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DOES THE DOG WAG THE TAIL OR THE TAIL THE DOG? COINTEGRATION OF INDIAN AGRICULTURE WITH NON-AGRICULTURE

by

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ABSTRACT

An oft-repeated refrain in the development literature has been the 'neglect' of the agricultural sector vis-a-vis the industrial sector in the development process of the less developed economies. Since infrastructure is crucially linked to both agricultural and industrial development, poor instructure development may make it appear as if slow agricultural growth has caused slow industrial growth. Further, in estimating the relation between agriculture and industry, the former should not be assumed to be exogenous; rather, this should first be established. Moreover, given that most time series are trended, conventional regression techniques may yield spurious regressions and significance tests. To circumvent these various problems, we study the cointegration of the different sectors of the Indian economy in a multivariate vector autoregression framework.

Two roads diverged in a wood, and I --
I took the one less traveled by,
And that has made all the difference.
... Robert Frost

1. Introduction

An oft-repeated refrain in the development literature has been the "neglect" of the agricultural sector vis-a-vis the industrial sector in the development process of the less developed countries. It is argued that with the objective of compressing the growth process into as short a period of time as possible, developing countries have been trying to industrialize rapidly over the past few decades. The consequence in a bewilderingly large number of countries, if not most, has been the relative neglect of the agricultural sector. This has proved counterproductive for industry itself, as well as for the overall performance of the economy. Indeed, an overwhelming emphasis on industry appears quite contrary to the perception of even the early development theorists. While industry was recognized as the 'prime mover' in the developing economy, Lewis [1954] realized that "... economies in which agriculture is stagnant do not show industrial development" (Timmer [1988]; World Development Report [1982]). Extending this argument, it is contended that even when agriculture is not stagnant, it must grow in tandem with the other sectors of the economy or else the entire economy-wide growth process may be jeopardized.

What, then, is the evidence regarding the 'neglect thesis'? First, the present levels of agricultural labour productivity in the African and Asian countries are about 45% less than those in the developed countries at the start of their industrialisation. Second, development policies seem to have been such that manufacturing labour productivity in less developed countries grew faster than agricultural labour productivity (between 1960-80), despite the low initial levels of agricultural productivity (Timmer, op.cit.). Third, according to norms established by Krishna [1982] for the share of agriculture in capital formation at different stages of economic growth, developing countries have neglected their agricultural sectors. As against a norm of 22% of total investment for low-income and lower-middle-income countries, not even one of the 20 sample countries allocated even 20% in 1966-68, and only three allocated even as little as 15% (Rao and Caballero [1990]). Fourth, despite the fact that the performance of the manufacturing sector in generating employment has been *persistently* dismal in the face of very large annual additions to the labour force, the less developed economies have continued to espouse industry as the fount of economic growth. In India, for instance, the organized manufacturing sector presently generates additional annual employment of about one million or less against annual additions of seven to eight million to the total labour force (Sundaram and Tendulkar [1995]). Yet development policies tend to stress the leading role of industry. Finally, studies show that most less developed economies have tended to tax their agricultural sectors relative to their industrial sectors by overvaluing their exchange rates, restricting/prohibiting exports of agricultural commodities, and providing sheltered markets to industry (Rao and Gulati [1994]). Taken together, this evidence amply supports the thesis of the neglect of the agricultural sector in the development processes of the less developed countries[1].

This becomes an especially important consideration for economies in which the agricultural sector has continued to be very large in terms of national income and employment. India is a prime example amongst less developed economies, though hardly an exception, to which the above observations apply. A strategy which placed overwhelming emphasis on the capital-intensive industrial sectors in the economy, has left as its consequence a feeling of 'lost decades'. While agriculture contributed 49% of the Gross Domestic Product (at factor cost at 1980-81 prices) in 1950-51, it still contributed as much as 28% in 1992-93.

By contrast, manufacturing industry grew from about 11% to less than 20% of GDP over the same period (NAS, various years). Similarly, the construction, infrastructure and services sectors account for relatively modest shares of GDP even today. The sectoral distribution in terms of shares of employment is even more unequal, with agriculture accounting for about 65% and manufacturing industry accounting for about 11% even as late as 1987-88. In other words, even after four decades of planned growth with emphasis on industry, agriculture continues to be the single largest sector in the economy. Could the neglect of agriculture, therefore, have throttled the growth of Indian industry? Stated alternatively, is there a positive, causal relationship between the growth of agriculture and the growth of the industrial sector (as well as the economy) in India?

The contribution of agriculture to industry has been analysed in terms of its role as: (i) a supplier of wage goods, (ii) a supplier of raw materials, and (iii) a market for industrial products (Timmer [op.cit.]). Considering its role as a supplier of wage goods, worsening agricultural performance would be reflected in terms of the production, marketed surplus and net availability of agricultural output, and hence (possibly) in a movement of the terms-of-trade against industry. Reviewing earlier evidence (Srinivasan [1979], Alagh and Sharma [1980], Sawant [1983]), and estimating some up-dated regressions for the period 1950-51/82-83, Ahluwalia [1985] does not find any evidence of an acceleraiton or deceleration in either agricultural or foodgrains production over this period. Further, Thamarajakshi [1977] shows that the annual growth rate of marketed surplus increased from 3.5% over the period 1951-52/65-66 to 4.2% over the subsequent period 1965-66/73-74. Thus, the rate of growth of marketed surplus exceeded that of production (about 2.5% per annum) in both the periods, and this margin infact increased during the latter period (Mody [1982]). But the production and marketed surplus of wage goods must be adjusted for exports and imports if we are to properly assess the existence of the wage goods constraint. Ahluwalia (op.cit.) finds that there was no trend in the per capita net availability of foodgrains over the period 1959-60/83-84, with the level fluctuating around 446 grammes per day. Finally, we look at the movements in the terms-of-trade between agriculture and industry. Note that a movement of the terms-of-trade in favour of agriculture will not only have a direct effect on industrial profitability by raising the product wage rate (Chakravarty [1974]), but may also have an indirect effect insofar as it changes the distribution of real incomes in favour of agriculture. To the extent that this change benefits the richer peasantry differentially, it may lead to a significant decline in the relative demand for consumption goods. This, together with the increase in the unit cost of production, would lead to a decrease in profitability, industrial investment and growth (Mitra [1977]). Note, however, that Mitra contended the movement in the terms-of-trade in favour of agriculture to have been brought about by a systematic class bias. While Chakravarty (1979) concurred with this assessment, Tyagi (1979) did not. In any case, all the studies looking at the terms-of-trade between agriculture and industry including Mitra's above, use the official wholesale price indices of agricultural and non-agricultural products for this purpose. But, as Ahluwalia observes, what we ideally require is an index of the price of *wage goods* relative to the price ot *industrial products*. In the absence of such a series, Ahluwalia looks at four alternative series to conclude that the evidence is inconclusive. Further, data do not support the hypothesis of a trend increase in income inequlity in the post-60s period (see Ahluwalia [op.cit.] and the references cited therein). Finally, Menon [1986b] reports that for the medium and large public limited companies (the most important segment of the Indian corporate sector), the post-tax rate of return exceeded the rate of interest for much of the period 1960-61/80-81. And while this margin decreased over time, this was primarily due to an increase in the cost of raw materials and not due to an increase in wage costs. Infact, wage costs as a proportion of the value of production declined over this period (Menon [1986a]). On balance, then, the wage goods constraint does not appear to have been a limiting factor.

Coming to the role of agriculture as a supplier of raw materials to the agro-industries, Ahluwalia (op.cit.) points out that although there occured a decline in the rates of growth of the cash crops in the post-mid-60s period, this was not matched by declines in the growth rates of the corresponding agro-industries. However, the available evidence is insufficient to properly address this issue.

Finally, the slow growth of agricultural incomes could have contributed to industrial stagnation. A growth of per capita agricultural income of less than 0.5% per annum over 1956-57/79-80 implied a severe demand constraint on the growth of industry, especially given the closed economy (and the fact that agriculture accounts for almost 30% of the GDP even today). However, Ahluwalia (op.cit., p. 168) cautiously adds that " ... [I]t is difficult to conclude that if only the growth of agricultural incomes had been faster, the growth of ... industries would have picked up. The supply constraints emanating from the *infrastructure* sector, the regulatory framework and poor productivity performance would most likely have held back growth ... " (emphasis added). Note the emphasis we have laid on the infrastructure constraint. We take up this point below.

It is a trite observation that both industrial and agricultural growth are dependent on the availability of adequate infrastructure. Infrastructure may be thought of as a critical input that itself does not directly enter production, but which is indispensable to the production activities of the economy. Rao and Caballero (op.cit., p. 904) note that " ... without massive investment in ... roads, extension services, rural education etc., significant increases in HYV adoption rates or in cropping intensity would not have come about". Similarly, industrial growth would be retarded by the inadequate availability of power, transport, communications etc.; as, indeed, Ahluwalia (op.cit.) finds in the case of the Indian economy. Since infrastructure is crucially linked to both agricultural and industrial development, poor infrastructure development by slowing down both agricultural and industrial growth rates, may make it *appear* as if slow agricultural growth has *caused* slow industrial growth. This has obvious implications in the context of sectoral linkages and policy issues relating to whether the industrial sector ('the tail') should be given over-riding emphasis over the agricultural sector ('the dog'), for it calls into question empirical studies that consider the relation between agricultural and industrial growth without properly accounting for the role of the infrastructure 'sector'.

