Can Globalisation Stop the Decline in Commodities' Terms of Trade?

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Abstract: In this paper we address the following important question: would a fully integrated world economy eliminate the widely reported decline in the terms of trade of primary commodities? We address the question by looking at the terms of trade (ToT) within the US (a highly integrated economy). Our findings show two results. First, US internal real commodities' ToT over the 1947-1998 period experienced slowly declining but significant trends. Second, once we control for the effect of US prices on international internal ToT, we find a long-run relationship between the US and international relative prices. These findings support the view that the decline of commodities' terms of trade bears no relationship with the process of globalisation. This seems to indicate that, if world ToT behaved as the US internal ToT, neither increased integration nor protectionist measures would eliminate this trend.

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1. Introduction

Since the seminal work of Prebisch (1950) and Singer (1950), a strand of the Development Economics literature has been concerned with the secular decline in the net barter terms of trade of commodities. The hypothesis is important because, if true, the gains accruing from trade and technological progress for commodity-exporting countries would be reduced. The negative long-run trend of commodity prices has been well documented in the literature [Grilli and Yang, 1988; Reinhart and Wickham, 1994]. Lutz (1999), for instance, finds support for the fact that there is a negative long-run trend in the relative price of primary commodities, using a general time series framework that encompasses univariate and bivariate models. León and Soto (1995) use nonparametric measures such as variance ratios to show that 19 of the 24 commodity prices present persistence levels lower than previous estimates over the 1900-1992 horizon[1]. Cashin and McDermott (2002) focus on volatility trends and acknowledge the downward trend in real commodity prices. Yet they dismiss it as of little practical policy relevance, due to the "smallness" of the trend. Regarding the terms of trade between commodities and manufactured goods, Ardeni and Wright (1992) find a robust secular deterioration of terms of trade. More recently, Zanias (2005) employs the extended Grilli and Yang (1988) terms of trade series and finds declining trend of terms of trade for the period 1900 to 1998. Bunzel and Vogelsang (2005) propose a test for trends in the data that does not require a-priori information about the serial correlation characteristics of the data and find significant negative trends in the net barter terms of trade of primary commodities.[2,3]

[1] Cuddington (1992) Badillo et al. (1999) and Kellard and Wohar (2005) examine trends in individual commodity prices and Sapsford (1985) and Cuddington and Urzua (1989) examine trends in aggregate commodity price indexes.

[2] For other studies reporting results that suggest that there has been a deterioration in the terms of trade see Spraos (1980), Thirlwall and Bergevin (1985), Powell (1991) and Bloch and Sapsford (1997).

[3] Nevertheless, authors such as Bleaney and Greenaway (1993) and Cashin and McDermott (2006) consider that the downward trend is often sample-specific and is confined to the 1920s and 1980s.

If one assumes that poor countries export mainly primary goods and industrialized countries specialize in the export of manufactured products, the worsening of the commodities' terms of trade may lead to a deterioration of the living standards in poor countries and reinforce a pattern of specialization in commodities that would keep them poor. Under these circumstances, trade would benefit mainly industrialized countries.

Both Singer (1950) and Prebisch (1959) consider the income elasticity of demand as an important element in the explanation of the deterioration in the terms of trade between commodities and manufactured goods. The income elasticity of demand, as suggested by Engel's Law, is higher for manufactured goods than for commodities. As income raises the demand for manufactured goods rise more than the demand for commodities. In addition, Prebisch (1959) stresses the uneven form in which technical progress has spread into the world economy and Singer (1950) regards the distribution of the benefits of technical progress to producers or to consumers as another important factor. For instance, if producers of industrial goods have market power they can capture the benefits of higher productivity in the form of higher incomes, while the producers of primary commodities generally take their prices as given, and all the benefits accrue to consumers. The policy prescription derived from the Prebisch-Singer hypothesis is that developing countries should diversify into manufacture exports. However, to achieve this objective these countries would need to substitute their imports, which implies a decrease in their international trade openness.

The Prebisch-Singer thesis outlined above spurred a huge body of literature known as North-South models of growth and trade. This literature emphasizes asymmetric interaction between two regions, and assumes one or more of the following: the North is specialized in manufactures and capital goods; producers are price-setters; demand for northern goods is price-elastic; the North employs high-skilled workers; the North creates new products and technologies; and the North has increasing returns. As for the South, it is assumed that it produces primary commodities, producers are price-takers; labour supply is more elastic; demand for southern goods is price inelastic; the South imitates the North; and the South has decreasing returns [Blecker, 1996].

In this paper we ask the question: *can the process of globalisation and integration of goods and factor markets stop the decline in the relative commodities' terms of trade?*

The question is important because as world markets become more integrated, one would expect to see the asymmetries between North and South become smaller. As capital, labour, and technology become more mobile and goods markets are more integrated, the North-South divide should, at least in theory, disappear. For instance, the production of manufactured goods would become globalized through FDI, which, in turn, would be a vehicle for the transfer of know-how. Skilled and unskilled workers would also be able to move between countries according to their marginal productivities. This would lead to a more homogeneous distribution of market structures. In order to address this question this paper studies the terms of trade between different commodity and manufactured goods price indexes in the US, which is assumed to be a fully integrated economy. The US economy is chosen because it is the largest economy in the world and also a very integrated market in terms of goods and factor movements. Our implicit assumption is that globalisation, understood as the process where the asymmetries viewed above fade away, would make the world economy behave as the US economy. In other words, globalisation would lead to a state in which the world economy becomes closer to an integrated national economy with different regions. Although we do not want to claim that the behaviour of world prices would necessarily mimic that of the US economy, the analysis of the commodities ToT in an integrated economy can shed light on whether globalisation is likely to play an important role for the dynamics of relative prices.

