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Another Prospective on Real Exchange Rate and the Traded Goods Prices: Revisiting Balassa–Samuelson Hypothesis

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Abstract: This paper proposes a new variant and reinvestigates the validity of the Balassa–Samuelson (BS) hypothesis for nine East and South Asian countries under new specifications. The BS hypothesis is often criticized for one of its fundamental, but oversimplified assumptions related to Purchasing Power Parity (PPP) holding which can be confirmed for cronss-country tradables' prices, implying nontraded-sector prices are solely responsible for inducing trend deviations in real exchange rate. The assumption, when empirically tested, does not always hold valid, revealing a price difference in tradables for Asian countries against the world (U.S.), a potential driver of their trend in real exchange rate deviations (appreciation). A new approach based on Fully Modified OLS (FMOLS) and Dynamic OLS (DOLS) is used to estimate the long-run BS coefficients, while the error correction mechanism is employed to estimate the short-run estimates. These results motivated us to allow for the inexistence of PPP for cross-country tradables; the standard form of the BS model is then tested in its relaxed form using time-series and panel data econometric tests. Despite a relaxing of the BS model in favor of tradables' price deviation from PPP, the results are not sufficiently supportive of the BS hypothesis. These findings hold strong economic implications for Asia, suggesting that intercountry sectoral productivity bias of regional economies with the world does not necessarily exert substantial effects on their long-run real exchange rates. Additionally, contrary to the core belief of the BS model, intercountry tradables' price differentials are found to substantially explain real exchange rate movements away from their long-run equilibrium.

Keywords: real exchange rate; trade; prices; Balassa–Samuelson hypothesis; purchasing power parity

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1. Introduction

Real exchange rate misalignment from its long-run equilibrium is a much-debated policy issue of international macroeconomics and finance [1]. The term 'misalignment' implies real exchange rate demonstrating a trend departure from its (underlying) long-run ideal or equilibrium level(s), that otherwise would have prevailed in the nonexistence of various factors including inward-looking monetary policy, persistent imbalances in current and capital account, nominal price rigidities, and many others. So far, no consensus is reached on this issue, determining the factors truly responsible for inducing real exchange rates' permanent departure from their long-run equilibrium.

Since the beginning of the transition process in general, and from the time of the eruption of the Asian financial crisis of 1997–1998 in particular, the regional states of East Asia have experienced considerably higher rates of inflation and seen a degree of real exchange rate appreciation. A handful of empirical studies have revealed that the real appreciation of Asian currencies has much to do with the structural shifts occurring in these economies, in their urge to catch up the developed world [2–6]. The idea can be traced back to the phenomenon of the productivity–real exchange rate nexus proposed by [7] and formalized individually by [8,9]. The productivity–real exchange rate nexus, proposed by above authors is known by the name of Balassa–Samuelson (BS) effect.

The Balassa–Samuelson (BS) hypothesis proposes that growing and transition economies tend to bring a higher degree of technological advancements to them [10,11]. Nevertheless, such an advancement is biased towards their traded sector. The nontraded sector remains relatively deprived of technological developments as a result. With the home country being more focused on traded-sector development, the relative growth performance of the intercountry traded sector for the home economy will be more pronounced. Assuming a state of a perfect labor market, the marginal product of labor will improve consequently. This will inflate the traded-sector wage rate at home and the wage-induced inflation will prevail economy-wide, with labor being perfectly mobile across sectors. Assuming Purchasing Power Parity (PPP) for intercountry traded sectors, the sectoral prices tend to demonstrate international arbitrage and therefore converge in international markets. However, no such convergence takes place on the part of nontraded-sector prices, with them being largely driven by domestic market forces. Inflating wage rates will trigger cost–push inflation, with nontradables' prices being a particular prey to this, thus pushing up the general price level of the country. Such a trend inflation in the economy will make the real exchange rate of the home country appreciate against the foreign, causing permanent deviations to the country's PPP from its long-run equilibrium.

One of the biggest criticisms of the BS hypothesis is of its unrealistic underlying assumptions. Many interesting studies have estimated the BS model by relaxing its over idealist assumptions and come up with surprising and unconventional results which they would have acquired otherwise [11]. Ito, et al. [4] while investigating APEC (Asia-Pacific Economic Cooperation) countries over a period of thirty years, reveal that the real exchange rate for regional economies is largely driven by cross-country relative price movements of tradable sectors. Such a finding is in sharp contrast to the BS theory which staunchly believes in the definite existence of PPP for tradable sectors and renders nontraded sectors solely responsible for inducing trend departures to the real exchange rate. This tremendous finding of [4] has proven to be a breakthrough in the current works on the similar line of research; therefore, the validity of PPP for traded-sector prices was investigated for other regions also [6,12–23]. Ref. [21] investigated the underlying causes of deviations in tradables' prices from PPP for ten OECD states and found the consumption of nontraded-sector goods (the distribution sector in particular) as one of the significant contributors to this problem. Such an unavoidable participation of nontradables into the production of tradables bears serious implications for price arbitrage mechanisms of international goods markets.

In the literature, the supply-side explanations of real exchange rate misalignments are less often investigated for Asian countries. The BS hypothesis is certainly the most primitive and authentic notion on the subject; nevertheless, keeping in view the economic transition occurring in East Asia for the last two decades, the model is not revisited for the region with enough criticism [5,24–31]. The present research takes a step forward and offers a novel contribution to existing works on Asia, studying the productivity–real exchange rate nexus from a new perspective. The study is an improvement over [32] work, examining a more liberal and relaxed version of the BS theorem for an extended sample study period. The standard version of the BS theory is econometrically tested in its modified form, permitting the inexistence of PPP for tradables, thus (plausibly) inducing trend departures to the real exchange rate from its long-run equilibrium. The estimable equation for this new variant of the theory is established in a way so that domestic prices of tradables may sufficiently depart away from their foreign (U.S.) counterpart, thus allowing violation of one of the core assumptions of the BS hypothesis, i.e., PPP always holds valid for tradable sectors. Such a scheme of theoretical modelling will not only pave the way to acquiring more realistic estimates of the BS theory, but also unveil the actual contribution of traded-sector prices, which otherwise are always understood as playing a dormant role in driving real exchange rate trend movements.

Such an approach will not only be supportive for obtaining more reliable estimates of the BS effect but will also provide an insight into the role of tradables' prices in determining real exchange rate trend departures from the long-run equilibrium.

The organization of the rest of the paper is as follows: Section 2 of the paper lays down the theoretical framework allowing the inclusion of tradables-based real exchange rate into the conventional BS model with modified OLS versions. Section 3 critically reviews the prior literature and uses the gap in the literature to justify the contribution of this paper. Section 4 presents some econometric models and tests for testing the PPP assumption of traded-sector goods' prices for the selected countries. Section 5 demonstrates the testing procedure of the relaxed version of the BS model and discusses the results of our empirical study. The final section contains some concluding remarks.

