Reinvestigating the PreBisch-Singer Hypothesis 1900-2015

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Abstract

This paper analyses the empirical validity of Prebisch-Singer hypothesis using the time series Grilli-Yang Commodity Price Index data spanning from 1900 to 2015. The methodology employed is encapsulated in a three fold approach: a) endogenous detection of structural breaks; b) estimation of trend through piece-wise linear regression; and c) validation of the statistical significance of the trends applying the Mann-Kendall test. The four structural breaks endogenously determined, primarily, coincides with four important historical/economic events over the last century: (a) World War I (1914 to 1918) and, thereafter, the Great Depression (1929 to 1939), (b) World War II (1939-1945) and immediate post war rebuilding (1950s), (c) First Oil Crisis (1973-74) and (d) Commodity Price Boom (late 1990s). From the trend results, the inference derived on the validity of Prebisch-Singer hypothesis is mixed. If the overall period of study is considered, then the empirical evidence in support of PS hypothesis is weak. However, if the terms of trade movement over the last century is considered, especially the second half, then the evidence in favor of Prebisch-Singer hypothesis is strong. The other important finding is that it also depends on the nature of the commodities i.e. the terms of trade of agricultural commodities are more prone to secular decline than metals.

Keywords: Prebisch-Singer hypothesis, deterioration hypothesis, terms of trade, commodity prices, trend estimation, Grilli Yang Commodity Price Index.

1 Introduction

Renowned classical economists like Ricardo (2001) and Malthus (1817, 1836) believed that the long-run trend in the ratio of primary commodity prices to those of the manufactured goods would move upwards; indicating a secular improvement in the terms of trade in favor of the primary commodities. This belief was, however, challenged during the middle of the last century when the issue of movements in terms of trade of primary commodities vis-á-vis manufactured goods came into the center stage of discussions in development economics.[1] Studies on the terms of trade experience of Britain from the late 19th century to the early 20th century (i.e. 1873 to 1938) provided empirical support to an alternative hypothesis, namely - *tendency of a secular decline in the terms of trade of primary products vis-á-vis manufactured goods.* This 'deterioration hypothesis' later came to be known as the Prebisch-Singer hypothesis (henceforth, PS hypothesis), after the publication of two independent research works by Economic Commission for Latin America (1950) and Singer (1950). In an empirical exercise, Economic Commission for Latin America (1950) showed that the index of the ratio of prices of primary commodities to those of manufactured goods declined from 100 in 1876-80 to 62.0 in 1931-35, and thereafter rose to 68.7 in 1946-47. Based on this empirical evidence, the PS hypothesis proclaimed a structural tendency for the terms of trade of the developing countries, specializing in the production of primary commodities, to deteriorate in their dealings with

[1]The phrase 'terms of trade' in this paper refers to the most widely used concept of the 'net barter terms of trade' or the 'commodity terms of trade' of primary commodities vis-á-vis manufactured goods.

the advanced and industrialized countries.

The PS hypothesis of a secular decline in the terms of trade became an issue of intense debate in the trade and development literature as well as in the area of applied econometric time series models. Till the early-1980s, the economic world primarily debated the theoretical validity of this hypothesis. Critics like Viner (1952), Atallah (1958), Ellsworth (1956), Morgan (1959), Haberler (1961) and several others questioned the theoretical foundations of the PS hypothesis. The sudden oil-shocks of the early-1970s leading to a drastic improvement in the terms of trade in favor of the primary commodities strengthened their criticisms against it. However,subsequent analysis of other economists in the mid-1980s found evidence in favor of this 'deterioration hypothesis'. Even after taking into consideration the arguments raised by the critics and incorporating the oil-shock episode of the early 1970s, Sapsford (1985), Thirlwall and Bergevin (1985) and Sarkar (1986, 1987) showed that the 'deterioration hypothesis' of Prebisch and Singer holds true.

Thereafter, with significant development in the field of econometrics, the debate majorly shifted in the literature towards econometrically testing and finding empirical evidence about the secular fall in terms of trade. Especially since the mid 1980s, rigorous empirical analyses were done using long time-series terms of trade data over the last century to substantiate the empirical validity of the PS hypothesis (Sapsford (1985); Thirlwall and Bergevin (1985); Sarkar (1986); Grilli and Yang (1988); Diakosavvas and Scandizzo

(1991); Sapsford et al. (1992); Ardeni and Wright (1992); Bleaney and Greenaway (1993); Reinhart and Wickham (1994); Sarkar (1994); Cashin and McDermott (2002); Bunzel and Vogelsang (2005); Razzaque et al. (2007)). However, these results were later contested by several others who did not find any significant empirical evidence in favor of this hypothesis (Cuddington and Urzua (1989); Powell (1991); Cuddington (1992); Newbold and Vougas (1996); Ocampo and Parra (2003); Zanias (2005); Yamada and Yoon (2014); Kellard and Wohar (2006); Balagtas and Holt (2009); Cuddington (2010); Ghoshray (2011)).[2] Although these studies did not find any evidence in favor of a secularly deteriorating trend in the relative prices of primary commodities, some among them argued that the relative prices deteriorated markedly in the course of the twentieth century due to the structural breaks in the early 1920s and 1980s (Powell (1991); Leon and Soto (1997); Ocampo and Parra (2003); Zanias (2005); Yamada and Yoon (2014)). Some recent studies of Harvey et al. (2010) and Arezki et al. (2014) expanded the span of the study period from 1650 to 2010 and arrived at mixed results toward the empirical validity of the PS hypothesis.

Nevertheless, with the development of such rigorous statistical analyses, the primary focus shifted away from the central idea - *the unequal distribution*

[2]Deaton and Laroque (2003) and, further developing on it, Ghoshray and Perera (2016) have concluded that real prices of commodities in developing countries can be characterized as containing no significant linear trend. However, we don't include them in this current study as they are more in the tradition of Lewis rather than Prebisch and Singer's original hypothesis.

of the gains from trade between the developed and developing countries. As Sapsford and Singer (1998, p.1654) wrote,

> The statistical literature surrounding the long-run deterioration issue is vast and continues to grow. Indeed, the debate has attracted the attention of statisticians, to the extent that it now represents to what amounts to a test-bed upon which the latest techniques of time-series analysis are routinely put through their paces. While this development is welcome from the intellectual standpoint it had posed some difficulties for practitioners in the sense that it has often proved difficult to disentangle the question of the existence, or otherwise, of a declining trend from that of the performance and adequacy of the particular statistical technique employed.

Sapsford et al. (1992, p.319) also argued,

> from an elementary time-series analysis on the basis of quinquennial averages, the Prebisch-Singer controversy has reached the stage of *high-tech* statistical debates.

This point has also been enunciated by Sapsford and Balasubramanyam (1994, p.1737),

> Given the simplicity of the statistical techniques employed in the pioneering work of Prebisch and Singer, it is perhaps ironic to notice that their declining long-run trend hypothesis has in recent years established itself as an important test bed, upon which time-

series statisticians nowadays routinely evaluate their latest trend estimation procedures.

The debate on the topic of long-run movements of terms of trade has comeback again to the mainstream discussion of trade and development literature since the real prices of primary commodities are increasing at a rapid pace in this millennium, and forecasting simulations show that this episode of rising prices will continue in the near future (Bank, 2009). The recent upsurge in primary commodity prices, especially those of food grains, had has been a matter of major concern for the global economy in so far as it has accentuated the already existing global food crisis in the third world countries, especially the least developed and net food-importing economies. Such an increase in food prices has adversely affected the poor countries where the majority of the people tend to spend around half on their family income on food items(Ghosh, 2010). Thus, it becomes extremely important from the context of these economies to reanalyze this important issue.