Hence, we use US Producer Price Index (PPI)-based data to test the Prebisch-Singer hypothesis for the internal US commodities' terms of trade. Our results show that most series can be represented as difference stationary series around a negative trend, which supports the Prebisch-Singer hypothesis. Given these supportive results, the only potential explanations left for these findings in a fully integrated economy are: 1) Engel's Law; 2) differences in the market structure between sectors of the US economy; and 3) uneven distribution of technology, human capital and knowledge. This implies that international trade and integration plays no role in explaining the declining terms of trade. The next step is then to test if this could also be the case for the international economy. To this end we test if US and international terms of trade share long-run common trends. Our findings show that the US series shares a positive long-run relationship with that of the international (non-US) counterpart. Given that both series appear to share common long-run trends, it follows that international trade does not appear to play an important role in causing the decreasing trend of the international terms of trade. As an implication, we would expect that globalisation would not eliminate this trend either. That is, if both internal US terms of trade and international non-US terms of trade behave in a similar fashion even though they are distinctly at very different levels of integration, globalisation cannot be an explanation for the decline in terms of trade. A corollary of this conclusion would be that declining terms of trade cannot be addressed either by protectionist policies.

The paper is organized as follows. Section 2 discusses the Prebisch-Singer hypothesis and the implications of globalisation. Section 3 discusses the data. Section 4 presents the empirical findings and Section 5 provides some concluding remarks.

2. The Prebisch-Singer hypothesis and globalisation

As discussed earlier, the Prebisch-Singer hypothesis was a starting point for a growing strand of the literature on North-South models of trade and growth. The Prebisch-Singer hypothesis is based on the existence of asymmetries in specialization patterns, patterns of technical progress between different sectors, and patterns of demand growth for commodities and non-commodity products. It follows that some sort of asymmetry between North and South motivated the models developed thereafter. Although the theoretical case for a downward trend in commodities' ToT did not have good foundations at the beginning of this literature, several explanations for this decline have arisen within the context of North-South models of trade and growth. These explanations are based on asymmetries in terms of technology, innovation and economic structure (labour and product markets).

In a recent survey, Chui et al (2002) classify this literature according to its use of old or new growth and trade models[4]. In the old growth and old trade models [e.g., Findlay, 1980; Burgstaller and Saavedra-Rivano, 1984] the fundamental asymmetries are

[4] However this classification is not exhaustive since some studies deal with alternative approaches, such as: the Marxist model of Dutt (1988), the structuralist approach of Taylor (1991) and the Pasinetti's structural economic dynamics of Araújo and Teixeira (2004). The model of Bloch and Sapsford (2000) is based on differences in price and wage setting mechanisms between manufacturing and primary commodities. See also Darity and Davis (2005).

related to surplus labour supply in the South. In the old growth and new trade models [e.g., Krugman, 1979; Dollar, 1986], asymmetries arise as a consequence of the higher rate of innovation of the North relative to the South. In the new growth and new trade models [e.g., Grossman and Helpman, 1991; Currie et al., 1999; Chui et al., 2002] through imitation the South eventually develops the ability to innovate through imitation, which can in turn improve the terms of trade and reduce unequal exchange.

The asymmetries between North and South, hence, help explain the deterioration of the terms of trade between commodities and manufactured goods. However, as the world economy progresses towards greater integration, through globalisation[5], it is natural to assume that all asymmetries between regions must, in the limit, disappear. Surplus labour differences, technological advantages and capital intensity would fade out as the world market becomes more integrated. As a consequence, one should expect that in a fully integrated world economy the evolution of the terms of trade should be determined ultimately by changes in productivity, tastes, and market structures. From this discussion it follows that if a clear trend appears in the terms of trade of commodities in a fully integrated economy, it cannot be due to the impact of international trade, but a consequence of the evolution of these three variables.

A natural economy to analyze in this context is the US. Given that the US economy is large and very integrated in terms of inter-regional trade and factor mobility, it would be an approximation to the fully integrated world economy. This is not, of course, meant to describe how a fully integrated World economy would work. The US provides us with a counterfactual in which trade, capital, cultural, and political barriers are close to inexistent. In this respect, an integrated global market would approximate in the limit the US market, but it is unlikely that it will behave in exactly the same way. Nevertheless, our intention is to provide evidence on whether the PS hypothesis would hold when asymmetries are eliminated. To the extent that globalisation reduces these asymmetries, the US case can be thought of as the limit towards which an integrated economy would move, but it is unlikely that border effects in the World markets would be erased in the same way as within the US economy. The US economy is also relatively closed with the rest of the world. Note, however, that this relative small degree of

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[5] See The World Bank's Development Education Program (2004).

openness is not a necessary condition to make the US an ideal field of analysis. Any change in the international (non-US) relative price of commodities stemming from international trade asymmetries should be corrected internally through a process of factor reallocation or technology diffusion. For instance, if product innovation takes place in the world manufacturing sector that drives up the relative price of manufactures in the world economy, we would expect that, at the national level (in the US) workers and capital would move to the manufacturing sector driving down its prices and up those of commodities. Hence, what matters here is only that the US is more integrated than the international economy.[6]

Given the discussion above, we address the question of the impact of globalisation on the terms of trade of primary commodities following a two-step procedure. First, we test if the internal terms of trade of the US economy follow a declining pattern as predicted by the Prebisch-Singer hypothesis. If this pattern appears, this is evidence against international integration being responsible for the declining terms of trade. Secondly, we test if the US terms of trade share common trends with the international ones. Evidence in favour of common trends would point out that the forces behind the reported decline in international terms of trade are driven by the same factors as those driving US terms of trade. The consequence would then be that asymmetries due to the lack of integration in world markets cannot explain the negative trend in international terms of trade.

