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The Dual Role of the Terms of Trade: The Indian Experience of Agriculture-Industry Interaction, 1950-2001*

by

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Abstract
Using Indian data for the period 1951-2000, this paper makes econometric tests of crucial propositions in W.A. Lewis's and N. Kaldor's models of the dual economy, viz. Kaldor's assumption that the intersectoral terms of trade is an exogenous variable, their common assumption (implicit in Lewis's model) of "autonomous" agricultural growth, and finally, their contesting propositions regarding the effect on industrial output of change in the terms of trade. Our econometric results indicate that neither agricultural growth nor the terms of trade are autonomous. On the other hand, Kaldor's emphasis on industrial output being demand-determined (by agriculture's demand) appears to be more justified, at least in the Indian context, than Lewis's view of supply-driven or cost-determined industrial output. In other words, the positive demand effect of more unfavourable terms of trade to industry appears to be stronger than the negative cost effect.

Key words: Dualism, Effective Demand, Terms of Trade.
JEL classifications: C12, C13, C22, E12, O13, O14, Q11, Q18.

1. Introduction

A long tradition in political economy going back to the early Physiocrats, emphasises the important role that the agricultural surplus plays in the process of economic development (cf. Meek 1962). And yet, there has been little agreement even among modern economists as to the exact mechanism through which the surplus impacts on industrial development. Assuming unlimited supplies of labour at a constant real wage rate in terms of "food", Lewis in his seminal paper (1954) argued that the availability of agricultural surplus, identified mostly with the supply of "food" to the industrial sector, sets the limit to the pace of industrial development.[1] Any attempt to raise further the pace that is permitted by the growth of the agricultural surplus, would create excess demand to drive up the price of food. Since the assumed constancy of the real wage rate in terms of food must entail that the money wage rate in industry rises in the same proportion as the price of food, profit in industry would be squeezed, forcing a lower rate of growth of the industrial sector. Thus, the intersectoral price mechanism, by shifting the terms of trade in favour of agriculture, would help in restoring balance between the two sectors.

This balancing role of the terms of trade which operates through adjustment in the production cost or supply price of industry, was viewed from an opposite angle by Kaldor (1967; 1989; 1996). While maintaining the same assumption of a constant real wage in terms of "food", he introduced a crucial modification, originally owing to Kalecki (1971), and postulated that the industrial price level is determined by a constant proportional mark-up on unit variable cost, consisting only of wage. This implies that the industrial price level would rise in the same proportion as the money wage when the latter rises in response to an increase in the price of food. Consequently, not only the real wage rate but also the terms of trade would be inflexible in this framework. In this case, the intersectoral price mechanism would be incapable of playing its balancing role; instead the economy would become prone to stagflationary price rise (Kalecki 1976; Kaldor 1996).

In this framework, any shift in the terms of trade is to be treated as autonomous, e.g. resulting from a change in the price policy of the government or technological change, rather than in response to excess demand or supply arising from imbalance between the two sectors. And, any such autonomous shift in the terms of trade in favour of agriculture would increase the purchasing power of that sector, and result in a larger potential market for industry to stimulate its demand-driven expansion.

Thus, the terms of trade can be seen to play opposite roles in the contesting frameworks of Lewis and Kaldor. A shift in the terms of trade in favour of agriculture

[1] In this framework, both sectors may be treated as 'vertically integrated', where all interindustry transactions of circulating capital are netted out through the Leontief inverse matrix. Thus we are concerned only with the value added by the sectors, and their respective final demands.

squeezes industrial profit and growth in Lewis's supply-governed model, but the same shift stimulates industrial demand and growth in Kaldor's demand-driven model.[2] Consequently, the expected *a priori* sign of higher terms of trade, defined as the ratio of agricultural to industrial price, would be negative in relation to industrial growth in the model of Lewis, but positive in that of Kaldor (cf. Bhaduri and Skarstein, 2003).

However, it should be recognised that a more general point underlies the opposite predictions of the two models. In so far as a change in any macroeconomically important relative price, such as the real wage rate, the foreign exchange rate or the terms of trade in the present example, is concerned, it tends to impact on the pattern of resource allocation, as well as on the level of effective demand. Consequently, an empirical test of the contesting propositions of Lewis and Kaldor may throw some additional light on this broader issue.