In the econometric literature on this issue, both the problems of identification of structural breaks and the consequent change in the trends of the commodity prices have assumed huge importance (Perron (1989); Powell (1991); Zivot and Andrews (1992); Leon and Soto (1997); Zanias (2005); Ghoshray (2011)). Though some of these studies have detected breakpoints in their long time series data, but the methodology applied in these studies have either limited the possibility of not having more than two structural breaks

by employing the Lumsdaine-Papell test methodology ((Lumsdaine and Papell, 1997) and (Lee and Starzicich, 2003)) or have determined the structural breaks *apriori*as critiqued by Perron (1989). This study is more similar to the study done by Yamada and Yoon (2014), where the authors have tested whether the PS hypothesis holds true over a long time frame by estimating the piecewise trends of individual primary commodity prices employing the trend filtering technique proposed by Kim et al. (2009). However, Yamada and Yoon (2014) have obtained seven structural breaks in their analysis for few commodities like cocoa, lamb, jute, wool and silver, whose defendability with particular historical events or significant economic events have not been provided.[3] This, *ipso facto*, brings back to limelight the concern of many developmental economists that the crucial debate on PS hypothesis has been reduced to a mere statistical exercise, without understanding the deep economic and policy significance it has for the least developed countries, whose export earnings still relies significantly on these primary commodities.[4]

Notwithstanding the risk of being accused of performing another empirical exercise, this research paper, applying the latest technique of structural break detection and linear trend estimation developed by Forkel et al. (2013), analyses the PS hypothesis using the Grilli-Yang dataset spanning over a period from 1900 to 2015. Grilli and Yang (1988) constructed an US dollar index

[3]It is extremely important that the potential drivers of the structural breaks are identified by simply matching those breaks to historical events as done by Arezki et al. (2014).

[4]For some 40 countries, their entire export earning depends on three or four primary commodities (Harvey et al., 2010).

of prices of twenty-four internationally traded non-fuel commodities beginning in 1900, which has been later updated till 2003 by Pfaffenzeller et al. (2007) and extensively used in the trade and development literature (Cuddington et al., 2007). Although a lot of empirical work does exist in this field, this paper, to the best of my knowledge, contributes to the literature in three significant ways. Firstly, the time period of this analysis spans over a period of 115 years ranging from 1900 to 2015, which is the most recent updated series available and, therefore, also significantly captures the recent ongoing episode of price rise of primary commodities. Secondly, this paper uses both the United Nation's Manufactured Unit Value (henceforth, UNMUV) as well as the United State's Manufacturing Price Index(henceforth, USMPI) as deflators to calculate the updated GYCPI as done in the original paper by Grilli and Yang (1988). Grilli and Yang (1988, p.5) used this additional index, USMPI, because "it gives an idea of the relationship between prices and unit values of exports that existed over time and of the reasonableness of the results obtained from the interpolation procedure used to fill the gaps in the MUVUN". Furthermore, it is also of added interest since it reveals the relationship between the prices of primary commodities and manufactured goods produced and marketed by the 'core of the core' economy i.e. the United States of America. Thirdly, and most importantly, this study also tries to retain the essence of the original study of Prebisch and Singer by employing a simple methdology that not only helps in calculating the trend but,simulataneously, gives equal emphasis to the structural breaks, which have caused unusual distortion of these commodity prices. Hence, this study, in an unique attempt, employs a methodology which tries to apply the

breakpoint detection algorithm as described by Bai and Perron (2003) and Zeileis et al. (2003) and later incorprated in the trend estimation alogorithm by Forkel et al. (2013).[5] The additional advantage of employing this methodology is that it can also test whether the piece-wise linear trend values are statistically significant or not depending on the test statistics. The remainder of this study is planned as follows: the next section describes the methodology employed in this study. The third section deals with the data and reports the results obtained from the regression analysis. The penultimate section of the paper interprets and discusses, in details, the results obtained from these regression analyses. The concluding section of the paper discusses the policy implications from this analysis and presents the concluding remarks.

2 Methodology

The methodology employed in this study is developed by Forkel et al. (2013), which is a combination of three fold statistical exercises to determine *unknown* structural breaks and, thereafter, estimate and stastically validate time trends in any data series. Firstly, the authors employ the breakpoint detection algorithm as described by Bai and Perron (2003) and Zeileis et al. (2003) to search for the *unknown* structural changes in a time series data, which implies that a detected breakpoint splits the time period into two different segments. Secondly, for each derived time segment, the slope of the time trend is tested by the linear least-squares regression of the annual values

[5]The importance of endogenizing the structural breaks and giving due importance to it has been discussed, in detail, by Grilli and Yang (1988) andYamada and Yoon (2014).

against time. Thirdly, the statistical significance of trends in each of these individual time series segments are estimated by the Mann-Kendall trend test. This methodology can be used to estimate trends on annual aggregated time series (AAT), seasonal trend model (STM) and de-seasonalized time series (Seasonal Adjusted). For this study, we will be primarily focusing on the first type of model i.e. AAT model. In the following three sub-sections we provide a detailed theory of the three steps involved in the estimation and validation of the time trend.

2.1 Detection of Structural Breaks

Suppose, we consider the standard linear regression model for determining structural breaks is given by:

$$p_t = x_t^{'}\beta_t + u_t \tag{1}$$

At time t ($\forall\ t \in 1(1)n$), p_t denotes the observation of the dependent variable (the natural logarithmic value of the GYCPI), x_t is the (kX1)vector of regressors, within which the first component is usually equal to unity and β_t is the (kX1) vector of regression coefficients, which may vary over time.[6] The time period t is defined as t=T_{j-1}+1,.....,T_j ($\forall\ j \in 1(1)m+1$) which implies that there are m breakpoints and (m+1) segments in the time series. In this equation, u_t is the disturbance term. Folowing Bai and Perron (1998), one can then argue that the purpose of this modeling exercise is to estimate the

[6]In our case, the β_t vector is a ($2X1$) vector, where the first component is unity and the second component is the t variable itself.

associated least square estimates of β_t for each m-partition $(T_1, T_2, ..., T_m)$ denoted as T_j, by applying ordinary least square segment by segment without considering any constraint therein. $\hat{\beta}(T_j)$ denotes the resulting estimates. Then, the residual sum of squares is given by:

$$RSS(T_1, T_2, ..., T_m) = \sum_{j=1}^{m+1} rss(T_{j-1} + 1, T_j) \tag{2}$$

where $rss(T_{j-1} + 1, T_j)$ is the usual minimal residual sum of squares in the $j-th$ segment. Therefore, the problem of dating the structural changes is to find the breakpoints $(\hat{T_1}, \hat{T_2}, ..., \hat{T_m})$ which minimizes the objective function:

$$(\hat{T_1}, \hat{T_2}, ..., \hat{T_m}) = argmin_{(T_1, T_2, ..., T_m)} RSS(T_1, T_2, ...T_m) \tag{3}$$

where, the minimization exercise is taken over all partitions $(T_1, T_2, ..., T_m)$ $\ni T_j - T_{j-1} \geq k$.

Therefore, on fruitfully employing this breakpoint detection methodology, it can be inferred that the breakpoint estimates *globally* minimizes the objective function. These globally minimum breakpoints in equation (3) are usually obtained by a dynamic programming approach, which is developed by Hawkins (2001). Zeileis et al. (2003) adopts Hawkins (2001) and Bai and Perron (2003) version of that dynamic programming algorithm for both pure and partial structural change models in the context of an ordinary least square regression. Zeileis et al. (2003) argues that the basic idea behind this dynamic algorithm is that of Bellman's principle that optimal segmentation satisfies recursion. For further details about this dynamic programming al-

gorithm, seeBai and Perron (2003) and Zeileis et al. (2003).[7]

2.2 Piece-wise Linear Regression Equation

Once these structural breakpoints are endogenously determined, the trend values are estimated by a segment to segment ordinary least square regressions:

$$(p_t)_j = (\beta_0)_j + (\beta_1 t)_j + (\epsilon_t)_j \tag{4}$$

$\forall\, j = 1, 2, ...(m+1)$ and ϵ_t denotes the error term at time t. This methodology really doesn't address the debate on whether a trend exists or not by testing for the unit roots as had been done in quite a number of earlier studies. As argued by (Bunzel and Vogelsang, 2005, p.390),

> the Prebisch-Singer hypothesis has nothing to do with whether the error term is stationary or has a unit root. In our opinion, the empirical literature has become distracted by the unit root issue. This is not surprising given the technical difficulties the presence of a unit root brings with it.