3. The Data

Our analysis employs US PPI data. We examine various series from the FRED database of the US Federal Reserve Board of Saint Louis (http://research.stlouisfed.org/), originally released by the BLS (http://www.bls.gov) of the US Department of Labor. This data set is available mostly for the postwar period with the exception of the "all commodities" that starts in 1921. This makes us confine the analysis in this paper to the

[6] A potential distorting factor for terms of trade of commodities and resource allocation within the US economy is farm subsidies. However, subsidies would affect the *level* of farm production and prices but not their trend. The same reasoning applies to factor movements, as subsidies can alter static factor allocation but not the *dynamics* of factor reallocation through time. This would require constantly growing or declining subsidies.

period starting in 1947. We inspect the classification scheme of goods in order to distinguish between commodity-based and manufactured goods. We then exclude the very general (e.g., the "all commodities" series) and concentrate on specific ones as detailed below. In fact, prior to 1978, with the transition to the current methodology, the BLS had focused on general indexes that were subject to bias from the multiple counting of price changes.[7]

Among the PPI series, the Finished Goods Price Index is a very closely watched indicator. According to the BLS (2003), movements in this index are considered to lead similar changes in inflation rates for retail markets, as measured by the CPI in the BLS.[8] The Index for Crude Materials Other than Foods and Energy, in contrast, is quite sensitive to shifts in total demand and can be a leading indicator of the state of the economy. Its limited scope, however, makes it less reliable as an indicator of future inflation.

All data use 1982 as base year, have been seasonally adjusted by the BLS, and run from 1947:4 to 1998:12 with a monthly frequency.[9] Our analysis will focus on the following series:

PFCGEF: Producer Price Index: Finished Consumer Goods Excluding Foods;

PPIFCF: Producer Price Index: Finished Consumer Foods;

PPIPCE: Producer Price Index Finished Goods: Capital Equipment;

PPIITM: Producer Price Index: Intermediate Materials, Supplies & Components; and

PPICRM: Producer Price Index: Crude Materials for further Processing.

Details on these price indexes can be found in Varella-Mollick et al (2005) where we explain the construction of these series at length. Given the descriptions from BLS,

[7] According to the BLS (2003) "Handbook of Methods", multiple-counting bias means that price changes for components that go through many stages of processing have an excessive influence on aggregate index series. This problem is common among highly aggregated traditional commodity groupings because they are calculated from price changes of commodities at several stages of processing, wherein each individual price change is weighted by its gross value of shipments in the weight-base year.

[8] On the divergence between CPI and PPI series, the BLS Handbook (2003) refers to the following facts: i) the Finished Goods Price Index excludes services, which constitute a major portion of the CPI; ii) the PPI does not measure changes in prices for imported goods, whereas the CPI does; and iii) the CPI does not capture changes in capital equipment prices, a major component of the Finished Goods Price Index.

[9] The series analyzed can be extended up until 2005. However, for comparison purposes with other studies and because in the following section we compare US and international terms of trade obtained from Zanias (2005), we decided to stop the sample in 1998.

PPICRM is clearly commodity-based, therefore serving as numerator of our COM/MAN variable. We used three different indexes in the denominator that are manufactured goods-based series: **PFCGEF, PPIPCE** and **PPIITM**. We hence define **CRMGEF, CRMPCE,** and **CRMITM** as the three series of interest that capture the behaviour of the prices of commodities relative to manufactured goods. Figure 1 shows that the three series present a very similar behaviour over time.

We also constructed another three series using the Finished Consumer Foods index in the numerator. This series differs substantially from the previous one mainly because it excludes oil and energy prices. The ratio of Finished Consumer Foods (**PPIFCF**) to finished goods except foods (**PFCGEF**) is called **FCFGEF**. The ratio of Finished Consumer Foods to Capital Goods Equipment (**PPIPCE**) is called **FCFPCE**. Finally, the ratio of Finished Consumer Foods to the Intermediate Materials Index (**PPIITM**) is referred to as **FCFITM**. These three series are plotted in Figure 2. Compared to Figure 1, the ratio between the Finished Consumer Foods and finished goods minus foods is much more stable over the 50-year period, whatever series appears in the denominator.

4. Empirical Results

4.1. Characterizing US terms of trade

The Prebisch-Singer hypothesis has been traditionally tested in the time series context by analyzing if the terms of trade series contains a negative trend. Testing these trends, however, will depend on whether the series is trend stationary (TS) or difference stationary (DS). If the series is TS, we can represent it as an autoregressive process such as

$$\Delta y_t = \alpha + \beta t + \rho y_{t-1} + \sum_{i=1}^{K} \varphi_i y_{t-i} + \omega_t , \qquad (1)$$

where t is a time trend, ω_t is an iid error term and K is the length of the lag augmentation. If $\rho < 1$ then it follows that verification of the Prebisch-Singer hypothesis is a test for H_o: $\beta < 0$. That is, the series is stationary around a negative deterministic trend. If the autoregressive root ρ equals one, the process would be DS. In this latter case, a test of the PS hypothesis would imply testing H_o: α < 0 in the regression

$$\Delta y_t = \alpha + \sum_{i=1}^{K} \varphi_i \Delta y_{t-i} + \omega_t \tag{2}$$

Given that the choice between (1) and (2) is not known a priori, it is necessary to test if there is a unit root in the data to discriminate between the two models. If the null of a unit root is not rejected when estimating equation (1), we cannot reject the DS against the TS model.

For this reason we first provide several unit-root tests in which a time trend is incorporated. We present the ADF test, the DF-GLS test of Elliott et al. (1996), the KPSS test by Kwiatkowski et al. (1992) for the null of stationarity, and the modified MZ_α and MZ_t tests of Ng and Perron (2001). The last two tests have less severe size distortions when the errors have a negative moving average (MA) root. The lag selection criterion used was the Modified Akaike Information Criterion of Ng and Perron (2001). For the KPSS tests the truncation is set at k = 4.

