Revisiting the Prebisch-Singer hypothesis in the era of globalization*

Ismay Jahan [i]

Noakhali Science and Technology University

S. M. Woahid Murad [ii]

Noakhali Science and Technology University

Md. Sabbir Hossain [iii]

Noakhali Science and Technology University

Abstract

This study revisits the validity of the Prebisch-Singer hypothesis in the era of globalization using monthly data from 1986M1 to 2019M7. To identify the trend and different stationary processes, we have estimated the linear unit root test of Elliott, Rothenberg, and Stock (1996), the nonlinear unit root test of Kapetanios, Shin and Shell (2003) and, finally, the LM unit root test of Lee and Strazicich (2003) which considers two structural breaks. Out of twenty-four primary commodities, thirteen commodities are trendless while nine of the remaining have a negative trend, and the remaining two have a positive trend. Furthermore, most of the food items follow a trend stationary process implying a temporary effect of shocks. On the other hand, most non-food and metal commodities follow a different stationary process, indicating that shocks' effect is permanent. Finally, these ambiguous findings hardly support the Prebisch-Singer hypothesis and conclude that this hypothesis could not be a generally accepted phenomenon in the globalized era.

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i) Postgraduate Student, Department of Economics, Noakhali Science and Technology University, Noakhali-3814, Bangladesh

ii) Corresponding author. Assistant Professor, Department of Economics, Noakhali Science and Technology University, Noakhali-3814, Bangladesh. Email: w.murad@nstu.edu.bd

iii) Assistant Professor, Department of Economics, Noakhali Science and Technology University, Noakhali-3814, Bangladesh

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1 Introduction

Classical economists relied on the notion that the long-run trend of primary commodity prices should be positive.[1] The availability of cultivable land restricts the supply of primary commodities. In contrast, the supply of manufactured goods depends on resource endowment and technological progress. According to their thought, these are the reason behind such a positive trend (Bleaney and Greenaway, 1993; Bahmani-Oskooee et al., 2017). According to the classical view, the symbol of such a positive movement is indicated in the nineteenth century, while the twentieth century gives the opposite direction of the relative price of primary commodities in the long-run (Prebisch, 1950; Singer, 1950; Sarker, 1986). Unlike the classical economists, Prebisch (1950) and Singer (1950) ruled out the view of a positive trend of primary commodity prices. According to the Prebisch-Singer hypothesis, prices of these commodities are decreasing rather than increasing in the long-run.

Consequently, the commodity terms of trade of underdeveloped countries deteriorate when they trade with developed countries. The presumption behind such deterioration is that the exports of underdeveloped countries mostly relied on primary commodities while the exports of developed countries comprise mainly manufactured commodities. The phenomenon of declining commodity terms of trade is familiar as the Prebisch-Singer hypothesis (henceforth, PSH). Since the 1950s, the PSH profoundly influenced trade policy and advocated export diversification and import substitution policies for underdeveloped and developing countries. For instance, according to the UK's exports covering 1870 to 1940, Prebisch (1950) found secular deterioration of the terms of trade of the primary commodities against the manufactured goods. Consequently, manufactured goods exporters gained more than the

[1] See Smith (1776: 173-206) and Mill (1848: 217-18) for details.

primary commodity exporters (Singer, 1991). Such deterioration could worsen the development progress of developing countries. This contradiction generated debate because it has a principal contribution to policy issues for developing countries (Bleaney and Greenaway, 1993). However, the PSH did not focus on the value of the trade but the gains from trade (Lutz, 1999a).

Though there is a declining trend in commodity prices since the 1980s, primary commodities remain the principal source of export earnings of developing nations in the age of globalization. This performance is also encouraged by the World Bank (Reinhart and Wickham, 1994; Ghosray, 2011).[2] Primary commodity is a crucial issue in international trade since about one-fourth of the world trade is based on primary commodities (Cashin and Pattillo, 2000). Hence any fluctuations in these commodity prices could lead a country to face severe trading problems in the world market. It is quite challenging to forecast the movement of any future structural shift. It is also not easy to know how commodity prices adopt such unpredictable fluctuations (Cashin and McDermott, 2002). Thus, it seems complicated for developing countries to intervene in primary commodity markets and anticipate what policies should be pursued to promote export earnings (Balagtas and Holt, 2009). In this study, we attempt to identify whether the hypothesis of the secular declining trend of primary commodities prices is valid in the age of globalization.[3]

The outline of this study is as follows: after introducing issues in section 1, section 2 covers the literature survey, while section 3 demonstrates model specification, description of data, and methodologies employed in this study. The empirical findings are reported in section 4, and finally, conclusions and policy recommendations are provided in section 5.

2 Literature Review

The PSH leads development economists to concentrate on the outcome

[2] Commodity price measures the non-fuel commodity price index drained by the manufactured price index of industrial countries provided by IMF.

[3] Economic globalization means increase of economic integration as well as interdependence among countries.

of a secular deterioration in primary commodity prices and to examine the distribution of the gains from trade. Lewis (1954) argued that the labor supply is abundant in the least developed countries. The earnings of workers in the traditional sectors remain at the subsistence level. Due to the trendless real wages, the price series of primary commodities do not exceed the production costs in the long-run.

Sarker and Singer (1991) found a declining trend in both exporting manufactured and primary commodity unit values. The declining rate in the unit values of primary commodities is less than half of the declining rate in the unit values of manufactured commodities. They strongly suggest in their analysis that the actual essence of the PSH is the loss of productivity gains that applies in both sides, i.e., primary commodities - manufactures and manufactures - manufactures, trade rather than barter terms of trade movement. Powell (1991) focused on the long-run relationship between the commodity price index and manufactured goods unit values and took into account the impact of this long-run relationship on the terms of trade of developing countries. He considered three negative shifts (1921, 1938, and 1975) that occurred after a higher growth in commodity prices than in manufactured goods prices. The author concluded that the non-oil commodity price index (COM) and manufactured unit value index (MUV) are not cointegrated. However, there is a long-run relationship between the commodity price index and the manufactured unit value index with either trend or breaks. Likewise, Bleaney and Greenaway (1993) updated the series given by Grilli and Yang to 1991 and extended the discussion of the relative price of primary commodities and drew some policy conclusions for the terms of trade of less developed countries. Considering different classes of primary products as a complete basket of primary products, they found a statistically significant downward trend for the relative price of primary products in terms of manufactured goods in the long-run. Considering structural breaks, Helg (1991) also found results for both difference and trend stationary that provide an indication in favor of the PSH that is a decline in the relative price of primary commodities.