This methodology presumes that a trend does exist from the observed path of the time series. However, whether that trend is statistically significant or not is later tested. From the ordinary least square regression procedure, we estimate the $\hat{\beta}_j$ for each time period j. This procedure of piece-wise trend estimation has recently been also done by Yamada and Yoon (2014) and Arezki et al. (2014). In the next sub-section, the Mann-Kendall trend

[7]The discussion in this section has immensely benefitted from Bai and Perron (1998) , Bai and Perron (2003) and Zeileis et al. (2003).

test is described which is the third step in the methodology employed to test whether the trends in each segment of time series j are statistically significant.

2.3 The Mann Kendall Test

The Mann-Kendall test (Mann, 1945) (hereafter, MK test) analyses whether to reject the null hypothesis of no monotonic trend against the alternative hypothesis that a monotonic trend is present. The important assumption in this test is that the null hypothesis is true and the data must be convincing beyond a reasonable doubt before null hypothesis is rejected and alternative hypothesis is accepted. Following Pohlert (2016), this statistical procedure is briefly described here. The MK test statistic is calculated according to:

$$S = \sum_{e=1}^{n-1} \sum_{d=e+1}^{n} sgn(p_d - p_e) \tag{5}$$

with,

$$sgn(p_d - p_e) = \begin{cases} 1, & \text{if } p_d - p_e > 0; \\ 0, & \text{if } p_d - p_e = 0; \\ -1, & \text{if } p_d - p_e < 0 \end{cases}$$

where, p_d and p_e denote the measurements of real price variables over the time period t such that $d > e$. The mean of S is $E(S) = 0$ and the variance σ^2 is given by $\sigma^2 = [n(n-1)(2n+5) - \sum_{j=1}^{m+1}(l_j)(l_j-1)(2l_j+5)]/18$ where l_j is the number of data points in the $j-th$ tied group. The statistics S is approximately normally distributed provided the following Z transformation

is employed as:

$$Z = \begin{cases} \frac{S-1}{\sigma}, & \text{if } S > 0; \\ 0, & \text{if } S = 0; \\ \frac{S+1}{\sigma} & \text{if } S < 0 \end{cases}$$

This test statistic S is closely related to Kendall's τ which is given by $\tau = \frac{S}{D}$ where, $D = [\frac{1}{2}(n)(n-1) - \frac{1}{2}\sum_{j=1}^{m+1} l_j(l_j-1)]^{\frac{1}{2}}[\frac{1}{2}n(n-1)]^{\frac{1}{2}}$.

From our perspective, suppose the objective is to test the null hypothesis of no monotonic trend against the alternative hypothesis of a downward monotonic trend at the Type I error rate $0 < \alpha < 0.05$ (i.e. α is the probability at which the MK test will falsely reject the null hypothesis). Then, the null hypothesis is rejected and alternative hypothesis is accepted at 5 percent level of significance if $Z \leq -Z_{(1-\alpha)}$ where $Z_{(1-\alpha)}$ is the $100(1-\alpha)th$ percentile of the standard normal distribution. In the next section, we will discuss the updated data for the Grilli-Yang commodity price index spanning over a time period from 1900 to 2015 and report the trend results which are found using this methodology.

3 Data and Results

3.1 Data

The seminal paper by Grilli and Yang (1988) gave a new direction to the empirical debate on the terms of trade movement. In their paper, the authors identified the lack of a long term consistent price data as a principal problem

for those focusing on research in the area of long-run trends in the terms of trade. Therefore, the authors Grilli and Yang (1988, p.3) computed,

> a U.S. dollar index of 24 internationally traded non-fuel commodities, beginning in 1900. The basic version of this new index is base weighted with 1977-79 values of world exports of each commodity used as weights.

The two deflators used in their study to derive the two sets of relative prices (or 'real prices') are the modified UNMUV and the USMPI. In recent studies, the latter deflator has not been much used. The UNMUV has been naturally preferred over USMPI because the former consists of a broader basket of commodities and covers a large number of industrial countries. However, in this study, the updated version of the USMPI till 2015 is also used, since it will be interesting to find out how the real prices of internationally traded primary commodities have behaved, in particular, with the prices of the manufacturing sector of the United States of America. It also overcomes the two disadvantages of using UNMUV. Firstly, for the years 1915 to 1920 and 1939 to 1947, the UNMUV index was unavailable and had been interpolated. Secondly, the UNMUV behaves slightly more erratically than USMPI (Grilli and Yang, 1988, p.4). Several studies like Bleaney and Greenaway (1993), Kim et al. (2003), Kellard and Wohar (2006), Razzaque et al. (2007), Kim et al. (2009), Yamada and Yoon (2014), Ghoshray (2011), Ghoshray and Perera (2016) and others have updated the GYCPI employing several different methodologies. To the best of my knowledge, the latest updated GYCPI is available till 2010. In this study, the GYCPI has been updated till 2015 using the methodology developed by Pfaffenzeller et al. (2007). The methodology

developed by these authors has two distinct advantages. Firstly, the figures obtained from this methodology and those obtained by Grilli and Yang (1988) give approximately the same results over the original time frame 1900 to 1986, which indicate the robustness of this methodology. Secondly, it is very flexible and has allowed researchers to update the price index till the latest available statistics, which in our case is 2015.

The figures 1 and 2 give a broad view about the movements in the terms of trade of individual commodities over a time period spanning from 1900 to 2015. Figure 1 summarizes the terms of trade data deflated by the UNMUV for individual commodities. An eyeball test of figure 1 shows that the terms of trade movements varied a lot across commodities and no uniform pattern can be seen across these individual commodities.

[Figure 1 about here.]

Figure 2 shows the terms of trade of the individually traded primary commodities vis-á-vis the manufactured goods in the United States. Similar to the observations in figure 1, it is difficult to conclude any certain pattern for all these individual commodities in figure 2.

[Figure 2 about here.]

3.2 Results

The methodology discussed is employed to estimate the trend values of the terms of trade each commodity and also to address the important question of the empirical validity of PS hypothesis. The slope and p-value of the real trend for each individual commodities are calculated based on the break-points and time series segments. Table 1 shows the slopes of the estimated time trends and the structural break dates for the terms of trade of each individual commodities deflated by the UNMUV.

[Table 1 about here.]

Table 1 helps to identify the dates of structural breaks and to check whether it has any defend-ability with events of international historical significance during the last century. For most commodities with the exception of timber, there were quite a few structural breaks which ranged from two in the case of rice, tobacco and zinc to five in the case of beef. However, these structural breaks for most commodities can be primarily identified in and around four important historical events over the last century: (a) World War I (1914 to 1918) and events, thereafter, leading to the onset of Great Depression (1929), (b) World War II (1939-1945) and the immediate post war rebuilding (1950s), (c) First Oil Crisis (1973-74) and the very recent (d) Commodity Price Boom (late 1990s). This does not, however, imply that all commodities experienced breaks on either all or exactly the same time of these historical episodes. Given the diversity in the nature of these commodi-

ties, such a finding itself will not be very realistic. But, the essential point is that all of these commodities, with the exception of timber, experienced structural breaks during these significant historical events and important economic episodes. As evident from Table 1 and Figure 3, another important break also occurred during the 1980s that affected the prices of quite a few commodities like maize, sugar, lamb, palm oil, cotton, hides, tobacco and aluminum. The breakdown of the International Commodity Agreement and the unfolding of the debt crisis in the early 1980s can be identified as two important economic events which probably caused this structural break over this period.