The results of these tests are presented in Table 1. The evidence strongly supports the hypothesis that the series are non-stationary in levels and stationarity in first differences. None of the tests reject the null of nonstationarity or accept the null of stationarity. Most of the tests also find that the series in first differences are stationary except for the MZ tests for the FCFPCE series. These results suggest that the series behave as DS processes.

An issue of relevance is to investigate whether this non-stationarity result is simply the consequence of the existence of infrequent breaks in the series. It is clear from figures 2 and 3 that in the first half of the 1970s the ratio moves up sharply. This shift, most probably due to the oil price shock, is followed by a continuous decline until the end of the sample. It is well known in the time series literature that these possible structural breaks reduce the power of unit root tests as they can be wrongly identified as permanent shocks. Formal inspection of this issue is undertaken by applying the method developed by Zivot and Andrews (1992). They develop a test for unit roots that allows for one structural break.[10] The break point λ is endogenously determined at the point where the evidence in favour of a unit root is weaker. That is, λ is the break point in the sample that yields the minimum t-ratio for testing the null hypothesis of a unit root in an ADF-type equation.

We employ Perron's (1989) model A, also called the "crash model", in which there is a one-time change in the level of the series. Visual inspection indicates that the series may have experienced a shift in the intercept with no break in the trend function. Table 2 reports the t_ρ for testing $\rho = 0$ in the ADF-type equation: $\Delta y_t = \alpha + \beta t + \theta DU_t + \rho y_{t-1} + \sum_{i=1}^{K} \Delta y_{t-i} + \varepsilon_t$, where $DU_t\ (\lambda) = 1$ if t >Tλ, and 0 otherwise, λ is the breakpoint related to the whole sample T ($\lambda = T_B/T$) and ε_t is an iid error term. The lag length (K) for ADF tests is chosen by a general-to-specific criterion using $K_{max} = 14$. The critical value from Table 2 in Zivot and Andrews (1992) at the 5% level is -4.80. The results reported in Table 2 show the unit root test (t_ρ) and the break date chosen. The tests show that, even controlling for the break in the data, the series appears to be non-stationary. The only exception is the FCFPCE series, which appears to be stationary. For all series the break date is chosen at either September or December 1973. Overall, the battery of tests applied favours a DS over a TS representation of the terms of trade series. The only possible exception is the FCFPCE series, which appears to be stationary after controlling for a shift break at the end of 1973.

Table 3 contains the estimates of α from the autoregressive model (2) together with the t-test for $\alpha = 0$. We estimated the model using only one lag augmentation and a lag augmentation chosen using a general-to-specific criterion with a maximum lag of 14. For the latter case the optimal lag was always found to be 13. In all regressions we included a dummy for an outlier observation at the end of 1973, which coincides with the date of break selected by the Zivot and Andrews (1992) test.[11] For the FCFPCE series we also provide with the estimate of β in equation (1), as this series appears to be TS. The

[10] Kellard and Wohar (2005) allow for up to two structural breaks in their tests. Their data, however, goes back to 1900. In this case there is another likely break in their series around 1920.

[11] An intercept shift in the autoregressive model used to test for unit roots would imply an impulse dummy in the first difference model (2). The outlier also appears clearly in the residual plot and in the recursive 1-step ahead Chow tests, which give values larger than 40 at this point.

results show that, for all the series, the estimate of α is negative. We can reject the null of a zero intercept term in all cases at the 10% level using the selected lag augmentation except for the FCFGEF series. The estimated value of β, using the selected lag augmentation, for the TS representation of FCFPCE is also significantly different from zero and negative, although small in value.

Overall, the evidence supports the existence of a negative trend in the terms of trade series. That is, the US internal terms of trade can be represented as a DS series around a negative trend. Exceptions to this are the FCFPCE series, which appears to behave as a negatively trended stationary variable and FCFGEF, which appears to behave as a DS series with no trend. These results are, overall, supportive of the Prebisch-Singer hypothesis of declining terms of trade. From the point of view of our previous discussion, this would imply that market integration is not the driving force behind the negative trend in the terms of trade.

4.2. The Long-Run relationship between US and international series

As described above, our next step is the investigation of the long-run relationship between US and international terms of trade series. The existence of a common long-run component would lend support to the hypothesis that there is a common cause for the decline in commodity prices, which would not be related to the degree of integration and openness, since it is unquestionably much higher among US regions than among countries.

Two issues need to be addressed before proceeding with the long-run analysis. The first one regards the dataset. We need to aggregate our monthly series into annual series in order to make them compatible with the $INTCOMTT_t$ data from Zannias (2005) and Grilli and Yang (1988). The INTCOMTT and CRMGEF annual series are plotted in Figure 3. The second one is methodological. Since the US economy plays a non-negligible role in international trade and price determination, international data may contain a component that originates from US data. This happens both directly through price index aggregation and indirectly through international market price interactions.[12] The long-run analysis would then be contaminated by the aggregation and market interaction effects if these go untreated. As a result, the US component in the international data needs to be separated from the non-US component.

To address this second issue we propose the use of an instrumental variable (IV) method. Assume that the international terms of trade ($INTCOMTT_t$) can be decomposed into a non-US dependent term (INT) and a US dependent term (US_t):

$$INTCOMTT_t = \alpha INT_t + \beta US_t \, , \tag{3}$$

where α and β are unknown aggregation weights, and the ratio $0<\beta/(\alpha+\beta)<1$ determines the relative participation of the US series in the international terms of trade series considering both the aggregation and the market interaction effects. Even though US_t is known (one of our six definitions of US internal terms of trade) a least squares regression of $INTCOMTT_t$ on US_t may lead to a biased estimation of β. This is because the residual ε_t in equation

$$INTCOMTT_t = \mu + \gamma t + \beta US_t + \varepsilon_t \, , \tag{4}$$

which is equal to a demeaned and de-trended representation of αINT, may be correlated with US_t.