Cuddington and Urzua (1989) reinvestigated the precision of the PSH using the Grilli-Yang series of price index, paying concern to the existence of structural breaks. They observed no structural breaks apart from one break in 1920 and found no persistent downward trend in the primary commodity prices. Specifically, about thirty-nine percent of average shock was permanent. In comparison, sixty-one percent was transitory, and the impact of such shock neutralized within three years if further shocks did not occur. Cuddington (1992) advocated that the PSH should not be considered as a universal phenomenon. He analyzed 26 individual primary commodity prices from which maximum prices did not follow any trend. Cuddington and Wei (1992) used an arithmetic index and a geometric index to examine the long-run trend, believing that an index for price series is sensitive to the result for price trend. They detect that the geometric index, whether containing the unit root or not, is not ready to follow a significant long-run trend. The arithmetic index rejects the PSH. Leon and Soto (1997) also found that the PSH is not universal. Considering the existence of structural breaks for each commodity price, they got the results for the PSH of commodity prices, a mixture of negative, zero, and positive trends.

Grilli and Yang (1988) establish three new price indexes, making a principal achievement for the PSH. Focusing on the long-term movements in the net barter terms of trade of developing countries, they took into account a newly formed commodity price index and two modified manufactured goods price indexes. They identified a significant downward trend in the net barter terms of trade during the period 1900-1983.

Lutz (1999a) practiced the statistical relationship between terms of trade for aggregate commodities and net barter terms of trade for different developing countries. According to this analysis, from 1970 to 1990, manufacturing exports doubled. In contrast, the primary export share declined by a third. Finally, he traced relevance to the long-term trend in the overall terms of trade for developing countries. Furthermore, Lutz (1999b) also found negative patterns of primary commodities' relative price in the long-run, which provided strong support for the PSH. Reinhart and Wickham (1994) found a downward long-run trend of commodity prices and also high volatility in commodity prices. They also suggest that the presence of such a negative pattern of relative prices of primary commodities causes a temporary shock to be prolonged for a longer time. Cashin and McDermott (2002) examined the changing behavior of primary commodity prices in the long-run. Finding volatility in the price movements, they acknowledged a downward trend in real commodity prices. Kim et al. (2003) estimated the unit root test of primary commodity prices. They found that some commodity prices to be different stationary for which they provided a little support to the PSH. Kellard and Wohar (2006) assigned the Lumsdaine-Papell test that allows up to two structural breaks. They found that 14 out of 24 primary commodity price series followed a single downward slope. It provides a little support on the side of the secular decline in commodity price series.

Zanias (2005), considering two structural breaks in 1920 and 1984, found that the relative price of primary commodities declined for which the terms of trade went down about one-third of their level compared to the start of the century. Balagtas and Holt (2009) Harvey et al. (2010) also found evidence for the PSH. Ghosray (2011) reinvestigated the PSH to check the standard of stationarity of the trend of twenty-four primary commodity prices. Allowing one or two structural breaks, Ghoshray found thirteen commodity prices holding trend stationary behavior and the remaining eleven commodity prices holding difference stationary. In his findings, there are only six commodities that significantly support the PSH. Such a result provides weaker support for the PSH, which hardens the state for policy recommendations for compound trend results. Bahmani-Oskooee et al. (2017) examined the popular PSH applying a recently developed Fourier quantile unit root test. The authors found more evidence for the PSH relative to the Ricardian hypothesis.

However, although many studies have been done on the PSH, almost all of the studies considered annual time series data.[4] This study's novelty is revisiting the hypothesis relied on high frequency (monthly) data, and the recently developed time series econometrics tools to obtain more reliable and precise results.

3 Theoretical framework, data sources, and methodology

This study is to reinvestigate the PSH that originates an extensive debate

[4] More specifically, the prior studies relied on the database of Grilli and Yang (1988) which is popularly known as Grilli-Yang commodity index or GYCI. Later, Stephan Pfaffenzeller regularly updated the index till 2011 in his website http://www.stephan-pfaffenzeller.com/gycpi/. This is an annual data which started from 1900.

in development economics, which discussed the deterioration in the trends of primary commodity prices. An appropriate test should be chosen to unveil whether the price series contains unit root in the stochastic process, indicating characteristics and cyclical movements of the trends (Beveridge and Nelson, 1981). Commodity prices could either follow a trend stationary or difference stationary process, which is determined by the presence of unit root in the trends (Nelson and Plosser, 1982).[5] It is essential to precisely identify trend and difference stationary processes since misspecification may lead to an inefficient outcome.[6] To check the stationarity of the price series, we estimate Elliott, Rothenberg, and Stock (ERS) (1996) linear unit root test and Kapetanios, Shin, and Shell (KSS) (2003) nonlinear unit root test. We also consider Lee and Strazicich (2003) unit root test to encompass two endogenously determined structural breaks in the price.

3.1 Model specification

Considering the following autoregressive model,

$$lnp_t = \alpha + \beta t + \beta_1 lnp_{t-1} + \varepsilon_t \tag{1}$$

If in equation (1) $\alpha \neq 0, \beta \neq 0$ and $\beta_1 = 0$ then it will be in the form,

$$lnp_t = \alpha + \beta t + \varepsilon_t \tag{2}$$

If one price series tends to follow the trend stationary process, then the time coefficient β should be estimated from the log-linear time trend model expressed in equation (2), where lnp_t is the natural logarithm of the commodity price series deflated by the producer price index (PPI) by industry, which covers entire manufacturing industries, and t is the linear trend. The time coefficient β is the measurement of the growth rate, on which terms of trade depends. The positive value of β indicates an improvement in terms of trade. On the other hand, a negative value of β

[5] Trend stationary model is stationary around the trend line or the mean. Difference stationary is the stationarity of the time series with first difference.