Despite the differences in perspective, both Lewis and Kaldor tended to argue in terms of an equilibrium characterised by balanced trade between agriculture and industry over time, with agricultural growth viewed mostly as an autonomous variable of the system. Nevertheless, they postulated very different paths of adjustment to the equilibrium. In the case of Lewis, the equilibrium is maintained by adjustment in the terms of trade. For instance, a growth rate of agriculture lower than the initial equilibrium would move the terms of trade, defined as the ratio of agricultural to industrial price, in favour of agriculture, to raise production costs and squeeze industrial profit and growth. However, in Kaldor's case, the adjustment works through the industrial output level responding to its demand. Thus, a similar shift in the terms of trade, considered autonomous by Kaldor, would raise the purchasing power of agriculture to stimulate the demand for industrial goods and the industrial growth rate.

2. The formal model

By abstracting from all complications due to foreign trade, price policy of the government, the rapid growth of a service sector outpacing both industry and agriculture etc., the essential equilibrium condition for balanced trade between agriculture and industry can be stated as,

(1) $p_a X_{ai} = p_i X_{ia}$

where the subscripts a and i stand for agriculture and industry, respectively, with the further general specifications,

[2] It has been argued both theoretically and empirically (Taylor 1983; Krishnaji 1992; Storm 1993) that higher food price may lead to a higher percentage of the income of the poorer industrial workers and agricultural labourers being spent on food owing to Engel's law. This may reduce the net demand for essential industrial consumption goods. Thus, a shift in the terms of trade in favour of agriculture may, in some circumstances, reduce the net demand for industrial goods, a complication ignored here.

(2) $X_{ai} = X_{ai}(X_i, p)$, and
(3) $X_{ia} = X_{ia}(X_a, p)$

The same system converted to growth rates is written as,

(1a) $g_p + g_{ai} = g_{ia}$
(2a) $g_{ai} = \eta_{ai}g_i + \varepsilon_{ai}g_p$
(3a) $g_{ia} = \eta_{ia}g_a + \varepsilon_{ia}g_p$

where,

X_{mn} = demand for (in equilibrium, also supply of) goods of sector m by (to) sector n (m = a, i; n = a, i).

X_m = output of sector m (m = a, i).

η_{mn} = partial elasticity of surplus (export) of sector m with respect to output of sector n.[3] In other words, $\eta_{mn} = (X_n/X_{mn})(\partial X_{mn}/\partial X_n)$.

ε_{mn} = partial (price) elasticity of surplus of sector m (import of sector n) with respect to the terms of trade, defined as the ratio of agricultural to industrial price, $p = p_a/p_i$. Thus, $\varepsilon_{mn}=(p/X_{mn})(\partial X_{mn}/\partial p)$.

g_j = is growth rate or rate of change of variable with subscript j (j = a, i, p).

Combining (1a) to (3a) we write the industrial growth rate g_i as a function of the growth rates of agriculture, g_a, and the terms of trade, g_p,

(4) $g_i = \alpha g_a + \beta g_p$

where $\alpha = (\eta_{ia}/\eta_{ai})$ is expected to be positive in the models of both Lewis and Kaldor, and, $\beta = [(\varepsilon_{ia} - \varepsilon_{ai} - 1)/\eta_{ai}]$ is expected to have a negative sign in the model of Lewis, but a positive sign in that of Kaldor.

[3] All partial point elasticities are estimated at the balanced trade equilibrium without facing the identification problem of whether they are demand or supply elasticities. The econometric tests that follow are constructed on this basis.

However, caution must be exercised in testing equation (4) against data. Apart from the starkness of the abstraction, the intersectoral trade balance – condition (1) or (1a) – from which (4) is derived, runs into a serious problem especially relevant for Kaldor's argument, but overlooked by him. The intersectoral trade balance condition appears as a "double coincidence of demand", as in a barter economy without the complications caused by money as a store of value. For instance, a higher price for agricultural goods might increase the purchasing power of the agricultural sector, but part of this purchasing power may be withheld as "store of value" without being spent on industrial goods within any given time period (Bhaduri and Skarstein 2003). This would lead to an unplanned accumulation of inventories in industry.

Consequently, equation (4) needs to be interpreted as a long-run equilibrium in which all such unplanned accumulation or de-accumulation of inventories has been eliminated through some mechanism of error correction. This also means that the two sectors are closely interlocked through creating balanced reciprocal demand along their growth paths. Thus, if equation (4) is to be satisfied, neither sector can grow autonomously, because it has to provide a market to absorb exactly the surplus of the other sector. This robs the agricultural sector in particular of its autonomous or exogenous status assumed by Kaldor, and implicitly also by Lewis.