[Figure 3 about here.]

Table 1 also provides the trend values for individual commodities. Although, nothing general can be concluded for all these individual commodities, two definite patterns can be observed for most of these commodities. Firstly, since the middle of last century till early 1990s, 15 out of 24 commodities (except sugar, lamb, banana, hides, tobacco, timber, copper,aluminum, tin and zinc) experienced a secular decline in their terms of trade. Secondly, all commodities except coffee, tea, cotton and hides are exhibiting a rising trend since the mid-1990s.

[Table 2 about here.]

[Figure 4 about here.]

Table 2 and Figure 4 show the trend analysis for the terms of trade of commodities deflated by the USMPI. As mentioned earlier, this is mainly done to see how the prices of the primary commodities have shaped over time in relation to the prices of manufacturing sector in the United States. The structural breaks identified for all commodities coincide with all those historical events mentioned earlier. As in the earlier case, there is no evidence of any structural breaks for timber. The behavior of trend observed in Table 2 also bears similarity to those in Table 1. This implies that the pattern of trend for most real commodity prices deflated by USMPI is closely comparable to those deflated by UNMUV with the exception of rice. Rice exhibited a dramatically opposite trend pattern when compared with Table 1. Although the rice prices deflated by UNMUV exhibited a strong negative trend, when deflated by USMPI it became a positive one. For all other commodities, the observations of Figure 4 are quite similar and coincides with the patterns for those of Figure 3. The two important distinct patterns which were observed in case of Figure 3 can be also observed in Figure 4. Firstly, cocoa, tea, wheat,maize, banana,cotton, jute, wool, hides and rubber exhibit a negative trend in the post world war II period till the early 1990s. And, secondly, most of the commodities (except coffee, tea, sugar, cotton, hides, tobacco and aluminum) have a statistically significant positive trend since the mid-1990s.

4 Interpreting the Results

Table 1 and Table 2 also show the statistical significance of the estimated time trend for the two time series of real prices of commodities. To estimate the overall direction and statistical significance of these estimated trend values, the trend slopes and p-values for each time series segment were classified into six trend classes following Forkel et al. (2013, p.2123). These classifications are:

N3: significant negative trend (slope<0 and $p \leq 0.05$)

N2: non-significant negative trend (slope<0 and $0.05<p\leq0.10$)

N1: no trend with negative tendency (slope<0 and $p>0.1$)

P1: no trend with positive tendency (slope>0 and $p>0.1$)

P2: non-significant positive trend (slope>0 and $0.05<p\leq0.10$)

P3: significant positive trend (slope>0 and $p\leq 0.05$)

To appraise the validity of the PS hypothesis, a simple methodology is employed following the procedure of Kellard and Wohar (2006)- the number of years of N3 is compared relative to the number of years of P3. In case, for any individual commodity, the number of years of N3 exceeds the number of years of P3, we conclude that PS hypothesis is valid for that individual commodity. Otherwise, we reject the empirical validity of PS hypothesis for that commodity.

[Table 3 about here.]

Table 3 summarizes the number of years in which each individual commodity experienced significant negative trend (N3) and significant positive trend (P3)over the study period (1900 to 2015). When the commodity prices are deflated by UNMUV, 10 out of 24 commodities provided support for the PS hypothesis. These commodities are coffee, cocoa, tea, rice, wheat, wool, hides, rubber, copper and lead. The remaining 14 commodities did not provide any statistically significant evidence in favor of the "deterioration hypothesis". When these commodity prices are deflated by USMPI, we find a similar result. Again, 10 out of 24 commodities showed evidence in favor of the PS hypothesis, while 14 commodities did not. However, the commodities which provided evidence in favor of PS hypothesis in the latter case are different. These commodities are coffee, cocoa, tea, wheat, maize, cotton, hides, rubber, silver and lead.

Although, in totality, there is no evidence in favor of the PS hypothesis, but two important points need to be noted here. Firstly, the recent episode of commodity price boom significantly affects the overall scenario of terms of trade over the last century. When one excludes this last phase and only takes into consideration the period spanning from 1900 until this commodity price boom, the real prices (deflated by UNMUV) of 15 out of 24 commodities provide evidence in favor of the PS hypothesis. In case the terms of trade are deflated by USMPI, the number stands at 13 out of the 24 commodities studied. Hence, it can be concluded from this finding that the recent episode

of commodity price boom had a significant impact on the secular trend of commodity prices.[8] Secondly, it seems that a lot also depends on the nature of the primary commodities i.e. whether these are agriculture-based or mining-based products. It is evident from Table 3 that agricultural commodities tend to support the 'deterioration hypothesis' rather than those belonging to the category of metals. Therefore, aggregating the commodities based on the categories like food items, agricultural raw materials and metals might help in further understanding of the PS hypothesis. [9]

4.1 Aggregating the Commodity Price Index

In this subsection, the trend results obtained after aggregating the primary commodities based on the categories of food, agricultural raw materials and metals are discussed. As mentioned above, one of the main reason for doing this is to identify whether the PS hypothesis depends on the particular nature of these primary commodities.

[Figure 5 about here.]

[Figure 6 about here.]

[8]Interestingly, this seems to be a general problem with time series studies since a lot depends on the start and end period of the study. In the literature, this problem has also been identified by Yamada and Yoon (2014, p.203).

[9]The aggregation of commodities to broader categories is subjected to criticism in the literature due to the issue of weights. However, we still apply this weightage methodology to formulate sub-groups of commodities to get a better idea about the PS hypothesis based on the nature of the commodities studied. Here, in this study, we formulate the categories using the same weights as used in the original study of Grilli and Yang (1988).

Figure 5 and Figure 6 show the movements of the international terms of trade of food items, agricultural raw materials and metals deflated by UNMUV and USMPI, respectively. The movements of the terms of trade for both these indices are quite identical. An eyeball test of these graphs seem to suggest that the first oil crisis of the early 1970s affected the food commodities more than those of agricultural raw materials and metals. We apply the same methodology to obtain structural breakpoints and trend values for each of these aggregated sub categories of primary commodities to test the PS hypothesis.

[Table 4 about here.]

Table 4 gives the estimates of the trend values and identifies the structural break dates of the sub-group of primary commodities, namely food items, metals and agricultural raw materials deflated by UNMUV and USMPI.

[Figure 7 about here.]

[Figure 8 about here.]

Similarly, Figure 7 and Figure 8 provides an illustration of the results obtained in Table 4. The structural breaks aptly coincide with the four historical episodes mentioned earlier. When deflated by UNMUV, the first structural break during 1917-1920 was marked by the end of World War I and then the onset of the Great Depression (1929-30). The second structural break coincides with period of World War II(1939-1945) and the immediate postwar rebuilding of the early 1950s. The third break point of the 1970s

corresponds to the First Oil Shock and the fourth with the recent episode of commodity price boom (1997-98). When the real prices of commodities are deflated by USMPI, the First World War I had an impact on metals, whereas the onset of Great Depression impacted the agricultural products i.e. food and agricultural raw materials. Thereafter, the structural breaks are marked by the World War II period and the post recovery. The first oil shock had an impact on the agricultural products, while the commodity price boom affected all the three categories of commodities. The evidence in Table 4 shows that terms of trade of agricultural commodities, whether food or agricultural raw materials, have declined relatively more compared to the metals. This evidence is stronger when deflated by UNMUV rather than USMPI. Secondly, although there has been statistically significant negative trend during the second half of last century, the recent episode of the commodity price rise had substantially improved the terms of trade for all categories of commodities. To get a clearer picture of this argument, another table (Table 5) is constructed to find out the total number of years in which these categories of commodities exhibit statistically significant positive (P3) and negative (N3) trends over the study period.

[Table 5 about here.]