[6] If a time series is difference stationary but treated as trend stationary, it is entitled as under differencing and if a time series is trend stationary but treated as difference stationary, it is entitled as over differencing.

indicates deterioration of terms of trade, which supports the PSH. The drift term is denoted by α. The error term ε_t follows the white noise process. Such errors in a regression model can hold a high serial correlation problem, and this problem should be taken into account to avoid inefficient estimation of trends. As a remedial measure of this serial correlation problem, an autoregressive moving average (ARMA) process is widely used. The ARMA (p, q) process can allow cyclical movements in real commodity prices.

An alternative technique to estimate the trend of price series, when it is not trend stationary, is merely taking the first difference of equation (2) that will obtain stationarity ejecting the unit root from the series. The difference stationary model can be expressed as the following form:

$$\Delta lnp_t = \beta + v_t \tag{3}$$

where, $\Delta lnp_t = (1 - L)lnp_t$ and L is the lag operator. Consequently, Δlnp_t presents the growth rate of price series p_t, while v_t is the stationary error process for this model. The time coefficient β is the same as before in (2). If the time coefficient β in the difference stationary model seems to be negative, as before, it will tend to verify the PSH.

In this study, we consider two structural breaks in the commodity price series. If structural breaks are found in the price, then it is essential to determine whether the trend is significant or not and also whether the trend appears as positive or negative.[7]

After determining how the trend shifted over the time and stationarity of the series, the next step is to fit the model for the error process as an ARMA (p, q) process. In this practice, the characteristics of a trend can be determined. It is more accurate to occupy an ARMA model accounting the break considering dummy slope. To Estimate trend stationary commodity series allowing for two breaks, the following regression model can be considered:

$$p_t = \vartheta + \mu_1 t + \mu_2 Break_{1,t} + \mu_3 Break_{2,t} + u_t \tag{4}$$

[7] One can further investigate the PSH using one or multiple structural breaks. Like some other prior studies, we only consider two structural breaks.

$$u_t = \varphi_1 u_{t-1} + \ldots.. + u_{t-p} + \varepsilon_t - \gamma_1 \varepsilon_{t-1} - \ldots.. - \gamma_q \varepsilon_{t-q} \quad (5)$$

In equation (5), ε_t is a white noise error and $\varepsilon_t \sim i.i.d.N(0, \sigma^2)$. $Break_{1,t}$ and $Break_{2,t}$ present the structural breaks in the series obtained from the prior identification. $Break_{1,t} = 1$ for $t > SB_1$ and 0 otherwise and, analogously, $Break_{2,t} = 1$ for $t > SB_2$ and 0 otherwise. Here SB_1 and SB_2 are the first and second structural breaks, respectively.

3.2 Data sources

The PSH, the most deliberating issue, was investigated frequently by development economists in the previous period. One of the most popular data series, which is commonly used by many economists to analyze this hypothesis, is the Grilli-Yang (G-Y) index provided by Grilli and Yang (1988) in their article. The authors used annual data series to analyze the long-run trend of commodity prices. Pfaffenzeller et al. (2007) updated this widely used Grilli and Yang commodity price index deflated by the index of the unit value of manufactured goods (MUV). They collected the data to update the G-Y index from the World Bank Development Prospects Group, Organization for Economic Cooperation Development (OECD), and the International Monetary Fund (IMF). The MUV was collected from the Global Economic Prospects team of the World Bank's Development Prospects Group.

However, prices of commodities fluctuate frequently over time, estimation relying on monthly data rather than quarterly or annual data will yield more precise outcomes. Therefore, we use monthly data of primary commodity prices to accommodate each consequence of a shock in the price series. In this study, we consider 24 individual commodity price series from year 1985M1 up to 2019M7 to obtain the relevance of deterioration in commodity price trends in the light of the PSH. The data series is collected from the 'World Bank Commodity Price Data' (Pink Sheet). The description of the commodities used in this analysis is like Pfaffenzeller et al. (2007) except five commodities, namely, barley, chicken meat, shrimps, and soybean oil. The description of these five commodities is given in the appendix. All monthly series are in nominal US dollars. The price series are deflated by the producer price index (PPI) which includes entire manufacturing industries as a proxy for MUV.[8] This producer price index is collected from the U.S. Bureau of Labor Statistics. Finally, the deflated prices are transformed into natural logarithms.

Table 1. Descriptive statistics

Commodities (in natural log)	Observation	Mean	Standard Deviation
Aluminum	403	2.475766	.2325807
Banana	384	-5.476176	.2426565
Barley	403	-.3224536	.2506003
Beef	403	-3.961177	.2011252
Coal	403	-4.395567	.2667521
Cocoa	403	-3.987739	.3629515
Coffee	403	3.148208	.4414413
Copper	403	-4.524716	.2672448
Cotton	403	1.375688	.4349718
Gold	403	5.931062	0.8691422
Lead	403	1.896474	.4774807
Maize	403	-.0885638	.2391861
Chicken meat	403	-4.570862	.0898426
Palm oil	403	1.315806	.2867585
Rice	403	.7866987	.2477609
Rubber	403	-4.672855	.4102539
Shrimps	403	-2.495338	.2766409
Silver	403	-2.818069	.4837138
Soybean oil	403	1.454071	.2478782
Sugar	403	-6.347824	.3015265
Tea	403	-4.262966	.150335
Tin	403	4.164806	.4267529
Tobacco	403	3.170283	.137587
Wheat	403	.1903973	.2273597
Zinc	403	2.305087	.3190417

The summary statistics of the chosen price series are provided in Table 1. The standard deviations show that none of the price series has higher volatility after converting the original data.

[8] U.S. Bureau of Labor Statistics, Producer Price Index by Industry: Total Manufacturing Industries, Index Dec 1984=100, Monthly, Not Seasonally Adjusted. Total Manufacturing Industries retrieved from Federal Reserve Bank of Louis, August 16, 2019.

