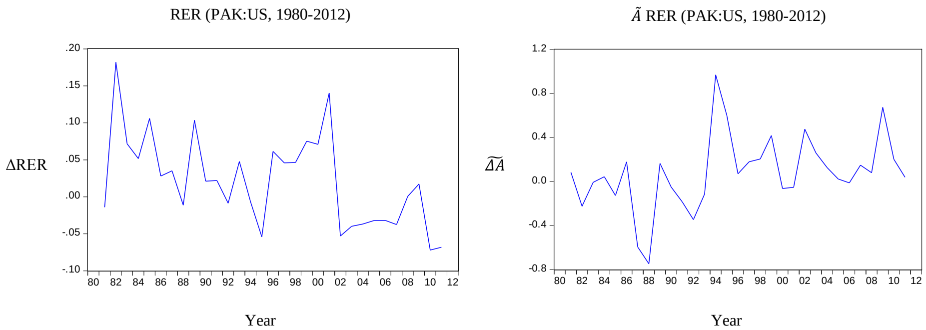
Testing for serial correlation is based on the Ljung-Box Q-statistic. The null hypothesis of the Ljung-Box Q-test is that there is no autocorrelation up to a designated number of lags, which I run from 1 to 10. For the *RER* series, Eviews selects zero lags (*p=0* in $\sum_{i=1}^{p} \beta_i \, \Delta RER_{t-i}$). I find that the resulting residuals are consistent with white noise, with the Ljung-Box Q-test failing to reject the null of no serial correlation for all cumulative lags up to 10. The smallest p-value is 0.412 and occurs at cumulative lag 6.

For the $\tilde{A}$ series, Eviews' SIC selection algorithm also selected zero lags (*p=0* in $\sum_{i=1}^{p} \beta_i \, \Delta\tilde{A}_{t-i}$). However, the resulting residuals showed evidence of serial correlation. Several of the p-values associated with the Ljung-Box Q-test were less than 5%, with the smallest p-value occurring at cumulative lag 7 (p-value = 0.017). I then added lag terms until I was able to produce white noise in the residuals. With two lags (*p=2* in $\sum_{i=1}^{p} \beta_i \, \Delta\tilde{A}_{t-i}$), the Ljung-Box Q-test fails to reject the null of no serial correlation for all cumulative lags up to 10, with the smallest smallest p-value being 0.156 at cumulative lag 7.

I now proceed to the respective ADF tests for unit root. The associated sample statistics and 5% critical values are reported in the last two columns of TABLE 2.1. The sample statistic for the ADF test of *RER* is – 0.448. This is greater than the 5% critical value of -3.562. As a result, I fail to reject the null hypothesis that *RER* has a unit root. Similarly for $\tilde{A}$, the ADF unit root test produces a sample statistic of -1.521, which is greater than the 5% critical value of -3.574. Based on this result, I also fail to reject the null that $\tilde{A}$ has a unit root.

Having determined that both series have unit roots, I next difference the two series and test if the differenced series are non-stationary. The time series plots of the two differenced series are reported in FIGURE 2.2.

FIGURE 2.2
Plots of ΔRER and $\Delta\widetilde{A}$ (1980-2012)



There is some visual evidence of a decreasing trend in ΔRER, and an increasing trend in $\Delta\tilde{A}$. The corresponding ADF specifications for ΔRER_t and $\Delta\widetilde{A_t}$ are thus given by:

(8) $\Delta(\Delta RER_t) = c_{RER} + \delta_{RER}t + \emptyset_{RER}\Delta RER_{t-1} + \sum_{i=1}^{p}\beta_i\,\Delta(\Delta RER_{t-i}) + \varepsilon_t^{RER}$,

(9) $\Delta(\Delta\tilde{A}_t) = c_{\tilde{A}} + \delta_{\tilde{A}}t + \emptyset_{\tilde{A}}\Delta\tilde{A}_{t-1} + \sum_{i=1}^{p}\gamma_i\,\Delta\left(\Delta\tilde{A}_{t-1}\right)\varepsilon_t^{RER} + \varepsilon_t^{\tilde{A}}$.

The results are reported in TABLE 2.2.

TABLE 2.2
ADF Test Statistics for ΔRER and $\Delta\tilde{A}$

Variables	***Deterministic Regressors***	***Lag Length***	***Residuals White Noise?***	***Sample Statistic***	***5% Critical Value***
ΔRER	Intercept + Trend	0	Yes	-5.485	-3.568
$\Delta\tilde{A}$	Intercept + Trend	1	Yes	-4.329	-3.574

NOTE: Lag length is determined by automatic selection based on the SIC, subsequently adjusted to produce white noise in the residuals, if necessary.

As before, I estimate the specifications with lags chosen by Eviews' SIC selection algorithm, and then test the residuals for white noise. For ΔRER, Eviews selects zero lags (*p=0*). Applying the Ljung-Box Q-test to the resulting residuals produces the conclusion that the residuals are white noise. For cumulative lags 1 to 10, the smallest p-value is 0.123 (for cumulative lag 6). Hence, the ΔRER series is pretty clean and does not show evidence of serial correlation.

For $\Delta\tilde{A}$, Eviews selects 5 lags. Using such a large number of lags will make us lose scarce degrees of freedom greatly. As an alternative, I'll start testing the series with 0 lags and will successively add lags until the residuals become white noise.

With 1 lag i.e. (*p=1* in $\sum_{i=1}^{p}\beta_i\,\Delta\tilde{A}_{t-i}$), there remains no more evidence of presence of serial correlation in $\Delta\tilde{A}$ series. . All of the p-values associated with the Ljung-Box Q-test are greater than 5%, with the smallest p-value occurring at cumulative lag 9 (p-value = 0.144). Thus, with one lag, the Ljung-Box Q-test fails to reject the null hypothesis of no serial correlation for all cumulative lags up to 10.

I now run ADF unit root tests for ΔRER and $\Delta\tilde{A}$ with 0 and 1 lags, respectively. The sample statistic for the ADF test of ΔRER is – 5.485. This is smaller than the 5% critical value of -3.568. As a result, I reject the null hypothesis that ΔRER has a unit root. Thus ΔRER is first differenced stationary. Similarly, the ADF unit root test for $\Delta\tilde{A}$ produces a sample statistic of -4.329, which is smaller than the 5% critical value of -3.574. Based on this result, I fail to accept the null that $\Delta\tilde{A}$ has a unit root. Putting all these results together, I conclude, on the basis of the ADF tests, that the level series, RER_t, and $\tilde{A}$, are both I(1).

The Dickey-Fuller Generalized Least Squares (DF-GLS) Unit Root Test. The DF-GLS unit root test is described in Elliot et al., 1996. Like the ADF test, DF-GLS test also follows the null hypothesis of unit root. Following the ADF treatment above, I choose the "Intercept + Trend" specification in the subsequent testing. TABLE 2.3 displays the DF-GLS unit root test results for the RER and $\tilde{A}$ series.

TABLE 2.3
DF-GLS Test Statistics for RER and $\tilde{A}$

Variables	***Deterministic Regressors***	***Lag Length***	***Residuals White Noise?***	***Sample Statistic***	***5% Critical Value***
RER	Intercept + Trend[1]	1	Yes	-1.362	-3.190
$\tilde{A}$	Intercept + Trend	1	Yes	-1.685	-3.190

NOTE: Lag length is determined by automatic selection based on the SIC, subsequently adjusted to produce white noise in the residuals, if necessary.

The sample statistics for the DF-GLS test of RER is – 1.362. This is greater than the 5% critical value of -3.190. As a result, I fail to reject the null hypothesis that RER has a unit root. Similarly

[1] DF-GLS has two specifications. In GLS de-trending the subject series is regressed on a constant and a linear trend and the resultant residual series is used in a standard DF regression. On the other hand, for GLS demeaning, the series is regressed on a drift term only and the resultant residuals series will be used in standard DF regression.

for $\tilde{A}$, the ADF unit root test produces a sample statistic of -1.685, which is greater than its corresponding 5% critical value. Based on this result, I also fail to reject the null that $\tilde{A}$ has a unit root.

Having determined that both series have unit roots, I next difference the two series and test the status of their order of integration.

TABLE 2.4
DF-GLS Test Statistics for ΔRER and $\Delta\tilde{A}$

Variables	*Deterministic Regressors*	*Lag Length*	*Residuals White Noise?*	*Sample Statistic*	*5% Critical Value*
ΔRER	Intercept + Trend	0	Yes	-5.160	-3.190
$\Delta\tilde{A}$	Intercept + Trend	1	Yes	-4.402	-3.190

NOTE: Lag length is determined by automatic selection based on the SIC, subsequently adjusted to produce white noise in the residuals, if necessary.

