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An Analysis Of Exports And Growth In India:
Some Empirical Evidence (1971 - 2001)

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Abstract

The relationship between exports and economic growth has been analysed by a number of recent empirical studies. This paper re-examines the sources of growth for the period 1971-2001 for India. It builds upon Feder's model to investigate empirically the relationship between export growth and GDP growth (the export led growth hypothesis), using recent data from the Reserve Bank of India, and by focusing on GDP growth and GDP growth net of exports. We investigate the following hypotheses: i) whether exports and GDP are cointegrated using both the Engle-Granger and the Johansen approach, ii) whether export growth Granger causes GDP growth, iii) and whether export growth Granger causes investment. Finally, a VAR is constructed and impulse response functions (IRFs) are employed to investigate the effects of macroeconomic shocks.

Keywords: India, trade, growth, cointegration, Granger causality, impulse response functions

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AN ANALYSIS OF EXPORTS, GROWTH AND CAUSALITY IN INDIA: SOME EMPIRICAL EVIDENCE (1971 - 2001)[1]

1. Introduction

India's experience of colonial rule and Nehru's sympathy for socialist beliefs resulted in a cautious policy environment where self-reliance and indigenous efforts were vigorously encouraged by government. In addition, the grand economic theories ('big push' theories and unbalanced/strategic growth models) attributed variously to Rosenstein-Rodan (1943), Harrod (1939) and Domar (1946), Hirschmann (1958) and Nurkse (1953) led to a dominant role for state in most areas of industrial activity. Nehru's pragmatism and ability to delegate to gifted specialists[2] soon gave way to dogma. During the 1970s and later, influenced by the *dependencia* school [Prebisch (1970); Frank (1969); Myrdal (1957)], the Indian state eventually developed an intricate body of rules and regulations, which led to a highly protected economy where government departments displayed increasing levels of interventionism in the basic functioning of the economy. The state sector grew, but even so, a large private sector remained extant. The key outcome was that private industry lobbied for and received protection behind tariffs and quota walls, which ultimately undermined the competitiveness of Indian industry in general and led to high-cost inefficient production. This was accompanied by rent seeking behaviour by agents of state [Bhagwati (1982), Krueger (1975), and Srinivasan (1985)]. Inspite of this, India has managed to create a highly diversified industrial base and it has managed to develop competences in a wide range of industrial activities [see Lall (2001)].

India has been described as an 'import substituting country *par excellence*' [Rodrik (1996: 15)]. A balance of payments crisis in 1991 led to the initiation of an ongoing process of trade liberalisation. These events corrected the in built systemic bias against exports and they have led to a degree of correction of the price distortions in the Indian economy through the creation of a more open economy. More importantly, increased competition and firm presence in foreign markets has injected a greater degree of quality consciousness and customer orientation, which had hitherto been largely absent due to the lack of competitive pressures. In the past foreign firms were largely absent from the protected market. These changes have reduced the tendency of Indian firms to seek and obtain protection from foreign imports. It has also reduced the effectiveness of attempts by Indian firms to hide behind high tariff barriers and it has challenged interests that have attempted to perpetuate inefficient production.

In recent years India's percentage share in world exports has been increasing. Further, there are indications that India is building up new areas of strength in export markets by moving to computer software exports, exports of pharmaceuticals and engineering manufactures in addition to traditional export strengths in gems, jewellery, textiles and primary products [NASSCOM (2002) and DGCIS (various issues)]. These events have succeeded in reducing the ideological opposition to trade which derived in part from India's colonial experience (the dominance of what was a trading company (the British East India Company)), along with a toning down of Nehruvian socialist rhetoric, combined with an obsession with self-sufficiency at any cost.[3]

The purpose of this paper is to investigate the following hypotheses: i) whether exports and GDP are cointegrated using first the Engle-Granger approach and secondly by using the Johansen methodology, ii) whether export growth Granger causes GDP growth, iii) and whether export growth Granger causes investment. Finally, a VAR is constructed and impulse response functions (IRFs) are employed to investigate the effects of macroeconomic shocks. This paper is structured as follows. Section 2 provides a review of previous studies as well as a survey of the work done for the case of India. It also outlines the data sources and provides a description of the specific time series investigated in this study. Section 3 outlines in detail the methodology and formal techniques employed in the empirical analysis, as well as presenting the results obtained. Section 4 summarises our main conclusions.