3.3 Econometric tools

It is essential to check the stationary properties of the price series to revisit the validity of the PSH. For this purpose, three different unit root tests are employed in our analysis.

3.3.1 The ERS unit root test

Elliott, Rothenberg, and stock (1996) developed a conditional GLS procedure to estimate the augmented Dickey-Fuller (ADF) test, which is more powerful modifications of the univariate ADF test. The null hypothesis of this test is the presence of unit root against the alternative of stationarity of the series. Assuming the absence of a deterministic trend in the underlying data series, the ERS test can be expressed as:

$$\Delta p_t^d = \gamma_0 p_{t-1}^d + \sum_{i=1}^{\rho} \delta_i p_{t-i}^d + \varepsilon_t \tag{6}$$

where, i denotes the lag for p_t^d which are included for the serial correlation problem in residuals. The GLS-detrended series of the original p_t is:

$$p_t^d = p_t - \widehat{\beta_0} - \widehat{\beta_1} t \tag{7}$$

where, the null hypothesis is $H_0: \gamma_0 = 0$ and the alternative hypothesis is $H_1: \gamma_0 < 0$.This model is used for the linear time series.

3.3.2 The KSS unit root test

An advanced test was built to test the null hypothesis of being unit root against nonlinear alternatives within which the time series follow a global stationary process like in the smooth transition autoregressive (STAR) model by Kapetanios, Shin and Snell (2003) named as KSS unit root test. According to KSS, it can be demonstrated that the prices follow the STAR process under the alternative:

$$\Delta p_t = \beta p_{t-1}[1 - \exp(-\theta p_{t-1}^2)] + \varepsilon_t \tag{8}$$

where ε_t is independently normally distributed with 0 mean and equal variance σ^2 and follows a range of $-2 < \beta < 0$. The null hypothesis is $H_0: \theta = 0$ (unit root) against the alternative hypothesis $H_0: \theta > 0$. Here, β unidentified under the null hypothesis. The ultimate solution to overcome this problem is to compute a first-order Taylor series approximation and derive the t-statistics for $\beta = 0$ in

$$\Delta p_t = \beta p_{t-1}^3 + \varepsilon_t \tag{9}$$

This model is used to consider the nonlinearity of the series.

3.3.3 LM unit root test

Lee and Strazicich (2003) developed a test for unit root considering up to two breaks under both null and alternative hypotheses.[9] Consider the following data generating process according to their model:

$$p_t = \theta' B_t + u_t \ and \ u_t = \varphi u_{t-1} + \varepsilon_t \tag{10}$$

where, $\varepsilon_t \sim iid\ N(0, \sigma^2)$ and B_t is a vector of exogenous variable and p_t is the price series. The dummy variables for structural breaks are considered in the vector B_t. The LM unit root test considering two-break can be estimated in the following way:

$$\Delta p_t = \theta' \Delta B_t + \varphi \tilde{X}_{t-1} + u_t \tag{11}$$

where, $\tilde{X}_t = p_t - \rho - B_t \tilde{\theta}, t = 2, \dots \dots \dots T$; $\tilde{\theta}$ are coefficients in the regression of Δp_t and ΔB_t . ρ is given by $p_1 - B_1 \tilde{\theta}$. Here, p_1 and B_1 indicates the first observation of p_t and B_t, respectively. The null for the unit root is $\varphi = 0$, and the τ statistics gives the test statistics. The minimum test statistics determine the breakpoints (SB_j) endogenously by improving a grid search as $LM_\tau = \inf \hat{\tau}\ (\lambda)$. The break fraction is denoted by $\lambda_j = SB_j/N$, N represents the total number of observations. In endogenous break tests, trimming off the infimum is made at 10% to eliminate endpoints.

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9 Another test for unit root test considering structural break is Lumsdaine and Papell (1997) test which consider breaks only under the alternative not under the null. In this manner rejection of null means rejection of unit root without break and the alternative means presence of unit root with breaks but the LM unit root test developed by Lee and Strazicich (2003) which clearly indicates the alternative hypothesis with stationarity.

4 Result and discussion

Both linear (the ERS, 1996) and nonlinear (the KSS, 2003) unit root tests are employed to justify the unit root processes of the price series. The lag length has been chosen by the Akaike's information criterion (AIC) for both tests. Table 2 and Table 3 present the unit root test results with the trend obtained from the ERS (1996) and the KSS (2003) unit root tests.

According to Table 2, prices of nine commodities, namely, banana, cotton, maize, chicken meat, palm oil, rice, shrimps, tea, and wheat, are statistically significant. The rejection of the null hypothesis indicates that these series follow the trend stationary processes. All of these nine commodities follow a statistically significant trend in the long-run. The remaining fifteen commodities accept the null and contain the unit root problem. It means that the prices of fifteen commodities do not follow the trend stationary process.

Table 2. Result of ERS (1996) GLS based linear unit root test

Series		AIC	Series		AIC
Aluminum	lags	1	Palm oil	lags	3
	t statistic	-2.561		t statistic	-2.810 *
	p-value	0.115		p-value	0.065
Banana	lags	0	Rice	lags	2
	t statistic	-7.483***		t statistic	-2.898*
	p-value	0.000		p-value	0.053
Barley	lags	3	Rubber	lags	1
	t statistic	-2.565		t statistic	-2.195
	p-value	0.114		p-value	0.235
Beef	lags	2	Shrimps	lags	1
	t statistic	-2.030		t statistic	-4.065***
	p-value	0.309		p-value	0.002
Cocoa	lags	1	Silver	lags	2
	t statistic	-1.651		t statistic	-1.457
	p-value	0.518		p-value	0.633
Coffee	lags	2	Soybean oil	lags	2
	t statistic	-1.877		t statistic	-2.314
	p-value	0.388		p-value	0.189
Copper	lags	2	Sugar	lags	2
	t statistic	-2.255		t statistic	-2.465
	p-value	0.211		p-value	0.141

Cotton	lags	1	Tea	lags	0
	t statistic	-3.833***		*t* statistic	-3.234**
	p-value	0.003		*p*-value	0.022
Gold	lags	2	Tin	lags	2
	t statistic	-0.919		*t* statistic	-1.813
	p-value	0.885		*p*-value	0.423
Lead	lags	1	Tobacco	lags	1
	t statistic	-2.419		*t* statistic	-1.869
	p-value	0.154		*p*-value	0.393
Maize	lags	1	Wheat	lags	1
	t statistic	-2.996**		*t* statistic	-3.324**
	p-value	0.041		*p*-value	0.017
Chicken meat	lags	3	Zinc	lags	1
	t statistic	-4.206***		*t* statistic	-2.582
	p-value	0.001		*p*-value	0.110

Notes: (a) all the variables are in natural log; (b) the Akaike's Information Criterion has selected the optimal lag length for the ERS test; (c) ***, **, and* indicates the statistical significance of the coefficient at 1%, 5%, 10% significance level, respectively.