The sample statistics for the DF-GLS test of ΔRER is – 5.160. This is substantially smaller than the 5% critical value of -3.190. As a result, I reject the null hypothesis that ΔRER has a unit root. Thus *RER* is first differenced stationary. For $\Delta\tilde{A}$, the automatic SIC lag selection procedure picks 5 lags. Based on my experience from the preceding ADF tests, I included only 1 lag for DF-GLS estimation. The DF-GLS unit root test for $\Delta\tilde{A}$ produces a sample statistic of -4.402, which is smaller than the 5% critical value of -3.190. Based on this result, I reject the null that $\Delta\tilde{A}$ has a unit root. Putting all these results together, I conclude, on the basis of the DF-GLS tests, that the level series, *RER* and $\tilde{A}$, are both I(1), the same as my ADF test findings.

Elliott, Rothenberg and Stock (ERS) Point Optimal Test. The ERS point optimal test is described in Elliot et al., 1996. Like the previous tests, the ERS test has the null of a unit root process.

Unlike previous tests, rejection of the null occurs when the sample statistic is smaller, not larger, than the critical value. The test results for *RER* and $\tilde{A}$ are given below.

TABLE 2.5
ERS Point Optimal Test Statistics for RER and $\tilde{A}$

Variables	*Deterministic Regressors*	*Lag Length*	*Residuals White Noise?*	*Sample Statistic*	*5% Critical Value*
RER	Intercept + Trend	0	Yes	57.524	5.720
$\tilde{A}$	Intercept + Trend	0	Yes	50.200	5.720

NOTE: Lag length is determined by automatic selection based on the SIC, subsequently adjusted to produce white noise in the residuals, if necessary.

For *RER*, the sample statistic value of 57.524 is substantially greater than the 5 percent critical value of 5.724. Similarly for $\tilde{A}$, the sample statistic is 50.200, which is greater than its 5 percent critical value. Thus, we are unable to reject our null of unit roots in levels for both RER and $\tilde{A}$. Now let's see, if the two series are difference stationary.

In TABLE 2.6, the sample statistics for ΔRER (7.925) is still greater than its corresponding 5 percent critical value. These results are not in line with our ADF and DF-GLS estimates, thus making us to unable to reject our null once again and indicating the series to be greater than I(1). For $\Delta\tilde{A}$, the sample statistics is 3.21 which is clearly less than its 5% critical value. Thus, for $\Delta\tilde{A}$, we may reject our null hypothesis of unit root and thus conclude that $\tilde{A}$ is I(1).

TABLE 2.6
ERS Point Optimal Test Statistics for ΔRER and $\Delta\tilde{A}$

Variables	***Deterministic Regressors***	***Lag Length***	***Residuals White Noise?***	***Sample Statistic***	***5% Critical Value***
ΔRER	Intercept + Trend	0	Yes	7.925	5.720
$\Delta\tilde{A}$	Intercept + Trend	1	Yes	3.21	5.720

NOTE: Lag length is determined by automatic selection based on the SIC, subsequently adjusted to produce white noise in the residuals, if necessary.

Now let's test RER once again in order to see if the series is stationary when differenced for a second time.

TABLE 2.7
ERS Point Optimal Test Statistics for ΔRER against Successive Differences

Variables	***Deterministic Regressors***	***Lag Length***	***Residuals White Noise?***	***Sample Statistic***	***5% Critical Value***
$\Delta^2(\Delta RER)$	Intercept + Trend	0	Yes	17.89	5.720
$\Delta^3(\Delta RER)$	Intercept + Trend	0	Yes	17.91	5.72

NOTE: Lag length is determined by automatic selection based on the SIC, subsequently adjusted to produce white noise in the residuals, if necessary.

The sample statistics reported against various orders of integration in TABLE 2.7 indicate that *RER* is not stationary even up to the third order of integration. The P-statistic is substantially higher than the 5 percent critical value at all levels of differencing. The ERS Point Optimal test makes it hard to identify the exact order of integration of *RER*, in contrast with previous results using the ADF and DF-GLS unit root tests..

<u>The Kwiatkowski, Phillips, Schmidt and Shin (KPSS) Stationarity Test</u>. The KPSS test is described in Kwiatkowski et al., 1992. Unlike previous tests, the KPSS test has stationarity as the null hypothesis, thus reversing the null and alternative hypotheses. The associated test results are given below.

TABLE 2.8
KPSS Test Statistics for *RER* and $\tilde{A}$

Variables	*Deterministic Regressors*	*Lag Length*	*Residuals White Noise?*	*Sample Statistic*	*5% Critical Value*
RER	NA	NA	Yes	0.166	0.146
$\tilde{A}$	NA	NA	Yes	0.169	0.146

NOTE: There is no option to choose lag length, so we just go with the default settings.

The results obtained for two series are exactly parallel to what we obtained from our ADF and DF-GLS unit root tests. For *RER*, the sample LM-Statistic is. 0.166 which is greater than the 5 percent critical value of 0.146. In this case, greater LM-value means one rejects the null hypothesis. Similarly for $\tilde{A}$, the sample LM-Statistics of 0.169 is greater than the 5% critical value, so that I reject the null of stationary for both RER and $\tilde{A}$. Now let's see, if the two series are difference stationary or not.

The results obtained for the two series are pretty evident. For Δ*RER*, the sample LM-Statistic of 0.074 is now smaller than the 5 percent critical value of 0.146. Thus, I am unable to reject the null hypothesis of stationarity in Δ*RER*, something parallel with our previous unit root results from ADF and DF-GLS tests. For $\tilde{A}$, the sample LM-Statistic is 0.085, which is clearly less than its 5 percent critical value. Hence, I fail to reject the null hypothesis of stationary in first differences for $\Delta\tilde{A}$. So, conclusively, both *RER* and $\tilde{A}$ are integrated of order 1, I(1).

TABLE 2.9
KPSS Test Statistics for ΔRER and $\Delta\tilde{A}$

Variables	*Deterministic Regressors*	*Lag Length*	*Residuals White Noise?*	*Sample Statistic*	*5% Critical Value*
ΔRER	NA	NA	Yes	0.074	0.146
$\Delta\tilde{A}$	NA	NA	Yes	0.085	0.146

NOTE: There is no option to choose lag length, so we just go with the default settings

Summary of unit root test results for RER and $\tilde{A}$. In the previous sections, I tested the orders of integration for *RER* and $\tilde{A}$ by using four different stationarity tests. On employing these four tests, I have well achieved the purpose of checking the robustness and consistency in my unit root tests results. Except for ERS Point Optimal Test findings for *RER*, all the tests are proving *RER* and $\tilde{A}$ to be first difference stationary. So, after a careful evaluation of the statistical evidences obtained from all the tests, I regard the two series to be integrated of order one, I(1).

TABLE 2.10 the results I obtained using the various unit root tests. The last column of the table states my conclusion about the stationary status of *RER* and $\tilde{A}$ for Pakistan.

TABLE 2.10
Summary of Unit Root Test Results for RER and $\tilde{A}$

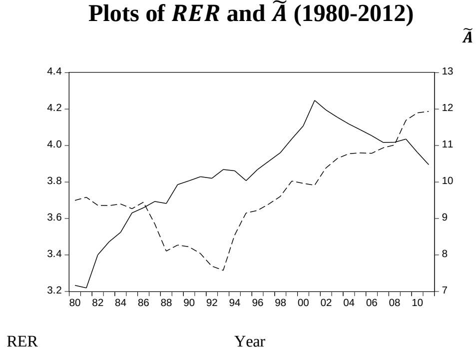
Variable	*Order of integration as determined by:*				*Conclusion*
	ADF	*DF-GLS*	*ERS*	*KPSS*	
RER	I(1)	I(1)	Indeterminate	I(1)	I(1)
$\tilde{A}$	I(1)	I(1)	I(1)	I(1)	I(1)

Identification of the long-run relationship between RER and $\tilde{A}$ against U.S. After obtaining sufficient evidence in favor of RER and $\tilde{A}$ being integrated of order one, I proceed towards establishing whether a long-run cointegrating relationship exists between the two series. Cointegration holds practical economic implications. While time series may be non-stationary in levels, they may move together in the long run. A cointegrating relationship can also be considered as a long term or equilibrium phenomenon where the subject variables diverge from equilibrium in the short-run but maintain an association in the long-run.

There are several ways of identifying a cointegrating relationship between economic series. I use a cointegration test that is embedded within a Vector Error Correction Model (VECM). The test requires several steps.

STEP 1: Graph the suspected cointegrating series. It is clear from FIGURE 2.1 that both RER and $\tilde{A}$ have a definite time trend and both are upward trended. As noted above, this is consistent with the BS hypothesis that an increase in $\tilde{A}$ contributes to RER depreciation and vice versa. FIGURE 2.3 rescales the series and juxtaposes them. The successive divergence and convergence of the two series is consistent with cointegrating behavior, although with a very slow speed of adjustment.