The problem can be easily solved using IV. We chose to use the net value added by the farm sector in the US in constant dollars of 2000 (NVA) as the instrument. The data source is the US Department of Agriculture (USDA). The NVA is a good choice of instrument not only because it is highly correlated with the local determinants of US commodity prices but also because it should not be significantly affected by international factors, after all rents and wages in the US should bear no or minimum relation with the international prices of commodities. The correlation matrix presented in Table 4, even

[12] For example, U.S. trade shares in world markets range from 3.5% for minerals to 15% for fresh food according to the U.N. Commodity Trade Statistics Database.

though not serving as a proof of suitability, indicates that the instrument choice is adequate. Note that, as will be the case in most of what follows, the estimated correlation values shown in Table 4 employed the first differences of the logs of the variables to eliminate non-stationarity.

Table 5 shows the two-stage least squares (TSLS) estimates of the parameters in equation 2 using first differences of the logs and our six different definitions of terms of trade in the US, with NVA as an instrument. Note that μ disappears after differentiation of equation (4). The time trend parameter is negative and typically equal to –0.01, although not statistically significant. Despite the fact that the estimates of β are also not statistically significant at the 5% level, they range from 0.10 to 0.25, which is consistent with the US share of trade in the international markets for commodities.

The residuals of the TSLS regressions are then used as the six proxies for the non-US component (INT) of the international terms of trade series. We now have to analyze if those non-US components are related in the long run with the US components. In other words, we want to know if they have a common factor that is driving down the terms of trade. One could perform a cointegration analysis for each pair of series. However, cointegration is not a necessary condition for the existence of a long-run relationship, since it implies a stricter form of long-run equilibrium among variables.[13] Finding a sizeable principal component, a significant level of pair-wise long-run correlation between the variables, or significant cumulative impulse responses could also provide indication of a long-run relationship. Our test for long-run relationships will thus be based on these three tests.

We start with the principal component analysis. Table 6 shows the eigenvalues and the variance proportions explained by the first and second principal components using the six US terms of trade definitions and the six non-US terms of trade obtained as residuals of the TSLS regressions. The pairs of series, with the exception of FCFGEF, appear to have a dominant first principal component, with explained variance proportions ranging from 59% to 72%, which provides evidence in favour of a long-run relationship.

[13] See, for example, Fisher and Seater (1993) for a discussion using an ARIMA framework and McCallum (2004) for a description of the restrictiveness of the cointegration hypothesis in the case of money demand.

One of the problems with the principal component analysis, as with standard correlation analysis, is that it includes only contemporaneous effects, not capturing the effects of lags or leads. We next use a long-run correlation block estimator to overcome this problem.[14] A block estimator implies however a time interval choice. Here we use the optimal time interval selection method based on the Newey and West (1994) optimal lag selection method for HAC covariance matrix estimation [see Albuquerque, 2001].[15]

Table 7 presents the estimated long-run correlation values with the optimal time interval and alignment selections. The p-values show the probabilities of falsely rejecting the null of zero long-run correlation. The long-run correlation estimates indicate that the US terms of trade definitions that use CRM in the numerator appear to have a long run relationship with the non-US terms of trade proxy. On the other hand, the US terms of trade definitions that use FCF in the numerator appear not to have a long run relationship with the non-US terms of trade proxy.

These results can be confirmed using VAR estimation and generalized impulse response functions (GIRFs), as defined in Pesaran and Shin (1998). We need however to test for cointegration before proceeding with the VAR analysis of the first differences of the logs. Results for the Johansen (1991) cointegration tests using MacKinnon-Haug-Michelis (1999) p-values are provided in Table 8. The number of VAR lags in each case was chosen using the Schwarz Information Criterion (SIC), and confirmed using lag exclusion Wald tests. The cointegration tests are based on the original international terms of trade and US terms of trade series ($INTCOMTT_t$ and US_t), since cointegration between these two series is a necessary and sufficient condition for cointegration between the non-US and the US terms of trade series (INT and US_t) as long as the identity parameters are nonzero, what can be easily verified using identity (3).[16] The results in

[14] The block estimator of long-run correlation is a simple correlation estimator of $y_t - y_{t-k}$ and $y_{t-a} - y_{t-k-a}$, where k is the time interval parameter and a is the alignment parameter. It has the same asymptotic properties of a Bartlett kernel nonparametric estimator.

[15] The Newey-West method is optimal in the case of covariance estimation, but not optimal in the case of correlation estimation. Notice that the asymptotic block estimator properties do not depend on the time interval selection method. The selection method only affects the optimality of the time interval choice.

[16] That is because any linear combination of two cointegrated variables is also cointegrated with either variable.

Table 8 show that we cannot reject the null hypothesis of noncointegration.[17] We hence carry out the analysis assuming that the series are non-stationary and do not cointegrate.

The GIRF analysis is based on the estimation of a VAR of the first differences of the logs. Some VAR statistics are presented in Table 9, where the non-US proxies and our US definitions of terms of trade were employed, and an impulse dummy was used to capture the effects of the oil shock in 1973. The number of lags was chosen in each case using the SIC. All equations, with the exception of the US equation for FCFITM, have statistically significant explanatory power. This does not imply, however, that long-run relationships exist, which is what the analysis of the GIRFs is able to do. The lower part of Table 9 shows the cumulative generalized impulse responses after 10 years. A significant impulse response of one variable in relation to the innovation of another variable after a sufficiently long period would support the existence of a long-run relationship. The results indicate that a long-run relationship is present in the cases of CRMGEF and CRMPCE for both innovations. This reinforces the previous results for the long-run correlation in Table 7. A negative long-run relationship is found in the case of FCFITM, but only for one of the innovations.