The KSS test follows globally stationary processes such as self-existing threshold autoregressive (SETAR) models. This test has a null of unit root against the nonlinearity as an alternative. Moving forward to the KSS test that considers the nonlinearity among the price series, the obtained result is reported in Table 3. This result shows fourteen commodities (aluminum, banana, beef, coffee, cotton, maize, chicken meat, palm oil, rice, shrimps, soybean oil, sugar, tea, and wheat) are statistically significant. It implies that the prices of these commodities follow a significant trend over time. The remaining ten price series are statistically insignificant that indicates evidence of unit root problem with the trend. These price series can be interpreted as that they do not follow the trend stationary process.

Comparing these two results from two different unit root tests, we find that all of the nine commodities that appear as statistically significant in the ERS test result also exhibit a similar property in the KSS test result. These price series show an exact match for the significance simultaneously in both tests. Despite being significant in the KSS test, aluminum, beef, coffee, soybean oil, and sugar are insignificant in the ERS test.

Table 3. Result of KSS (2003) OLS based STAR nonlinear unit root test

Series		AIC	Series		AIC
Aluminum	lags	1	Palm oil	lags	3

	t statistic	-4.082***		t statistic	-3.083**
	p-value	0.001		p-value	0.034
Banana	lags	1	Rice	lags	2
	t statistic	-5.333***		t statistic	-3.659***
	p-value	0.000		p-value	0.006
Barley	lags	3	Rubber	lags	1
	t statistic	-2.110		t statistic	-2.176
	p-value	0.300		p-value	0.268
Beef	lags	2	Shrimps	lags	1
	t statistic	-2.948**		t statistic	-3.954***
	p-value	0.049		p-value	0.002
Cocoa	lags	1	Silver	lags	2
	t statistic	-2.615		t statistic	-1.570
	p-value	0.111		p-value	0.605
Coffee	lags	2	Soybean oil	lags	2
	t statistic	-4.562***		t statistic	-3.020**
	p-value	0.000		p-value	0.041
Copper	lags	2	Sugar	lags	2
	t statistic	-2.379		t statistic	-3.613***
	p-value	0.183		p-value	0.007
Cotton	lags	1	Tea	lags	0
	t statistic	-5.093***		t statistic	-4.199***
	p-value	0.000		p-value	0.001
Gold	lags	2	Tin	lags	2
	t statistic	-0.959		t statistic	-2.782
	p-value	0.840		p-value	0.075
Lead	lags	1	Tobacco	lags	2
	t statistic	-2.636		t statistic	-2.107
	p-value	0.106		p-value	0.301
Maize	lags	1	Wheat	lags	1
	t statistic	-3.001**		t statistic	-3.926***
	p-value	0.043		p-value	0.002
Chicken meat	lags	3	Zinc	lags	1
	t statistic	-6.002***		t statistic	-2.536
	p-value	0.000		p-value	0.132

Notes: (a) all the variables are in natural log; (b) the Akaike's Information Criterion has selected the optimal lag length for the KSS test; (c) ***, **, and * indicates the statistical significance of the coefficient at 1%, 5%, 10% significance level, respectively.

Neither the ERS (1996) test nor the KSS (2003) test considers the possibility of any structural changes in the price series. Consequently, acceptance of a unit root problem may be due to not considering breaks in the intercept or trend. Therefore, we go forward to encompass structural breaks in the commodity price series because the structural break may influence the power of the unit root test. To test the unit root considering structural breaks, we employ the LM unit root test introduced by Lee and Strazicich (2003). The result obtained from the LM unit root test is represented in Table 4.

Table 4. Result of the LM unit root test

Commodity	1st Structural Break	2nd Structural Break	t-ratio lags	Critical Values		
				1%	5%	10%
Aluminum	1990m09	2006m05	-5.10 (5)*	-5.86	-5.29	-5.01
Banana	1998m10	2008m03	-5.94 (8)***	-5.75	-5.23	-4.99
Barley	2006m05	2014m03	-5.05 (6)*	-5.72	-5.17	-4.87
Beef	1995m02	2011m01	-5.47 (8)**	-5.73	-5.26	-4.99
Cocoa	1989m06	2008m02	-3.97 (7)	-5.86	-5.29	-5.01
Coffee	1994m08	2004m05	-4.20 (2)	-5.75	-5.20	-4.92
Copper	1998m03	2005m09	-4.38 (5)	-5.78	-5.26	-5.02
Cotton	1999m04	2010m06	-5.91 (7)***	-5.78	-5.26	-5.02
Gold	2000m03	2011m07	-4.17 (1)	-5.86	-5.29	-5.01
Lead	2000m06	2006m12	-5.10 (6)*	-5.87	-5.26	-4.96
Maize	2006m07	2014m02	-4.92 (7)*	-5.72	-5.17	-4.87
Chicken meat	1990m02	1993m01	-4.53 (8)	-5.65	-5.04	-4.77
Palm oil	1999m03	2007m05	-4.90 (4)	-5.87	-5.26	-4.96
Rice	2000m02	2008m02	-5.84 (1)**	-5.87	-5.26	-4.96
Rubber	1998m10	2010m04	-4.31 (8)	-5.78	-5.26	-5.02
Shrimps	2002m01	2010m08	-5.80 (1)***	-5.65	-5.22	-4.90
Silver	2003m05	2013m02	-4.29 (7)	-5.75	-5.20	-4.92
Soybean oil	1998m12	2007m09	-4.89 (6)	-5.87	-5.26	-4.96
Sugar	1998m07	2009m06	-5.11 (1)*	-5.78	-5.26	-5.02
Tea	1991m04	2008m03	-4.86 (6)	-5.77	-5.21	-4.95
Tin	2003m08	2011m12	-5.01 (7)***	-5.75	-5.20	-4.92
Tobacco	1992m08	2007m11	-4.61 (7)	-5.86	-5.29	-5.01
Wheat	1997m04	2007m11	-4.68 (1)	-5.78	-5.26	-5.02
Zinc	1990m05	2005m10	-4.71 (7)	-5.86	-5.29	-5.01