FIGURE 2.3
Plots of RER and $\tilde{A}$ (1980-2012)



STEP 2: Determining the lag length of the VECM specification. Before the cointegration test can be carried out, it is necessary to specify the number of lags that will be used in the associated VECM. To do that, I estimate a VAR model and use information criteria to select the appropriate number of lags. The VECM will use this lag length minus one to account for the fact that it is estimated in differences, not levels. Eviews provides a number of information criteria to assist in the selection of lag length, including the Akaike information criterion (AIC), the Final Prediction Error (FPE) criterion, the Schwarz Information Criterion (SC), and the Hannan-Quinn information criterion (HQ). The results are reported below in TABLE 2.11.

Since RER and $\tilde{A}$ series are taken on annual basis, the lag order selection is done from a maximum of 4 lags in order to ensure good levels of adjustment in the model and for the attainment of well behaved residuals. From TABLE 2.11, we may see that the four selection criteria are unanimous in selecting 1 lag for the VAR model.

TABLE 2.11
Information Criteria Values for Different Lag Lengths
for the Multivariate VAR with RER and $\tilde{A}$

		Information Criterion		
Lag	***FPE***	***AIC***	***SC***	***HQ***
0	0.029	2.160	2.257	2.188
1	0.000*	-2.189*	-1.899*	-2.106*
2	0.000	2.036	-1.552	-1.896
3	0.000	-1.985	-1.308	-1.790
4	0.000	-1.774	-0.903	-1.523

** Indicates lag order selected by the criterion*
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Before proceeding to the identification of cointegrating vectors, I check whether the residuals produced from the proposed VAR model are serially correlated. As I did for the unit root testing, once again I'll use the Ljung-Box Q-statistic to see if the proposed VAR model has any issue of serial correlation. As proposed by two of our lag selection tests, on employing 1 lag in the VAR model, I find that the resulting residuals are not consistent with white noise. The smallest p-value is 0.027 and occurs at cumulative lag 6. So, in order to obtain white noise residuals, I increase the number of lags until I get white noise in the residuals. The smallest p-value with 4 lags is 0.064 and occurs at cumulative lag 8. This is indicative of the fact that we must include 4 lags in our VAR specification. As a result, I will include 3 (= 4 - 1) lags in my subsequent estimation of the VECM.

STEP 3: Deciding the specification of deterministic regressors. After determining the appropriate lag length for my VECM specification, I look into exploring a cointegrating relationship between RER and $\tilde{A}$. As I already have mentioned in the earlier sections of my study, I will employ VAR-based cointegration tests using the methodology developed by Johansen (1991, 1995). The basic advantages of this approach in comparison to Engle-Granger type single equation models is that (i) the model does not necessitate the pre-discrimination between dependent and explanatory variables (ii) it gives a definite solution to the problem of more than one cointegrating vector by identifying the exact number of vectors and generates maximum likelihood estimates of identified vectors. Besides, the approach allows testing the statistical significance of key variables.

The specification of deterministic regressors in the Johansen test is very important. EViews allows the following 5 specifications of deterministic regressors:

Case 1: Assumes no deterministic trend in the data and no intercept or trend in the VAR and in the cointegrating equation (CE)

Case 2: Assumes no deterministic trend in the data, but an intercept in the CE and no intercept in VAR

Case 3: Assumes a linear deterministic trend in the data and an intercept in CE and test VAR

Case 4: Allows for a linear deterministic trend in data, intercept and trend in CE and no trend in VAR

Case 5: allows for a quadratic deterministic trend in data, intercept and trend in CE and linear trend in VAR.

I choose to use the specifications of cases 3 and 4 as the time series plots of the series indicate a time trend.

STEP 4: Testing for the number of cointegrating vectors in the VECM. Eviews uses two tests, the Trace and Maximum Eigenvalue tests, to determine whether the series are cointegrated and, if they are, the number of cointegrating equations that exist.[2] Given two series, there can either be 0, 1, or 2 cointegrating equations. A finding of 0 cointegrating vectors indicates that the series are not cointegrated. A finding of 2 cointegrating vectors indicates that the series are stationary. A finding of 1 cointegrating vector means that the series are non-stationary and cointegrated.

Eviews selects the number of cointegrating equations conditional on the specification of deterministic regressors included in the error correction model (see Cases 1 through 5 above). TABLE 2.12 reports the results of this analysis.

TABLE 2.12: Johansen Cointegration Rank Test Results

Test	***Case 1***	***Case 2***	***Case 3***	***Case 4***	***Case 5***
Trace	0	0	0	0	0
Max Eigen	0	0	0	0	0

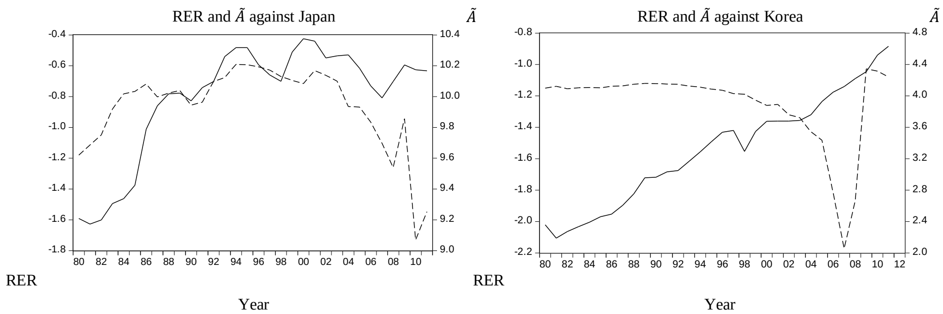
[2] See Johansen and Juselius (1992) for details regarding these two tests.

Based on the time series plots for RER and $\tilde{A}$, I decided that either Case 3 or Case 4 best described the series. As it turns out, it doesn't make a difference which case one chooses, because the Trace and Maximum Eigenvalue tests conclude that the series are not cointegrated. Hence, we cannot proceed with estimation of Vector Error Correction Model (VECM) for RER and $\tilde{A}$ as there is no significant statistical evidence in favor of a cointegrating relationship between two series. I interpret this as evidence against the BS hypothesis.

Identification of the long-run relationship between RER and $\tilde{A}$ against Japan and Korea. TABLE 1.2 above identified that Japan and Korea are also imporant trading partners of ASEAN member states. Following Chinn (2000) and Thomas and King (2008), I next study Pakistan's exchange rate and productivity behavior against (i) Japan and (ii) Korea, respectively. While the U.S is a commonly used benchmark, Japan and Korea may be more appropriate because of their geographical immediacy with the Asian region. This should make traded goods arbitrage between Pakistan and these trading partners more accurate. Once again, I will employ four unit root test procedures in order to determine the order of integration of the RER and $\tilde{A}$ series of Pakistan against Japan and Korea. Afterwards, the Johansen Cointegration test procedure and the Vector Error Correction Model (VECM) will be used to figure out the number of cointegrating vectors, and the long-run elasticities between RER and $\tilde{A}$, if applicable.

I being by plotting time series plots of the respective RER and $\tilde{A}$ series, each calculated with respect to Japan and Korea, rather than the U.S. For the sake of brevity, I only report the juxtaposed series in FIGURE 2.4. This allows one to simultaneously identify trending behaviour, as well as observed any crossings of the series that would indicate cointegration behaviour. By design, the series are plotted so that they intersect at least once. Here, as well as throughout this chapter, the solid line represents the RER series, while the dotted line represents $\tilde{A}$.

FIGURE 2.4
Pakistan's RER and $\tilde{A}$ against Japan and Korea



Unlike in the case with the U.S., the two series do not evidence a generally positive relationship, as one would expect if the BS hypothesis were operative. Nor is there much visual evidence to support an interpretation that deviations from the two series cause RER to adjust towards some equilibrium value. Nevertheless, I proceed with formal testing. The results are reported in TABLE 2.13 below.

TABLE 2.13

Unit Root Tests for PAK:Japan and PAK:Korea

		Against Japan			
Unit Root Tests Results					
		Order of integration as determined by			
Variable	ADF	DF-GLS	ERS	KPSS	Conclusion
RER	I(1)	I(1)	I(1)	I(1)	I(1)
$\tilde{A}$	I(1)	I(1)	Greater than I(1)	I(1)	I(1)
		Against Korea			
Unit Root Tests Results					
		Order of integration as determined by			
Variable	ADF	DF-GLS	ERS	KPSS	Conclusion
RER	I(1)	I(1)	Greater than I(1)	I(0)	Indeterminate
$\tilde{A}$	Greater than I(1)	Greater than I(1)	Greater than I(1)	I(0)	Greater than I(1)

Starting with Japan, results from the four unit root tests[3] show that *RER* is undisputedly integrated of order one , I(1)[4]. I obtain similar results for $\tilde{A}$ as well, except for the findings of the ERS Point Optimal Test. However, considering the evidences from the majority of the tests, I conclude that $\tilde{A}$ is integrated of order one, I(1). Upon finding the two series eligible for developing a cointegrating relationship, I tested them using the Johansen[5] cointegration procedure. As in the previous section, I judged Cases 3 and 4 to be best at describing the subject series. The Trace and Maximum Eigenvalues of both cases indicated a rank of zero, suggesting no cointegrating relationship between RER and $\tilde{A}$. This is the same result I obtained in the previous case using the U.S. Because the series are not cointegrated, there is no long-run relationship between RER and $\tilde{A}$. This supports the previous finding against the BS hypothesis.