Second, empirical studies looking at the relationship between agriculture and industry *assume* agriculture to be exogenous, and then estimate the effect it has on the industrial sector (Rangarajan [1982], Ahluwalia and Rangarajan [1989]). In fact, however, this is a proposition that should be tested first rather than assumed. Third, in specifying the estimable relationships, conventional methods require an a priori bifurcation of the system variables into 'endogenous' and 'exogenous', and zero restrictions are sought to be placed on some of these variables to achieve identification. While economic intuition may well aid in this regard, such decisions may involve a greater or lesser element of arbitrariness and may hence be undesirable (Sims [1980]). Fourth, input-output models and multi-equation systems have additional drawbacks such as heavy data requirements and untenable assumptions regarding unchanging technology (Rudra [1967]). Fifth, given that most economic time series are trended, conventional regression techniques may yield spurious regressions and significance tests which are uninterpretable (Phillips [1986], Granger and Newbold [1986]). To circumvent all these problems, we study the cointegration of the various sectors of the Indian economy -- namely, agriculture, manufacturing industry, construction, infrastructure and services -- in a multivariate vector autoregression framework. The basic idea behind such an enquiry is to determine the long-run relationship between these sectors each of which typically exhibits nonstationary behaviour. Since economic theory suggests a long-term relationship between (some subset of) these sectors, even though they may appear to be drifting apart over shorter spans of time, over the longer run forces may push them back into equilibrium. If indeed these sectors are moving together along some long run path, deviations from this path will be stationary. Engle and Granger [1987] formally developed such a cointegrating relationship through the use of an error correction mechanism; which, they suggested, may be estimated by means of a two-step procedure. However, their method assumes the existence of only one cointegration vector, whereas in actual fact there may be more than one error correction mechanism at work in the system. Hence, in this exercise we utilise a more powerful estimation procedure due to Johansen and Juselius [1992, 1990] (and Johansen [1988]), which corrects for this shortcoming through the FIML estimation of a multivariate vector autoregression model. Section 2 briefly sets up the basic model and describes the data used in its estimation. Section 3 presents a discussion of the estimation results. Finally, section 4 sketches out the conclusions.

2. Basic Model and Data Set

Since economic time series are generally nonstationary processes, Johansen and Juselius express the unrestricted vector autoregression model in first differences as:

$$\Delta y_t = \Sigma_{i=1}^{k-1} \Gamma_i \Delta y_{t-i} + \Pi y_{t-k} + \mu D_t + \varepsilon_t \qquad (1)$$

where y_t is the column vector of the current values of all the variables in the system (integrated of order one), D_t is a matrix of deterministic variables such as an intercept and time trend, ε_t is NIID$(0,\Omega)$ and $(\Gamma_i,\Pi,\mu,\Omega)$ are the parameter matrices. While the first term in expression (1) captures the short run effects on the regressand, the second term captures the long run impact. Since our objective is to investigate the long run underlying relationships, we focus attention on the elements of matrix Π. If the vector y_t contains n variables, matrix Π will be of order nxn with a maximum possible rank of n. Then, using the Granger representation theorem (see Engle and Granger, op.cit.), if the rank of Π is found to be r<n, the matrix Π may be factored as $\alpha\beta'$ where α and β are both of order nxr. Matrix β is such that $\beta' y_t$ is I(0) even though y_t itself is I(1). In other words, it is the cointegrating matrix describing the long run relationships in the model. The weights matrix α gives us the speed of adjustment of specific variables on account of deviations from the long run relationship[2].

We estimate this model for the Indian economy by defining the column vector y_t to comprise the gross domestic product at factor cost at constant (1980-81) prices for five sectors: 'agriculture', 'manufacturing industry', 'construction', 'infrastructure' and 'services'[3]. These may be denoted as A, M, C, I and S for convenience. Data were available for the period 1950-51/1992-93. Preliminary investigation through Dickey-Fuller and Augmented Dickey-Fuller tests revealed the A, I and S series to be integrated of order 1, whereas M and C were integrated of order 2[4]. Therefore, the vector y_t is defined as ($\ln A_t$, $\Delta \ln M_t$, $\Delta \ln C_t$, $\ln I_t$, $\ln S_t$)$'$. An inspection of the plots of (the logs of) each of the variables against time supports the inclusion of a time trend (see Figure 1). Hence, a time trend was included both in (1) above as well as in the cointegration space. An important variable that must be pre-determined is the maximum lag length k in expression (1) above. While a long lag may ensure the desired residual properties, it may not make much economic sense as regards adjustments to deviations from the long run path (as the bulk of such adjustments are usually found to be completed in a relatively small number of periods). We found k=2 acceptable on both the above considerations. An inspection of table 1 (pertaining to the residual statistics from (1) above) supports the assumptions of normality and lack of serial correlation in the error processes of our equation system[5].

3. Estimation Results

3.1 Testing for the number of cointegration vectors

Several pieces of evidence were adduced to determine the rank of matrix Π. First we use two likelihood ratio tests proposed by Johansen and Juselius (op.cit.). To test the hypothesis of reduced rank r they propose the use of the trace statistic $Q_1 = -T \Sigma_{i=r+1}^{n} \ln(1-\lambda_i)$ and maximal eigenvalue statistic $Q_2 = -T \ln(1-\lambda_r)$, where T is the total number of observations and λ_i is the i^{th} eigenvalue. According to both tests (see table 2), the rank is at least equal to 2. Further, it seems that the rank may well be 3, since both statistics marginally exceed their 95% critical values. However, since the computed and critical values are virtually the same, we must consider further evidence before deciding on the number of cointegrating vectors in this system. Therefore, we next take a look at the graphs of the (residuals of the) cointegrating relations, and the (residuals of the) cointegrating relations corrected for short-run dynamics (Figure 2). If r=3 the first three processes must look stationary, whereas if r=2 this should hold only for the first two processes. An inspection of figure 2 suggests that r=2 would be a more reliable inference, since the graph of the residuals of the cointegrating vector corrected for short run dynamics for the third process appears to show some non-stationarity. Therefore, we choose r=2. The presence of these cointegrating relations in our system reflects an inherent tendency in the system to revert towards equilibrium subsequent to a short-run shock. Thus, the graphs of the cointegrating relations describe the deviations from the long-run equilibrium path of the economy on account of the short-run shocks (small or large). And the graphs of the cointegrating relations corrected for short-run dynamics describe the actual adjustment path corrected for these short-run dynamics. Even though the economy does not stay in equilibrium for any length of time on account of the periodic short run shocks that it receives, the large number of crossings of the 'mean line' displayed in these graphs shows the system's tendency to return to equilibrium.

3.2 The unrestricted cointegration space

In all of the following analysis we assume the presence of two stationary relations and three common trends in our system. Their estimates are presented in table 3 along with the corresponding adjustment matrix α. To facilitate the analysis of the cointegration space as summarized by the estimates, we also compute certain likelihood ratio test statistics which indicate the relative importance of the individual β and α values. A test of the null hypothesis for α, H_0: $\alpha_{i1}=\alpha_{i2}=0$ tests whether the equation Δy_i contains any cointegrating relation. Individual elements of these joint tests are reported within brackets in table 3. The estimates tell us that the first eigenvector β_1 primarily links manufacturing sector income positively with agricultural income[6] and negatively with construction sector income. The corresponding loading vector $\hat{\alpha}_1$ and the associated test statistics within brackets tell us that this relation is mostly important in the manufacturing and construction sector equations. Note that this also reflects the slow 'speed of adjustment' of the other variables to the short-run shocks that dislodge the system from its long-run path. While this implies that we can standardize this eigenvector on either manufacturing sector income or construction sector income, we have chosen to do so on the former. The second eigenvector β_2 seems to explain construction sector income as significantly related to all the variables, with the possible exception of infrastructure sector income. The corresponding weights vector $\hat{\alpha}_2$ indicates that this relation is important in the construction sector equation only. Therefore, we standardize this eigenvector on the construction variable. Tests for exogeneity (i.e. the joint test H_0: $\alpha_{ij}=0$, j=1,2) strongly support the weak exogeneity of the agriculture, infrastructure and services variables. Specifically, for agriculture the test statistic $\chi^2(2)=1.57$, for infrastructure 2.25 and for services 1.53 with p-values of 0.46, 0.32 and 0.47 respectively. This implies that the system may be effectively reduced to a two-dimensional one without affecting the estimates of β. Alternatively stated, the cointegration relations are to be found in the M and C sector equations only.