The evidence arising from the analysis above indicates that the series based on CRM, especially CRMGEF and CRMPCE, have a positive long-run relationship with their international non-US counterparts. There is also evidence of a positive long-run relationship for the CRMITM series. There is no apparent evidence of long run relationships for the series based on FCF. For the CRM-based series, thus, we can conclude that the factors behind the secular decreasing trend of the international terms of trade cannot be the result of globalisation or of lack of economic integration. This suggests that globalisation could not possibly change the underlying common factors driving downward the terms of trade.[18]

[17] Unit root tests based on annual frequency (N=52) for INTCOMTT suggest an I (1) process. There are some rejections at 10% of the unit root null in levels but they are weak. All five unit root tests support stationarity in first-differences at the 1% level. Since there are also unit roots for the U.S. series, the Johansen cointegration method is appropriate.

[18] Note that this would be true regardless of whether ToT have or not a negative trend. The finding of a common trend indicates a common factor driving internal US and international ToT. This does not necessarily imply that international ToT would continue its decline, but simply that any trend is not caused by the degree of integration of the world economy. For our sample period this trend appears to have been negative and, from our results, a possible reversal of this trend is unlikely to come about as a result of increased integration.

5. Concluding Remarks

The international evidence on the existence of declining terms of trade (ToT) between commodities and manufactures has been interpreted as favouring the Prebisch-Singer hypothesis. This raises the question of what happens to the relative price of commodities if the world economy becomes fully integrated through globalisation. We address this question by proposing an original methodological approach. Assuming that globalisation would make the world economy behave as the US economy, we study the US internal terms of trade between commodities and manufactures over the 1947-1998 period. Evidence in favour of declining terms of trade in such an integrated economy would rule out globalisation as an explanation of this phenomenon internationally. Although it is not likely that a fully integrated world economy would exactly mimic the behaviour of the internal US commodities' ToT, this methodology allows us to analyse whether integration plays an important role for the evolution of the ToT. The US economy, rather than a good description of how the World economy would work with further integration, provides us with a limit case.

Our results document a negative trend of the price of commodities relative to manufactures for the US economy. We find that the series behave mostly as difference stationary around a negative trend. This result is in line with the Prebisch-Singer hypothesis. In order to address if there are common factors driving this decline in terms of trade in the US and the world economy, we test for the existence of a long-run relationship between these series using a battery of different tests. The results show that the US series based on crude materials in the numerator have a positive long-run relationship with their international non-US counterparts. The factors behind the secular decreasing trend of the international terms of trade cannot therefore be the result of international trade, globalisation, or of lack of economic integration. This also indicates that globalisation (leading to the increasing integration of world markets) would not be sufficient to eliminate the sources of this trend. On the other hand, policies aiming at reducing the degree of integration of an economy with the rest of the world would not be effective for eliminating it either.

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Figure 1. Ratios of Crude Materials to Manufactured Goods US