2. Theoretical Background of PPP and BS Effects

One of the fundamental beliefs of the BS theory rests on the assumption that intercountry traded-sector prices significantly converge, i.e., PPP holds for tradables. The belief owes to one of the model's underlying assumptions stating that home and foreign traded-sector goods are perfect substitutes; therefore, PPP inevitably holds for the sector. Therefore, the real exchange rate based on tradables' prices (rer^T) tends to equate to one or reach to one. Such a notion holds strong theoretical implications for the dynamic behavior of, i.e., rer^T tends to be mean reverting and any shocks received will be transient and short-lived only. With technology infusion being more pronounced for the traded sector (for transition economies in particular), domestic marginal labor productivity (MP_L) will grow at a faster pace, thus pulling up the wages for the sector. Nevertheless, the inflated wage rate would not affect traded-sector prices, with the sector (strictly) observing PPP with its foreign counterpart. This whole situation reflects on the home economy's real exchange rate which result permanent deviation (appreciation).

To relax this assumption in favor of the nonexistence of PPP in cross-country traded-sector prices, one needs to revisit the standard version of the BS model. The standard (international) version of the theory models the overall real exchange rate of a catching-up economy against its relative sectoral productivity differential with its trading partners(s).

$$rer = -\beta\left\{\left(\gamma/\delta a^T - a^{NT}\right) - \left(\gamma/\delta a^{T*} - a^{NT*}\right)\right\} \quad (1)$$

where γ/δ imply sectoral labor intensity which is assumed to be homogenous across countries; see for detail Ishaq (2016) from where some part of the material is taken.

rer = Overall real exchange rate of catching up (home) country against its (foreign) trading partner. *rer* is a combination (product) of nominal exchange rate (bilateral one) between home and foreign and their relative (overall) prices measured through a value-added-based GDP deflator.

$$RER_t = \frac{E_t P_t^*}{P_t} \quad (2)$$

A logarithmic transformation of the variables' yields:

$$rer_t = e_t + p_t^* - p_t \quad (3)$$

a = Measure of sectoral labor productivity. Labor productivity is proxied through real value-added-based Average Labor Productivity (APL). T, NT = Traded and nontraded sectors, respectively. $*$ = Foreign variables.

However, if PPP does not hold for cross-country tradables, the biased relative productivity of home tradables can cause trend departures in real exchange rates from their long-run equilibrium through both nontraded and traded-sector price movements. In such an event, Equation (1) will be restated as:

$$rer^{NT} = \left(e + p^{T*} - p^T\right) - \beta\left\{\left(\gamma/\delta a^T - a^{NT}\right) - \left(\gamma/\delta a^{T*} - a^{NT*}\right)\right\} \quad (4)$$

p^{T*} and p^{T*} are home and foreign tradable sector prices, measured through their value-added-based GDP deflator.

Equation (4) can be titled as the relaxed version of the BS hypothesis. Starting from the first term on the right-hand side of Equation (4), it reflects the state of PPP existing for cross-country tradables, thus subsiding the effects of relative prices of tradables on the real exchange rate of the catching-up country. The term therefore assumes a value of zero in the instance of valid PPP holding between intercountry tradables. However, if PPP is invalidated, then there are fair chances of tradables' prices to induce trend departures in relative prices of nontradables, so that they may see long-lived deviations from their equilibrium. The valid and significant existence of such behaviors on the part of intercountry tradables' prices holds serious implications for the standard BS proposition, therefore challenging the standard version of the BS model accusing relative prices of nontradables (only) for displacing real exchange rates from their PPP-based long-run equilibrium.

Since the relative prices of intercountry tradables in a common currency $\left(e + p^{T*} - p^{T}\right)$ are fairly comparable to tradable-prices-based real exchange rate (rer^{T}), Equation (4) will become:

$$rer^{NT} = rer^{T} - \beta\left\{\left(\gamma/\delta a^{T} - a^{NT}\right) - \left(\gamma/\delta a^{T*} - a^{NT*}\right)\right\} \quad (5)$$

$$rer^{NT} = rer^{T} - \beta\widetilde{a} \quad (6)$$

where $\widetilde{a} = \left(\gamma/\delta a^{T} - a^{NT}\right) - \left(\gamma/\delta a^{T*} - a^{NT*}\right)$.

The empirical verification of the BS theory is done for Asian countries, but only in a handful of studies. There is a mix of evidence on the productivity–real exchange rate nexus [10] proposed under the BS theorem; therefore, no consensus on this matter has been reached so far. A substantial number of studies find only partial (or even no) empirical support in favor of the BS proposition for developing Asian countries [24,29–31,33]. Their inability to obtain sufficient econometric evidence in support of the BS effect may be owed to the underlying model assumption of PPP for traded-sector goods, which is challenged (empirically) by several non-Asian studies [31,34–37]. Nevertheless, the refutation of PPP assumption (for tradables) does not invalidate the BS mechanism. It only causes the problem of under-specification to the standard version of the BS model [6]. The lack of sufficient convergence between cross-country tradables may cause rer^{T} to depart from its PPP-based long-run equilibrium and therefore may yield deficient BS estimates.

Let us now take a glance through earlier works on this subject to see what amount of evidence can be obtained in favor of the valid existence of long-run PPP for tradables. As evident from earlier works, tradables' prices are found to be volatile, experiencing long-lived deviations. Bilateral nominal exchange rates, unregulated markets, product differentiation, trade barriers, intermarket distances, transportation cost, etc., are those few causes which are investigated empirically for their ability to obstruct convergence in intercountry traded-sector prices, thus preventing PPP to hold in the long-run. For Canada, Germany, Japan, and the U.S., Ref. [34] confirms the inexistence of PPP. Using highly disaggregated sample data, nominal exchange rate fluctuation is found to determine the relative prices of tradables at a high level of statistical significance. Ref. [38] also does not obtain enough statistical evidence in support of the PPP theorem while testing Canada and the U.S., as the traded-sector prices of two countries do not tend to demonstrate an equi-proportionate relationship over longer periods of time. Additionally, Canadian tradables' prices turn out to be highly sensitive towards the nominal exchange rate of the country. Testing Canada for confirming the valid existence of the Law of One Price (LOP), Ref. [37] received no encouraging results and attributed its inexistence towards the real exchange rate (CPI-based) of the country against the U.S. Moreover, physical distance and border restriction are also found to be significant factors behind the failure of LOP for Canada.