4. Implications and Conclusions

We now summarize the above results. First, we find that the economic sectors moved together over the sample period and hence their development was interdependent. This is not to imply that some of the sectors did not outpace others, but only that the economic forces at work functioned in such a way as to tie together these sectors in a long-run structural equilibrium. And while short-run shocks may have lead to deviations from this long-run path, forces existed whereby the system reverted back to it. The significance of this result may be gauged by comparing it to the existence, say, of a positive relation between the raw data series. Thus, if we were to find a positive relation between the sectoral incomes in the context of conventional econometric models, this could merely be due to the presence of common trends (and not cointegrating relations) in the data and hence may not signify a genuine relationship between the growth processes of the different sectors. Although we do find the presence of three common trends in our data, we also find the presence of two cointegrating relations. In this sense there exists a long-run equilibrium relationship between the different sectors of the Indian economy.

Second, the system reveals not one but two cointegrating relations in the economy; while the first one may be taken to pertain to the manufacturing sector, the second one may be taken to relate to the construction sector. This should caution us that the assumption of a unique cointegrating relation in the economy as within the Engle-Granger [op.cit.] formulation may be erroneous.

Third, the infrastructure and service sectors (and to a lesser extent the agriculture sector also) exhibit very slow speeds of adjustments to deviations from the long run path. This is probably reflective of the wide-spread administrative controls over the activities comprising these sectors for the bulk of the sample period. Thus, the infrastructure sub-sectors such as electricity, gas, water supply and communications, and the services sub-sectors such as rail transport, financial and insurance services were almost totally within the state sphere over the sample period[7]. These activities, therefore, tended to depend on budgetary allocations rather than directly on impulses emanating from the other growing sectors of the economy. This probably undermined the adjustment speeds of these sectors consequent to deviations of the system from the long-run equilibrium path.

Finally, the agriculture, infrastructure and services variables are found to be weakly exogenous with respect to the long-run parameters β. (Note that this exogeneity is not *assumed* as in some studies noted above). This may be taken to imply that while these sectors significantly affect the process of income generation in the manufacturing and construction sectors, the reverse has not been true. This may be explained by the fact that the growth process in the agricultural sector has important implications for the manufacturing sector[8] to the extent that it relaxed the wage goods and foreign exchange constraints. Further, it provides a potentially large market for manufactured products, especially consumer goods. On the contrary, the growth process in the manufacturing sector does not significantly impact the agricultural sector in view of the fact that the predominant bulk of the rural households are either small and medium farmers with tiny surpluses or landless labour. Given that agriculture is even today the single largest sector in the economy, it may be seen as a driving force for the other sectors. Similarly, infrastruntural development significantly influences the development of the manufacturing and construction sectors of the Indian economy. Since the reverse linkages towards income generation in the agricultural and infrastructural sectors have been found to be weak, encouraging the manufacturing sector alone or even primarily (as in the recent "liberalisation" policies) will not help to boost the entire economy in the long run. Rather, the agricultural and infrastructural sectors will have to be directly encouraged.

Table 1

Residual Statistics

Eqn.	Mean	S.D.	Skewness	Excess Kurtosis	Normality test	AC coeff.
A	0.000	0.043	-0.740	0.509	3.532	0.227
M	0.000	0.029	-0.270	1.131	1.650	-1.283
C	0.000	0.047	-1.049	2.220	12.223	-1.817
I	0.000	0.018	0.685	1.654	5.748	0.466
S	0.000	0.012	-0.982	2.245	11.519	-0.147

Notes:(i) The normality test uses the Jarque-Bera LM statistic, which is distributed as $\chi^2(2)$ under the null.

(ii) The "AC coeff." refers to the coefficient of the lagged errors term in the Durbin 'large sample test'.

Table 2

Tests for number of cointegrating vectors

Eigenvalues in descending order:

0.73288	0.59818	0.41385	0.18617	0.01334

LR Test based on Maximal Eigenvalue statistic

Null	Alternative	Statistic	95% c.v.
r=0	r=1	52.8021	33.4610
r≤1	r=2	36.4704	27.0670
r≤2	r=3	21.3669	20.9670
r≤3	r=4	8.2400	14.0690
r≤4	r=5	0.5370	3.7620

LR Test based on Trace statistic

Null	Alternative	Statistic	95% c.v.
r=0	r=1	119.4164	68.5240
r≤1	r=2	66.6143	47.2100
r≤2	r=3	30.1439	29.6800
r≤3	r=4	8.7770	15.4100
r≤4	r=5	0.5370	3.7620

Notes: (i) The critical values are from Osterwald-Lenum [1992]

Table 3

Estimated Eigenvectors and corresponding Adjustment matrix

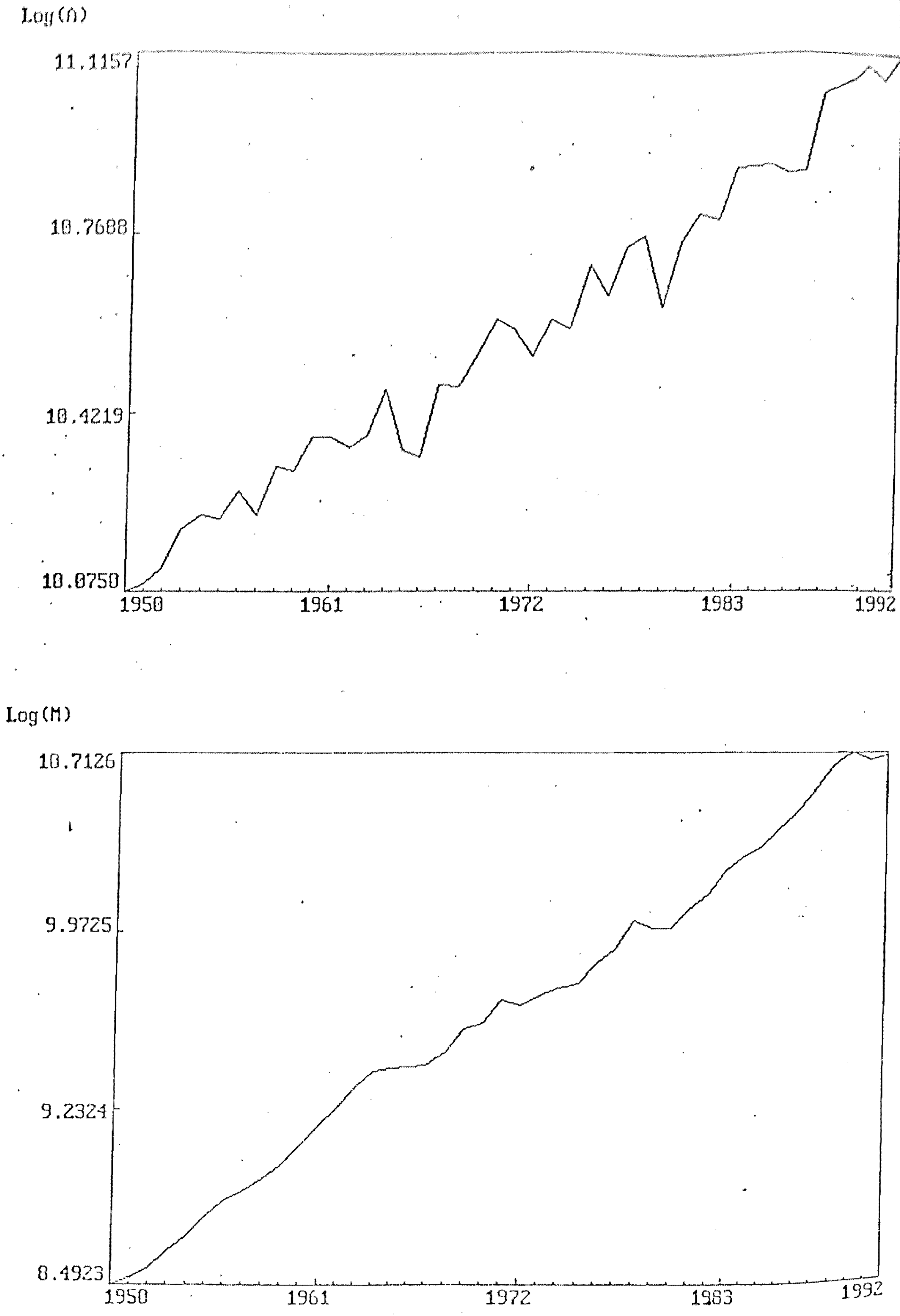
Estimated Eigenvectors

Var	β_1	β_2	$\hat{\upsilon}_3$	$\hat{\upsilon}_4$	$\hat{\upsilon}_5$
A	-0.2270	-0.2100	1.2114	-0.5618	0.3629
M	-1.0000	1.1358	-1.0000	-1.0000	-1.0000
C	-0.3882	-1.0000	-0.1685	-0.2610	0.0738
I	0.0199	-0.0843	-0.0108	0.0172	-0.4921
S	0.0151	0.2655	-0.5946	0.3721	0.6810