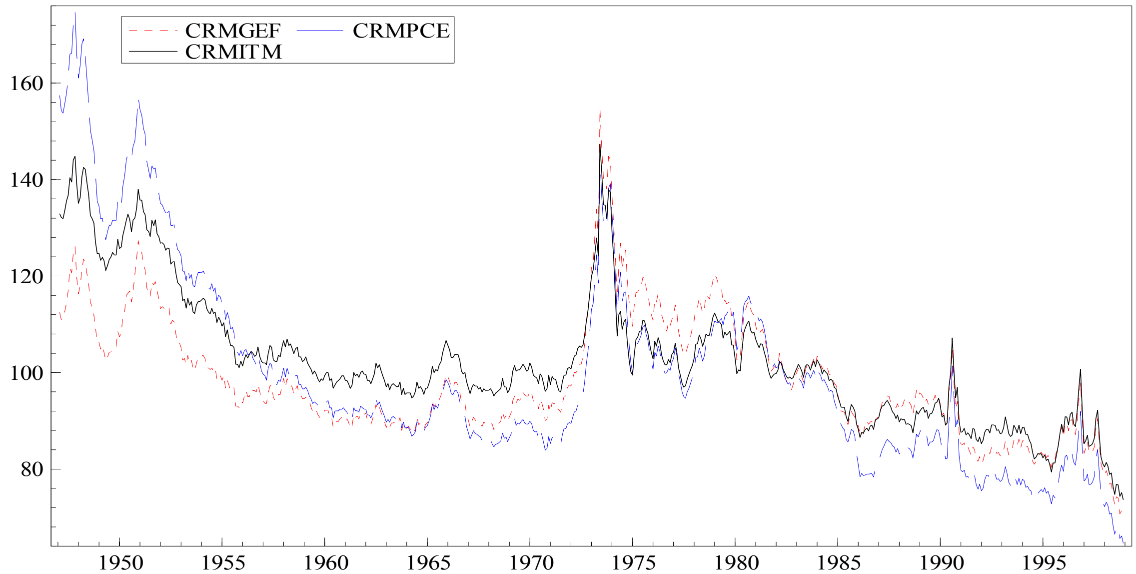

Figure 2. Ratios of Finished Consumer Foods to Manufactured Goods US

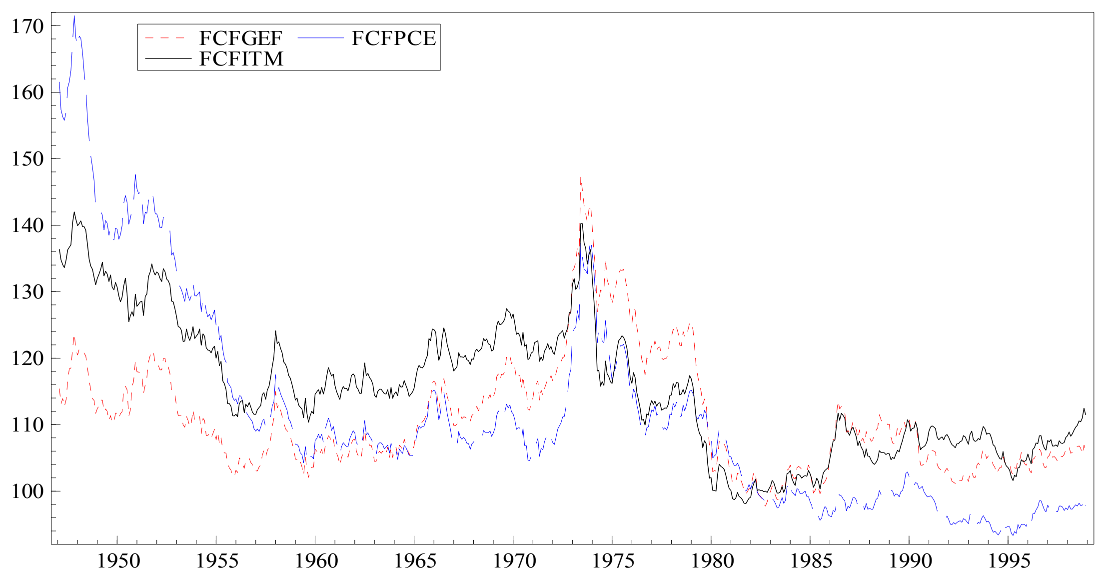

Figure 3. The Ratio of International Prices between Commodities and Manufactures (INTCOMTT) from Zanias (2005) compared to the US Price Ratio between Crude Materials and Finished Consumer Goods Excluding Foods (USCRMGEF).

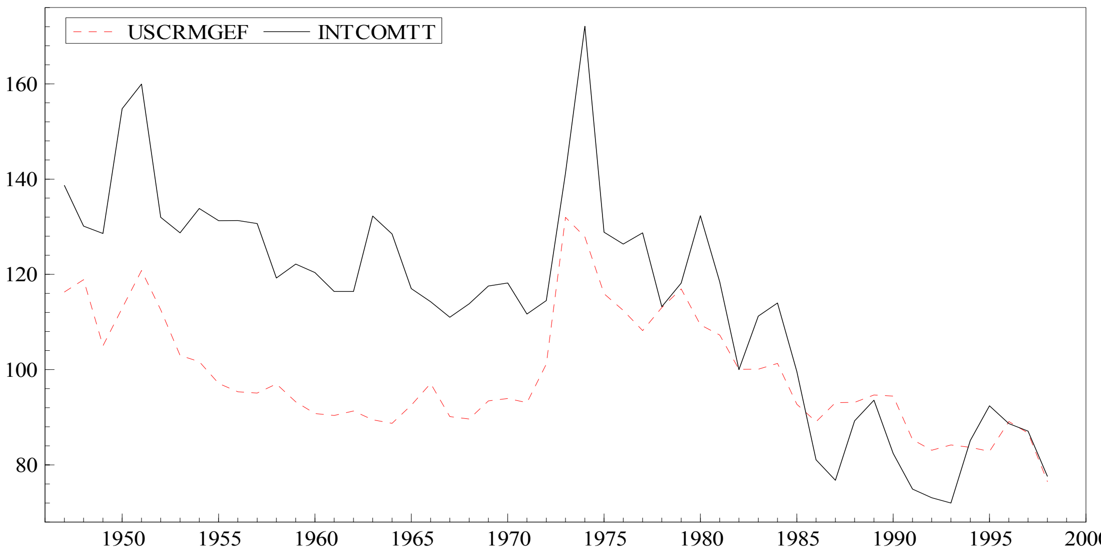

Table 1. Unit Root Tests on Monthly US series

Series and Type of Tests	**ADF**	**DF-GLS**	**KPSS (4)**	**Ng-Perron MZ_{α}**	**Ng-Perron MZ_{t}**
CRMGEF	-2.20	-2.21	1.09**	-10.22	-2.21
Δ(CRMGEF)	-8.34**	-6.46**	0.07	-40.03**	-4.46**
CRMPCE	-3.26	-1.86	1.15**	-6.57	-1.81
Δ(CRMPCE)	-7.77**	-4.86**	0.13	-18.89*	-3.07*
CRMITM	-3.36	-2.53	0.88**	-12.63	-2.51
Δ(CRMITM)	-22.83**	-7.83**	0.05	-98.84**	-7.02**
FCFGEF	-2.41	-2.39	1.04**	-11.63	-2.41
Δ(FCFGEF)	-8.15**	-4.17**	0.05	-16.23	-2.94*
FCFPCE	-2.66	-1.16	1.04**	-3.17	-1.17
Δ(FCFPCE)	-7.84**	-3.18*	0.31	-7.11	-1.86
FCFITM	-2.84	-2.47	0.56**	-13.17	-2.49
Δ(FCFITM)	-8.12**	-5.17**	0.09	-27.37**	-3.70**

Notes: Lag length selection based on Ng and Perron's (2001) MAIC. For the KPSS test we used a truncation of 4. The symbols * (**) indicate rejection of the null at the 5%, and 1% levels, respectively.

Table 2. Unit Root Tests with Unknown Break Point.

Series	**t_ρ**	**Break date**
CRMGEF	-2.40	December 1973
CRMPCE	-3.92	September 1973
CRMITM	-3.66	September 1973
FCFGEF	-2.39	December 1973
FCFPCE	-5.22*	September 1973
FCFITM	-4.58	September 1973

Notes: Unit root tests follow the Zivot and Andrews (1992) test described in the text. The corresponding critical value from Zivot and Andrews (1992) at the 5% level is -4.80. The symbol * indicates rejection of the null at the 5% level.

