NOTES

Two Notes On Prebisch-Singer Hypothesis : Implications of the Unit Root Tests

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Introduction**

The past few years have witnessed an increasing interest in the work of Prebisch (1950) and Singer (1950). Both advanced the hypothesis that over the long run the terms of trade (P) of raw material producing economies will be subject to deterioration. In the literature, indeed in recent ones, inference on the validity of the Prebisch- Singer hypothesis is carried out using time series techniques (see Cuddington and Urzua, 1989; Cuddington, 1992; Reinhart and Wickham, 1994; Gafar, 1995). The testing procedure goes as follows: (i) determine the integration property of the terms of trade by testing whether its trend is stochastic using unit root tests and; (ii) depending on the validity of the Prebisch-Singer hypothesis is based on the sign of the trend coefficient (c.f. Reinhart and Wickham, 1994; Gafar, 1995). That if the trend function of the terms of trade is deterministic, a linear trend model is fitted and the Prebisch-Singer hypothesis is accepted only if the coefficient on the time trend is negative. But if the terms of trade is an intergrated process of order one, an ARIMA is fitted to the data and the hypothesis is accepted if the drift is less than zero.

In this letter, it will be demonstrated that as the logs of (P) is a ratio . for Prebisch-Singer hypothesis to hold it imposes restrictions on the

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integration properties of the export and import price indices ,PE and PI respectively . Furthermore,the second note will take the debate on testing the Prebisch - Singer hypothesis a step forward by suggesting an alternative test based on Markov chains , That is if the logs of P_t, is an integrated of order one ,I(1),and the growrh rate in the ARIMA model is not significantly different from zero as in Cuddington (1992,Table3), inference on the Prebisch -Singer hypothesis can be based on the results from the Markov chains test .

Since PE and PI are individually upward trending (UP),the discussed restrictions on the first note are confined to such cases. Nevertheless , for price series with different properties ,it will be trivial to show the required integration property for Prebisch -Singer hypothesis to hold .

II . First Note: Restrictions on the Integration Properties .

Proposition: As the terms of trade a ratio of two series, inference on the validity of the Prebisch-Singer hypothesis imposes restrictions on the integration property of each of the price series.

The propsition is demonstrated for two most obvious cases. The terms of trade are measured as:

$$P_t = PE_t / PI_t \qquad (1)$$

Rewriting (1) in logs yields

$$p_t = pe_t - pi_t \qquad (2)$$

Here a small letter denotes the logs of a capital letter . In this note ,(2) is utilised to discuss integration restrictions on pe and pi for the Prebisch -Singer hypothesis to hold .

Case I:pe and pi are TS and Up:[1]

Such that

$$pe_t = a_1 + \beta_1 t + v_t \qquad (3)$$

and

$$Pi_t = a_2 + \beta_2 t + \varepsilon_t \qquad (4)$$

Where v_t and ζ_t are noise functions which can be modelled as

autoregressive moving average processes:

$$A(L)v_t=B(L)\ \zeta_t \qquad (5)$$

and

$$C(L)\varepsilon_t =D(L)\upsilon_t \qquad (6)$$

Here A(L),B(L),C(L) and D(L) are polynomials in the lag operator L. ζ_t and υ_t are white noise. It is assumed that the roots of the moving average polynomials are strictly outside the unit circle. For both price indices to be stationary,the largest modulus of the autoregressive polynomials have to be strictly less than one. For such series ,equation (2) can be rewritten as

$$p_t =+\beta t+\zeta_t \qquad (7)$$

here $\alpha =\alpha_1 -\alpha_2$, $\beta=\beta_1-\beta_2$ and $\zeta_t=v_t -\varepsilon_t$. The Prebisch -Singer hypothesis holds only when $\beta_2>\beta_1$.

Case II: pe,pi ~ I(1):

Assuming that the trend of each of the price series is determinsitic and that each of the autoregressive polynomials of (5) and(6) has a unit root,applying the Beveridge and Nelson (1981) decomposition to (3) and (4) yields

$$pe_t =\alpha_1+\beta_1 t+\Theta(1)\sum_{i=1}^{t}\zeta_t + \Theta^*(L)\zeta_t \qquad (8)$$

and

$$pi_t = \alpha_2+\beta_2 t+\Gamma(1)\sum_{j=1}^{t}\upsilon_t + \Gamma^*(L)\,\upsilon_t \qquad (9)$$

where

$$\Theta^*(L) = (1-L)^{-1}\ [\Theta^*(L) - \Theta(1)], \qquad \Gamma^*(L) = (1-L)^{-1}\ [\Gamma(L) - \Gamma(1)\ ]$$

$$\Theta(L) = A^*(L)^{-1}\ B(L), \qquad L(L) = C^*(L)^{-1}\ D(L), \qquad A^*(L) = A(L)\ /\ (1-L)$$

and $C^*(L)=C(L)/(1-L)$ The third term in the right hand side of (8) and(9) corresponds to the stochastic trend and the second and third