Estimated Adjustment Matrix

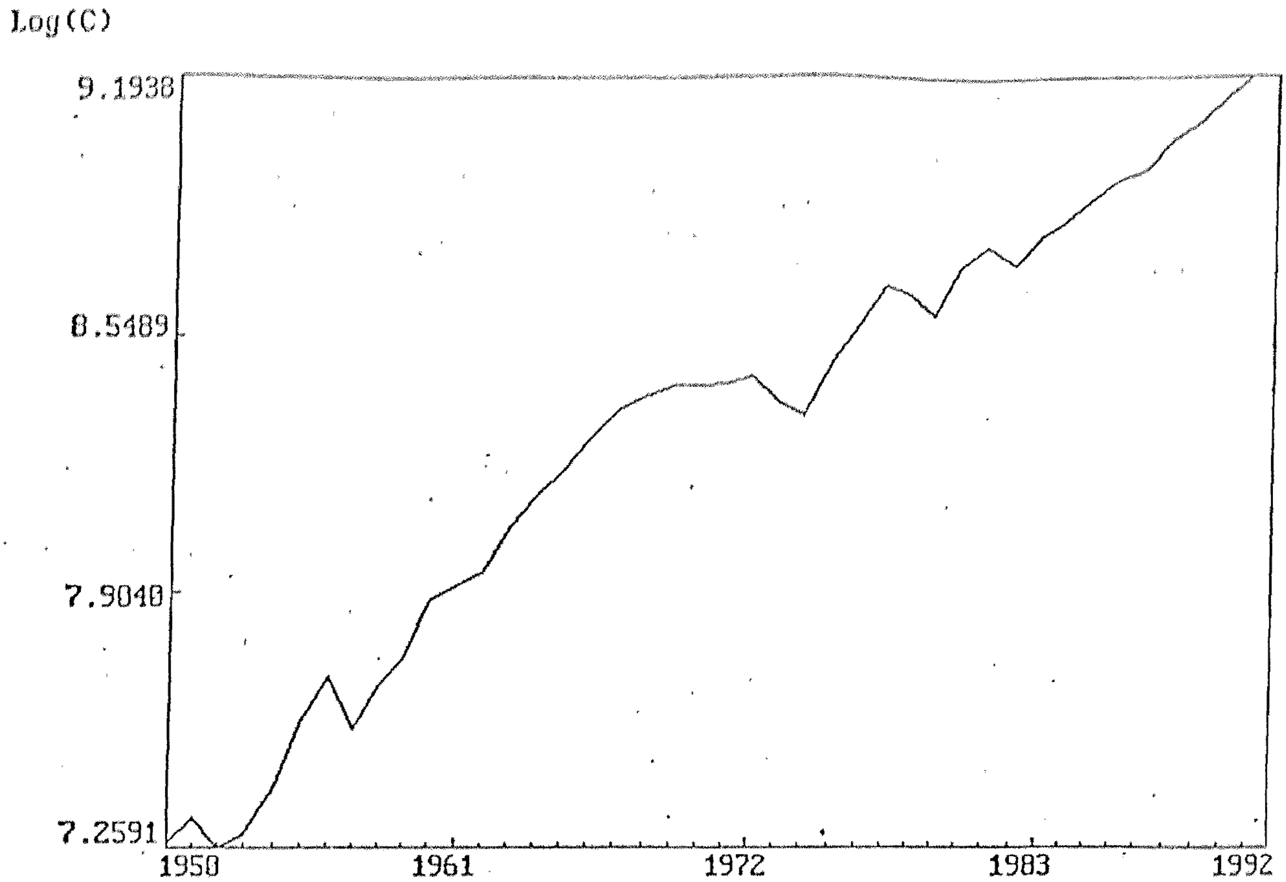
Eqn	$\hat{\alpha}_1$	$\hat{\alpha}_2$	$\hat{\omega}_3$	$\hat{\omega}_4$	$\hat{\omega}_5$
ΔA	0.0924 (1.26)	0.0241 (0.30)	-0.1607	-0.0910	-0.0095
$\Delta^2 M$	0.1545 (7.58)	-0.0913 (7.93)	0.0022	-0.0524	-0.0120
$\Delta^2 C$	0.2034 (3.55)	0.2954 (14.6)	0.0218	-0.0255	-0.0129
ΔI	0.0363 (0.27)	0.0095 (1.98)	-0.0288	0.0278	0.0109
ΔS	-0.0262 (0.02)	0.0070 (1.51)	-0.0071	-0.0178	-0.0086

Notes: (i) Individual components of the LR test statistic for the null H_o: $\alpha_{ij}=0$, j=1,2 are reported within brackets.



Log(A)
11.1157
10.7688
10.4219
10.0750
1950
1961
1972
1983
1992
Log(M)
10.7126
9.9725
9.2324
8.4923
1950
1961
1972
1983
1992

Fig. 1


Log(C)
9.1938
8.5489
7.9040
7.2591
1950
1961
1972
1983
1992

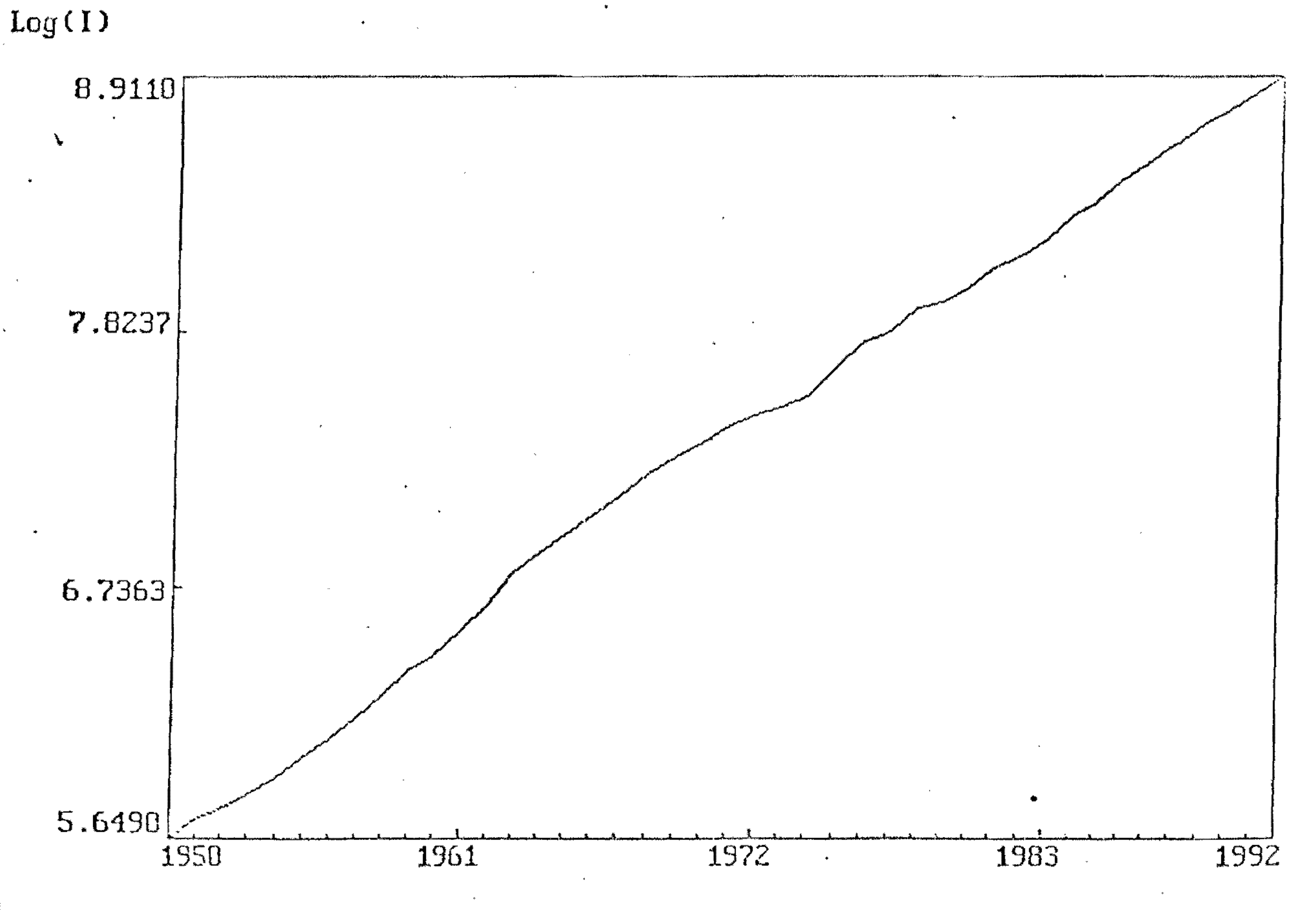

Log(I)
8.9110
7.8237
6.7363
5.6490
1950
1961
1972
1983
1992

Fig. 1 contd.