Table 5 shows that the 'real prices' of metal commodities do not provide empirical support to the PS hypothesis when deflated either by UNMUV and USMPI. On the other hand, the terms of trade of agricultural raw materials provide strong support for the PS hypothesis in both these cases. However,

the experience with the food items is mixed. When the prices of food items are deflated by UNMUV, it provides support in favor of PS hypothesis, while being deflated by USMPI, it does not provide a substantial empirical support. Nonetheless, the other interesting point to note in this discussion is that, similar to the experience of the individual commodity case, if one excludes the experience of recent commodity price boom, then both categories of agricultural commodities, food items and agricultural raw materials, experienced a deteriorating trend over the last century. It further strengthens our earlier observation that the recent episode of commodity price boom had has a significant impact on the overall experience of terms of trade since 1900.

5 Conclusion

This study addresses an age-old debate that persists till date in the trade and development literature - a debate with reference to movements in the terms of trade of primary commodities vis-á-vis manufactured goods. In the middle of last century, Prebisch and Singer hypothesized that there is a tendency of a secular decline in the terms of trade of primary commodities vis-á-vis manufactured goods. This paper tries to analyze the empirical evidence for it using the GYCPI data set over a time period spanning from 1900 to 2015. The methodology employed can be encapsulated as a three fold approach: a) endogenous determination of structural breaks; b) estimation of trend through piece-wise linear regression; and c) validation of the statistical significance of the trends applying the Mann-Kendall test. Applying these

methodology on the GYCPI data set, the results which we obtain are diverse. There are four structural breaks endogenously determined that correspond to four important historical events over the last century: (a) World War I (1914 to 1918) and it's effects thereafter leading to the onset of Great Depression (1929-30); (b) World War II (1939-1945) and the immediate post war rebuilding (1950s); (c) First Oil Crisis (1973-74) and (d)Commodity Price Boom (late 1990s). If one considers, in totality, the entire period of study i.e. 1900 to 2015, then the empirical evidence in support of PS hypothesis is weak. However, if one considers the experience of the last century, especially the period spanning from the post World War II rebuilding till the recent episode of commodity price boom i.e. late 1990s, then the evidence in favor of PS hypothesis is strong. The other important finding which came out from this research is that the PS hypothesis is also affected by the nature of the commodities i.e. the terms of trade of agricultural commodities are prone to more secular decline than metals.

The findings in this study have some serious implications in terms of policy and future research direction. The policy implications from the writings of the classical economists were that a developing country, specializing in the production of agricultural commodities, need not industrialize to enjoy the fruits of technological progress in the manufacturing sector; free play of the international market forces would distribute the gains from technological progress of the industrial countries to the developing countries by turning the terms of trade in favor of the primary commodity producing countries. How-

ever, as noted by Prebisch and Singer and as this research also shows, if one considers the experience over the last century, that evidence went contrary to the classical proposition. The policy prescription of Prebisch and Singer was, therefore, an "inward-oriented" industrialization of the developing countries by suspension of free play of market forces, which proceeds basically by means of import substitution. However, with the ongoing phenomenon of liberalization and globalization since the 1980s, the reality had has been quite the opposite. Most economies, especially the developing ones, have been opened up to the free play of market forces. Since then, the movement of agricultural prices can be divided into two segments. During the first half, a dramatic decline in commodity prices till the late 1990s and since then, for almost two decades now, there is a commodity price boom that has substantially increased the real commodity prices. The factors causing this price rise have been discussed, in great details, in various articles including Chakraborty (2015), Ghosh (2010) and Patnaik (2008). It has been argued, elsewhere, that this recent commodity price boom is a fallout of the declining terms of trade experienced during the first phase leading to an agrarian crisis. Hence, based on the overall weak evidence in support of PS hypothesis from the current research, it won't be a good idea, especially in the context of the developing countries, to completely abandon the policy prescription of Prebisch and Singer. In fact, rather, it needs to be implemented more strongly. The agricultural farmers need to be supported so as to enable them to improve the agricultural supply conditions and their farm incomes and livelihoods. Furthermore, the developing country economies, especially the LDCS, whose export basket still has a substantial part of these primary commodities, need

to be protected from the vagaries of these fluctuating prices.

As evident from this research, it is indeed true that the present episode of rise in commodity prices has surpassed all previous similar episodes of the last century in terms of both the magnitude and duration. Nonetheless, the important question is to analyze whether this situation of rising commodity prices is turning out to be a permanent one, as predicted by Krugman, or is it another common episode of price volatility (Caine, 1963). This question needs to be further investigated and will become an important task for the researchers in the near future.

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Figure 1: Terms of Trade of Primary Commodities deflated by UNMUV (1900 to 2015)

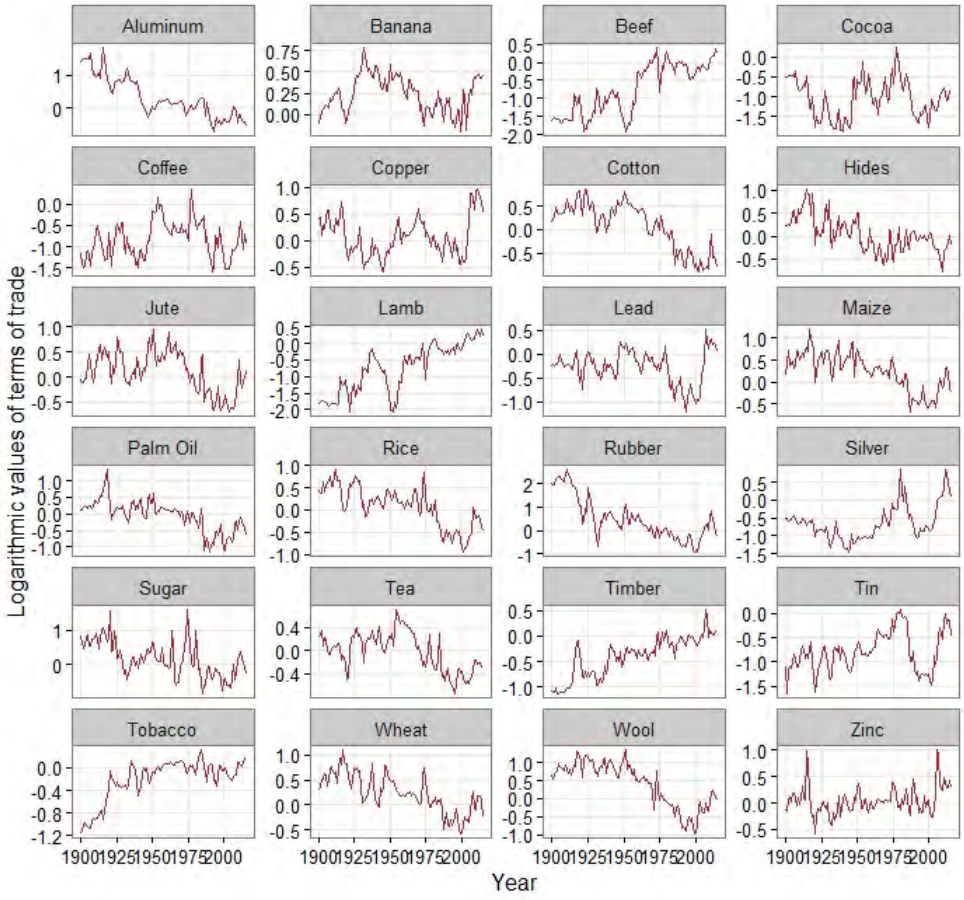

Figure 2: Terms of Trade of Individual Primary Commodities deflated by USMPI (1900 to 2015)