Lastly, upon taking Korea as major trading partner of Pakistan, ADF and DF-GLS unit root tests clearly state that country's *RER* against Korea is first difference stationary. In contrast, the ERS point Optimal test provides that the series has an order of integration greater than one; while the KPPS test concludes that the series are I(0). With respect to $\tilde{A}$, none of the four unit root tests[6] find that the series is I(1). Hence the two series are not eligible to be tested for the BS effect because the series cannot be cointegrated.

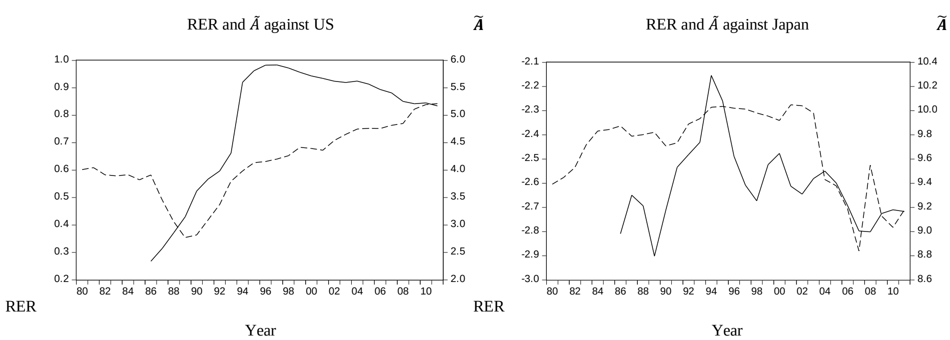
[3] The VAR specification of regression equations of our unit root tests, both for RER and $\tilde{A}$, are robust to serial correlation.
[4] The visual inspection of two series suggests inclusion of both a drift and a linear trend term in unit root regression equations.
[5] Various lag order selection criteria suggested a VAR specification with 2 lags which is robust to serial correlation but not dynamically stable (even up to 6 lags).
[6] The visual inspection of two series suggests inclusion of both a drift and a linear trend term in unit root regression equations.

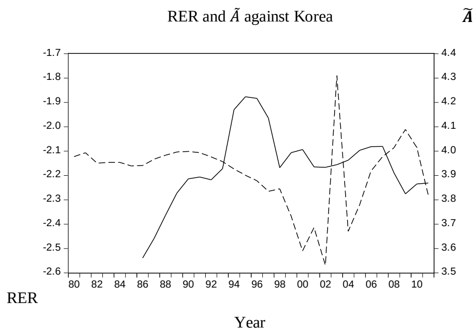
III. COUNTRY STUDY: China

This section begins country-by-country reporting of results associated with testing the BS hypothesis. The previous section on Pakistan provided a detailed report of the the many steps involved in testing the BS hypothesis. The remainder of this chapter gives a much abbreviated report for each country in the interests of brevity, starting with China. However, all of the steps underlying my analysis are included in the EViews programs that are in the Appendix to this chapter.

I begin by displaying time plots of *RER* and $\tilde{A}$, where the exchange rates and productivity differentials successively reference the U.S., Japan, and Korea. I only report one set of figures for each reference country, with the solid line representing RER and the dotted line representing $\tilde{A}$. The left-hand scale reports the values of RER, and the right-hand scale reports the values of $\tilde{A}$. The graphs have been constructed such that the series intersect at least once.

FIGURE 3.1
China's RER and $\tilde{A}$ against its Three Major Trading Partners





Visual evidence consistent with the BS hypothesis is (i) both series trending in the same direction, and (ii) *RER* adjusting to close the gap resulting from productivity differential shocks that drive the series away from long-run equilibrium. The figures above provide weak evidence in favour of the BS hypothesis. For example, the first graph, which uses the U.S. as the reference country, shows both series trending upwards over time, with the *RER* series seemingly moving downwards in the later years to close the gap between the two series. However, the speed of adjustment is very slow.

I proceed with formal testing. First, the RER and $\tilde{A}$ series will be tested though four tests for unit roots. If the two series are concluded to be I(1), I will use the Johansen Cointegration procedure to see if they are capable of establishing a long term cointegrating relationship. Upon finding evidence of a cointegrating equation, I will estimate a Vector Error Correction Model (VECM) to obtain an estimate of the long run BS coefficient. The results of my testing are reported in TABLE 3.1 below.

The table is sectioned into three divisions, displaying China's RER and $\tilde{A}$ relationship against the U.S, Japan and Korea. Against U.S, two out of four unit root tests (the ADF and DF-GLS tests) indicate that China's RER series is I(1). In contrast, the other two tests (the ERS Point Optimal and KPSS tests) indicate an order of integration greater than one. With respect to $\tilde{A}$, most of the tests indicate that this series is I(0). As one of the series is concluded to have a unit root, and the other series is stationary, the two series cannot be cointegrated. This constitutes evidence against the BS hypothesis.

Upon taking Japan as China's major trading partner, we obtain substantially different results from our previous case. At least three out of four tests indicate that both RER and $\tilde{A}$ series of China are first-differenced stationary, I(1), making them eligible to be tested for a long-run cointegrating relationship. However, when I use the Johansen Cointegration Test, I find that the rank of the cointegrating matrix is zero for all five cases. This is evidence that the BS effect doesn't hold for China when that country's major trading partner is Japan.

Lastly, taking Korea as China's major trading partner, for country's RER, I obtain results similar to the first case where China's major trading partner was the U.S. The results from the respective unit root tests are mixed, indicated that the series is level stationary, first-difference stationarity, or more than first-difference stationary. This leaves me uncertain about the actual order of integration of the series. On the contrary, for $\widetilde{A}$, the majority of the tests point to the series being level stationary. Given the different orders of integration for the two series, I terminate my testing for cointegration. On the basis of all my tests, I conclude that the BS hypothesis does not hold for China.

TABLE 3.1
Summary of Test Results for China

Against U.S

Unit Root Tests Results

Order of integration as determined by

Variable	ADF	DF-GLS	ERS	KPSS	Conclusion
RER	I(1)	I(1)	Greater than I(1)	Greater than I(1)	Indeterminate
$\tilde{A}$	I(0)	I(0)	Greater than I(1)	I(0)	I(0)

Against Japan

Unit Root Tests Results

Order of integration as determined by

Variable	ADF	DF-GLS	ERS	KPSS	Conclusion
RER	I(1)	I(1)	I(1)	I(0)	I(1)
$\tilde{A}$	I(1)	I(1)	Greater than I(1)	I(1)	I(1)

Johansen Cointegration Test Results

Test Specifications and No. of Cointegrating Vectors

Test	Case 1	Case 2	Case 3	Case 4	Case 5
Trace	0	0	0	0	0
Max Eigen	0	0	0	0	0

Against Korea

Unit Root Tests Results

Order of integration as determined by

Variable	ADF	DF-GLS	ERS	KPSS	Conclusion
RER	I(1)	I(1)	Greater than I(1)	I(0)	Indeterminate
$\tilde{A}$	I(0)	I(0)	Greater than I(1)	I(0)	I(0)

IV. COUNTRY STUDY: Japan

For Japan, we first inspect the RER and $\tilde{A}$ series visually. Both against the U.S and Korea, the two plots displayed in FIGURE 4.1 indicate that (i) over certain years (though not over all years) RER and $\tilde{A}$ trend in the same direction, and (ii) the RER series shows some evidence of trying to adjust the long run disequilibrium caused by sectoral productivity gaps. On the whole, the visual examination of the behavior of RER and $\tilde{A}$ series provides some evidence in favor of BS hypothesis for Japan. I proceed with testing.

FIGURE 4.1
Japan's RER and $\tilde{A}$ against its Two Major Trading Partners

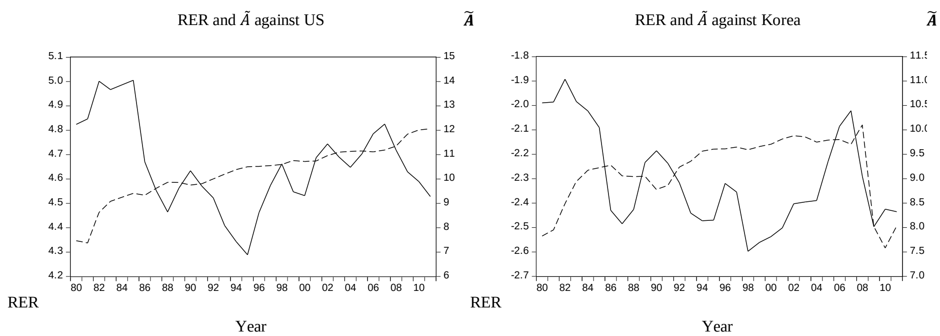


TABLE 4.1 displays the unit root and cointegration tests statistics for Japan against its two trading partners. Against the U.S, we see that all the four unit root test statistics are indicating the *RER* series to be first-difference stationarity. However, for $\tilde{A}$, I obtain a mix of statistical evidences from the four stationarity tests. The results alternatively indicate that $\tilde{A}$ is level stationary, first-difference stationarity, or integrated of order greater than one. Due to the undesirable behavior of $\tilde{A}$, the two series cannot be tested for developing a cointegrating relationship.