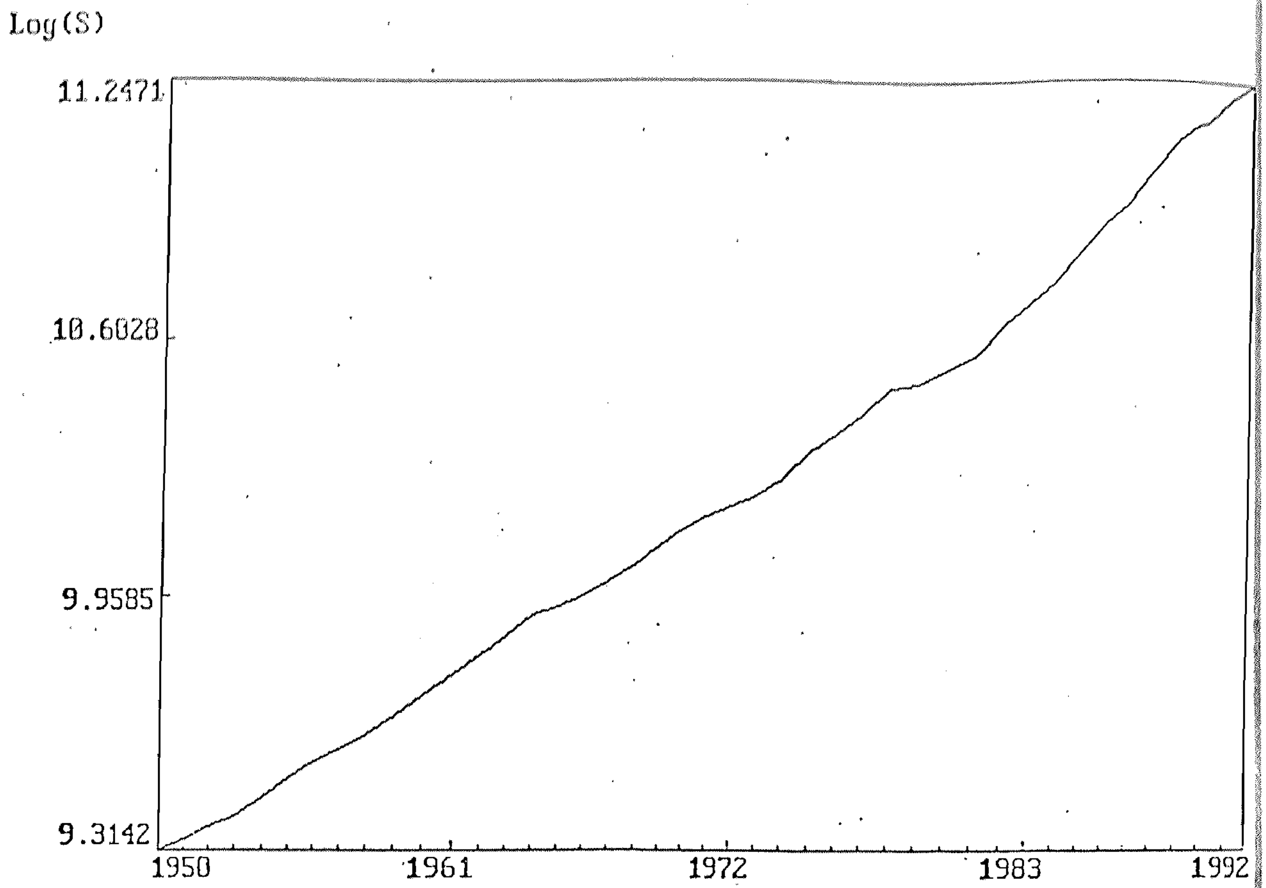


Fig. 1 contd.

Residuals of cointegrating vector 1

Residuals of cointegrating vector 1 adjusted for short-run dynamics

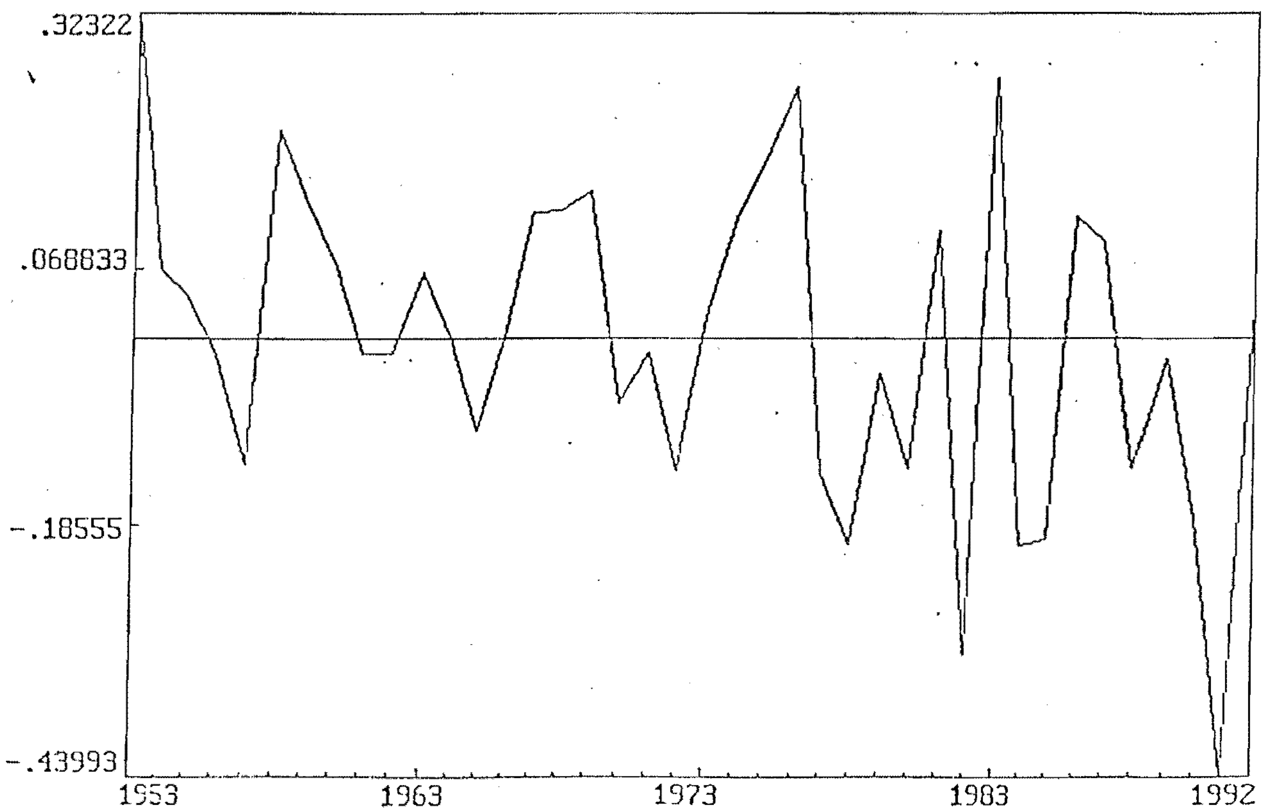
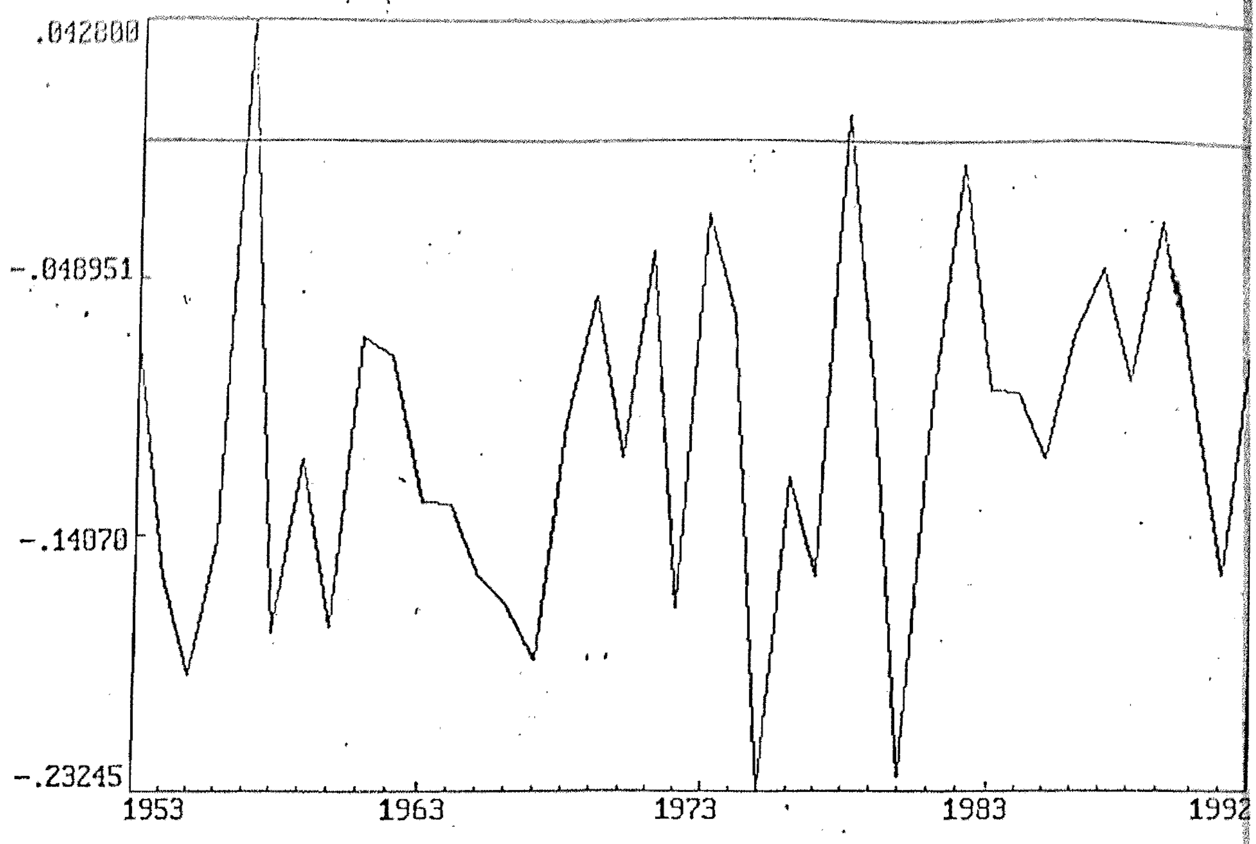