The phenomenon of PPP is less often studied for Asia. Ref. [4] work is taken to be the pioneer work for Asia, Western Hemisphere and Oceania countries studying the productivity–real exchange rate nexus under the framework of the Balassa–Samuelson hypothesis. Investigating three regions vis à vis the U.S., for the dominant number of

countries, long-run sustained departures are found in relative traded-sector prices. Ref. [39] explored the PPP phenomenon from a new, different perspective by discrimination between its 'strong' and 'weak' variants. This new perspective of PPP validation has received much popularity and has been tested in many commendable research studies [40–43] Extracted from a similar viewpoint of PPP testing, Ref. [6] investigated the equi-proportionate relationship between home and U.S. tradables' prices for nine emerging Asian countries using error correction representation. Their findings decline the PPP theorem for at least half of the subject countries. Likewise, mixed evidence in favor of PPP is obtained in [44] work examining Asian countries. Nevertheless, some valid empirical support is yielded (only) for PPP in tradables' prices when the restriction homogenous cointegration vectors are imposed in the model.

Overall, there exists a limited amount of empirical evidence for Asia to develop a clear understanding around the subject. Only a handful of studies have examined the effects of internally biased productivity growth trends in favor of tradables and the consequent permanent deviations in intercountry traded-sector prices from their PPP equilibrium levels. This paper deals with testing two distinct but interlinked conditions for investigating the authenticity of the BS effect for emerging Asian countries, (i) validating (invalidating) the existence of long-run PPP for traded-sector prices of sample Asian states against the U.S, and (ii) testing the BS hypothesis when the core assumption of tradables' PPP is relaxed in favor of its nonexistence for those states whose traded-sector prices are evidently found to be deviating from long-run PPP.

3. Literature Review

The empirical verification of the BS theory is carried out for Asian countries, but only by a handful of studies. There is a mix of evidence on the productivity–real exchange rate nexus, proposed under the BS theorem; therefore, no consensus on this matter has been reached so far. A substantial number of studies find only partial (or even no) empirical support in favor of the BS proposition for developing Asian countries [24,29–31,33]. Their inability to obtain sufficient econometric evidence in support of the BS effect may be owed to the underlying model assumption of PPP for traded-sector goods, which is challenged (empirically) by several non-Asian studies [34–38]. Nevertheless, the refutation of the PPP assumption (for tradables) does not invalidate the BS mechanism. It only causes the problem of under-specification to the standard version of the BS model [6]. The lack of sufficient convergence between cross-country tradables may cause rer^T to depart from its PPP-based long-run equilibrium and therefore may yield deficient BS estimates.

Let us now take a glance through earlier works on this subject to see what amount of evidence can be obtained in favor of the valid existence of long-run PPP for tradables. As evident from earlier works, tradables' prices are found to be volatile, experiencing long-lived deviations. Bilateral nominal exchange rates, unregulated markets, product differentiation, trade barriers, intermarket distances, transportation cost, etc., are those few causes which are investigated empirically for their ability to obstruct convergence in intercountry traded-sector prices, thus preventing PPP to hold in the long-run. For Canada, Germany, Japan, and the U.S., Ref. [34] confirms the inexistence of PPP. Using highly disaggregated sample data, nominal exchange rate fluctuations are found to determine the relative prices of tradables at a high level of statistical significance. Ref. [38] also does not obtain a sufficient amount of statistical evidence in support of the PPP theorem while testing Canada and the U.S., as the traded-sector prices of two countries do not tend to demonstrate an equi-proportionate relationship over longer periods of time. Additionally, Canadian tradables' prices turn out to be highly sensitive towards the nominal exchange rate of the country. Testing Canada for confirming the valid existence of the Law of One Price (LOP), Ref. [37] received no encouraging results and attributed its inexistence towards the real exchange rate (CPI-based) of the country against the U.S. Moreover, physical distance and border restriction are also found to be significant factors behind the failure of LOP for Canada. Ref. [45] develop a new open-economy model in which a TFP shock in the tradable

sector weakens the real exchange rate. This behavior in the real exchange rate is explained by lowering the price of intercountry tradables which supersedes the effect of the rising relative price of nontradables. Ref. [11] for OECD member states, strongly negated the idea of a dormant role of intercountry traded-sector prices on relative sectoral productivity growth and revealed that productivity growth in tradables bears depreciating effects on the real exchange rate. Skill-based technological change induces higher productivity in the tradable sector thus lowering wages, which in turn leads to lower prices of nontradables and hence to a depreciation in the real exchange rate. In a recent study conducted by [46] real exchange rate was studied under the New Keynesian framework after having its detailed disaggregation. The real exchange rate was found to be significantly driven in the long run by deviations from the Law of One Price on the part of foreign prices of identical goods relative to the home prices.

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Overall, there exists a limited amount of empirical evidence for Asia to develop a clear understanding around the subject. Only a handful of studies have examined the effects of internally biased productivity growth trends in favor of tradables and the consequent permanent deviations in intercountry traded-sector prices from their PPP equilibrium levels. This paper deals with testing two distinct but interlinked conditions for investigating the authenticity of the BS effect for emerging Asian countries, (i) validating (invalidating) the existence of long-run PPP for traded-sector prices of sample Asian states against the U.S, and (ii) testing the BS hypothesis when the core assumption of tradables' PPP is relaxed in favor of its nonexistence for those states whose traded-sector prices are evidently found to be deviating from long-run PPP through.

4. Econometric Methodology and Model Specifications

Empirical Verification of Purchasing Power Parity Assumption for InterCountry Traded-Sector Prices

The idea of PPP originally stems from the Law of One Price (LOP). The LOP hypothesizes that identical goods, when their national prices are measured in a common currency, should be sold for a common price, while being traded at different geographical locations. Generalizing the phenomenon by aggregating across various intra-sector and inter-sector tradables yields the notion of Purchasing Power Parity (PPP) in tradables, a common basket of goods consisting of tradables (only), traded across borders for a similar price.

Theoretically, for home and international tradables, with dissimilar currencies and different locations of production, and ignoring transaction costs, the law of PPP can be stated as:

$$p_t^T = e_t + p_t^{T*} \tag{7}$$

where e_t is the bilateral nominal exchange rate between home (Asia) and U.S. at time t, and p_t^T and p_t^{T*} are home (Asia) and international (U.S.) tradables' prices.

The operational (estimable) version of the model is given as:

$$p_t^T = \gamma + \theta\left(e_t + p_t^{T*}\right) + \varepsilon_t \quad (8)$$

The validity of the assumption of PPP for tradables is determined through testing Equation (8). The equation is tested for two distinct but interlinked conditions, stated below.

C1. In the long run, home prices of tradables should comove with their foreign counterpart.

The first condition serves as a necessary condition for validating the assumption of PPP. It implies that long-run co-movement amongst intercountry tradables' prices can be taken as evidence in support of PPP. With home country (Asia) being a small open economy, its traded-sector prices may retain their individuality in the short run. However, in the long run, it does not have enough market power to influence foreign prices (U.S.) and hence, will follow the trend movements of U.S. prices. Thus, in the long run, the tradables' prices of the home country are largely determined by foreign prices, thus satisfying the law of tradable' PPP.