2. Literature Review and Data Issues

There is a large literature on the empirical investigation of the export led growth (ELG) hypothesis, as well as investigations using Granger (1969) causality and the Sims' (1972) method. There is the well known argument about the greater effectiveness of export oriented industrialisation (EOI) [Keesing (1967), Bhagwati (1982), Krueger (1975), and Srinivasan (1985)] as compared to import substituting industrialisation (ISI) [Prebisch (1970); Frank (1969); Myrdal (1957)]. The opposing views on trade as an 'engine' of growth [Lewis (1980)] or a 'handmaiden' of growth [Kravis (1970); Riedel (1984)] are also well known.

There have been several studies that have found some association between exports (or export growth) and output (GDP) levels (or output growth). For the case of developing countries analytical work originally focused on correlations between exports and income [Emery (1967), Maizels (1968), Kravis (1970)], moving on to studies with limited samples [Balassa (1978)], followed by studies focusing on aggregate production functions that included exports as an explanatory variable [Feder (1982)]. There have been studies on the existence of a threshold effect as well [Kavoussi (1984), Moschos (1989), Kohli and Singh (1989)]. These have been supplemented by causality tests [Jung and Marshall (1985); Chow (1987)]. The econometric methods employed in this analysis have been significantly influenced by the work of Granger (1969), Sims (1972), Engle and Granger (1987), Johansen (1988), and Johansen and Juselius (1990), among others.

The idea that export growth is one of the major determinants of output growth (viz. the export led growth (ELG) hypothesis) is a recurrent one. Export growth may effect output growth through positive externalities on nonexports, through the creation of more efficient management styles, improved production techniques, increased scale economies, improved allocative efficiency and dynamic competitiveness. If there are incentives to increase investment and improve technology this would imply a productivity differential in favour of the export sector (in other words, marginal factor productivities are expected to be higher in the export sector than in the other sectors of the economy). It is thus argued that an expansion of exports, even at the cost of other sectors will have a net positive effect on the rest of the economy. It may also ease the foreign exchange constraint. There could also be positive spillover effects on the rest of the economy. These factors notwithstanding, the empirical evidence for the ELG hypothesis is mixed. Time series evidence fails to provide uniform support to the ELG hypothesis whereas a wide body of literature applying a range of cross section type methodologies strongly supports an association between exports and growth. In other words, cross section results appear to find a close and robust relationship, while time series results are less conclusive.

Studies such as Jung and Marshall (1985), Chow (1987), Hsiao (1987), Darrat (1987), Afxentiou and Serletis (1991), Bahmani-Oskooee et al (1991), Dodaro (1991), Greenaway and Sapsford (1994) and Love (1992) have cast some doubt on the validity of the ELG hypothesis. Others such as Serletis (1992), Henrique and Sadorsky (1996), Bahmani-Oskooee and Alse (1993), Ghatak et al (1995) and Nidugala (2001) provide fairly robust evidence in favour of the ELG hypothesis. Most of the time series studies employ the Granger or the Sims' method, while only a few studies combine Granger's test with the Akaike's Information Criterion (AIC) to determine the optimal lag length in the Granger causality test. The latter approach removes the ambiguity involved in the arbitrary choice of lag lengths. Further, most studies (with exceptions like Afxentiou and Serletis (1991) and Bahmani-Oskooee and Alse (1993)) do not consider whether exports and income are themselves cointegrated. Thus there may not exist a genuine long term relationship between exports and output: the results may indicate a pure short run relationship. [4]