3. Econometric testing

Our econometric tests are based on annual time series data for India, available over half a century (1950-2001), from which agricultural and industrial outputs, as well as terms of trade data are derived (see Appendix A). Using this data, we estimated (4) as,[4]

(4A) $g_i = 0.055 + 0.088 g_a + 0.002 g_p$

(4.8) (1.28) (0.026)

$R^2 = 0.036$; DW = 1.45; NOBS = 50.

(Figures in parentheses are t-ratios)

AR 1-2 test: F(2,45)=3.23 (0.0488)

ARCH 1-1 test: F(1,45)=1.2270 (0.2739)

Normality Test: χ^2 (2)=0.44 (0.8021)

Heteroscedasticity Test: F(4, 42)=0.99 (0.4220)

Heteroscedasticty with X Test: F(5,41)=0.79 (0.5614)

RESET Test: F(1,46)=8.95 (0.0044*) * refers to significance.

(Figures in parentheses after the test statistic are probability levels.)

[4] With annual time series data for India, the continuous growth rates are approximated by the first difference between two successive annual observations on the logarithmic scale.

Inspection of the time series data (see Appendix, table A.1) reveals that, except for the terms of trade ($p = p_a/p_i$), both agricultural and industrial output are normally distributed on the logarithmic scale. Since even visual inspection of the data (Graphs 1A and 1B) exhibits a positive time trend with respect to both the output variables and no significant trend for the terms of trade variable, equation (4) used for the above estimate is obviously misspecified.[5] Time trends could be deterministic or stochastic. First, a deterministic trend was introduced in the above model to obtain the estimated equation (5). A reason for introducing deterministic trend in the above equation is to eliminate spurious correlation between agricultural and industrial growth since both could be highly correlated due to a common trend. A common deterministic trend among these variables is captured by the use of the time trend variable in the regression model.

Equation (4) is now estimated using the growth rate in agricultural output, the rate of change in the terms of trade and a deterministic time trend as follows:

$$(5) \qquad g_i = (0.05117 + 0.00014\,t) + 0.0859 g_a - 0.0021 g_p$$
$$(5.57) \quad (0.484) \quad (1.25) \quad (-0.0288)$$

where t is time in terms of years.
(Figures in parentheses are t-ratios)
R^2=0.0409; DW=1.46; NOBS=50.
AR1-2 Test: F(2,44)=3.16 (0.0523)
ARCH 1- test= F(1,44)=0.9921 (0.3247)
Normality test: χ^2 (2)=0.7107 (0.7009)
Heteroscedasticity test: F(6,39)=1.1574 (0.3486)
Heteroscedasticity with X test: F(9,36)=1.4047 (0.2226)
RESET test: F(1,45)=4.7942 (0.0338*) * refers to significance.
Figures in parentheses after the test statistic are probability levels.

The above growth equation does not satisfy all the econometric criteria and both serial correlation and general misspecification still prevails. In addition, the growth in agricultural output is not significant because of collinearity between time trend and growth in agricultural output.

The next step is to investigate whether agricultural output, industrial output and terms of trade have stochastic trends. The hypothesis of stochastic trends was tested (Table 1) using unit root tests and these results confirmed the prevalence of unit root and provided the order of integration of each of the variables.[6] Using the maximum data

[5] That is to be expected, because equation (4) is derived on the assumption of a closed economy with only two sectors (agriculture and industry, i.e. no government and no services sector), with balanced trade between the two sectors.

[6] If there is a stochastic trend in agricultural, industrial and terms of trade variables the use of a deterministic trend will be incorrect as considered in equation (5).

period with four lags we chose the model with constant and deterministic time trend for each of the variables with optimum lag structure. For each of the growth rate variables, the null hypothesis of unit root is conclusively rejected at 1% level of significance.[7]

Insert Table 1 here

Furthermore, the model needs to be modified to take account of endogeneity of g_i, g_a and g_p, and also the imbalances in output levels from their equilibrium values. In other words, misspecification of the above equation may be due to an omitted variable, as for example, observed industrial output and equilibrium output may differ in the short run and this could have significant impact on growth rates. The methodology familiarised by Engle and Granger (1987) and Johansen and Juselius (1990) permits us to model all three variables (namely industrial output, agricultural output and terms of trade) as endogenous and estimate both long-run and short-run relationships.