The valid long-run co-movement in home and U.S. traded-sector prices is verified using two single-equation cointegration regression estimators: Fully Modified Ordinary Least Squares (FMOLS) and Dynamic Ordinary Least Squares (DOLS). If both estimators produce a statistically significant long-run relationship between the two model variables (p^T and $e + p^{T*}$), this will be taken as strong evidence in support of long-run co-movement ("YES"). If only one of the two estimators supports cointegration, the situation will be concluded as mixed evidence in support of long-run co-movement ("MIXED"). In either case (YES or MIXED), the second model condition (S2) is tested. On the other hand, if both cointegration estimators produce a statistically insignificant long-run relationship, this will be indicative of the fact that two price variables do not have a long-run relationship ("NO"), and hence, no further testing of condition (S2) will be permissible.

C2. Home prices bear a direct and equi-proportionate relationship with their foreign counterpart.

This second condition is tested formally through a Wald coefficient test. The corresponding null and alternative hypotheses are given as follows:

$$Null\ Hypothesis : H_0 :\ \hat{\theta} = 1$$
$$Alternative\ Hypothesis : H_1 :\ \hat{\theta} \neq 1$$

Strong evidence in favor of PPP exists if both cointegration estimation procedures fail to reject the null hypothesis above ("YES"). In this case, the modified version of the BS model is not "permissible." If both cointegration estimation procedures reject the null hypothesis, this will be taken as strong evidence against PPP ("NO"); hence, that estimation of the modified BS model would be permissible. Additionally, if one of the cointegration estimation procedures rejects the null hypothesis, while the other fails to reject it ("MIXED"), this will be taken as sufficient support to warrant estimation of the modified BS model.

5. Results and Discussions

In this section, we describe the important results derived from our empirical study. To begin, let us consider Table 1 which summarizes the conditions above necessary to validate (invalidate) the assumption of PPP for tradables in individual country studies. The last column of the table shows whether the estimation of the modified version of the BS hypothesis is permissible or not under different combinations of S1 and S2. The country estimates for Equation (8) are reported in Table 2. As a prerequisite, the two model time series (p^T and $e + p^{T*}$) are tested for their order of integration, using ADF and DF-GLS unit root tests (for the purpose of brevity, unit root tests' results are not reported. However, the results can be requested from the corresponding author). For each country, the two model conditions (S1 and S2) are tested individually. FMOLS and DOLS estimates with subsequent F-statistics, obtained through a Wald coefficient test, are reported in the second

and third column of Table 2, respectively. A 10 percent significance level is used in testing hypotheses associated with S1 and S2.

Table 1. Summary of conditions to validate (invalidate) the assumption of PPP for tradables.

C1—Establishing Cointegration (FMOLS and DOLS) $p_t^T = \gamma + \theta(e_t + p_t^{T*}) + \varepsilon_t$ H_1: *Cointegration Exists* θ *is Statistically Significant*	**C2—Testing for EquiProportionate Relationship (Wald Coefficient Test)** H_0: $\hat{\theta} = 1$ H_0: **EquiProportionate Relationship between** p^T **and** $e + p^{T*}$	**Is Estimation of Modified BS Model Permissible?**
Yes¯Absolute support for H_1	'YES' absolute support for H_0	No
	'MIXED' support for H_0	Yes
	'NO' support for H_0	Yes
Mixed support for H_1	'YES' absolute support for H_0	No
	'MIXED' support for H_0	Yes
	'NO' support for H_0	Yes
No support for H_1	NA	Yes

Table 2. Results for Testing the Assumption of PPP for Intercountry Tradables.

Country	**S1—Establishing Cointegration Cointegration Regression Estimates**		**S2—Testing for Equiproportionate Relationship F-Statistics from Wald Test**		**Does PPP Hold for Tradables' Prices?**
	FMOLS	**DOLS**	**FMOLS**	**DOLS**	
Indonesia (1976–2018)	1.03 [16.62]	1.00 [15.01]	0.21 (0.65)	0.00 (0.99)	Yes
Japan (1970–2018)	0.04 [0.20]	0.07 [0.30]	-	-	No
Korea (1973–2018)	1.38 [24.95]	1.33 [25.30]	47.84 (0.00)	28.03 (0.00)	No
Malaysia (1981–2018)	1.01 [5.84]	1.02 [5.58]	0.03 (0.97)	0.10 (0.92)	Yes
Pakistan (1973–2018)	0.89 [23.13]	0.86 [24.69]	7.33 (0.01)	15.12 (0.00)	No
Philippines (1971–2018)	1.10 [34.35]	1.06 [34.38]	3.03 (0.00)	2.10 (0.04)	No
Singapore (1970–2018)	1.90 [4.43]	1.72 [3.81]	2.10 (0.04)	1.59 (0.12)	Mixed
Sri Lanka (1980–2018)	1.19 [19.28]	1.09 [14.51]	3.06 (0.00)	1.24 (0.23)	Mixed
Thailand (1971–2018)	1.32 [13.62]	1.24 [12.48]	3.34 (0.00)	2.43 (0.02)	No

t-values are given in square brackets. *p*-values are given in parentheses. Sample statistics of two-unit root tests are tested against the null hypothesis at 5 percent significance level.

Korea, Pakistan, the Philippines, and Thailand are four countries for which the valid existence of PPP with the U.S. can be rejected at high statistical significance (better than 5 percent significance level). For these countries, the traded-sector prices hold a significant cointegration relationship with corresponding U.S. prices, as evidenced from both the FMOLS and DOLS model estimates. Furthermore, when the long-run coefficients from the two cointegration regression estimators are tested for equality with one, the null hypothesis is rejected, pointing to the fact that the coefficient on $(e + p^{T*})$ is significantly different from one. Hence, the tradables' price gap of these countries with the U.S. turns out to be a plausible determinant of their long-run real exchange rate appreciation. The results for Singapore and Sri Lanka produce mixed findings with respect to PPP. The FMOLS and DOLS estimates support the existence of long-run co-movement between home and

U.S. traded-sector prices. However, only the DOLS estimates fail to reject the null of equi-proportional long-run co-movement between home and U.S. prices. The FMOLS estimates reject this null, and thus are evidence against PPP. Indonesia and Malaysia are the only two countries for which strong statistical support in favor of the valid existence of PPP is yielded. Their traded-sector prices are found to co-move with U.S. prices. Furthermore, intercountry tradables' prices show evidence of an equi-proportionate long-run relationship, as the Wald tests fail to reject the hypothesis that the respective coefficients equal one.

Having no statistical basis for including the tradables' price gap for Indonesia and Malaysia against the U.S. in the real exchange rate equation, the study therefore does not employ the modified model to test the BS hypothesis for these two countries. Japan deserves special mention because it is the only country in our sample that fails the test of PPP assumptions at its initial stage (S1). The FMOLS and DOLS test results suggest that that country's traded-sector prices do not converge to U.S. prices. This implies that Japanese prices can retain their individuality in international markets even in the long run. These results are in line with [4] who found sustained departures in Japan's traded-sector prices vis à vis the U.S. This behavior in Japan's tradables' prices makes the country the most ideal candidate to use the modified version of the BS model.