Turning now to Korea as Japan's major trading partner, I once again come up with indeterminate results for the two series. The order of integration for *RER* is unclear when focused on Korea as Japan's trading partner. The respective unit root tests give different orders of integration. However, all four tests unanimously indicate $\tilde{A}$ to be integrated of order one, I(1). Thus, similar to the case against U.S, Japan's RER and $\tilde{A}$ against Korea mutually do not statistically qualify to be tested for cointegration. Putting together all the preceding results, I conclude that the BS hypothesis does not hold for Japan.

TABLE 4.1
Summary of Test Results for Japan

			Against U.S		
Unit Root Tests Results					
		Order of integration as determined by			
Variable	ADF	DF-GLS	ERS	KPSS	Conclusion
RER	I(1)	I(1)	I(1)*	I(1)	I(1)
$\tilde{A}$	I(0)	I(1)	Greater than I(1)	I(1)	Indeterminate
			Against Korea		
Unit Root Tests Results					
		Order of integration as determined by			
Variable	ADF	DF-GLS	ERS	KPSS	Conclusion
RER	I(1)	I(1)	I(0)	Greater than I(1)	Indeterminate
$\tilde{A}$	I(1)	I(1)	I(1)*	I(1)	I(1)

V. COUNTRY STUDY: Korea

Firstly, in FIGURE 5.1, the visual examination of RER and $\tilde{A}$ series of Korea against the U.S and Japan shows that (i) Over the entire sample period, RER and $\tilde{A}$ are sharing a common trend, and (ii) the RER series shows considerable evidence of trying to adjust the long run disequilibrium caused by sectoral productivity gaps in case where Korea's major trading partner is Japan. Nevertheless, it is less often against the U.S. On the whole, the visual examination of the behavior of RER and $\tilde{A}$ series provides enough support to test Korea for BS hypothesis.

FIGURE 5.1
Korea's RER and $\tilde{A}$ against its Two Major Trading Partners

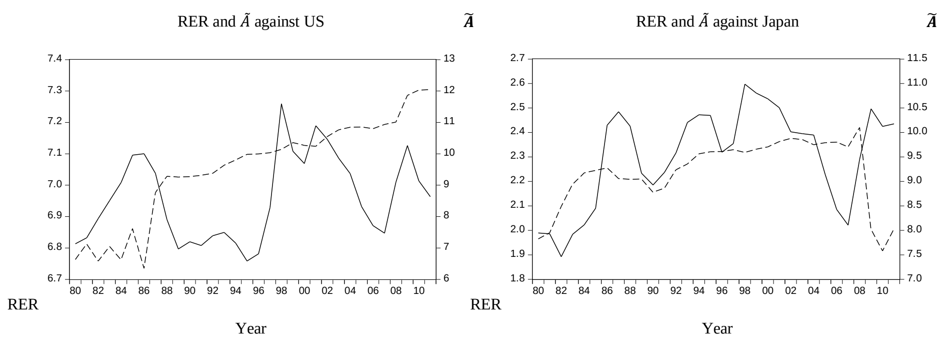


TABLE 5.1 reports Korea's result against U.S and Japan. The order of integration of country's RER against U.S is difficult to determine as ADF and DF-GLS tests are showing the series to be first-difference stationary whereas the other two tests are favoring the series to be stationary in levels. Nevertheless, all the tests are collectively showing country's sectoral productivity differential against U.S. i.e. $\tilde{A}$ to be integrated of order one, I(1). But, being inconclusive about the stationarity status of RER, I cannot proceed further with testing the cointegrating relationship between the two series.

Now coming towards Japan as Korea's largest trading partner, the country's situation is no different from the preceding case. I am once again imprecise about the correct order of integration for RER. So as a consequence, I am unable to test country's RER and $\tilde{A}$ against BS hypothesis. However, all the four tests are mutually displaying $\tilde{A}$ to be differenced stationary. Based upon my statistical findings, I say that Korea is not eligible to be tested for BS effect, both against the U.S and Japan.

TABLE 5.1
Summary of Test Results for Korea

		Against U.S			
Unit Root Tests Results					
		Order of integration as determined by			
Variable	ADF	DF-GLS	ERS	KPSS	Conclusion
RER	I(1)	I(1)	I(0)	I(0)	Indeterminate
$\tilde{A}$	I(1)	I(1)	I(1)	I(0)	I(1)
		Against Japan			
Unit Root Tests Results					
		Order of integration as determined by			
Variable	ADF	DF-GLS	ERS	KPSS	Conclusion
RER	I(1)	I(1)	I(0)	Greater than I(1)	Indeterminate
$\tilde{A}$	I(1)	I(1)	I(1)*	I(1)	I(1)

VI. COUNTRY STUDY: Singapore

Starting with the visual assessment, in FIGURE 6.1 Singapore comes up with even lesser evidence in favor of BS hypothesis in comparison to its earlier discussed regional member economies. Against its three major trading partners, the graphical analysis of RER and $\tilde{A}$ reveals that from the Year 1980-2000, Singapore's RER and $\tilde{A}$ against the U.S are exhibiting opposite trends. But, the two series seem to be following a positive trend since year 2000 onwards. However, against Japan and Korea, RER and $\tilde{A}$ pursue very much common trend over the entire sample period. On the average, the situation is quite convincing for testing the country for BS hypothesis.

FIGURE 6.1
Singapore's RER and $\tilde{A}$ against its Three Major Trading Partners

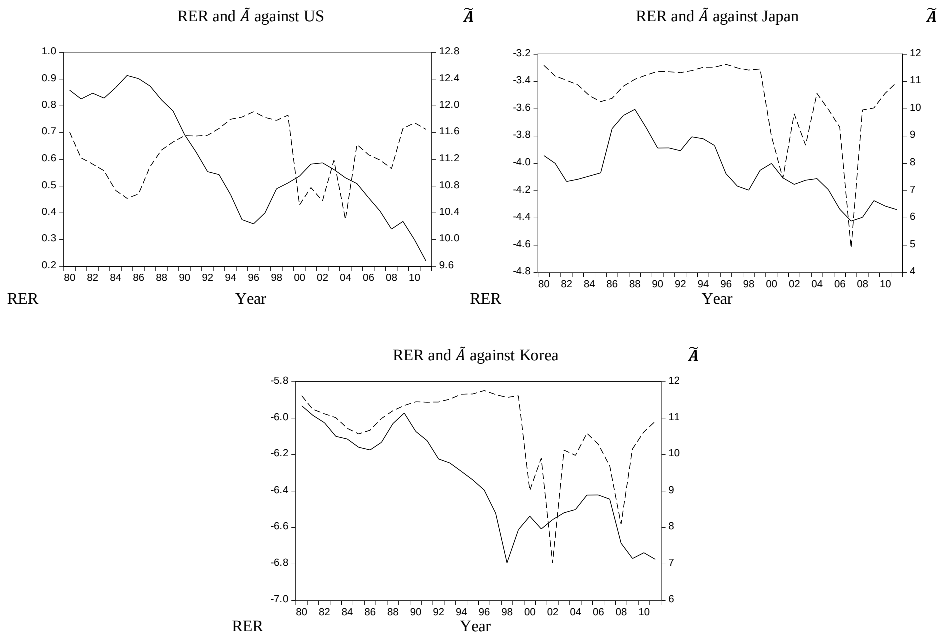


TABLE 6.1 displays Singapore's results against the U.S, Japan and Korea. Against the U.S, it is evident from three out of four unit root tests that Singapore's RER is stationary in levels, a situation not compliant with Cointegration test procedure. For $\tilde{A}$, I am indefinite about the right order of stationarity since I am getting a mix of results from our four unit root tests.

Upon taking Japan as Singapore's major trading partner, I obtain substantially different results from previous case. Though, not all four, but at least three out of four tests are proving both RER and $\tilde{A}$ series of Singapore to be first-difference stationary, I(1). After qualifying to be tested for long run cointegrating relationship with each other, at second stage I test the two series for Johansen Cointegration Test procedure. As anticipated from the visual analysis, I obtain a rank

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of zero against all of Johansen's five cases proving the fact that despite of being first-difference stationary, $\tilde{A}$ have no good tendency of explaining the long run dynamics of Singapore's *RER*.