Note: (a) all the variables are in natural log; (b) the numbers in parentheses denote the lag length chosen through the General to Specific methodology suggested by Lee and Strazicich (2003); (c) ***, **, and * indicate the statistical significance of the coefficient at 1%, 5%, 10% significance levels, respectively.

According to Table 4, eleven commodities out of twenty-four appear to be trend stationary after considering two structural breaks. These eleven commodities are aluminum, banana, barley, beef, cotton, lead, maize, rice, shrimps, sugar, and tin. These commodities are said to be trend stationary with two structural breaks. The remaining thirteen commodities, i.e., cocoa, coffee, copper, gold, chicken meat, palm oil, rubber, silver, soybean oil, tea, tobacco, wheat, and zinc, are insignificant. These thirteen commodities are nonstationary with the trend. However, the LM unit root test is employed in this study to identify the date of two structural breaks.

Table 5. Trend stationary models with breaks

Commodities	SB1	SB2	t-statistics
Aluminum	1990M09	2006M05	−.0001172 (−0.14)
Banana	1998M10	2008M03	.0002211 (0.34)
Beef	1995M02	2011M01	.0004892 (0.64)
Coffee	1994M08	2004M05	−.0019053* (−1.91)
Cotton	1994M04	2010M06	−.0010607** (−2.09)
Maize	2006M07	2014M02	−.000168 (−0.24)
Chicken meat	1990M02	1993M01	.0003046*** (6.31)
Palm oil	1999M03	2007M05	.0005218 (0.67)
Rice	2000M02	2008M02	.0002844 (0.31)
Shrimps	2002M01	2010M08	−.0016996*** (−3.51)
Soybean oil	1998M12	2007M09	.0007448 (0.96)
Sugar	1998M07	2009M06	.0000222 (0.03)
Tea	1991M04	2008M03	−.0005243** (−2.03)
Wheat	1997M04	2007M11	−.0006345 (−0.81)

Note: (a) all the variables are in natural log; (b) SB1 and SB2 denote the structural break 1 and 2, respectively; (c) coefficients obtained considering dummy are recorded in the t-statistics column; (d) ***, **, and * indicate the significance of the time coefficients at 1%, 5%, and 10% level of significance; (e) the numbers in the parentheses represent the t-ratios.

The KSS (2003) unit root test is more potent against the nonlinear exponential smooth transition autoregressive (ESTAR) stationary processes compare to the standard augmented Dickey-Fuller test.

Therefore, for the purpose of obtaining a consistent result, the trend and difference stationary process of the price series has been selected for ARMA and ARIMA tests, respectively, following the KSS test in this analysis. According to the KSS test, fourteen commodity price series follow a trend stationary process and the remaining ten price series are accepted as a difference stationary process. The two structural breaks have been incorporated in the ARMA and ARIMA model as dummy variables to obtain a precise estimation. The result obtained in such a way has been represented in Table 5 for trend stationary and in Table 6 for difference stationary processes. The result for the ARMA (p, q) test employed in our research work is stable because all of the eigenvalues lie inside the unit circle (see Appendix B).

Table 6. Difference stationary models with breaks

Commodities	SB1	SB2	Constant
Barley	2006M05	2014M03	.001121 (0.24)
Cocoa	1989M06	2008M02	−.0177427* (−1.84)
Copper	1998M03	2005M09	.0002238 (0.04)
Gold	2000M03	2011M07	−.003832*** (−3.00)
Lead	2000M06	2006M12	−.0029173* (−1.72)
Rubber	1998M10	2010M04	−.0011534 (0.905)
Silver	2003M05	2013M02	−.0019393* (−1.73)
Tin	2003M08	2011M12	−.0028312*** (−3.30)
Tobacco	1992M08	2007M11	.0005911 (0.40)
Zinc	1990M05	2005M10	.0175666* (1.75)

Note: (a) all the variables are in natural log; (b) SB1 and SB2 denote the structural break 1 and 2, respectively; (c) coefficients obtained considering dummy are recorded in the t-statistics column; (d) ***, **, and * indicate the significance of the time coefficients at 1%, 5%, and 10% level of significance; (e) the numbers in the parentheses represent the t-ratios.

Table 5 consists of 14 primary commodities which follow the trend stationary process. Among these commodities, only five commodities, namely, coffee, cotton, chicken meat, shrimps, and tea are statistically significant at least at the 10% significance level. It implies that these price series follow a significant trend over the long-run, and the rest of the nine commodities are trendless. More specifically, out of five commodities, only chicken meat follows a positive trend while the other four commodities have a negative trend. However, the trend stationary process, by assumption, follows a deterministic trend. The effect of any shock on the trend of these fourteen commodities is cyclical, which means that the shock outcome is not steady-state. The cyclical movement depends on the values of MA(q).

Table 6 presents the commodity prices for which the null hypothesis of unit root cannot be rejected and fitted as a difference stationary process. The trend of six commodities, namely, cocoa, gold, lead, silver, tin, and zinc are significantly different from zero. The commodity zinc, modeled as difference stationary, has a statistically significant positive trend, and the remaining five commodities have a negative trend. Unlike the trend stationary process, any shock (or innovation) can permanently affect the long-run growth path of prices in the difference stationary process.