Empirical Verification of the Relaxed Version of Balassa–Samuelson Hypothesis

Nonstationary (trended) time-series data can be a major problem when estimating interrelationship between time-series variables. It is well known that trends, either stochastic or deterministic, may cause spurious regressions, yielding unreliable and inconsistent estimates. However, most macroeconomic time-series are subject to some type of trend. Cointegration analysis, however, allows nonstationary data to be used to make meaningful inferences, so that spurious results are avoided. The estimation and testing of a cointegrating relationship can be performed in a single-equation framework (e.g., Engle–Granger type residual-based framework) or in a multivariate (VAR-based) framework (e.g., Johansen–Juselius Maximum Likelihood procedure). The two types of cointegration models have their own strengths.

The paper empirically evaluates the long-run co-movement between the nontradable sector prices-based real exchange rate $\left(rer^{NT}\right)$ and intercountry sectoral productivity differential $(\widetilde{a})$, under the relaxed version of the BS hypothesis, using two different approaches to cointegration modelling. The use of different tests will reveal the robustness of model estimates across different estimators of cointegration. The estimation strategy comprises of single-equation cointegration estimators (S1 and S2) as well as multivariate cointegration tests (M1 and M2) (the order of integration of model variables is determined through the (i) Augmented Dickey–Fuller (ADF) unit root test, and the (ii) Dickey–Fuller Generalized Least Squares (DF-GLS) unit root test).

- S1. Residual-Based Single-Equation Cointegration Test:

For establishing the long-run association between rer^{NT}, rer^{T} (rer_t^T = deflator-based traded-sector real exchange rate) and $\widetilde{a}$ (intercountry sectoral productivity differential is measured through the average productivity of labor in traded and nontraded sectors, i.e., $\widetilde{a}_t = -\left[\left(a_t^T - a_t^{NT}\right) - \left(a_t^{T*} - a_t^{NT*}\right)\right]$), the residuals obtained through regressing rer^{NT} on rer^{T} and $\widetilde{a}$ must be generated through a stationary process. The Engle-Granger cointegration procedure used for long run relationships [47]. The testing procedure is the augmented version of [48] type static long-run regression models.

$$rer_t^{NT} = \alpha + \hat{\gamma} rer_t^T + \hat{\beta}\,\widetilde{a}_t + \epsilon_t \tag{9}$$

$$\epsilon_t = rer_t^{NT} - \alpha - \hat{\gamma} rer_t^T - \hat{\beta}\,\widetilde{a}_t, \tag{10}$$

ϵ_t represents the residual series obtained from regressing rer^{NT} on rer^{T} and $\widetilde{a}$ using the HAC-OLS estimator.

$$(1.3)' \rightarrow \Delta\epsilon_t = \delta + \varphi\epsilon_{t-1} + \sum_{j=1}^{p} \omega_j \Delta\epsilon_{t-j} + u_t, \tag{11}$$

Under the condition of mean reverting residuals, the estimated statistics for φ in Equation (11) is compared against the test critical values at the 10% significance level. The associated critical values for the t-statistic for $\hat{\varphi}$ are taken from [49].

- S2. Estimating the Error Correction Model (ECM):

A statistically significant error adjustment (correction) parameter is analogous to establishing a valid long-run association between rer^{NT} on rer^{T} and $\widetilde{a}$. A negative and statistically significant EC coefficient implies significant speed of adjustment of model variables, so that short-lived fluctuations of *rer* can be corrected and *rer* may converge to its long-run equilibrium.

$$\Delta rer_t^{NT} = \gamma + \theta\left(rer_t^{NT} - \alpha - \beta_1 rer_t^{T} - \beta_2\,\widetilde{a}_t\right) + \sum_{i=1}^{k}\mu_1\Delta rer_{t-k}^{NT} + \sum_{i=1}^{m}\mu_2\Delta rer_{t-m}^{T} + \sum_{i=1}^{n}\lambda_i\Delta\,\widetilde{a}_{t-n} + \nu_t \quad (12)$$

$EC\,Coefficient = \theta,\ \theta < 0$ and is statistically significant.

Estimating the Long-Run Balassa–Samuelson Coefficient under Single-Equation Cointegration Approach: Having cointegration established between rer_t^{NT} and its determinants, the long-run BS coefficient is obtained through employing two cointegration regression estimators, the Fully Modified Ordinary Least Squares (FMOLS) estimator and the Dynamic Ordinary Least Squares (DOLS) estimator.

S(LR)-A. A positive and statistically significant BS coefficient (β in Equation (11)) is estimated using Fully Modified OLS (FMOLS).

S(LR)-B. A positive and statistically significant BS coefficient (β in Equation (11)) is estimated using Dynamic OLS (DOLS).

M1. Maximum-Likelihood-Based Rank Test of Cointegration: The condition for establishing a cointegrating relationship under this model comes [50–52] ML cointegration procedure. As this is a system of equations, it allows the possibility of more than one cointegrating vector. The existence of valid cointegration is detected using the Trace and Maximum Eigenvalue statistics. Given the rank of the test (r) and the number of model variables (n), the valid cointegration necessitates that $0 \leq r^* < n$. The Trace test tests the null hypothesis of no more than r^* cointegrating vectors against the alternative hypothesis of more than r^* cointegrating vectors. The Maximum Eigenvalue test, on the other hand, tests the null hypothesis of r^* cointegrating vectors against the alternative hypothesis of $r^* + 1$ vectors.

The existence of a valid BS effect also requires $\widetilde{a}$ to be weakly exogenous. For this purpose, the Vector Error Correction (VEC) model is estimated through two equations. The following conditions are required to prove the exogeneity (weak) of $\widetilde{a}$.

M2. Vector Error Correction (VEC) Model and Test for Exogeneity: Similar to the single-equation error correction model, the VEC estimator may entail an error adjustment process, under the system of equation approach. Valid cointegration between rer^{NT} and its determinants requires that the error correction coefficient in the *rer* equation (EC_{rer}) is negative and statistically significant.

$$\Delta rer_t^{NT} = \gamma_1 + \theta_{rer^{NT}}\left(rer_t^{NT} - \alpha_1 - \beta_{11} rer_t^{T} - \beta_{12}\,\widetilde{a}_t\right) + \sum_{i=1}^{k}\mu_{11}\Delta rer_{t-k}^{NT} + \sum_{i=1}^{m}\mu_{12}\Delta rer_{t-m}^{T} + \sum_{i=1}^{n}\lambda_1\Delta\,\widetilde{a}_{t-n} + \nu_{1t} \quad (13)$$

$EC_{rer} = \theta_{rer^{NT}},\ \theta_{rer^{NT}} < 0$ and is statistically significant. This implies that *rer* adjusts to deviations from the long-run equilibrium in *rer* and $\widetilde{a}$.