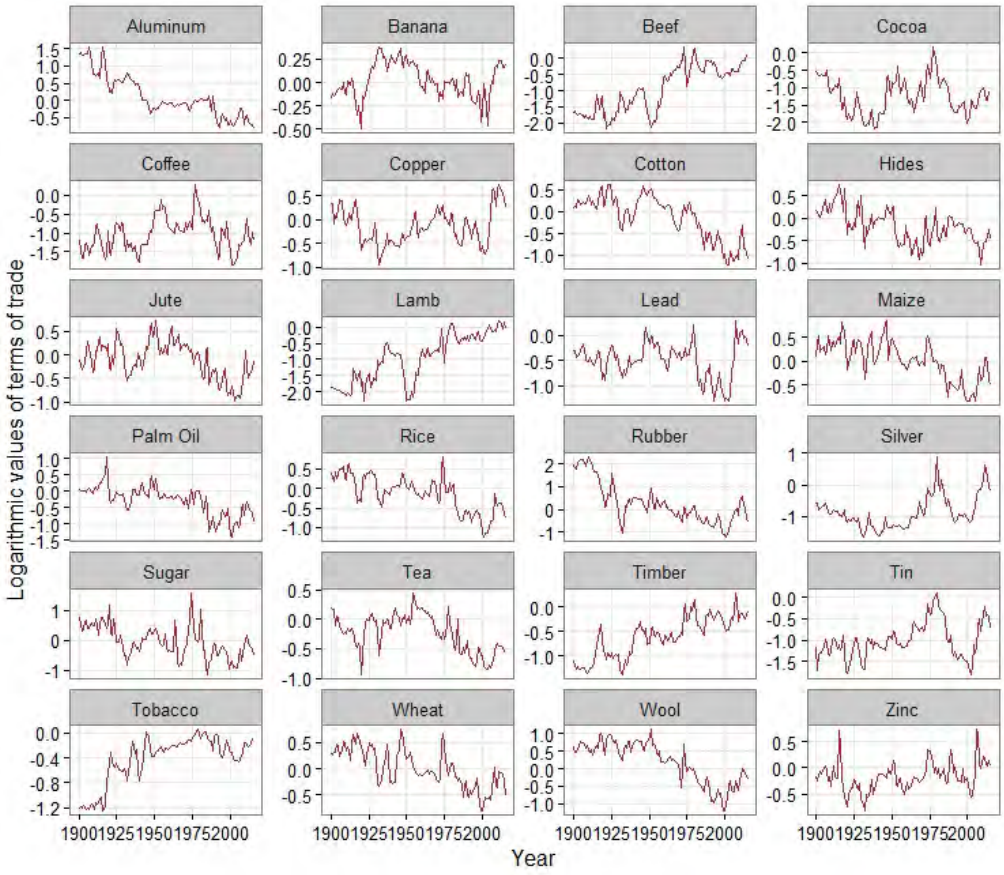

Figure 3: Structural Breaks and Trends in Terms of Trade deflated by UN-MUV(1900 to 2015)

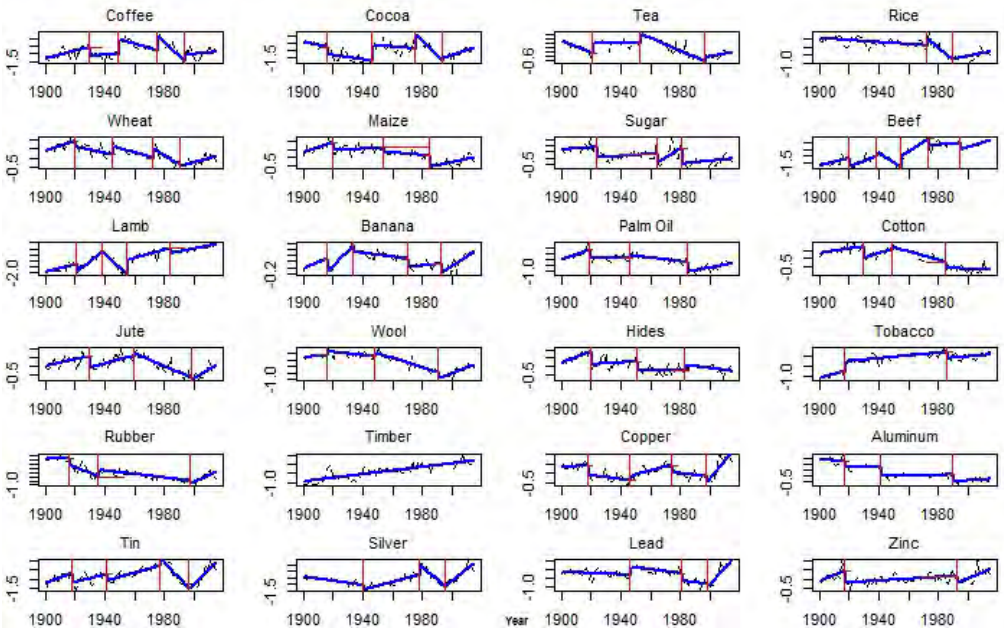

Figure 4: Structural Breaks and Trends in Terms of Trade deflated by USMPI (1900 to 2015)

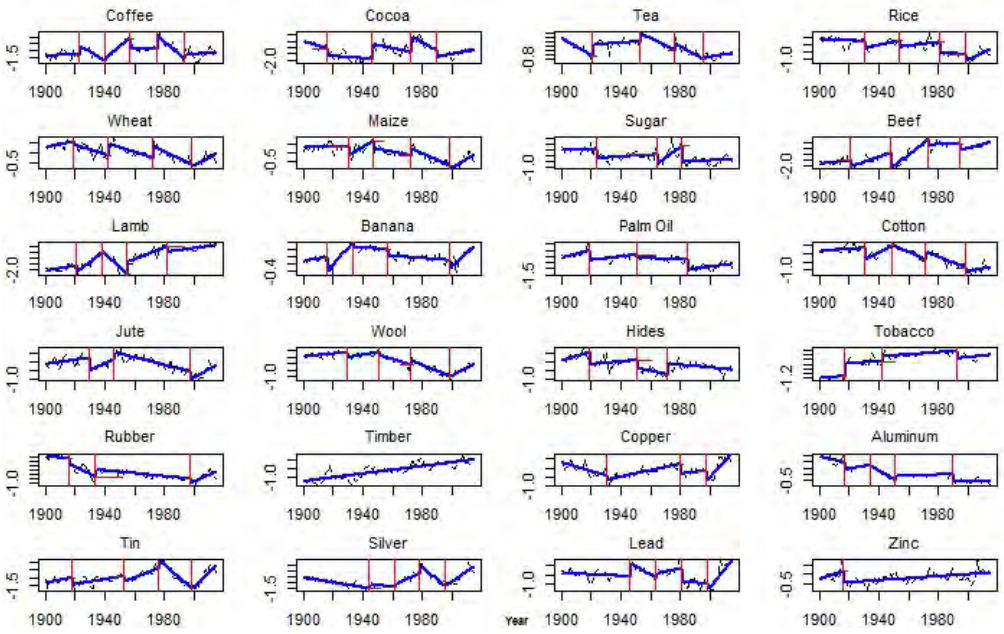

Figure 5: Terms of Trade of Aggregated Primary Commodities deflated by UNMUV (1900 to 2015)