There are a few studies on this subject for the case of India as well. Dhawan and Biswal (1999) investigate the ELG hypothesis using a vector autoregressive (VAR) model by considering the relationship between real GDP, real exports and terms of trade for India between 1961-93. They employ a multivariate framework using Johansen's cointegration procedure. They find one long-run equilibrium relationship between the three variables and the causal relationship flows from the growth in GDP and terms of trade to the growth in exports. However, they conclude that the causality from exports to GDP appears to be a short run phenomenon. In a similar framework, Asafu-Adjaye et al (1999) consider three variables:

exports, real output and imports (for the period 1960-1994). They do not find any evidence of the existence of a causal relationship between these variables for the case of India and no support for the ELG hypothesis, which is not too surprising given India's economic history and trade policies. Anwer and Sampath (2001), also find evidence against the ELG hypothesis for India. In contrast, Nidugala (2001) builds on Esfahani's (1991) model and uses an augmented production function with exports as a regressor. Nidugala finds evidence in support of the ELG hypothesis for the case of India particularly in the 1980s. He finds that export growth had a significant impact on GDP growth. Further, his study reveals that growth of manufactured exports had a significant positive relationship with GDP growth while the growth of primary exports had no such influence. Ghatak and Price (1997) test the ELG hypothesis for India for the period 1960-1992, using as regressors a measure of GDP that nets out exports, along with exports and imports as additional variables. Their results indicate that real (aggregate) export growth is Granger-caused by nonexport real GDP growth in India over 1960-92. Their cointegration tests confirm the long run nature of this relationship. However, imports do not appear to be important for the case of India. As corroborated subsequently by Nidugala (2001), their disaggregated analysis shows that nontraditional manufactured exports (such as machinery and transport equipment) are found to Granger cause output growth, while traditional manufactures (such as textiles, wood, paper) have little effect.

DATA SOURCE

There are two basic sources for data on Indian exports. One set is compiled by the DGCIS (Directorate General of Commercial Intelligence and Statistics), Ministry of Commerce of India and the other is compiled by the Indian Central Bank, the Reserve Bank of India (RBI). The DGCIS compiles information on real transactions, reporting quantities/ volumes of exports as well as export earnings in Indian rupees (INR). Exports are decomposed into headings congruent with the ITC (HS)[5] Standard Industrial Classification (SIC) codes. Thus exports are broken down by SIC categories and by destination (i.e. according to the country they are exported to). RBI export data is compiled by aggregating the economy wide financial transactions related to exports, as reported by exporting firms. Exporters and financial intermediaries have to provide this information to the RBI by statute. DGCIS data has been used much more frequently in the literature and the RBI's data has been relatively less frequently referred to. In this study we decided to employ the RBI's data sets for our analysis, in part to correct the above mentioned lacuna. Accordingly, the data used in this exercise has been obtained from the Reserve Bank of India's *Handbook of Statistics on the Indian Economy 2000-01*.[6]

The following time series are analysed for the period 1971-2001:

1. Y: GDP (gross domestic product)
2. YX: GDP net of exports
3. RX[7]: real exports (exports deflated by the time series of unit price index of exports)
4. RIM: real imports
5. INV: real gross domestic capital formation (domestic investment) (investments deflated by the GDP deflator)
6. POP: population
7. EMP: employment in the formal sector

Constant GDP estimates are used and exports and investments are deflated using the relevant deflators to permit intertemporal comparisons. (As mentioned, the time series of unit price index of exports is used to deflate the export series while the GDP deflator is used to deflate the time series INV). The prefix 'L' stands for the natural logarithm of the concerned time series, and 'D' denotes differencing of the relevant time series. All econometric estimations in this paper have been carried out using Eviews 4.1.

EXCLUDING GROWTH ACCOUNTING EFFECTS

In empirical analysis of trade data a major problem arises from the fact that exports are themselves a component of output, via the national income accounting identity [see Michaely (1977, 1979), Heller and Porter (1978), Feder (1982), Afxentiou and Serletis (1991), Love (1992), Esfahani (1991), Greenaway (1994), Ghatak and Price (1997) and Sheehey (1990)].