We consider a **y**-vector, **y** = (log X_i, log X_a, log p), in which a deterministic linear trend is more likely given the technological change in both industrial and agricultural sectors over the period 1950-2000.[8] A vector autoregression of order 4 is specified and the best model is chosen for cointegration analysis.[9] The model includes an intercept term and the deterministic trend; the latter is expected to reflect the autonomous growth rate in the industrial sector's output in the long-run model. Using the standard test procedures, the VAR of order 1 was found to be the best. The residuals of the model for each equation were random and satisfied all the criteria, as shown in table 2.

Insert Table 2 here

Using the VAR of order 1, cointegration analysis was performed and statistical tests yielded one long-run cointegrating vector with positive trend. Table 3 reports the results of Johansen tests.[10]

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[7] If the absolute value of the test statistic is higher than the critical value obtained from the Dickey-Fuller tables, then the null hypothesis of unit root is rejected.

[8] A quadratic deterministic trend in levels is not a possible long-run outcome. The trend is forced to lie in the cointegration space, thereby restricting the system to at most a linear deterministic trend in levels.

[9] Beginning with a generous lag structure of 4 on annual data of all three variables, the model was made parsimonious by reducing the number of lags sequentially. It was found that the model with one lag achieved the best performance on the basis of Hannan-Quinn criteria and sequential F-tests for model reduction.

[10] The trace test rejected the hypothesis of a zero cointegrating vector but failed to reject the hypothesis of r = 1 against r = 2. The cointegration test was performed using the Johansen procedure.

Insert Table 3 here

The following unique cointegrating vector was found using the VAR model and the multivariate cointegration approach, (Graph 1C)

$$(7) \qquad \log X_i = \underset{(8.7314)}{1.2582} \cdot \log X_a + \underset{(3.3029)}{0.2610} \cdot \log p + \underset{(5.8828)}{0.02259} \cdot TREND$$

where log X_i is the log of industrial output, log X_a is the log of agricultural output and log p is the log of terms of trade.
Adjustment coefficients[11]: $\alpha_1 = -0.1217$ (1.94); $\alpha_2 = 0.3884$ (2.98); $\alpha_3 = 0.3627$ (3.01)
(Figures in parentheses are asymptotic t-ratios.)

4. Short-run error correction system

Further, theoretical structure on the econometric model may be imposed by testing the restrictions, namely weak exogeneity.[12] This implies that the long-run relationship (deviation of actual industrial output from its equilibrium level) does not have any effect on the growth rates of agricultural output and terms of trade relationships.[13] We impose a linear restriction on the weight matrix of α of a unique cointegrating vector which affects solely the variable growth in industrial output. Tests for weak exogeneity, meaning thereby that the adjustment coefficients (α's) are zero in the growth equations of the agricultural sector and the terms of trade were conducted.[14] The model using the restrictions on α's was estimated and the χ^2 with two restrictions turned out to be 22.561. The test rejected the restrictions on α, and both the growths in agricultural output and terms of trade adjust to disequilibrium in the industrial output[15]. Next, the error correction *system* with all I(0) variables was estimated and the most parsimonious system was derived.

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[11] Standard errors of coefficients of cointegrating vector are derived on the assumption that adjustment coefficients are known.

[12] Weak exogeneity of the variables in the parameters of interest implies that the long-run relationship does not enter all equations of the VAR system. In the presence of weak exogeneity we can estimate the short-run model using a single equation approach without having to estimate the system.

[13] When the observed value of industrial output in the last period is above the equilibrium level, the negative coefficient with the equilibrium error term produces decline in the growth rate of industrial output to restore the equilibrium in industrial output if weak exogeneity is satisfied.

[14] In a way, this also tests the frequent Kaldorian assertion that agricultural output and the terms of trade as "autonomous" variables are determinants of industrial growth (cf. Kaldor 1967: 56; 1978: 207-210; 1989: 429-30).