However, in a multivariate framework, cointegration established through the error correction mechanism necessitates weak exogeneity on the part of the model regressors (Thomas and King, 2008). This calls for imposing a special kind of restriction, i.e., EC coefficient in rer^{T} $(\theta_{rer^{T}})$, and $\widetilde{a}$ $(\theta_{\widetilde{a}})$ equations are statistically insignificant.

$$\Delta rer_t^{T} = \gamma_2 + \theta_{rer^{T}}\left(rer_t^{NT} - \alpha_2 - \beta_{21} rer_t^{T} - \beta_{22}\,\widetilde{a}_t\right) + \sum_{i=1}^{k}\mu_{21}\Delta rer_{t-k}^{NT} + \sum_{i=1}^{m}\mu_{22}\Delta rer_{t-m}^{T} + \sum_{i=1}^{n}\lambda_2\Delta\,\widetilde{a}_{t-n} + \nu_{2t} \quad (14)$$

$$\Delta\widetilde{a}_t = \gamma_3 + \theta_{\widetilde{a}}\left(rer_t^{NT} - \alpha_3 - \beta_{31} rer_t^{T} - \beta_{32}\,\widetilde{a}_t\right) + \sum_{i=1}^{k}\mu_{31}\Delta rer_{t-k}^{NT} + \sum_{i=1}^{m}\mu_{32}\Delta rer_{t-m}^{T} + \sum_{i=1}^{n}\lambda_3\Delta\,\widetilde{a}_{t-n} + \nu_{3t} \quad (15)$$

Given $EC_{rer^T} = \theta_{rer^T}$ and $EC_{\widetilde{a}} = \theta_{\widetilde{a}}$ are statistically insignificant, this implies that rer^T and $\widetilde{a}$ are weakly exogenous, i.e., two model regressors are unaffected by deviations from the long-run equilibrium in rer^{NT}, rer^T, and $\widetilde{a}$.

Estimating the Long-Run Balassa–Samuelson Coefficient under Multivariate Cointegration Approach: A positive and statistically significant BS coefficient in the error correction term under the VEC model validates the BS effect.

Discussing the results of Table 3 obtained from the Engle–Granger (EG)-type single-equation cointegration estimator first (S1), there is no evidence of valid long-run co-movement between the model variables. This implies that the residuals from the test turn out to be nonstationary in levels. The residuals do not display a mean reverting behavior, necessary to establish a valid long-run co-movement in the model variables.

Table 3. Individual Country Analysis Using Single-Equation Cointegration Approach.

Country	Single-Equation Cointegration Approach		LR Coefficients Obtained through Cointegration Regression				Does BS Effect Hold?
	Are EG Test Residuals I(0)?	EC Coefficient	FMOLS		DOLS		
			$\tilde{a}$ = BS Coefficient	rer_def_t	$\tilde{a}$ = BS Coefficient	rer_def_t	
Japan (1970–2018)	No	−0.02 [−0.09]	-	-	-	-	No
Korea (1970–2018)	No	−0.27 [−2.26]	−0.11 [−1.90]	0.63 [2.57]	−0.09 [−1.06]	0.63 [1.49]	No
Pakistan (1973–2018)	No	−0.09 [−1.73]	−0.14 [−0.32]	1.59 [3.46]	2.43 [2.16]	3.67 [3.91]	Mixed
Philippines (1971–2018)	No	−0.20 [−2.04]	0.37 [2.60]	1.03 [3.17]	0.58 [2.46]	1.27 [2.31]	Yes
Singapore (1970–2018)	No	0.05 [1.15]	-	-	-	-	No
Sri Lanka (1981–2018)	No	−0.07 [−0.26]	-	-	-	-	No
Thailand (1971–2018)	No	−0.09 [−1.12]	-	-	-	-	No

ADF and DF-GLS unit root tests indicate that all three model variables are unit root process.

In contrast to the findings acquired through the EG-type cointegration test, there is a mix of evidence in support of (statistically) significant cointegration existing between the model variables, when tested through ECM (S2). For three out of seven subject countries, the test results reveal that significant corrections against short-run errors (misalignments) are being made by the model time series at substantial speed, so that part of the *rer* convergence to its long-run equilibrium levels is achieved by these adjustments. A valid (holding a negative sign) and (statistically) significant error correction coefficient of value −0.27, −0.09, and −0.20 is received against Korea, Pakistan, and the Philippines, respectively. This implies that in each period, movements in *rer* of Korea, Pakistan, and the Philippines, at the speed of 27-, 9-, and 20 percent, respectively, correct the errors in the series, thus making it converge to its equilibrium in the long run. Through ECM, after having valid cointegration established for Korea, Pakistan, and the Philippines, only these countries stand eligible for producing a long-run BS coefficient. Using two cointegration regression estimators (FMOLS and DOLS), only the Philippines (undisputedly) evidences the existence of valid (holding an intuitively correct sign) BS effect, with high statistical significance. The two estimators are yielding coefficient values of 0.37 and 0.58, respectively. As shown by the estimated BS coefficients, rer_def_t is associated with significant and sizeable changes in rer_def_nt. This provides evidence on large and persistent deviations in tradables' prices of the Philippines and the U.S. from the long-run PPP-based equilibrium. These findings are consistent with those of [4,44]. For Pakistan, the evidence is mixed, since only DOLS is

generating a reliable BS effect, yielding a coefficient value of 2.43. For Korea, the estimated long-run relationship is not consistent with the BS hypothesis. Both FMOLS and DOLS estimators produce negative and/or statistically insignificant long-run BS coefficients.

The multivariate cointegration method also yields no substantial support for the existence of the BS hypothesis. Whilst estimating Fisher-Johansen Combined Cointegration estimator and the Vector Error Correction Model (VECM), the specification of deterministic regressors is of vital importance. The model is estimated using the econometric package of EViews allowing five different specifications of deterministic regressors. The paper employs specifications 3 and 4 of the test (here after titled as Case 3 and Case 4) as these allow a reasonable degree of generality in incorporating trending behavior in the data. Case 3 assumes a linear deterministic trend in the data and an intercept in cointegrating equation and test VAR. On the other hand, Case 4 allows for a linear deterministic trend in data, intercept and trend in cointegrating equation and no trend in VAR. For most of the countries, both the Trace statistic and Maximum Eigenvalue statistic (against Cases 3 and 4 (both)) find no existence of valid cointegration vector(s).In every instance, the tests' results in Table 4 indicate a rank of zero, suggesting that the model series are not cointegrated. Nevertheless, for Korea, Pakistan, and Sri Lanka, there is some partial support, favoring cointegration. For both Case 3 and Case 4 of the Johansen test, the Trace statistic indicates the existence of one valid cointegrating vector. This allows the estimation of the VEC model, and therefore for the above-mentioned three economies (only). However, the VEC model does not produce sufficient evidence to support the existence of a BS effect for all three countries. This is because the model precondition is not met, i.e., the test produces a statistically insignificant EC coefficient. This implies that rer_def_nt does not adjust to deviations from the long-run equilibrium with productivity differentials, thus hindering the series from adjusting to restore its long-run equilibrium.