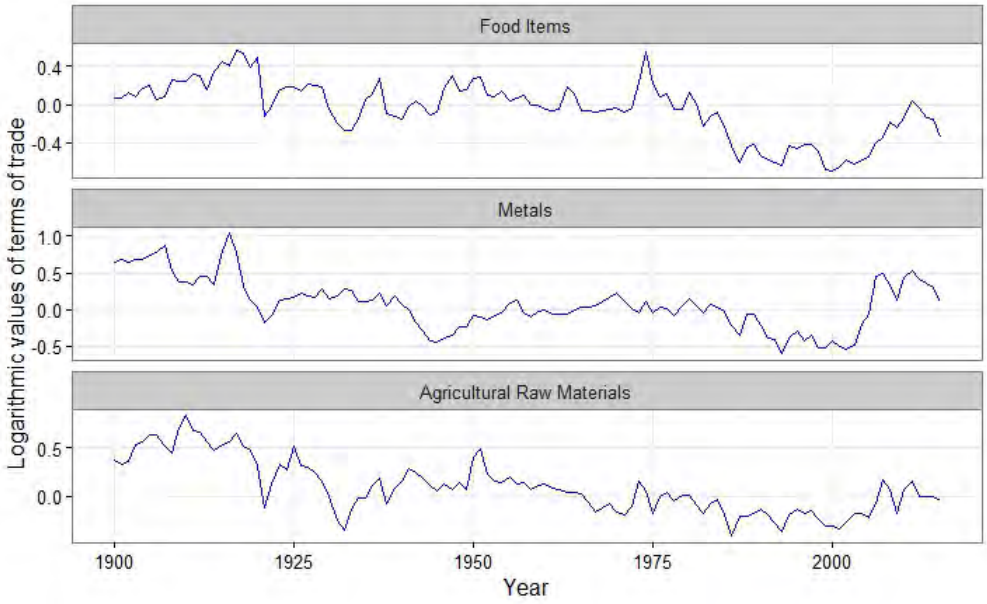

Figure 6: Terms of Trade of Aggregated Primary Commodities deflated by USMPI (1900 to 2015)

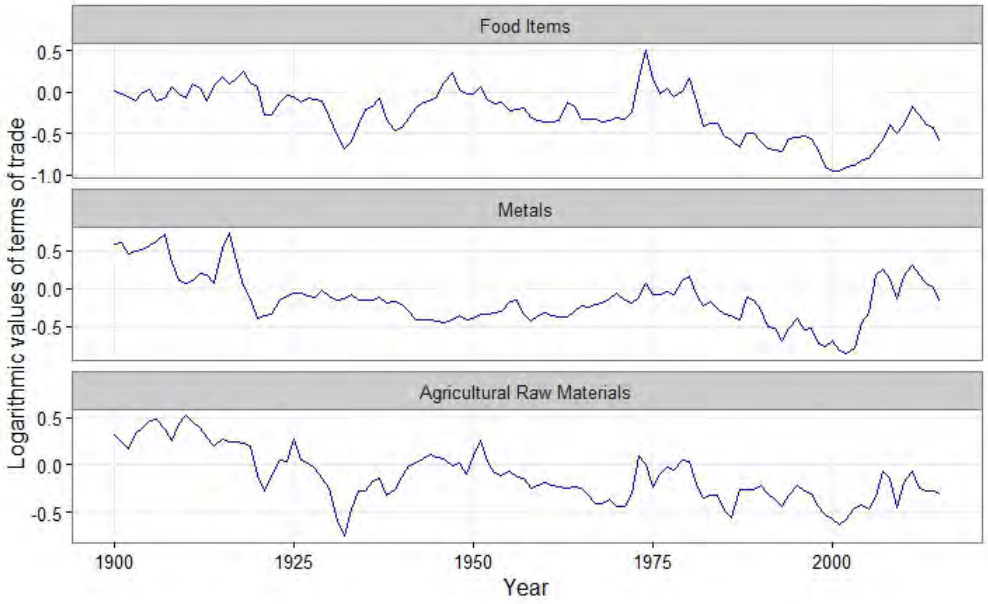

Figure 7: Structural Breaks and Trends in Terms of Trade of Aggregated Primary Commodities deflated by UNMUV (1900 to 2015)

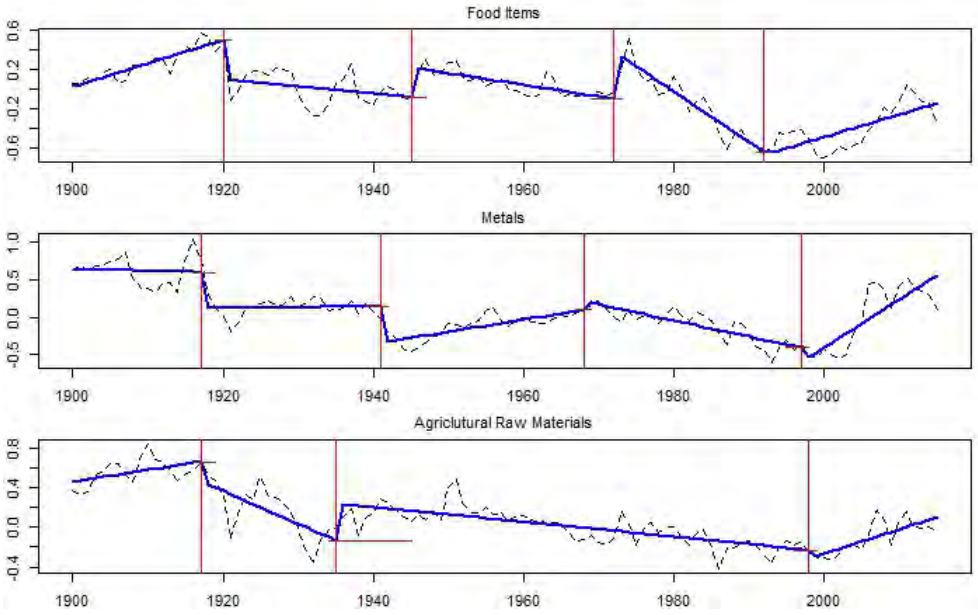

Figure 8: Structural Breaks and Trends in Terms of Trade of Aggregated Primary Commodities deflated by USMPI (1900 to 2015)