Fig. 2

Residuals of cointegrating vector 2



Residuals of cointegrating vector 2 adjusted for short-run dynamics

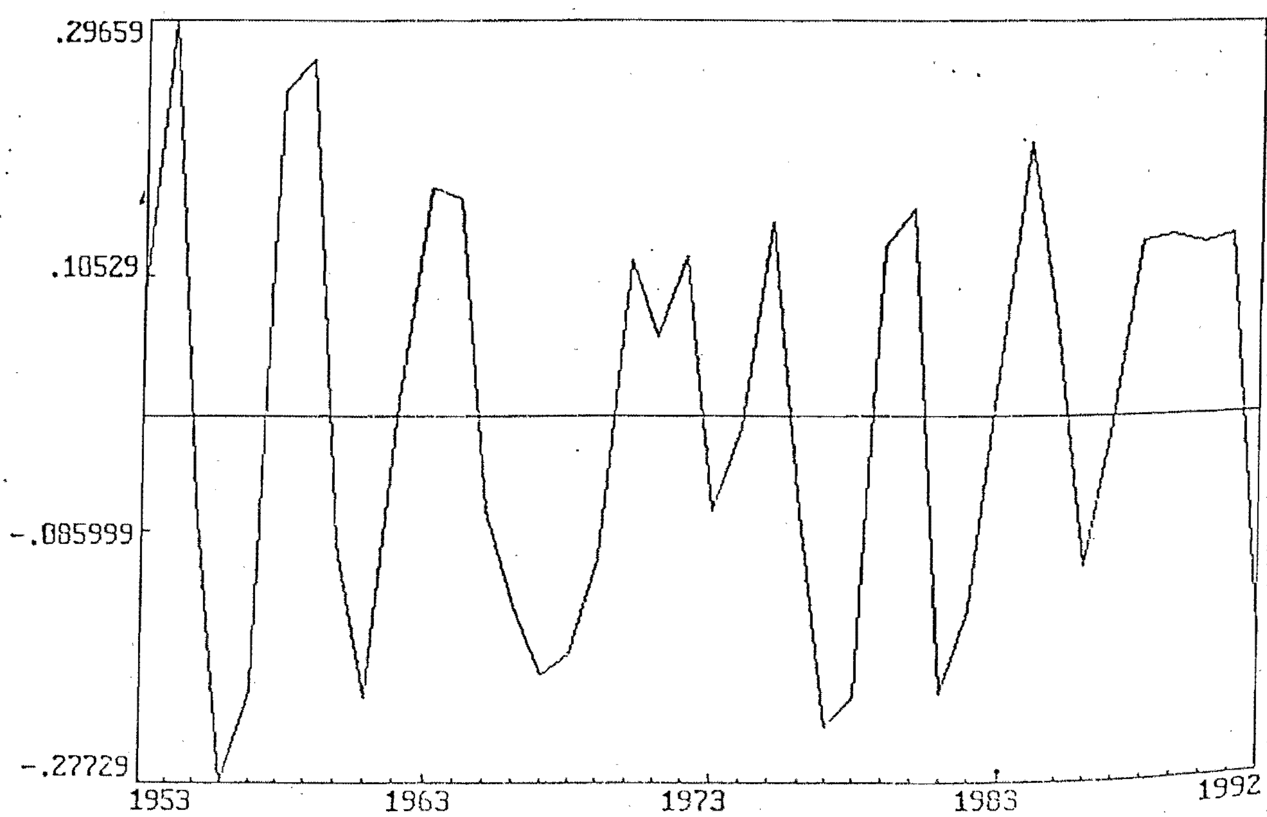
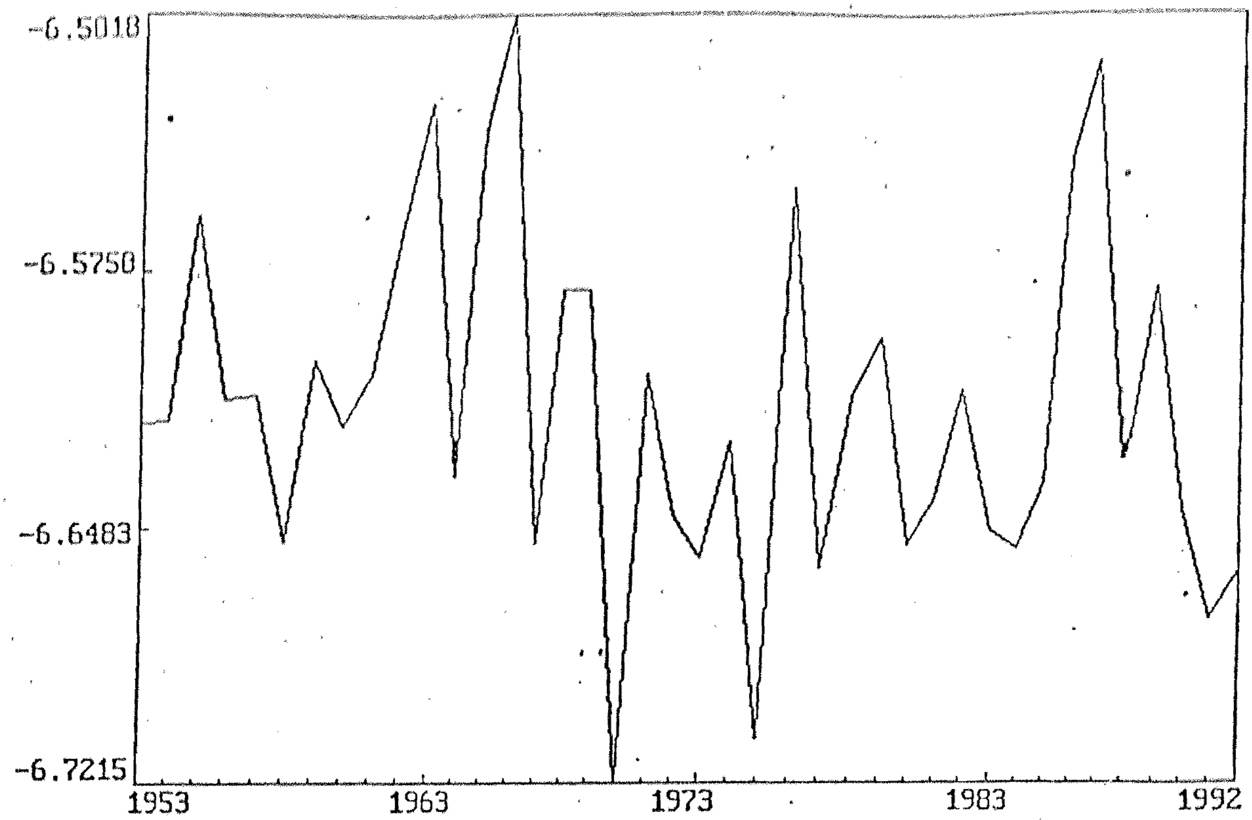


Fig. 2 contd.