Table 4. Individual Country Analysis Using Multivariate Cointegration Approach.

Country	Multivariate Cointegration Approach		Vector Error Correction Model (VECM)						Does BS Effect Hold?
			Case 3 of VECM			Case 4 of VECM			
	Trace Statistics (Case 3/Case 4)	Max Eigenvalue (Case 3/Case 4)	$EC_{rer\_def\_nt}$	rer_def_t	$\tilde{a}$ (BS Coefficient)	$EC_{rer\_def\_nt}$	rer_def_t	$\tilde{a}$ (BS Coefficient)	
Japan (1970–2018)	0/0	0/0	-	-	-	-	-	-	No
Korea (1970–2018)	1/0	1/0	0.00 [1.20]	66.31 [3.43]	−7.51 [−1.77]	-	-	-	No
Pakistan (1973–2018)	1/1	1/0	−0.00 [−0.33]	10.36 [5.80]	10.76 [5.17]	−0.08 [−1.13]	2.38 [7.18]	1.94 [5.56]	No
Philippines (1971–2018)	0/0	0/0	-	-	-	-	-	-	No
Singapore (1970–2018)	0/0	0/0	-	-	-	-	-	-	No
Sri Lanka (1981–2018)	0/1	0/0	-	-	-	−0.05 [−0.85]	1.09 [2.28]	−1.93 [−4.10]	No
Thailand (1971–2018)	1/0	1/0	−0.02 [−1.50]	6.21 [5.29]	−2.22 [−4.31]	-	-	-	No

For the purpose of establishing the robustness of the results acquired from individual country studies, the real exchange rate (both tradables and nontradables) and intercountry sectoral productivity differential panels are tested against the single equation cointegration test and multivariate cointegration approach. On part of single-equation panel cointegration estimator, Pedroni's (1999) heterogeneous panel cointegration test is employed, allowing cross-sectional interdependence with individual effects. Provided the data panels are unit root in levels, the Pedroni residual-based cointegration test is an extensively used tool to investigate if a long-run cointegration association exists between model variables. For the

multivariate cointegration approach, the Fisher–Johansen combined panel cointegration test is used, comprising of two individual test statistics, i.e., Trace and the Maximum Eigenvalue statistics. The estimation strategy for determining (plausible) cointegration through single-equation cointegration estimators (P1A) and multivariate cointegration testing (P1B and P1C) is given below (The individual panels in pooled data will be tested for their order of integration using (i) Combining p-values Test- Fisher-Type Panel Unit Root Tests including Fisher-ADF Unit Root Test and Fisher-PP unit root test, and (ii) Hadri LM Residual-Based Stationarity Test.).

P1A. Pedroni Residual-Based Single-Equation Cointegration Test: Under the single-equation cointegration approach, the existence/inexistence of cointegration amongst the model panels is determined through [53] seven residual-based tests.

The guideline for establishing a valid cointegration between *rer* and $\widetilde{a}$ is if a majority of the seven tests reject the null hypothesis of no cointegration with appropriate statistical significance. This will be taken as evidence in support of long-run co-movement between *rer* and $\widetilde{a}$.

P1B and P1C. Fisher–Johansen Combined Multivariate Cointegration Test: Like [52] ML cointegration test, the Fisher–Johansen combined cointegration method is also a maximum-likelihood-based cointegration test. The evidence on cointegration is yielded through the rank of the model, tested against (a) the Johansen–Fisher Trace Test, and (b) the Johansen–Fisher Max Eigenvalue Test.

Once cointegration is established (through either of the two or both estimators of cointegration), the long-run Balassa–Samuelson coefficient will be estimated using the following set of cointegration regression estimators.

P2A. A positive and statistically significant BS coefficient, β, established through the Panel Fully Modified OLS (PFMOLS) estimator.

P2B. A positive and statistically significant BS coefficient, β, established through the Panel Dynamic OLS (PDOLS) estimator.

Evidence in favor of or against the existence of a valid BS effect will be concluded as follows:

"YES"

(i) At least two of P1.A, P1.B, and P1.C;
(ii) Both P2.A and P2.B hold valid.

"MIXED"

(i) At least two of P1.A, P1.B, and P1.C;
(ii) P2.A or P2.B (but not both) hold valid.

If any situation other than 'YES' and 'MIXED' occurs, that will be concluded as 'NO'.

With respect to testing PPP for intercountry traded-sector prices, there is mixed evidence in support of equi-proportionate long-run co-movement between home and U.S. tradables' prices. PFMOLS and PDOLS both estimate significant long-run co-movement (cointegration) between home and U.S. traded-sector prices. However, inconsistent results are yielded whilst testing the existence of an equi-proportionate relationship. The test based on PFMOLS suggests a disproportionate long-run relationship between home and foreign prices, whereas the test based on PDOLS fails to reject a one-to-one movement between the two prices. The fact that one of the tests rejects PPP is sufficient to proceed with estimating the modified (panel) BS model.

Table 5 shows the results of unit root testing and Table 6 displays the test results for the Pedroni and Johansen–Fisher panel cointegration tests. All seven statistics associated with the suite of Pedroni cointegration tests consistently failed to reject the null hypothesis of no cointegration between model variables at the 10 percent significance level. Based on the Pedroni tests, I conclude that the series are not cointegrated and thus reject the BS hypothesis for the dataset of nine developing Asian economies. Unlike the Pedroni tests, the Fisher–Johansen panel cointegration tests support the existence of a long-run association between model variables. The Trace and Maximum Eigenvalue statistics of the

two specifications (Case 3 and Case 4) indicate a rank of one, suggesting the existence of one valid cointegrating vector for the estimated model.

Table 5. Summary of Results for Panel Unit Root and Cointegration Tests for Modified Balassa–Samuelson Hypothesis.

Panel Unit Root Test Results (Order of Integration as Determined by)				
Variables	**Fisher-ADF**	**Fisher-PP**	**Hadri**	**Conclusion**
p^T	I(0) ***	I(0) ***	Greater than I(1)	I(0)
$e + p^T$	I(1) ***	I(1) ***	I(1) ***	I(1)
rer_def_nt	I (0) *	I (1) ***	I (1) ***	I (1)
rer_def_t	I (1) ***	I (1) ***	I (1) ***	I(1)
$\widetilde{a}$	I (0) **	I (0) **	Greater than I (1)	I(0)

Testing for Tradables' PPP (t-ratios and *p*-values are given in square brackets and parentheses, respectively.)				
P1. Testing for Cointegration		**P2. Testing for Equiproportionate Relationship** (F-Statistics from Wald Coefficient Test)		**Does PPP Hold for Tradables' Prices?**
PFMOLS	**PDOLS**	**PFMOLS**	**PDOLS**	
1.08	1.01	7.25	0.06	Mixed
[37.73]	[34.49]	(0.01)	(0.80)	

***, **, and * are representing significance of sample statistics at 1%, 5%, and 10% levels, respectively; Hong Kong is omitted from panel estimations.