The results of such a model are likely to suffer from a simultaneity bias since export growth may itself be a function of the increase in output. To remedy this we use the following method. Following Feder (1982), the economy can be divided into two sectors, export and nonexport. We separate the 'economic' influence of exports on output from that incorporated in the growth accounting relationship by using a measure of GDP (Y) that nets out exports (YX).[8]

3. Empirical Analysis

3.1 DATA

The data employed in this study are graphically displayed in Appendix 1 (logarithmic transformations of time series data) and Appendix 2 (the first differences of the logarithmic transformations). In all the cases except GDP and GDP without exports, the probability of the Jarque-Berra test statistic provides evidence in favour of the null hypothesis of a normal distribution (extra tables available from the authors). Additionally, simple correlations are estimated for the first differences of the series. It is pertinent to note the negative correlations between employment (and population) and all economic variables (income, income without exports, real exports and real investment).

3.2 Unit Roots and Cointegration

In investigating the export led growth (ELG) hypothesis, the traditional approach of first differencing disregards potentially important equilibrium relationships among the levels of the series to which the hypotheses of economic theory usually apply (see Engle and Granger 1987). The first step of the Engle-Granger methodology is to test for a unit root. Table 1 summarises the results for unit root tests on levels and in first differences of the data. Strong evidence emerges that all the time series are *I(1)*.

INSERT TABLE 1 HERE

Since a unit root has been confirmed for the series, the question is whether there exists some long-run equilibrium relationship between *ln*(GDP) and / or *ln*(GDP net of exports) on the one hand and exports on the other. This corresponds to the second step of the Engle-Granger procedure. The results are presented in Table 2. Two cases are considered. First we test whether there is a cointegrating relationship between exports and GDP. Secondly we consider the case of exports and GDP net of exports in order to avoid the "accounting effect". In both cases the residuals appear to be *I(1)*. This provides evidence contrary to the conclusions reached in some other studies such as Nidugala (2001) and Ghatak and Price (1997). It also suggests that a cointegration relationship between exports and GDP does not exist. This provides preliminary evidence casting doubt on the significance of the ELG hypothesis for the case of India.

Given the inability of the Engle-Granger approach to work in a multivariate framework and the well-known problems of this methodology (see for example Harris and Sollis 20003, p92), we will proceed with the Johansen methodology.

INSERT TABLE 2 HERE

Within the Johansen multivariate cointegrating framework, the following system is estimated:

$$\Delta z_t = \Gamma_1 \Delta z_{t-1} + \ldots + \Gamma_{k-1} \Delta z_{t-k-1} + \Pi z_{t-1} + \mu + \varepsilon_t : \qquad t = 1, ..., T \qquad (1)$$

with the usual definitions: Δ being the first difference operator, z = vector of variables, $\varepsilon_t \sim$ niid$(0,\Sigma)$, μ is a drift parameter, and Π is a $(p\times p)$ matrix of the form $\Pi = \alpha\beta'$, where α and β are both $(p\times r)$ matrices of full rank, with β containing the r cointegrating relationships and α carrying the corresponding adjustment coefficients in each of the r vectors. The Johansen approach can be used to carry out Granger-causality tests as well.

In the Johansen framework the first step is the estimation of an unrestricted, closed p*th* order VAR in k variables. Johansen (1995) suggests two tests statistics to determine the cointegration rank. The first of these is known as the trace statistic

$$trace(r_0 / k) = -T \sum_{i=r_0+1}^{k} \ln(1-\hat{\lambda}_i) \qquad (2)$$

where $\hat{\lambda}_i$ are the ordered (estimated) eigenvalues $\lambda_1 > \lambda_2 > \lambda_3 > \ldots > \lambda_k$ and r_0 ranges from 0 to $k-1$ depending upon the stage in the sequence. This is the relevant test statistic for the null hypothesis $r \le r_0$ against the alternative $r \ge r_0 + 1$. The second test statistic is the maximum eigenvalue test known as $\lambda_{\max}$; we denote it as $\lambda_{\max}(r_0)$. This is closely related to the trace statistic but arises from changing the alternative hypothesis from $r \ge r_0 + 1$ to $r = r_0 + 1$. The idea is to try and improve the power of the test by limiting the alternative to a cointegration rank which is just one more than under the null hypothesis.