In prior studies, the commodities were categorized into three categories: food, non-food, and metal. If we interpret the result following these categories, it shows that cocoa, coffee, chicken meat, shrimps, and tea has a significant trend from the category of food. Except for the chicken meat, the other four prices have a negative trend in the long-run. Chicken meat tends to follow a significant positive trend. From the non-food category, only cotton has a statistically significant negative trend. Gold, lead, silver, and tin have a significant negative trend from metal commodities, while only zinc has a positive trend. Moreover, most food items follow the trend stationary process, implying the transitory effect of shocks. In contrast, most non-food and metal commodities follow the different stationary process where the effect of shocks is permanent.

5 Conclusion

The PSH was first introduced from the seminal work by Prebisch (1950) and Singer (1950). However, this hypothesis became a debating issue in the aftermath of World War II. Our study revisits this contradictory issue since primary commodities have a significant contribution to developing countries' exports. Hence, the relative price of primary commodities in terms of manufactured goods has important policy implications for the terms of trade of developing economies. To re-examine whether primary commodities' relative prices suffer from a long-run secular deterioration, we consider 24 individual commodity price series deflated by PPI of all manufacturing industries (as a proxy of MUV). Possible problems could arise in the interpretation when using the aggregate indices. The application of aggregate indices may mislead to provide a statement about the secular deterioration in primary commodities. The aggregation bias can be solved by the use of disaggregated series in this analysis. In addition, the disaggregate data analysis is inevitable for commodity-specific policy insights.

A unique data series has been applied considering 24 individual commodity price series for this analysis. We employ two different unit root tests to check the stationarity of the primary commodity price series. Since structural breaks dominate the power of unit root tests, the LM unit root test is employed to incorporate two structural breaks, which is developed by Lee and Strazicich (2003). The LM test is used to identify the date of structural changes. Another powerful unit root test, namely, the KSS test, which considers the nonlinearity of the series, is used to determine the trend and difference stationary model of the relative commodity prices and the ERS unit root test.

A fundamental finding of this study is that ten commodities out of twenty-four have appeared as difference stationary, which implied that the shocks of these commodities would be permanent. In contrast, the effect of shocks on the rest of the commodities is cyclical. Changes in environment and economic conditions, economic fluctuations, technological changes, changes in supply and demand of the commodity, and the number of time length chosen in the data series might be responsible for the structural breaks considered in our analysis. Prebisch (1950) and Singer (1950) had also suggested some determinants to explain the secular degradation in different commodity prices. They are changes in income and price elasticities, market structures, and rates of technological changes with time, etc.

Applying the ARMA (p, q) test for trend stationary and ARIMA (p, d, q) for difference stationary models, this analysis concludes that 13 commodity prices have appeared as trendless, which supports the Lewis (1954) hypothesis. From the remaining eleven price series, two commodities have a statistically positive trend, and nine commodities have a negative trend, which supports the Ricardo (1817) hypothesis and the PSH, respectively. It can be interpreted that most of the food and metal commodities follow a trend relative to non-food types of commodities. These findings confirm that secular declining commodity prices cannot be a universal phenomenon.

Some commodities tend to follow either a negative trend or a positive trend, while the majority of the commodities are trendless. Unless the actual reasons behind the price movements are monitored, it is extremely hard to predict how the economy should respond to them. Though this study yields mixed trend results, it provides an ambiguous conclusion about a secular deterioration in the primary commodity price in terms of manufactured goods. Hence, it is quite challenging to imply policy recommendations having such mixed results. However, international fora, for instance, the WTO or UNCTAD, may intervene in the global market of the primary commodity where the price of the commodity follows a secular declining trend.

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Appendix

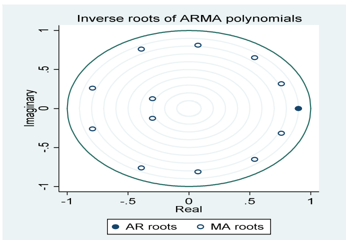
Appendix A:

Barley: (US) feed, No. 2, spot, 20 days To-Arrive, delivered Minneapolis from May 2012 onwards; during 1980 - 2012 April Canadian, feed, Western No. 1, Winnipeg Commodity Exchange, spot, wholesale farmers' price.
Gold: (UK), 99.5% fine, London afternoon fixing, an average of daily rates.
Chicken meat: (US), Urner Barry North East weighted average for broiler/fryer, whole birds, 2.5 to 3.5 pounds, USDA grade "A" from 2013 onwards; 1980-2012, Georgia Dock weighted average, 2.5 to 3 pounds, wholesale; previously World Bank estimates.
Shrimp: (US), brown, shell-on, headless, in frozen blocks, source Gulf of Mexico, 26 to 30 count per pound, wholesale US beginning 2004; previously New York.
Soybean oil: Dutch crude degummed, FOB NW Europe beginning January 1999; previously crude, f.o.b. ex-mill the Netherlands, nearest forward.

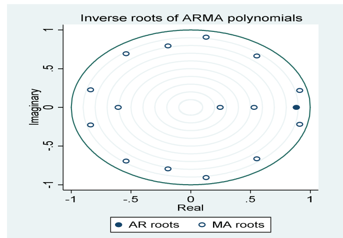
Appendix B:

Figure 1. The stability condition of the MA (q) using eigenvalues (cont.)