[15] Tiffin and Dawson (2003) conducted a similar study using the United Nations data for the period 1955-1995 and accepted the hypothesis of weak exogeneity. They concluded that disequilibrium in terms of trade had no effect on agricultural or industrial output and therefore, both agricultural and

As mentioned, the error correction term gives the distance between observed industrial output and the equilibrium industrial output. VAR model of growth rate variables with error correction terms was estimated using lags up to order 3 and a parsimonious VAR was derived. The estimated system in Table 4 reflects the adjustment in short-run of each of the variables towards their long-run equilibrium values. Over a long period, the economic system cannot move away from its equilibrium value. The move towards long-run equilibrium comes via adjustment in each of the three variables of the system. The error correction model suggests that adjustment towards long run equilibrium explains a substantial part of the growth in industrial output. The ECM system suggests that all short-run variables depend on short-run changes and equilibrium error term.[16] Empirically, this supports our previous conjecture that unplanned (error from equilibrium) inventories in industrial output in the previous period will lead to decline in growth of the industrial output in current period. The same unplanned inventories in industrial output in the last period will affect both agricultural growth and terms of trade relationships of current period in order to restore equilibrium of the system suggesting that neither agricultural sector nor industrial sector remains autonomous, violating one of the assumptions of Kaldor and implicitly of Lewis.

Insert Table 4 here

5. Concluding observations

By trying to isolate for investigation the problem of interaction between agriculture and industry, our analysis left out important considerations such as foreign trade, the growing services sector, and perhaps most importantly, the agricultural support price system of the government. It is evident that by ignoring all these factors, we cannot even hope to present a comprehensive and realistic empirical analysis of the evolving pattern of agriculture-industry interaction in India. However, that is not the intention of this paper.

Our aim is to highlight and analyse empirically with Indian data an issue of general theoretical interest. It focuses on the two-sided or dual role that any macroeconomically important relative price – such as the terms of trade in the present context, or the real wage rate in the familiar Keynesian "wage-cut controversy", or

industrial outputs were exogenous in their study. Their work supposedly draws on dual economy literature but there is no explicit theory or a model consistent with any economic model. Our study suggests that all three variables namely, terms of trade, agricultural and industrial outputs are endogenous and they all need to adjust to bring the system to equilibrium.

[16] The coefficient with respect to the error correction term is at least three times higher in the agricultural sector and the terms of trade growth equations than in the industrial sector growth equation, with the *a priori* expected signs.

the exchange rate devaluation in stabilising foreign trade – is likely to play. Because, like the real wage rate or the exchange rate, the terms of trade may impact on the supply side of industry through the cost of production, while at the same time it might also influence the level of aggregate demand. Lewis and Kaldor presented interesting models in this context by emphasising one side or the other.

Despite the starkly schematised nature of our model, our econometric analysis seems to suggest that Kaldor's emphasis on demand was probably more justified, at least in the Indian context. However, this finding had to be qualified in some important ways contrary to Kaldor's argument. Our analysis revealed the inappropriateness of treating the growth of the agricultural sector as an autonomous or exogenous variable in the equilibrium of intersectoral balanced trade assumed by both Lewis and Kaldor. Indeed, in a monetary economy, the postulate of balanced trade can at best hold as a long-term equilibrium relation with a convergent error correction mechanism over time. Our econometric model clearly incorporated this, while it also showed that the Kaldorian postulate of the terms of trade as being inflexible to the pressures of intersectoral excess demand or supply is probably overdrawn. In brief, without assigning particular importance to the estimated values of the parameters, our analysis based on the recent Indian experience points to the importance of the aggregate demand effect of the long-term movement in the terms of trade.

It would naturally be interesting to investigate how general this conclusion is in the context of other large developing economies with a significant agricultural sector. If our result turns out to be of general significance, it would also have serious policy implications, namely that exclusive emphasis on the cost of production aspect of relative prices such as the terms of trade, the real wage rate or the exchange rate might be misleading.

Table 1: Augmented Dickey-Fuller (ADF) tests with constant and trend

$$\text{Model used: } \Delta y_t = \alpha + \mu t + \beta y_{t-1} + \sum_{i=1}^{n} \gamma_i \Delta y_{t-i} + u_t$$

Name of the variable	Optimum lags	t-test ADF	β	$\hat{\sigma}$	AIC
$\log X_i$	1	–2.139	0.8496	0.0296	–6.951
$\log X_a$	1	–2.988	0.5066	0.0573	–5.632
Logp	1	–2.358	0.8284	0.0540	–5.751
g_i	2	–4.920	–0.1046	0.0297	–6.925
g_a	4	–5.424	–2.450	0.0569	–5.589
g_p	1	–5.314	0.0603	0.0552	–5.710

Notes: Models with and without time trends were estimated and for terms of trade results were similar for both so we have presented the unit root test with time trend variable. Unit root tests for growth variables do not include time trend variable.

t-value of the longest lag and significance of the longest lags are also calculated. The criterion of minimum Akaike Information (AIC) value is used to choose the optimum lags. For each variable data from 1956-2000 are used because of lags up to 4. The unit root hypothesis is rejected for the growth rate variables.