Table 3. Intercept term in the first difference autoregressive model

COM/MAN Series	α	t-ratio	p-value
CRMGEF			
AR (1)	-0.117	-1.52	0.127
AR (13)	-0.135	-1.81	0.069
CRMPCE			
AR (1)	-0.187	-2.35	0.019
AR (13)	-0.200	-2.55	0.011
CRMITM			
AR (1)	-0.134	-1.83	0.068
AR (13)	-0.160	-2.23	0.026
FCFGEF			
AR (1)	-0.042	-0.823	0.411
AR (13)	-0.044	-0.881	0.378
FCFPCE (DS model)			
AR (1)	-0.123	-2.52	0.012
AR (13)	-0.123	-2.53	0.012
FCFITM			
AR (1)	-0.057	-1.23	0.220
AR (13)	-0.087	-1.72	0.086
FCFPCE (TS model)	$\hat{\beta}$	$\hat{\beta}$ $t-ratio$	$\hat{\beta}$ $p-value$
AR (1)	-0.000	-1.03	0.302
AR (13)	-0.001	-1.99	0.047

Table 4. Correlations of the First Differences of the Logs.

	CRMGEF	CRMPCE	CRMITM	FCFGEF	FCFPCE	FCFITM	INTCOMTT	NVA
CRMGEF	1.00	0.95	0.96	0.69	0.80	0.49	0.44	0.76
CRMPCE		1.00	0.94	0.53	0.81	0.37	0.51	0.70
CRMITM			1.00	0.60	0.76	0.55	0.31	0.77
FCFGEF				1.00	0.84	0.87	0.04	0.68
FCFPCE					1.00	0.73	0.26	0.73
FCFITM						1.00	-0.27	0.64
INTCOMTT							1.00	0.05
NVA								1.00

Table 5. IV Regressions Using First Differences of the Logs.

INTCOMTT is the dependent variable, NVA is the instrument.

	CRMGEF	CRMPCE	CRMITM	FCFGEF	FCFPCE	FCFITM
$\hat{\gamma}$	-0.010	-0.010	-0.010	-0.011	-0.010	-0.010
(*t*-Statistic)	(-0.73)	(-0.66)	(-0.68)	(-0.76)	(-0.64)	(-0.68)
$\hat{\beta}$	0.11	0.10	0.13	0.20	0.18	0.25
(*t*-Statistic)	(0.37)	(0.37)	(0.37)	(0.36)	(0.37)	(0.35)
$\overline{R}^2$	0.036	0.050	0.018	-0.020	0.011	-0.071
D.W.	1.90	1.89	1.89	1.90	1.88	1.89

Table 6. Principal Components of the First Differences of the Logs.

Residuals of the TSLS regressions are proxies for the non-US terms of trade.

Principal Component		CRMGEF	CRMPCE	CRMITM	FCFGEF	FCFPCE	FCFITM
First	Eigenvalue	1.38	1.45	1.25	1.04	1.19	1.34
	Variance Proportion	0.69	0.72	0.63	0.52	0.59	0.67
Second	Eigenvalue	0.62	0.55	0.75	0.96	0.81	0.66
	Variance Proportion	0.31	0.28	0.37	0.48	0.41	0.33

Table 7. Long-Run Correlation Estimates.

Residuals of the TSLS regressions are proxies for the non-US terms of trade.

	CRMGEF	CRMPCE	CRMITM	FCFGEF	FCFPCE	FCFITM
Long-Run Correlation	0.61	0.54	0.53	0.11	0.20	-0.24
Estimate S.D.	0.14	0.11	0.18	0.16	0.16	0.15
(P-Value, Zero LRC)	(0.008)**	(0.001)**	(0.040)*	(0.501)	(0.221)	(0.138)
Optimal Time Interval	4	2	5	2	2	2
Optimal Alignment	0	0	1	-1	-1	0

Notes: * indicates statistical significant at 5%; ** at 1%. Optimal time interval represents the number of years used in the difference operator. Optimal alignment represents the number of years used in the shift operator.

Table 8. Johansen Cointegration Test (Null Hypothesis is Noncointegration).

Trace test with deterministic trends in data and in cointegrating equation.

Number of Cointegrating Equations		CRMGEF	CRMPCE	CRMITM	FCFGEF	FCFPCE	FCFITM
None	Trace Statistic	13.01	15.56	15.05	16.52	15.86	19.37
	(P-Value)	(0.737)	(0.528)	(0.570)	(0.452)	(0.504)	(0.260)
At Most One	Trace Statistic	2.07	2.80	3.09	4.16	4.11	6.46
	(P-Value)	(0.964)	(0.900)	(0.866)	(0.719)	(0.726)	(0.405)
VAR Lags (Based on SIC)		2	2	2	2	2	2

Table 9. VAR Regressions and Cumulative Generalized Impulse Responses.

Residuals of the TSLS regressions are proxies for the non-US terms of trade.

VAR		CRMGEF	CRMPCE	CRMITM	FCFGEF	FCFPCE	FCFITM
	Lags	2	2	2	2	2	2
non-US	$\overline{R}^2$	0.36	0.32	0.36	0.31	0.28	0.30
Equation	*F*-Statistic	6.46**	5.53**	6.35**	5.22**	4.68**	5.12**
US	$\overline{R}^2$	0.52	0.47	0.47	0.23	0.42	0.06
Equation	*F*-Statistic	11.3**	9.57**	9.54**	3.84**	7.94**	1.60

GIRFs

Innovation		CRMGEF	CRMPCE	CRMITM	FCFGEF	FCFPCE	FCFITM
of INT_t^*	*10-year IR*	0.0270	0.0259	0.0164	-0.0086	-0.0021	-0.0282
To US_t	*(t-Statistic)*	(2.56)*	(2.38)*	(1.44)	(-0.59)	(-0.16)	(-1.76)
of US_t	*10-year IR*	0.0163	0.0189	0.0083	-0.0079	-0.0005	-0.0148
to INT_t^*	*(t-Statistic)*	(2.64)*	(2.57)*	(1.60)	(-1.13)	(-0.09)	(-2.30)*

Notes: * denotes significance at 5%; ** at 1%. *t*-Statistics for the GIRFs are based on 10,000 Monte Carlo repetitions.