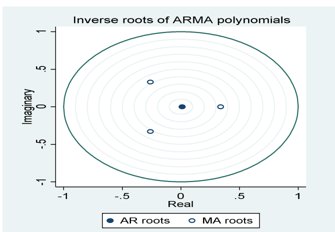
Aluminum



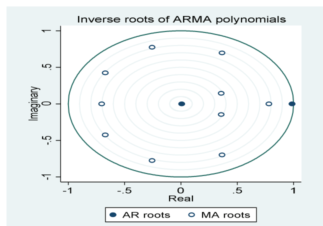
Banana



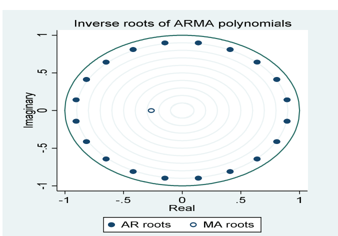
Barley



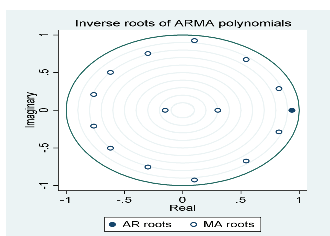
Beef



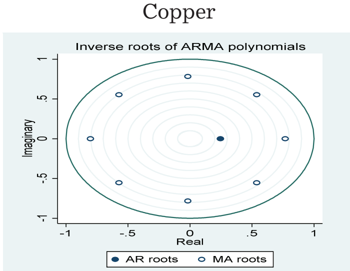
Cocoa



Coffee



Copper



Cotton

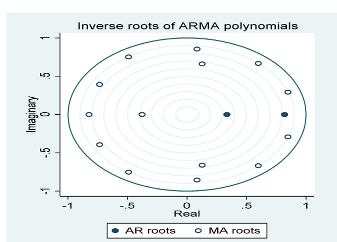
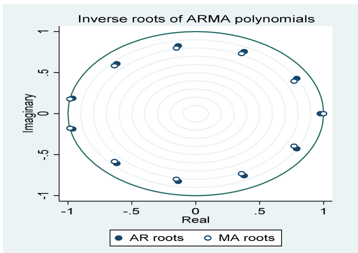
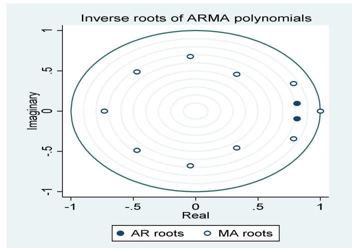


Figure 1. The stability condition of the MA (q) using eigenvalues (cont.)

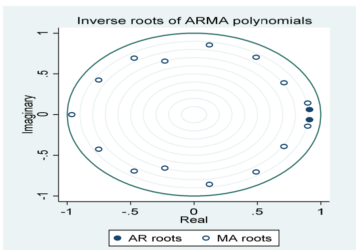
Gold



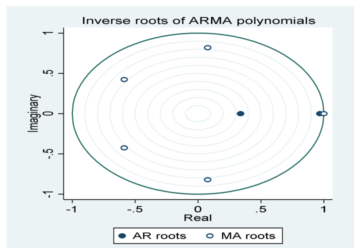
Lead



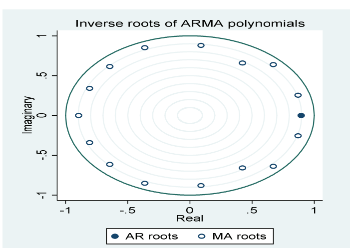
Maize



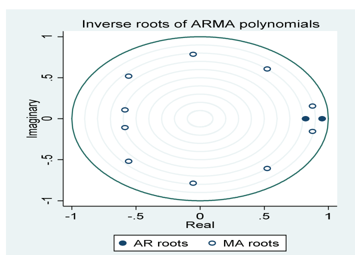
Chicken meat



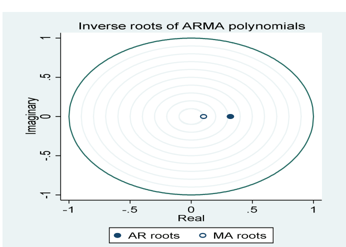
Palm oil



Rice



Rubber



Shrimps

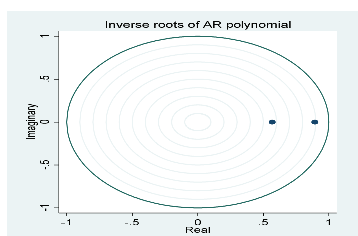
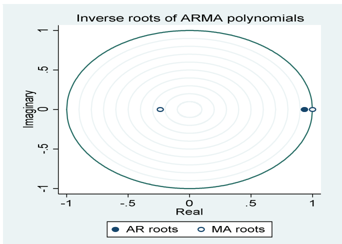
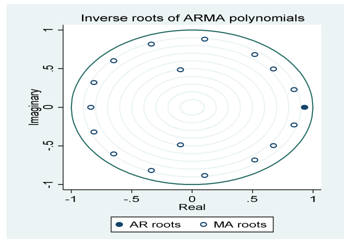


Figure 1. The stability condition of the MA (q) using eigenvalues (cont.)

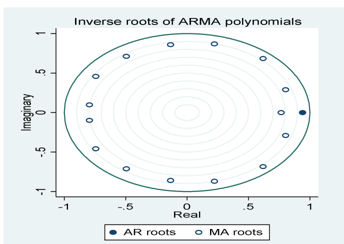
Silver



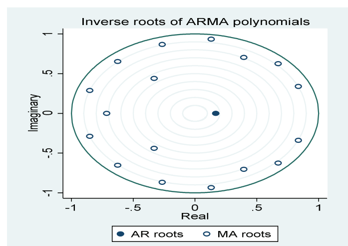
Soybean oil



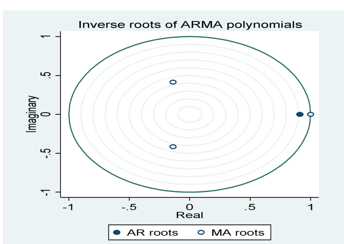
Sugar



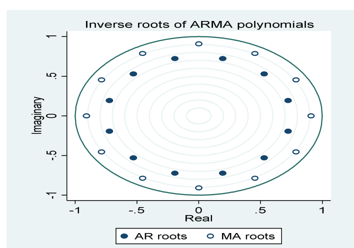
Tea



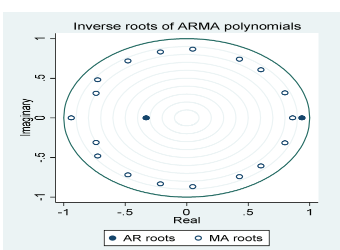
Tin



Tobacco



Wheat



Zinc