Residuals of cointegrating vector 3



Residuals of cointegrating vector 3 adjusted for short-run dynamics

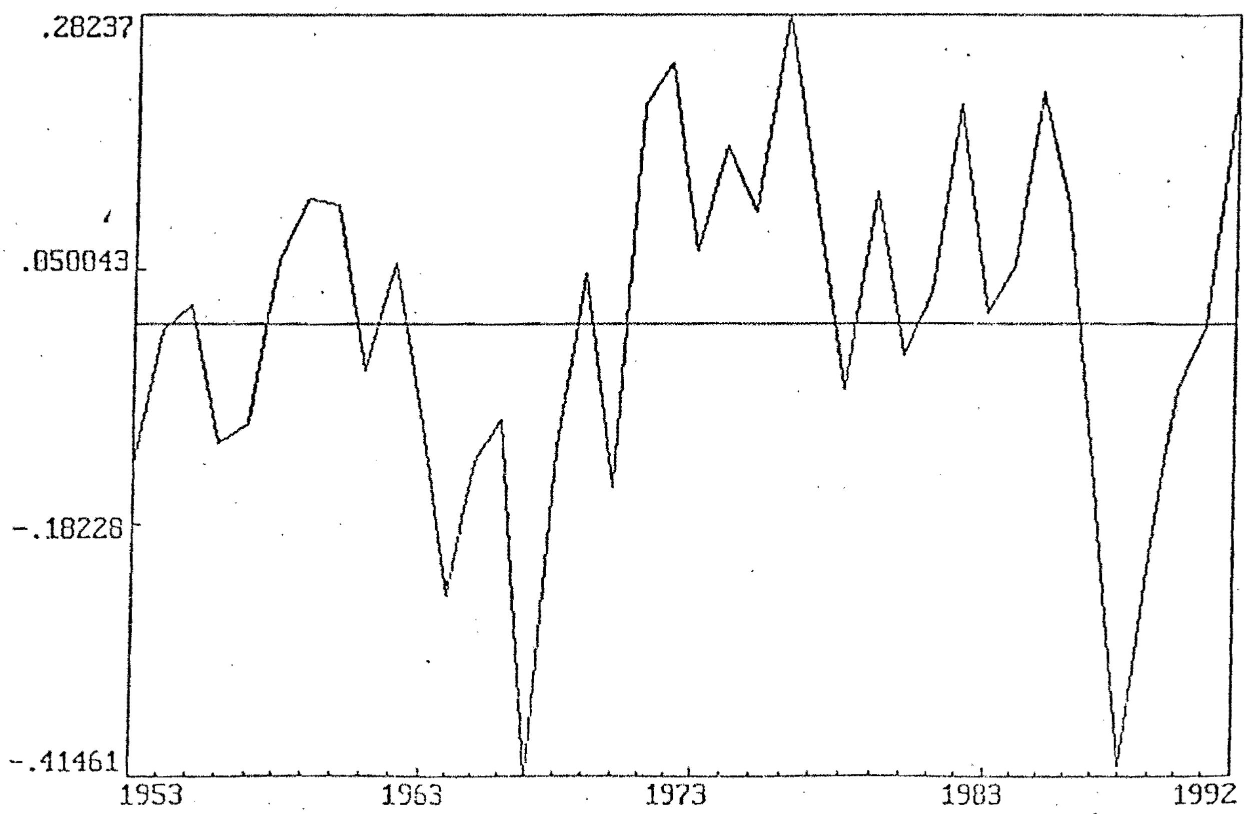
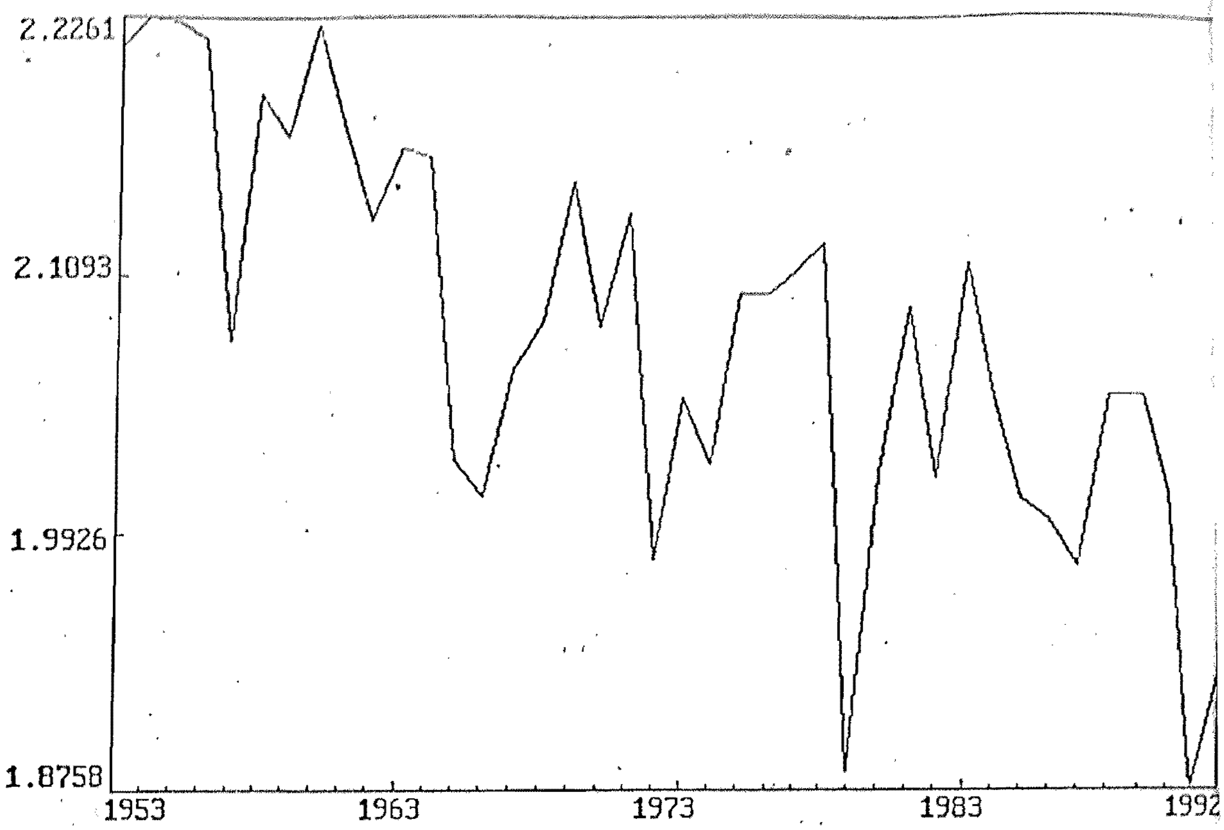


Fig. 2 contd.