Critical values at 5% and 1% are –3.51 and –4.17 for 46 observations are from Mackinnon, (1991).

Table 2: Test of residuals of each equation in VAR model

Equation for the variable	Portmenateau test	Autoregressive lag (1-2) F(2,43)	Normality	ARCH1	HET F(18,36)	HET*X F(14,30)
g_i	20.92	2.45	9.20	0.4319	0.6103	0.7124
g_a	4.35	1.214	9.524	0.0255	1.247	0.906
g_p	7.58	3.86	4.841	0.1146	1.628	1.038
Vector test	66.96	1.3245 (0.1879)	14.574* (0.0238)		1.075 (0.3625)	0.9182 (0.6028)

Figures in parenthesis are the probability levels.

*significant and normality is violated.

Table 3: Cointegration tests, 1950/51 to 1999/2000 (50 observations)

Eigenvalue	Log likelihood	Rank (r)	Trace test	P-value
	242.044	0	67.132	0.000*
0.5663	262.931	1	25.358	0.056
0.3333	273.066	2	5.087	0.591
0.0967	275.61	3	-	-

* significant

Note: Cointegrating vector (β) and the feedback coefficients (α) and the long-run matrix are available. Trace test indicates that there exists one cointegrating vector. The hypothesis of zero cointegrating vector is rejected. The sequence of trace tests leads to a consistent test procedure, but no such result is available for the maximum eigenvalue test. Hence, we have not used the eigenvalue test.

We used trend (restricted), constant and one lag of each of the variables to obtain the cointegrating vector.

Critical values for cointegration tests are from Mackinnon (1991).

Table 4: Restricted reduced form system with first differences and cointegrating vector

	g_i (−1)	Coint(−1) Adjustment coefficients	Const.	$\hat{\sigma}$/RSS	OB	PAR	PORT(6)	AR−2	Normality	HET	HET*X	ARCH
g_i	0.2769* (2.04)	-0.119 (-1.95)	-0.482 (-1.80)	0.0287 0.0379	49	9	11.0	0.40	7.09*	1.62	1.46	0.005
g_a	-0.3729 (-1.29)	0.381* (2.93)	1.728* (3.02)	0.0613 0.1731			3.18	2.34	6.10*	0.96	0.76	0.85
g_p	0.3445 (1.29)	0.365* (3.04)	1.589* (3.01)	0.0565 0.1471			5.73	1.96	9.05*	0.35	0.32	0.21

Note: The results presented in equation (7) use unrestricted VAR in I(0) space while this table uses restricted error correction system eliminating the insignificant lags.

Vector Port(6) = 58.42; Vector AR1-2 = 1.0759; Vector Normality = 16.069*

Vector Hetero = 1.0246; Vector Hetero*X = 0.8384; log L= 261.19

*Significant at 5% level; Figures in parentheses are t-ratios.

$$COINT = \log X_i - 1.2582 \cdot \log X_a - 0.2610 \cdot \log p - 0.02259 \cdot TREND$$

Appendix

Data of the Indian gross domestic product (GDP) at constant and current prices were obtained from the Central Statistical Organisation for the period 1950/51 to 1999/2000. Data on components of annual GDP were also available. The constant price annual GDP data for agriculture and manufacturing components were at 1993/94 prices. From agricultural GDP at current and constant price, the agricultural price deflator was obtained. Agriculture includes forestry and fishing products. Similarly, the industry GDP at current and constant prices were used to obtain the industrial price deflator with 1993/94 = 100. The agricultural price deflator was divided by the industrial price deflator to obtain the terms of trade indicator. All the annual data come from one source and no adjustment to any of the indicators was necessary. We thus have three important variables, agricultural GDP at constant prices, industrial GDP at constant prices and the terms of trade (defined as agricultural price deflator divided by industrial price deflator). As it is a long time series over 50 years, we decided to reduce the variability by taking logs of each of the three variables. Means and standard deviations of all three variables in logs and their growth rates are given in table A.1.