Table 6. Estimating the Modified Version of the Balassa–Samuelson Hypothesis.

Pedroni Panel Cointegration Test Results							
Common AR Coefficients (Within Dimension)				**Individual AR Coefficients (Between Dimension)**			
Panel v Statistics	**Panel ρ Statistics**	**Panel PP Statistics**	**Panel ADF Statistics**	**Group ρ Statistics**	**Group PP Statistics**	**Group ADF Statistics**	**Does BS Effect Hold?**
−0.13	**1.96**	**2.10**	**1.33**	**2.00**	**1.30**	**0.65**	**No**

Johansen–Fisher Panel Cointegration Test Results (lag selection is done through SIC under panel VAR).		
Case 3: Intercept (no trend) in cointegrating equation and VAR		
Fisher Stat (From Trace Stat)	Fisher Stat (From Max Eigenvalue)	Does BS Effect Hold?
1	1	See below
Case 4: Intercept and trend in cointegrating equation—no trend in VAR		
1	1	See below

Pedroni panel cointegration is a test for null of no cointegration in both homogenous and heterogeneous panels. The test statistics are standardized and asymptotically normally distributed. See Pedroni (1995, 1999) for further details.

Having established the possibility of cointegration from the Fisher–Johansen panel cointegration test results in Table 7, it is legitimate to estimate the long-run relationship between rer_def_nt, on the one hand, and rer_def_t and $\widetilde{a}$, using the panel FMOLS (PFMOLS) and panel DOLS (PDOLS) single-equation cointegration regression estimators. Both panel estimators yield a negative and statistically significant long-run BS coefficient. This is inconsistent with the prediction of the BS hypothesis. Thus, allowing for the divergence of tradables' prices from PPP does not bring us any closer to finding support for the BS hypothesis. As a result, strong evidence against the BS hypothesis is concluded from the above set of estimations. Finally, in the context of long-run PPP between intercountry tradables' prices, the long-run elasticities produced by the PFMOLS and PDOLS estimators suggest a significant contribution of rer_def_t to the deviations in rer_def_nt from its long-run equilibrium. Thus, the lack of PPP between home and U.S. tradables generates trend departures in the home country's real exchange rate.

These results are consistent with previous results regarding violation of the assumption of tradables' PPP built into the classical formulation of the BS hypothesis [4,6,44].

Table 7. Estimating the Long-Run Cointegrating Vectors for the Modified Balassa–Samuelson Hypothesis.

Results for Panel FMOLS and DOLS (Lead = Lag = 1) Estimators			
Estimator	**Long-Run Coefficient (t-Values Are Given in Square Brackets)**		**Does BS Effect Hold?**
PFMOLS	rer_def_t	$\widetilde{a} = BS\ Coefficient$	No
	0.30	−0.13	
	[2.70]	[−2.87]	
PDOLS	0.27	−0.12	No
	[1.88]	[−2.24]	

6. Concluding Remarks

This paper conducted a careful examination of the famous productivity-based approach towards trend movements in real exchange rate, the Balassa–Samuelson (BS) effect. Many challenges are associated with the measurement of model variables, overshadowing the reliability of estimates from earlier empirical works on the BS model. This study, however, paid special attention to: (a) data inconsistencies that arise over time, across countries and across alternative measures of output and prices at the sectoral level; and (b) division of the real economy into traded and nontraded sectors, aspects which often have been overlooked in the earlier empirical studies investigating the BS hypothesis.

The model was re-examined from a new perspective, using a modified version of the theory. The hypothesis is often criticized for one of its underlying but highly idealistic assumptions: assuming Purchasing Power Parity (PPP) holding for tradables' prices across countries. The plausible inexistence of PPP amongst cross-country tradables was tested empirically, using FMOLS and DOLS cointegration regression estimators, allowing for the failure of the Law of One Price (LOP) to hold in the long run. For Japan, Korea, Pakistan, the Philippines, and Thailand, the results rejected any possible existence of PPP with the U.S., suggesting that the tradables' price gap of these countries with the U.S. can be a plausible determinant of their long-run real exchange rate appreciation. Singapore, Hong Kong, and Sri Lanka, however, yielded mixed results. Indonesia and Malaysia were the only two countries generating strong support for PPP, their traded-sector prices being significantly co-moving with their U.S. counterparts. Furthermore, their prices showed evidence of an equi-proportionate long-run relationship with those of the U.S., indicating the presence of PPP in its absolute version. Having established the inexistence of PPP (to a large extent) for tradables, the assumption was relaxed, and the BS model was empirically tested in its relaxed version using a variety of time-series and panel data econometric tests. In addition to the intercountry sectoral productivity differential, tradables' prices of home and the U.S. were set free to deviate from their PPP equilibrium, displaying a potential of inducing trend movements in the nontradable-prices-based real exchange rate of home economies. Nevertheless, this effort proved fruitless. Allowing for the divergence of tradables' prices from PPP did not bring us any closer to finding substantial support for the BS hypothesis. Of all the countries, only Pakistan and the Philippines showed any evidence of a valid BS effect, although even here the evidence was mixed, with supporting evidence coming only from the single equation cointegration models. To evaluate the consistency of estimates acquired through time-series estimators, pooled data econometric tests of Panel FMOLS (PFMOLS) and Panel DOLS (PDOLS) were also employed. The estimates from the pooled data analysis strongly reject the modified version of the BS model. The panel estimators yielded a negative and statistically significant long-run BS coefficient. This is inconsistent with the theoretical prediction of the BS hypothesis, which therefore can be interpreted as strong evidence against the reliable existence of the BS hypothesis. Finally, in the context of long-run PPP between intercountry tradables' prices, the long-run elasticities produced by the PFMOLS and PDOLS estimators suggest a significant contribution of traded-sector prices to the deviations in real exchange rate from its long-run equilibrium, based on nontradables' prices. Thus, the lack of PPP between home and U.S. tradables was found to significantly induce trend departures in the home country's real exchange rate.

These findings hold strong economic implications for Asia, suggesting the fact that intercountry sectoral productivity bias of regional economies with the world does not necessarily impart substantial effects on their long-run real exchange rates. Additionally, contrary to the core belief of the BS model, intercountry tradables' price differentials were found to substantially explain real exchange rate movements away from the long-run equilibrium.

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