TABLE 6.1
Summary of Test Results for Singapore

Against U.S

Unit Root Tests Results

			Order of integration as determined by		
Variable	ADF	DF-GLS	ERS	KPSS	Conclusion
RER	Greater than I(1)	I(0)	I(0)	I(0)	I(0)
$\tilde{A}$	I(1)	I(1)	Greater than I(1)	I(0)	Indeterminate

Against Japan

Unit Root Tests Results

			Order of integration as determined by		
Variable	ADF	DF-GLS	ERS	KPSS	Conclusion
RER	I(1)	I(1)	I(1)	I(0)	I(1)
$\tilde{A}$	I(1)	I(1)	I(1)*	I(0)	I(1)

Johansen Cointegration Test Results

			Test Specifications and No. of Cointegrating Vectors		
Test	Case 1	Case 2	Case 3	Case 4	Case 5
Trace	0	0	0	0	0
Max Eigen	0	0	0	0	0

Against Korea

Unit Root Tests Results

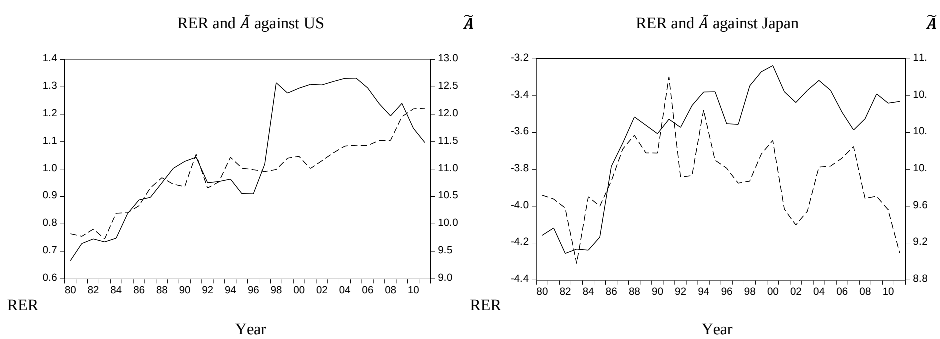
			Order of integration as determined by		
Variable	ADF	DF-GLS	ERS	KPSS	Conclusion
RER	I(1)	I(1)	I(1)*	I(0)	I(1)
$\tilde{A}$	I(1)	I(0)	Greater than I(1)	I(0)	Indeterminate

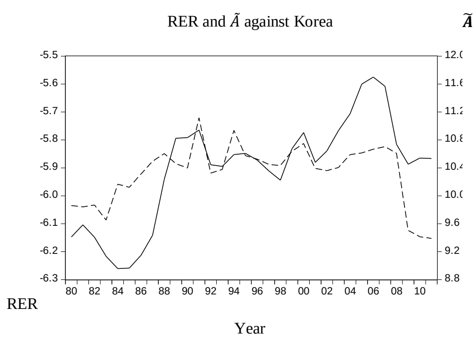
Against Korea, I am once again unable to test country's RER and $\tilde{A}$ for BS hypothesis. Though $RER's$ order of integration is one, I(1), I am indeterminate about the exact level of stationarity of $\tilde{A}$ as I get varying results from the four stationarity tests. Conclusively, BS effect does not hold for Singapore against any of its three largest trading partners.

VII. COUNTRY STUDY: Malaysia

FIGURE 7.1 demonstrates Malaysian RER and $\tilde{A}$ behavior against the U.S, Japan and Korea. The plots provided in the figure represent that (i) the two series are crossing each other quite frequently (from 1980-94 against U.S and Japan and till 2000 against Korea) which is indicative of their good potential of establishing a long run cointegrating relationship with each other, and (ii) throughout the sample period, the two series are following the same common trend, specifically for the case where Malaysia's major trading partner is Korea. These conduct of RER and $\tilde{A}$ are very illuminating in a sense that they signify the possibility of presence of BS effect for Malaysia.

FIGURE 7.1
Malaysia's RER and $\tilde{A}$ against its Three Major Trading Partners





By looking into TABLE 7.1, I can see Malaysia's results against its three trading partners in the context of BS effect. Starting with U.S as Malaysia's largest trading partner, for RER, all the four unit root tests are commonly recommending the series to be first-difference stationary. However, for $\tilde{A}$, I am getting ambiguous results as all the four unit root tests are displaying contradictory results. Due to this uncertainty, Malaysia is not eligible to be tested for BS hypothesis when U.S is country's major trading partner.

Now, when Japan is Malaysia's major trading partner, the statistical evidences obtained from all of four unit root tests show that $\tilde{A}$ is undisputedly integrated of order one , I(1). I obtain pretty same results for RER as well, except for the findings of ERS Point Optimal Test which proves the series with order of integration greater than one. However, taking into consideration the evidences from majority of the tests, I treat RER to be integrated of order one, I(1). Upon finding the two series eligible for developing a cointegrating relationship, I tested them for Johansen cointegration procedure. The Trace and Maximum Eigen values of both cases are suggesting no cointegrating relationship between RER and $\tilde{A}$, yielding a rank of zero. Hence, I cannot proceed with estimation of Vector Error Correction Model (VECM) for RER and $\tilde{A}$ as there is no significant statistical evidence in favor of a cointegrating relationship between two series.

TABLE 7.1
Summary of Test Results for Malaysia

Against U.S

Unit Root Tests Results

		Order of integration as determined by			
Variable	ADF	DF-GLS	ERS	KPSS	Conclusion
RER	I(1)	I(1)	I(1)*	I(0)	I(1)
$\tilde{A}$	I(1)	I(0)	I(1)	I(0)	Indeterminate

Against Japan

Unit Root Tests Results

		Order of integration as determined by			
Variable	ADF	DF-GLS	ERS	KPSS	Conclusion
RER	I(1)	I(1)	I(1)	Greater than I(1)	I(1)
$\tilde{A}$	I(1)	I(1)	I(1)	I(1)	I(1)

Johansen Cointegration Test Results

		Test Specifications and No. of Cointegrating Vectors			
Test	Case 1	Case 2	Case 3	Case 4	Case 5
Trace	0	0	0	0	0
Max Eigen	0	0	0	0	0

Against Korea

Unit Root Tests Results

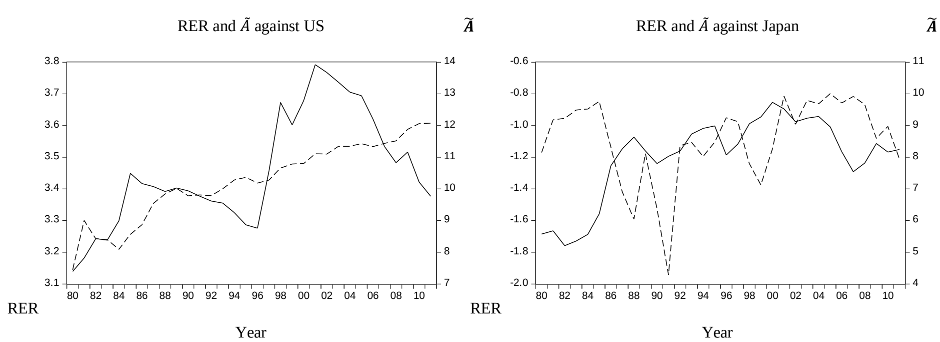
		Order of integration as determined by			
Variable	ADF	DF-GLS	ERS	KPSS	Conclusion
RER	I(1)*	I(1)	I(0)	I(0)	Indeterminate
$\tilde{A}$	I(1)	I(1)	I(1)	I(1)	I(1)

Lastly, taking Korea as Malaysia's major trading partner, for country's RER, I am obtaining a blend of statistical evidences from four stationarity tests, displaying the series to be level stationary as well as first-difference stationarity thus leaving me uncertain about the actual order of integration of the series. On contrary, for $\widetilde{A}$, all of the tests advocate the series to be differenced stationary. Hence, the present situation once again prevents me to test two series for establishing any possible long run cointegrating relationship. Thus, convincingly, like all the prior cases, BS hypothesis does not hold for Malaysia as well.

VIII. COUNTRY STUDY: Thailand

Figure 8.1 contains three plots for Thailand against its major trading partners. From the graphical view, it is very much obvious that (i) except for the U.S, country's RER and $\tilde{A}$ series are crossing each other time and again which makes it plausible that BS hypothesis could hold for Thailand against Japan and Korea, and (ii) Almost for the entire sample period, two series are co-moving in the same direction thus sharing a common trend. These data characteristics provide me with an adequate rationale to proceed with the formal tests of cointegration.