$\Theta^*(L)\zeta_t$ and $\Gamma^*(L)\upsilon_t$

terms represent the total trend of each series. and are the cyclical components .If both series are trend stationary then by Campbell and Mankiw`s(1987) measure of persistence

$$\Theta(1) = \Gamma(1) = 0$$

and equations (8) and (9) are,respectively ,equal to (3) and(4) .
However,if both series are as modelled in (8) and(9),the terms of trade will be

$$p_t=(\alpha_1 - \alpha_2)+(\beta_1 - \beta_2)t+[\Theta(1)\sum_{i=1}^{t}\zeta_i - \Gamma(1)\sum_{j=1}^{t}\upsilon_j] + [\Theta^*(L)\zeta_t - \Gamma^*(L)\upsilon_t] \qquad (10)$$

In this case inference on Prebisch -Singer hypothesis will depend whether the series have deterministic trend .Let us start with the simpler case in which $\beta_1 - \beta_2 = 0$. If $P_t \sim I(0)$, that the export and import price series are cointegrated such that

$\Theta(1)\sum\zeta_i = \Gamma(1)\sum\upsilon_j$, this leads to rejection of the Prebisch -Singer hypothesis However ,if they are not cointegrated ,the results will depend on the specification of the stochastic trend. In the case in which each of the price series is a random walk with drift

$$pe_t = (1-L)^{-1}(\beta_1 + \nu_t) \qquad (11)$$

for export price series and

$$pi_t = (1-L)^{-1}(\beta_2 + \varepsilon_t) \qquad (12)$$

for import price series
Rewriting (7) and applying the first difference operator yields:

$$(1-L)\,p_t = (\beta_1 - \beta_2) + \zeta_t \qquad (13)$$

Equation (13) is an ARIMA . It is obvious form(13) that if both stochastic trends are random walk without drift,the Prebisch -Singer

hypothesis can not be accepted. Cuddington(1992 Table 3) shows many raw material terms of trade to posses such property . Nevertheless,if the drifts are significantly different from zero,the hypothesis is accepted if only $\beta_2 > \beta_1$ i.e., the growth rate of import prices is larger than the growth rate of export prices

III . Second Note:Alternative Test When P~I(1) and Downward Trending

For Prebisch and Singer technological skocks are the main source of divergence between both price indices In the case of manufactured goods, such shocks lead to higher income while for raw materials they result in lower prices Thus following a technical shock(boom period),raw material prices will rise at a higher rate than that of manufactured goods but will fall at a higher rate in a recession This high sensitivity to output changes over the business sycle results in ever increasing divergence between both price indices In this respect Prebisch (1950,p.13)stated:

"The prices of primary products rise more rapidly than industrial prices in the upswing ,but also they fall more in the downswing, so that in the course of the cycles the gap between prices of the two is progressively widened "

Given the terms of trade ,Prebisch`s statement holds only when the average growth rate of improvement of the terms of trade is less than the average growth rate of deterioration ,thus giving p its downward trending shape.There are many series which exhibit such characteristic and in which the trend follows a random walk without drift (e.g.Cuddington,1992 Table 3.) Consequently,in a business cycle model,such a hypothesis can be tested by modelling the transition between states(improvement and deterioration)as a Markov chain as developed by Hamilton (1989)To see this let the terms of trade be the sum of a trend (x) and a stochastic components (ε)

$$p_t = x_t + \varepsilon_t \qquad (14)$$

the stochastic component follows a zero mean ARIMA (p,1,0)process and the transition between the two states is modelled by allowing the trend component to follow a Markov trend in levels:

$$x_t = \beta_0 + \beta_1 k_t + x_{t-1} \qquad (15)$$

Differencing(14)and rearranging yields

$$(1-L)\, p_t = \beta_0 + \beta_1 k_t + \varepsilon_t \qquad (16)$$

$$\sim\varepsilon_t = (1-L)\, \varepsilon_t \qquad (17)$$

Here the state k_1,is allowed to take the value 1 and 0,respectively,for an improvement and deterioration of the terms of trade. Thus in improvement and deterioration periods the average growth will be $\beta_0+\beta_1$ and B_0 respectively .Hence the Prebisch-Singer hypothesis is accepted only if $\beta_0<\beta_0+\beta_1$.

This test is useful whenever P is an integrated process, downward trending and the results from the ARIMA model show that the constant term is not significantly different from zero such as in Cuddington (1992.Table 3).

IV.Conclusions

It is demonstrated in this letter that testing for unit root in the terms of trade imposes restrictions on the integration of the export and import price series and inference on the validity of the Prebisch - Singer hypothesis is conditional on these restrictions. Additionally an alternative test is proposed to test the Prebisch - Singer hypothesis whenever the terms of trade is a first order integrated process,downward trending and the mean of ARIMA model is not significantly different from zero .

Footnote:

(1) TS stands for trend stationary.

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