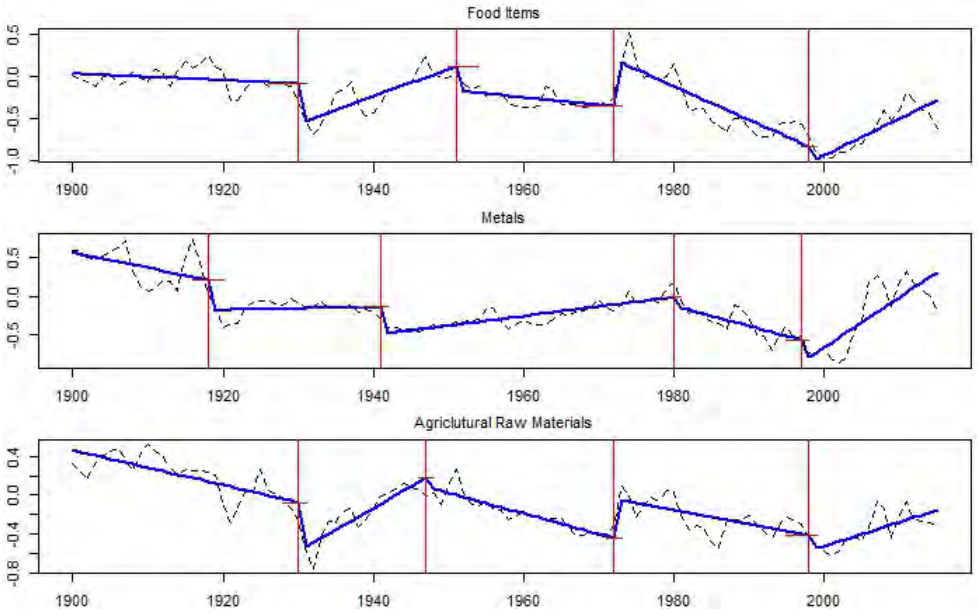

Table 1: Slopes(in percent) and structural break dates of ToT deflated by UNMUV

Commodities	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6
Coffee	2.46**	0.46	-2.89**	-9.07**	0.86	
	[1929]	[1949]	[1975]	[1993]		
Cocoa	-2.17**	-1.53**	-0.82	-10.10**	3.17**	
	[1916]	[1946]	[1975]	[1993]		
Tea	-2.71**	-0.09	-3.05**	1.24		
	[1921]	[1953]	[1996]			
Rice	-0.64**	-7.83**	1.78**			
	[1972]	[1989]				
Wheat	2.58**	-1.75**	-2.35**	-5.01**	2.23**	
	[1920]	[1945]	[1972]	[1990]		
Maize	3.07**	0.56	-0.75**	1.96**		
	[1920]	[1954]	[1985]			
Sugar	0.86	0.81	7.13**	1.19*		
	[1924]	[1964]	[1981]			
Beef	2.79	4.60**	-6.84**	-7.34**	0.98	3.61**
	[1920]	[1938]	[1955]	[1973]	[1994]	
Lamb	3.00	10.20**	-11.00**	3.32**	2.35**	
	[1921]	[1938]	[1955]	[1984]		
Banana	1.86**	5.25**	-0.61**	0.53*	3.09**	
	[1916]	[1933]	[1970]	[1992]		
Palmoil	4.32**	0.14	-1.51**	2.34**		
	[1919]	[1946]	[1985]			
Cotton	1.33**	2.61**	-2.46**	-0.38		
	[1929]	[1949]	[1985]			
Jute	1.76**	2.19**	-3.49**	4.68**		
	[1929]	[1959]	[1998]			
Wool	1.01	-1.23**	-3.57**	4.30**		
	[1916]	[1948]	[1990]			
Hides	3.32**	0.54	0.02	-1.15**		
	[1920]	[1951]	[1983]			
Tobacco	1.91**	0.67**	0.59**			
	[1917]	[1986]				
Rubber	-0.21	-2.75**	-2.12**	7.74**		
	[1916]	[1935]	[1997]			
Timber	0.99**					
Copper	0.71	-1.01**	2.10**	-0.75*	8.98**	
	[1918]	[1946]	[1974]	[1997]		
Aluminum	-1.28	0.27	0.14	0.83*		
	[1917]	[1941]	[1989]			
Tin	3.20**	2.30**	2.42**	-9.49**	8.31**	
	[1918]	[1941]	[1977]	[1996]		
Silver	-1.64**	3.13**	-1.05**	8.81**		
	[1940]	[1978]	[1995]			
Lead	-0.38**	-1.03**	-1.11	9.27**		
	[1946]	[1981]	[1998]			
Zinc	3.2**	0.5**	3.2**			
	[1917]	[1992]				

Table 2: Slopes(in percent) and structural break dates of ToT deflated by USMPI

Commodities	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6
Coffee	0.44	-6.52**	8.38**	0.099	-9.3**	0.26
	[1923]	[1940]	[1957]	[1975]	[1993]	
Cocoa	-3.45**	-0.89	-2.34**	-6.40**	2.24**	
	[1916]	[1946]	[1972]	[1989]		
Tea	-3.75**	0.43*	-3.39**	-3.39**	1.02	
	[1921]	[1953]	[1976]	[1995]		
Rice	-0.51	2.21**	1.28*	-0.44	4.66**	
	[1930]	[1954]	[1981]	[1998]		
Wheat	1.52**	-2.55**	-2.49**	-3.80**	3.94**	
	[1919]	[1942]	[1972]	[1998]		
Maize	0.17	4.78	-1.65**	-3.97**	4.87**	
	[1930]	[1947]	[1972]	[1998]		
Sugar	0.10	0.86	9.25**	0.75		
	[1924]	[1964]	[1981]			
Beef	1.31	4.18**	9.68**	0.64	3.07**	
	[1921]	[1948]	[1973]	[1994]		
Lamb	1.96	9.94**	-11.10**	4.87**	1.64**	
	[1921]	[1938]	[1955]	[1982]		
Banana	0.59**	5.15**	-0.12	-0.33**	3.75**	
	[1916]	[1933]	[1957]	[1998]		
Palmoil	3.12**	1.54**	-0.51	1.54**		
	[1919]	[1951]	[1985]			
Cotton	0.53	4.73**	-4.06**	-3.72	1.82	
	[1930]	[1949]	[1971]	[1998]		
Jute	1.19**	3.69**	-2.12**	4.50**		
	[1929]	[1946]	[1997]			
Wool	1.00**	1.97**	-3.64**	-4.78**	5.95**	
	[1929]	[1951]	[1972]	[1998]		
Hides	2.62**	0.84**	-1.95**	-0.82**		
	[1919]	[1951]	[1971]			
Tobacco	0.50	0.32	0.45**	0.65		
	[1917]	[1942]	[1992]			
Rubber	-1.5	-9.13**	-1.75**	7.69**		
	[1916]	[1935]	[1997]			
Timber	1.04**					
Copper	-2.41**	1.8**	1.00	8.93**		
	[1930]	[1980]	[1997]			
Aluminum	-2.7**	2.15**	-6.33**	0.32**	0.037	
	[1917]	[1934]	[1951]	[1989]		
Tin	1.87**	1.56**	3.74*	-8.54**	9.28**	
	[1918]	[1953]	[1976]	[1998]		
Silver	-2.08**	-0.74**	5.78**	-10.4**	8.42**	
	[1944]	[1961]	[1978]	[1995]		
Lead	-0.41**	-4.60***	1.40*	-0.47	9.34**	
	[1946]	[1963]	[1981]	[1998]		
Zinc	2.45	0.52**				
	[1916]					

Table 3: A Comparison of the Number of years in N3 and P3 category (1900-2015)

Commodities	ToT Deflated by UNMUV			ToT deflated by USMPI		
	Years of N3	Years of P3	Valid	Years of N3	Years of P3	Valid
Coffee	44	29	YES	35	17	YES
Cocoa	64	23	YES	59	26	YES
Tea	64	0	YES	63	0	YES
Rice	99	27	YES	0	41	NO
Wheat	70	45	YES	79	36	YES
Maize	31	50	NO	42	17	YES
Sugar	0	18	NO	0	17	NO
Beef	35	37	NO	0	73	NO
Lamb	17	78	NO	17	77	NO
Banana	37	56	NO	41	50	NO
Palm-oil	39	49	NO	0	81	NO
Cotton	36	49	NO	22	19	YES
Jute	39	76	NO	51	64	NO
Wool	74	25	YES	48	68	NO
Hides	32	20	YES	64	51	YES
Tobacco	0	115	NO	0	50	NO
Rubber	81	18	YES	81	18	YES
Timber	0	115	NO	0	115	NO
Copper	51	46	YES	30	68	NO
Aluminum	0	0	NO	34	55	NO
Tin	19	95	NO	22	93	NO
Silver	57	58	NO	78	34	YES
Lead	81	17	YES	63	17	YES
Zinc	0	115	NO	0	95	NO

Table 4: Slopes(in percent) and structural break dates of ToT deflated by UNMUV and USMPI

Commodities	Period 1	Period 2	Period 3	Period 4	Period 5
Deflated by UNMUV					
Food Items	2.37**	-0.73	-1.20**	-5.17**	2.29**
	[1920]	[1945]	[1972]	[1992]	
Metals	-0.21	0.09	1.62**	-2.15**	6.43**
	[1917]	[1941]	[1968]	[1997]	
Raw Materials	1.18*	-3.32**	-0.74**	2.41**	
	[1917]	[1935]	[1998]		
Deflated by USMPI					
Food Items	-0.39	3.25**	0.85*	-3.97**	4.31**
	[1930]	[1951]	[1972]	[1998]	
Metals	-1.97*	0.19	1.22**	-2.59**	6.38**
	[1918]	[1941]	[1980]	[1997]	
Raw Materials	-1.79**	4.44**	-2.11**	-1.46**	2.48**
	[1930]	[1947]	[1972]	[1998]	

Table 5: A Comparison of the Number of years in N3 and P3 category (1900-2015)

Commodities	N3	P3	Valid
Deflated by UNMUV			
Food Items	45	43	YES
Raw Materials	81	34	YES
Metals	29	45	NO
Deflated by USMPI			
Food Items	26	38	NO
Raw Materials	81	34	YES
Metals	17	57	NO