FIGURE 8.1
Thailand's RER and $\widetilde{A}$ against its Three Major Trading Partners



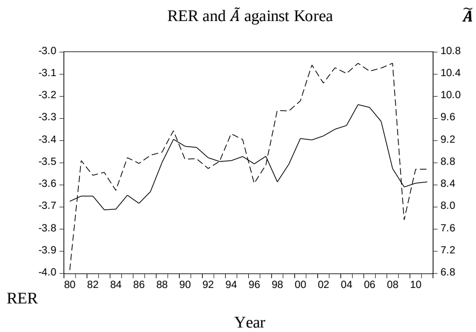


TABLE 8.1 is displaying Thailand's results. When country's largest trading partner is U.S, all of the four unit root tests are collectively showing RER to be first-difference stationary. However, the results for $\tilde{A}$ are altogether contradictory. All the unit root tests are verifying the series to be stationary in levels, something which stops me from testing the country for BS hypothesis.

Against Japan, I obtain substantially good evidence in favor of both RER and $\tilde{A}$ to be integrated of order one. But when I tried to establish a long run cointegrating relationship between the two series, I obtain zero rank against all the five cases of Johansen cointegration test. Hence, despite of being non-stationary in levels, the two series don't cointegrate with each other thus refuting BS hypothesis for Thailand.

, against Korea, similar to all of our previously discussed cases, Thailand RER and $\tilde{A}$ together don't qualify to develop a long run cointegrating relationship. Though I obtain sufficiently strong evidence in favor of RER to be stationary in first-differences, the stationarity status of $\tilde{A}$ is unclear as I am obtaining conflicting results from our unit root tests. In nutshell, BS hypothesis is not validated for Thailand.

TABLE 8.1

Summary of Test Results for Thailand

Against U.S

Unit Root Tests Results

Order of integration as determined by

Variable	ADF	DF-GLS	ERS	KPSS	Conclusion
RER	I(1)	I(1)	I(1)*	I(0)	I(1)
$\tilde{A}$	I(0)	I(0)	I(0)	I(0)	I(0)

Against Japan

Unit Root Tests Results

Order of integration as determined by

Variable	ADF	DF-GLS	ERS	KPSS	Conclusion
RER	I(1)	I(1)	I(1)*	Greater than I(1)	I(1)
$\tilde{A}$	I(1)	I(1)	I(1)	I(0)	I(1)

Johansen Cointegration Test Results

Test Specifications and No. of Cointegrating Vectors

Test	Case 1	Case 2	Case 3	Case 4	Case 5
Trace	0	0	0	0	0
Max Eigen	0	0	0	0	0

Against Korea

Unit Root Tests Results

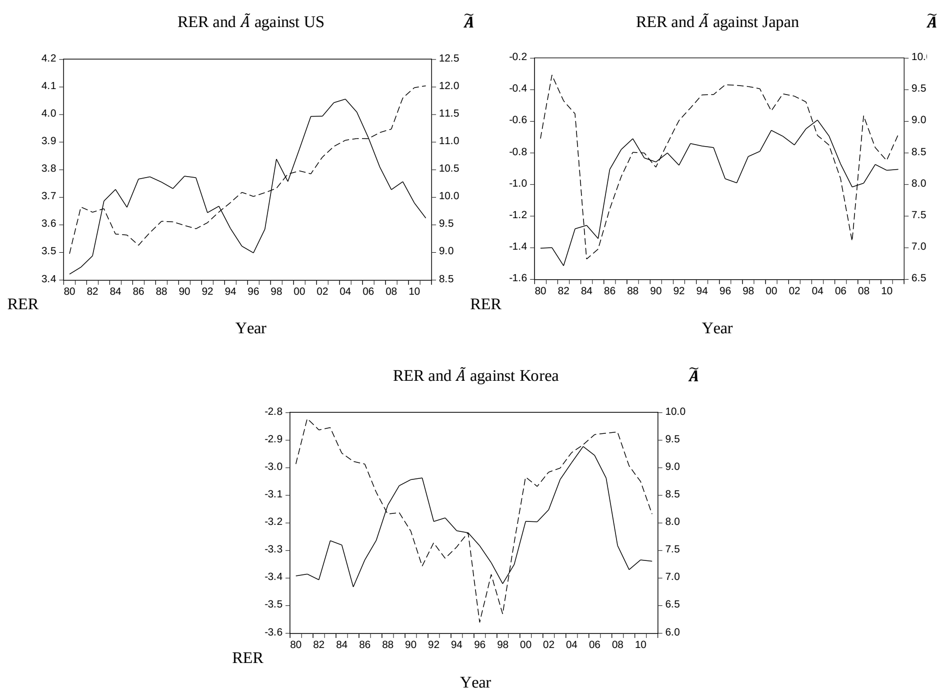
Order of integration as determined by

Variable	ADF	DF-GLS	ERS	KPSS	Conclusion
RER	I(1)	I(1)	I(1)*	I(0)	I(1)
$\tilde{A}$	I(1)	I(1)	Greater than I(1)	I(0)	Indeterminate

IX. COUNTRY STUDY: Philippines

In FIGURE 9.1, from the visual assessment of Philippines, we get substantially lesser evidence in favor of BS hypothesis in comparison to its earlier discussed regional member economies. Despite of the fact that against all the three trading partners of Philippines, RER and $\tilde{A}$ are following a common trend but the less frequent crossing of two series yields relatively weaker evidence in favor of any probable long term cointegrating relationship. However, taking benefit of doubt, I test the country for BS hypothesis.

FIGURE 9.1
Philippines's RER and $\tilde{A}$ against its Three Major Trading Partners



From the results reported in TABLE 9.1, it is hard to decide the exact order of integration of both RER and $\tilde{A}$ against U.S. As I am obtaining a mix of statistics, I am not in a position to say something definite about the actual order of integration of both the series. Hence the two series do not fulfill the pre-requisites of being tested for cointegration.

But against Japan, both RER and $\tilde{A}$ of Philippines are integrated of order one. However, when I tested the two series if they make any long run cointegrating relationship with each other, I obtain a rank of zero representing the fact that despite of being non-stationary in levels the two series are not cointegrating thus failing to explain BS hypothesis for Philippines.

Similar to the case against U.S, Philippines is unable to establish a long run relationship between RER and $\tilde{A}$ against Korea as well because RER is stationary in levels, something in conflict with eligibility for cointegration. Though, it is evident from majority of the unit root tests that $\tilde{A}$ is stationary in first-differences, due to undesirable order of stationarity of *RER*, I cannot proceed with establishing a cointegrating relationship between two series. Thus, similar to its earlier discussed regional economies, Philippines does not seem to hold BS effect against any of its three prominent trading partners.

TABLE 9.1

Summary of Test Results for Philippines

Against U.S

Unit Root Tests Results

	Order of integration as determined by				
Variable	ADF	DF-GLS	ERS	KPSS	Conclusion
RER	I(0)	I(1)	I(1)*	I(0)	Indeterminate
$\tilde{A}$	I(1)	I(1)	Greater than I(1)	Greater than I(1)	Indeterminate

Against Japan

Unit Root Tests Results

	Order of integration as determined by				
Variable	ADF	DF-GLS	ERS	KPSS	Conclusion
RER	I(1)	I(1)	I(1)*	I(1)	I(1)
$\tilde{A}$	I(1)	I(1)	Greater than I(1)	I(1)	I(1)

Johansen Cointegration Test Results

	Test Specifications and No. of Cointegrating Vectors				
Test	Case 1	Case 2	Case 3	Case 4	Case 5
Trace	0	0	2	0	0
Max Eigen	0	0	0	0	0

Against Korea

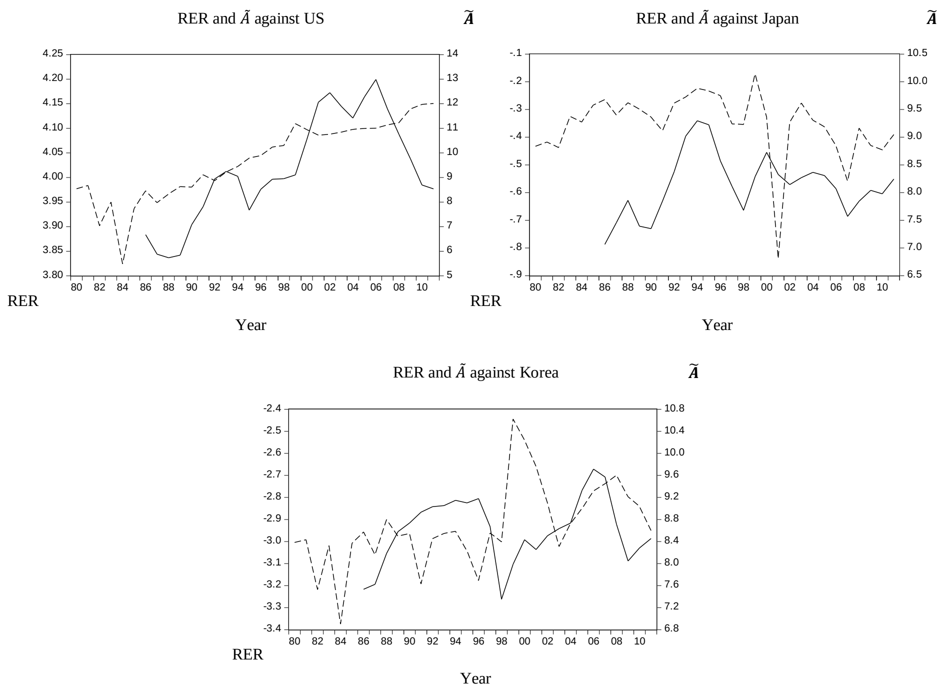
Unit Root Tests Results

	Order of integration as determined by				
Variable	ADF	DF-GLS	ERS	KPSS	Conclusion
RER	I(0)	I(0)	Greater than I(1)	I(0)	I(0)
$\tilde{A}$	I(1)	I(1)	Greater than I(1)	I(1)	I(1)