Residuals of cointegrating vector 4



Residuals of cointegrating vector 4 adjusted for short-run dynamics

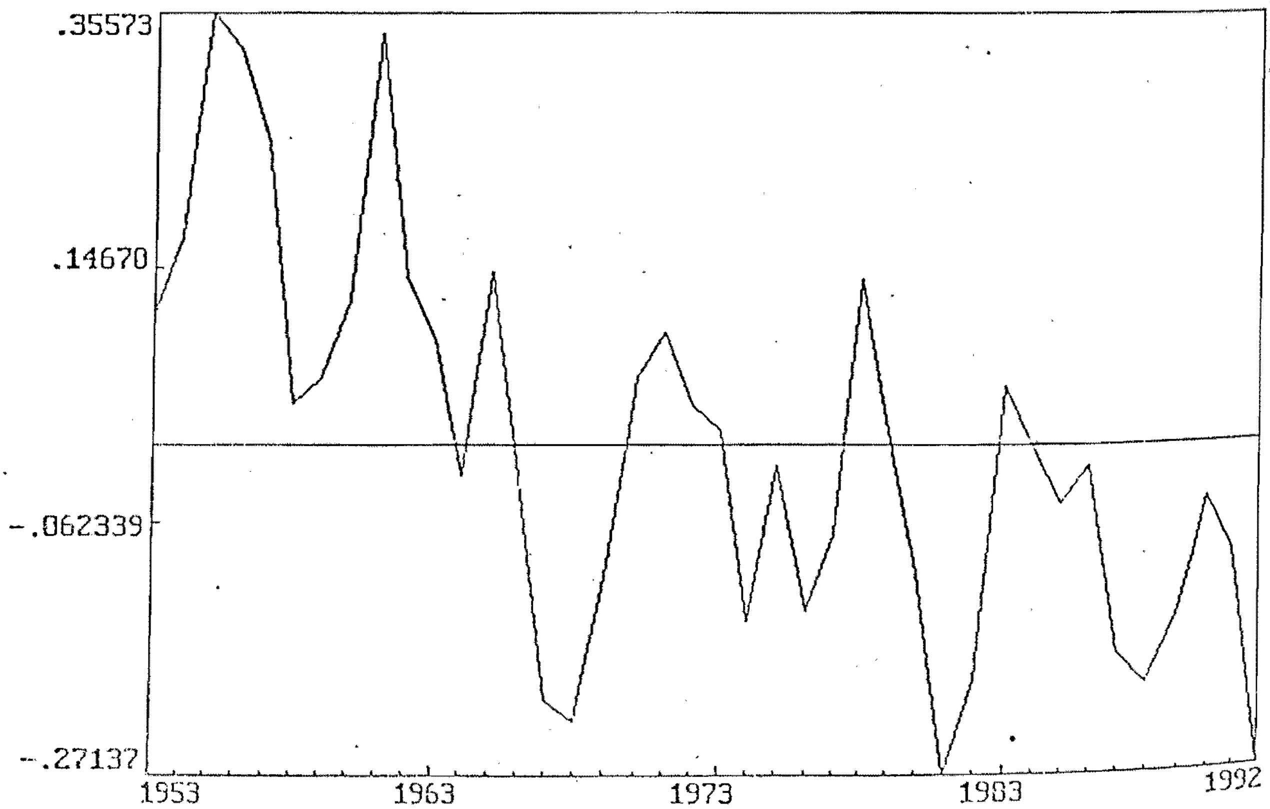
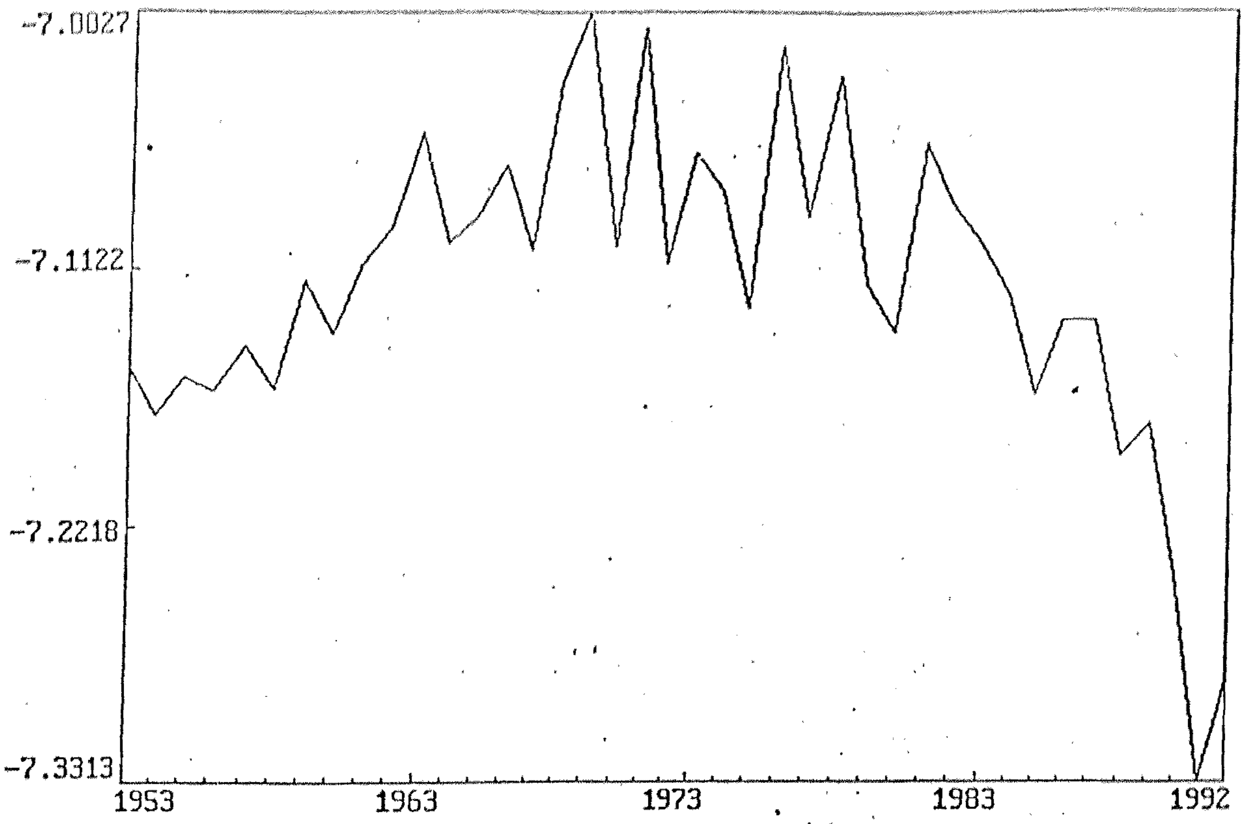


Fig. 2 contd.

Residuals of cointegrating vector 5



Residuals of cointegrating vector 5 adjusted for short-run dynamics

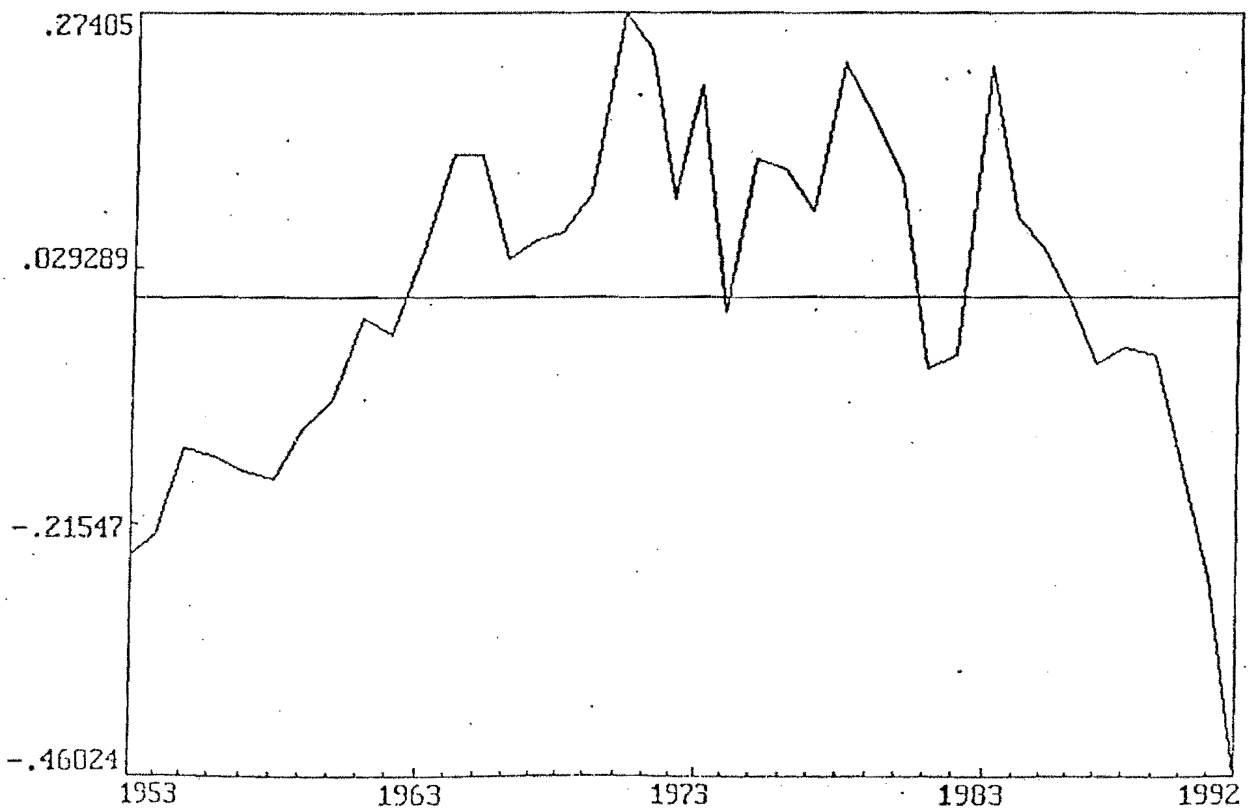


Fig. 2 contd.

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Notes

1. Rao and Caballero [op. cit., p. 904] make the pertinent observation that "The neglect of agriculture ... is sometimes attributed simply to policy mistakes ... ". Conscious discriminatory policies are not, therefore, necessarily implied in the neglect thesis.

2. See Hall [1989] for the computation of these constituent matrices.

3. These data are taken from the National Accounts Statistics published by the Government of India (see GOI, various issues). The five sectors mentioned in the text were defined as follows: 'Agriculture' = Agriculture+Forestry+Fisheries; 'Manufacturing Industry' = Registered+Unregistered manufacturing; 'Construction' ; 'Infrastructure' = Electricity,gas,water supply+Storage+Communications; and 'Services' = Rail transport+Transport by other means+Trade, hotels and restaurants+Financial, insurance, real estate and business services+Other services. The category of 'Public administration and defence' was excluded from the definition of 'services' on account of its rather different nature from the other services.

4. The test results may be had from the author (or checked for oneself since the data are in the public domain).

5. In the case of equations C and S the Jarque-Bera LM test statistic exceeds the 1% critical value of $\chi^2(2) = 9.21$. However, this may not be serious. Also see Johansen and Juselius [1992, p. 220] and [1990, p. 176].

6. Note that a negative relation between $\Delta \ln M_t$ ($=\ln M_t/M_{t-1}$) and $\ln A_t$ is consistent with a positive relation between $\ln M_t$ and $\ln A_t$. This can be

easily proved by a numerical example.

7. Financial and insurance services came within the purview of the state sector (although the former not totally) only since the 1970s.

8. See Rangarajan [1982] and Ahluwalia and Rangarajan [1989]; although they *assume* the exogeneity of agriculture. A 1% growth of agriculture is found to translate into a 0.5% growth of manufacturing industry and a 0.7% growth in the overall economy. Unfortunately, this relationship is not estimated for industry. Our estimates are not directly comparable with the above since we have focussed on the long run relationship only; besides, the use of a VAR framework lies in studying the system dynamics and emphasis is usually not placed on the estimates per se.

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