Table A.1: Means, Standard Deviations, Skewness, Kurtosis and Normality Test 1950-51 to 1999-2000 (51 observations)

Name of the variable	Mean	Standard deviation	Skewness	Kurtosis	Normality test $\chi^2(2)$
Log X_i	11.019	0.8312	0.0919	–1.0670	2.4923
Log X_a	11.801	0.3888	0.2347	–1.3010	3.1820
Log p	–0.0392	0.1151	0.3168	–0.9002	2.5754
g_i	0.0573	0.0299	–0.3216	0.0775	0.8746
g_a	0.0262	0.0653	–0.2004	0.2576	0.4729
g_p	0.0024	0.0605	–0.9323	1.2619	10.560*

*Normality violated on asymptotic test.
log X_i = log of industrial output at constant prices (of 1993/94)
log X_a = log of agricultural output at constant prices (of 1993/94)
log p = log of agricultural to industrial price deflator, 1993/94 = 100
g_i = growth in industrial output approximated by first differences of log X_i
g_a = growth in agricultural output approximated by first differences of log X_a
g_p = rate of change in price deflator approximated by first differences of log p.

Table A.1 shows that the terms of trade has become unfavourable for agriculture on the long-period series data as the ratio of mean of agricultural to industrial prices is less than one (i.e. approximately 0.96). The growth in the industrial sector on an average is about 5.7% per annum while the growth in agricultural sector is about 2.6% per annum. Terms of trade (agricultural price deflator divided by industrial price deflator) are not normally distributed and do not have any significant trend.