The $\lambda_{\max}$ test statistic is

$$\lambda_{\max}(r_0) = -T \ln(1-\lambda_i) \text{ for } i=r_0+1. \qquad (3)$$

Following a multivariate approach we proceed to apply the Johansen test. In particular we consider the issue of cointegration or non-cointegration between income, income without exports, exports and imports. The results are presented in Table 3:

INSERT TABLE 3 HERE

Once again, we cannot reject the null hypothesis of no cointegration at both the 5% and the 1% significance level. This result is consistent with the previous one. However, it should be noted that the Engle-Granger and Johansen procedures are grounded within different econometric methodologies. Most notably, in the Engle-Granger modelling approach, the endogenous / exogenous division of variables is assumed (and therefore there might be only one cointegrating relation) while in the Johansen approach, based on *VAR* modelling, there are no exogenous variables.

Summarising the findings of this section, we find evidence against the hypothesis that exports and GDP are cointegrated and our results question the relevance of the ELG hypothesis for the case of India.

3.3 GRANGER CAUSALITY

To investigate the causality between GDP (and GDP less exports) on the one hand and exports on the other, we perform a simple Granger causality test by estimating the bivariate autoregressive processes for GDP (and GDP less exports) and exports. Additionally, we considered the case where exports indirectly affects income through investment. As a result the causality between exports and investment is also tested. Thus we have (for Y and X)[9]:

$$\Delta y_t = a_0 + a_1 \Delta y_{t-1} + \ldots a_l \Delta y_{t-l} + b_1 \Delta x_{t-1} + \ldots + b_l \Delta x_{t-l} \tag{4}$$

$$\Delta x_t = a_0 + a_1 \Delta x_{t-1} + \ldots + a_l \Delta x_{t-l} + b_1 \Delta y_{t-1} + \ldots + b_l \Delta y_{t-l} \tag{5}$$

The reported *F*-statistics are the *Wald* statistics for the joint hypothesis

$$b_1 = \ldots = b_l = 0 \tag{6}$$

The null hypothesis is therefore that *X* does not Granger-cause *Y* in the first regression and that *Y* does not Granger-cause *X* in the second regression.

INSERT TABLES 4A, 4B AND 4C HERE

In all the cases in Tables 4a, 4b and 4c, the reported probabilities are greater than 0.05 and thus no evidence is found to suggest that real exports Granger cause GDP or vice versa. The assumptions that exports Granger causes investment (or vice versa) can also be rejected. At the 10% significance level, we could marginally accept the hypothesis that growth in income Granger causes growth in real exports. The evidence in this section does not provide any support for the causality relationship between exports and income. There is weak evidence suggesting that the direction of causality runs from GDP to exports, which strengthens the case against the ELG hypothesis for the case of India.

3.4 VAR – IRF Analysis

In order to illustrate the dynamic affects of the impact of unitary shocks on the macroeconomic variables under consideration, we consider the formulation of a *VAR* (vector autoregressive) model. The first differences of the variables will be employed, since they are neither stationary nor cointegrated. A VAR representation is utilised in order to analyse the dynamic impact of random disturbances on the system of variables. The mathematical representation of the VAR can be given by

$$\Delta y_t = A_1 \Delta y_{t-1} + \ldots + A_p \Delta y_{t-p} + B\Delta x_t + \varepsilon_t \qquad (7)$$

where y_t is a k vector of endogenous variables, x_t is a vector of exogenous variables, $A_1, \ldots, A_p$ and B are matrices of coefficients to be estimated, and ε_t is a vector of innovations that may be contemporaneously correlated but are uncorrelated with their own lagged values and uncorrelated with all of the right-hand side variables. The (atheoretical) VAR approach is utilised since it overcomes the need for structural modelling by treating every endogenous variable in the system as a function of the lagged values of all of the endogenous variables in the system. Income, investment and exports are considered to be endogenous and all the other variables exogenous. The estimated unrestricted VAR is presented in the appendix. The preferred model is the one that minimises the AIC and the BIC criteria values (available from the authors).