X. COUNTRY STUDY: Bangladesh

As I already have discussed Pakistan from South Asia, coming towards Bangladesh as another important participant of SAARC agreement, the country's real exchange rate and sectoral productivity gaps with the U.S, Japan and Korea are given in FIGURE 10.1. It is very much visible from the figure that (i) against all the three trading partners, Bangladesh's RER and $\tilde{A}$ are not co-moving in a common direction, and (ii) the two series are rarely crossing each other. Both of these characteristics leave me with little evidence in favor of BS hypothesis. Nevertheless, visual inspection being an inadequate verification, I will test two series for a possible cointegrating relationship, if any exists.

FIGURE 10.1
Bangladesh's RER and $\widetilde{A}$ against its Three Major Trading Partners



In TABLE 10.1, I have given unit root and cointegration tests results for Bangladesh against its largest trading partners. Against U.S, I am unable to test country for BS hypothesis because of disagreeable stationarity orders of RER and $\tilde{A}$. I am unable to determine the correct order of integration of RER because the four unit root tests are providing me with conflicting stationarity levels. On the other hand, majority of the unit root tests are displaying an inclination towards level stationarity when it comes to decide the order of integration of $\tilde{A}$. Hence the two series are not eligible to be used for establishing a long run cointegrating relationship.

Similarly against Japan, once again Bangladesh cannot be tested for BS hypothesis. Though country's *RER* against Japan is first-difference stationary, the country's sectoral productivity differential with Japan i.e. $\tilde{A}$ is stationary in levels, preventing me to employ two series for Johansen Cointegration Test procedure.

Like the preceding two cases, once again, against Korea, I am obtaining disagreeable order of integration for $\tilde{A}$ i.e. the series is level stationary. Though RER is first-difference stationary, we are not in a position to test Bangladesh for BS hypothesis because of undesirable stationarity behavior of $\tilde{A}$. Hence, BS hypothesis fails for Bangladesh as I remained unable to find any log run cointegrating relationship between RER and $\tilde{A}$ against any of country's largest trading partners.

TABLE 10.1

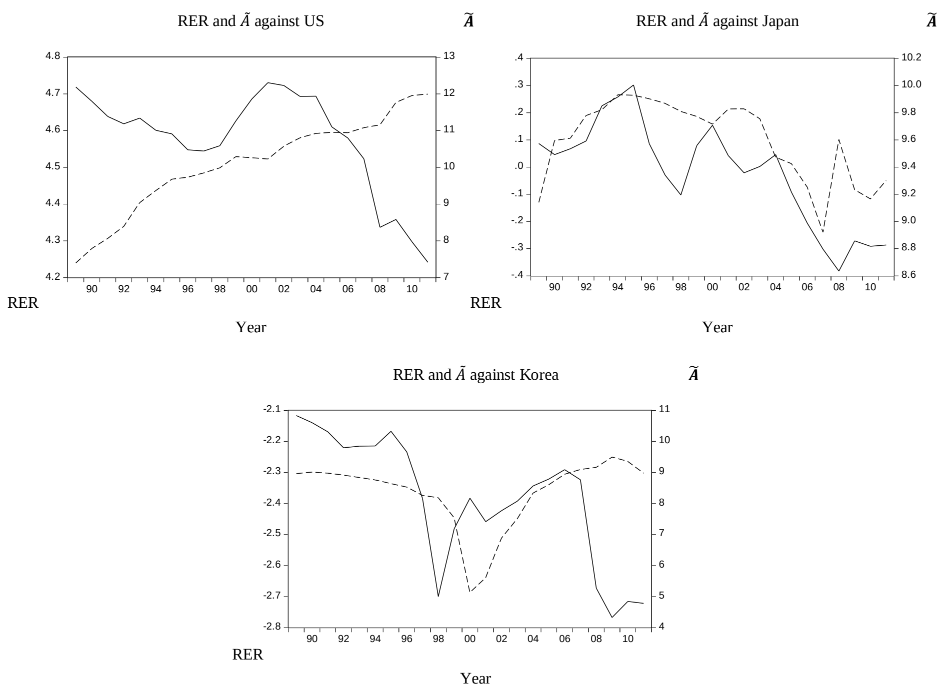
Summary of Test Results for Bangladesh

Unit Root Tests Results			***Against U.S***		
			Order of integration as determined by		
Variable	ADF	DF-GLS	ERS	KPSS	Conclusion
RER	I(1)*	I(1)	Greater than I(1)	I(0)	Indeterminate
$\tilde{A}$	I(0)	I(0)	Greater than I(1)	I(0)	I(0)
Unit Root Tests Results			***Against Japan***		
			Order of integration as determined by		
Variable	ADF	DF-GLS	ERS	KPSS	Conclusion
RER	I(1)	I(1)	I(1)	I(0)	I(1)
$\tilde{A}$	I(0)	I(0)	I(0)	Greater than I(1)	I(0)
Unit Root Tests Results			***Against Korea***		
			Order of integration as determined by		
Variable	ADF	DF-GLS	ERS	KPSS	Conclusion
RER	I(1)	I(1)	I(1)	I(0)	I(1)
$\tilde{A}$	I(0)	I(0)	I(0)	I(0)	I(0)

XI. COUNTRY STUDY: Sri Lanka

From Figure 11.1, the visual examination of RER and $\tilde{A}$ series of country against the U.S, Japan and Korea shows that (i) Over the entire sample period, RER and $\tilde{A}$ are rarely sharing a common trend, and (ii) Against all three trading partners, the RER series does not show any substantial evidence of trying to adjust the long run disequilibrium caused by sectoral productivity gaps as the two series are seldom crossing each over the entire sample period. On the whole, the visual examination of the two series does not give us enough hope that country's *RER* may be affected by BS effect.

FIGURE 11.1
Sri Lanka's RER and $\widetilde{A}$ against its Three Major Trading Partners



The country results are given in TABLE 11.1. Country's RER and $\tilde{A}$ and against U.S are hard to determine, if they are difference stationary or not. This uncertainty is making me indeterminate about the accurate order of integration of two series.

Similar is the situation against Japan. A mix of statistical evidences from four unit root tests are preventing me to say something determinedly about the order of integration of RER and $\tilde{A}$. Hence, I declare the status of two series as indeterminate and thus unable to test them in the context of BS hypothesis for Sri Lanka where country's major trading partner is Japan.

TABLE 11.1

Summary of Test Results for Sri Lanka

Against U.S

Unit Root Tests Results

		Order of integration as determined by			
Variable	ADF	DF-GLS	ERS	KPSS	Conclusion
RER	I(1)	I(1)	Greater than I(1)	I(0)	Indeterminate
$\tilde{A}$	I(1)	I(1)	Greater than I(1)	I(0)	Indeterminate

Against Japan

Unit Root Tests Results

		Order of integration as determined by			
Variable	ADF	DF-GLS	ERS	KPSS	Conclusion
RER	I(1)	I(0)	I(1)	I(0)	Indeterminate
$\tilde{A}$	I(0)	I(0)	Greater than I(1)	I(1)*	Indeterminate

Against Korea

Unit Root Tests Results

		Order of integration as determined by			
Variable	ADF	DF-GLS	ERS	KPSS	Conclusion
RER	I(1)	I(1)	Greater than I(1)	I(0)	Indeterminate
$\tilde{A}$	I(0)	I(1)	I(1)	I(1)*	I(1)

*Note: (i): * is representing significance of sample statistics at 10% level.*
(ii): All the unit root tests' regressions include both a constant and a linear trend term as suggested by visual inspection of RER and $\tilde{A}$ series.
(iii): ADF test specifications are tested for autocorrelation through L-Jung Box Q-statistics.

Against Korea, country's sectoral productivity differential is difference stationary but RER being level stationarity hinders us from testing two series for any possible cointegrating relationship. Therefore, not being able to obtain any good support in favor of BS mechanism, I say that the hypothesis does not hold true for Sri Lanka.