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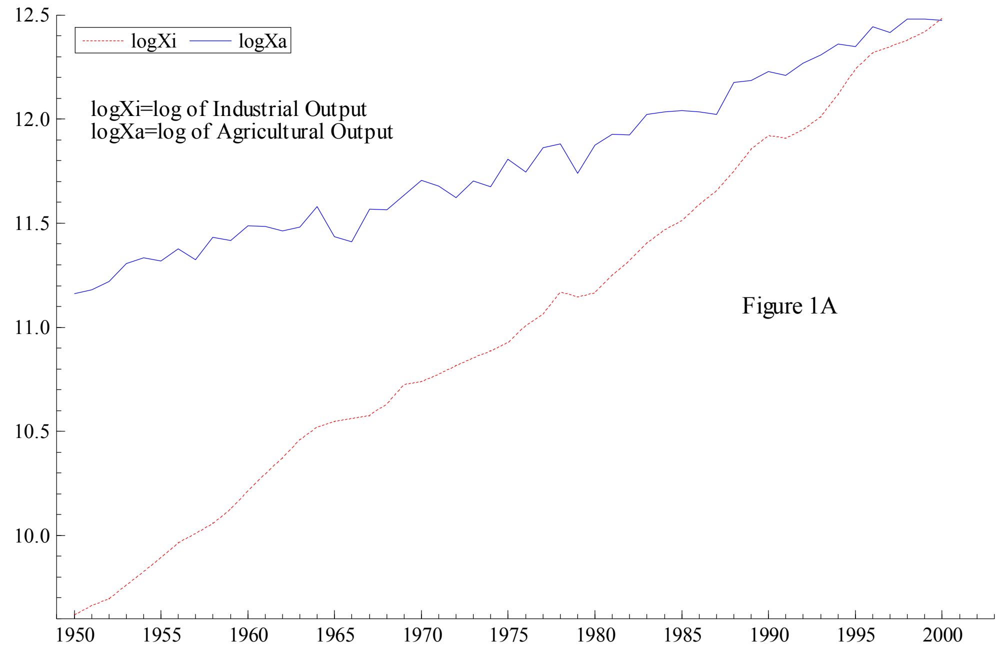
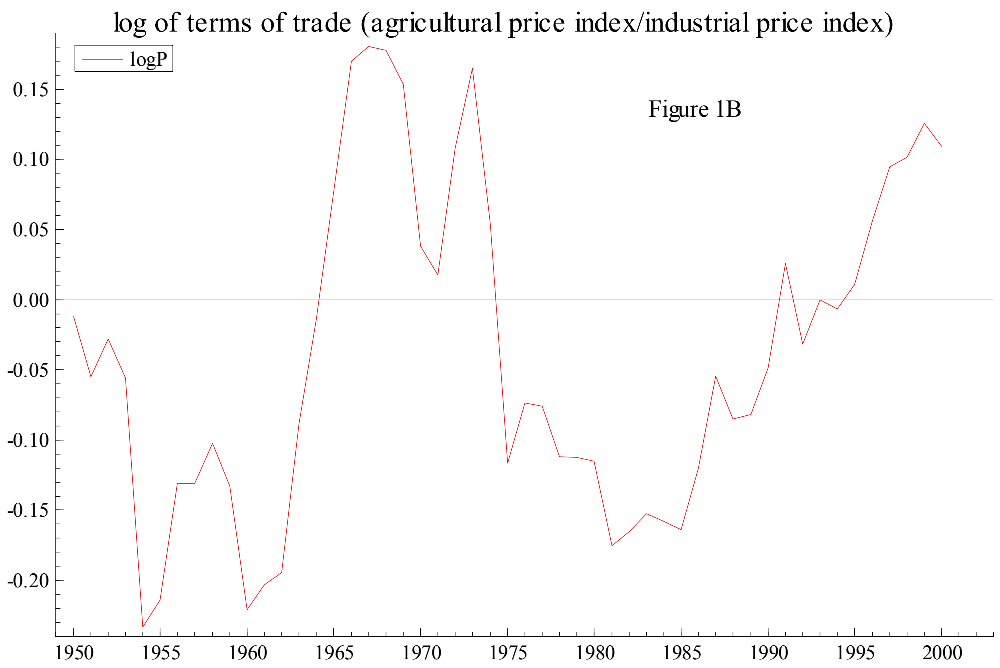
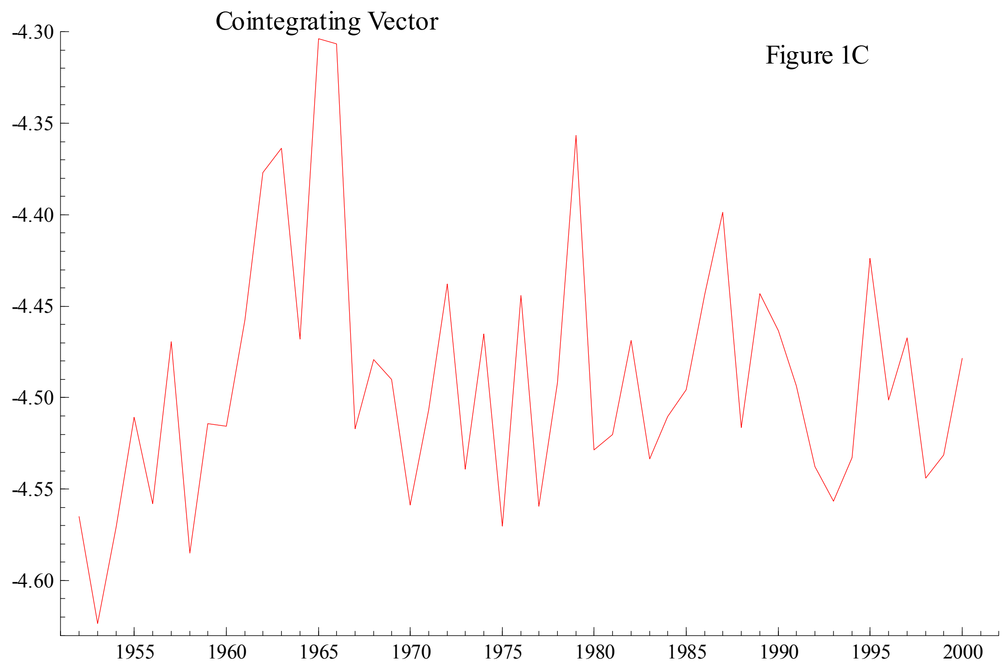

12.5
12.0
11.5
11.0
10.5
10.0
logXi
logXa
logXi=log of Industrial Output
logXa=log of Agricultural Output
Figure 1A
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000


log of terms of trade (agricultural price index/industrial price index)
logP
Figure 1B
0.15
0.10
0.05
0.00
-0.05
-0.10
-0.15
-0.20
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000


Cointegrating Vector
Figure 1C
-4.30
-4.35
-4.40
-4.45
-4.50
-4.55
-4.60
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000