Although a general production function could be assumed where GDP growth is a function of the growth in capital and labour force, the drawback of this approach is that VAR systems are not supported by a rigorous framework. However, constructing a VAR model allows us to generate impulse response functions (IRFs).

3.5 IMPULSE RESPONSE FUNCTIONS

Using the VAR system that has been estimated in the previous section, we extend the analysis and generate impulse response functions. A shock to the *i*th variable not only directly affects the *i*th variable but it is also transmitted to all the other endogenous variables through the dynamic (lag) structure of the VAR. An impulse response function (IRF) traces the effect of a one-time shock to one of the innovations on current and future values of the endogenous variables. If the innovations ε_t are contemporaneously uncorrelated, the interpretation of the impulse response is straightforward. The *i*th innovation $\varepsilon_{i,t}$ is simply a shock to the *i*th endogenous variable y_{it}.

The generalised IRF (GIRF) can be defined as

$$GIRF(n, \varepsilon_t, \omega_{t-1}) = E[y_{t+n} | \varepsilon_{j,t}, \omega_{t-1}] - E[y_{t+n} | \varpi_{t-1}] \qquad (8)$$

where y_t is a random vector, ε_{t+i} is a random shock, ϖ_{t-1} a specific realisation of the information set Ω_{t-1} and n is the forecast horizon. The GIRF is a random variable given by the difference between two conditional expectations which are themselves random variables. We estimate the generalized impulses (GIRF) following Pesaran and Shin (1998). They construct an orthogonal set of innovations that does not depend on the VAR ordering. The generalized impulse responses from an innovation to the *j*th variable are derived by applying a variable specific Cholesky factor computed with the *j*th variable at the top of the Cholesky ordering [for more details see Pesaran and Shin (1998)].

It would be important to point out that that IRF analysis can be viewed as a ‘conceptual experiment’. We are interested in investigating the consequences of introducing a shock to the system. Appendix 3 presents the results of our IRF analysis. Introducing a positive shock to the GDP, we observe a positive response from both exports and investment which dies out after 4 periods. In the second graph the shock is introduced to investment. A positive response from GDP is observed which dies out very quickly (after two periods) and a non-significant response from exports. Lastly, if the positive shock is introduced on exports, we do get a (‘small’) positive response from investment and a (‘small’) negative response from GDP. This reinforces the argument from the previous section for the non-significant role of exports in the growth of the Indian economy.

In this section we have used the notion of IRFs as a conceptual experiment. A one standard deviation (SD) positive shock in real exports elicits a positive response from GDP but this is not ‘big’ and dies out very quickly. We do not observe any significant responses as a result of introducing a shock to the economic system. The non-significant response as a result of the positive shock introduced in exports further reinforces our argument for the non-validity of the ELG hypothesis in the case of India.

4. Conclusions

In this study, we test the export led growth (ELG) hypothesis for the case for India using different approaches employing a robust data set. The data set we use is more up-to-date than that used in most recent studies on this topic. We investigate the following hypotheses: i) whether exports and GDP are cointegrated using the Engle-Granger approach, ii) whether exports and GDP are cointegrated using the Johansen approach, iii) whether export growth Granger causes GDP growth, iv) and whether export growth Granger causes investment. For the first two cases, strong evidence is found against cointregration. The evidence against the ELG hypothesis using the simple Engle-Granger approach contradicts the results of some recent studies. The Johansen approach does not negate the results obtained from the Engle-

Granger approach. We also fail to find support for the argument that exports Granger cause GDP, using two measures for GDP (GDP with exports and GDP without exports). The same holds for the relationship between exports and investment. Finally, we have utilised the concept of impulse response functions in order to investigate how the system behaves as a result of a shock. This approach allows us to simulate the effect of a given (predetermined) shock on the economic system. We conclude that relatively ‘big’ shocks in real exports do not generate significant responses. This strengthens the argument against the ELG hypothesis for the case of India and strengthens the argument that inspite of reforms, it still retains some characteristics of an import substituting economy.

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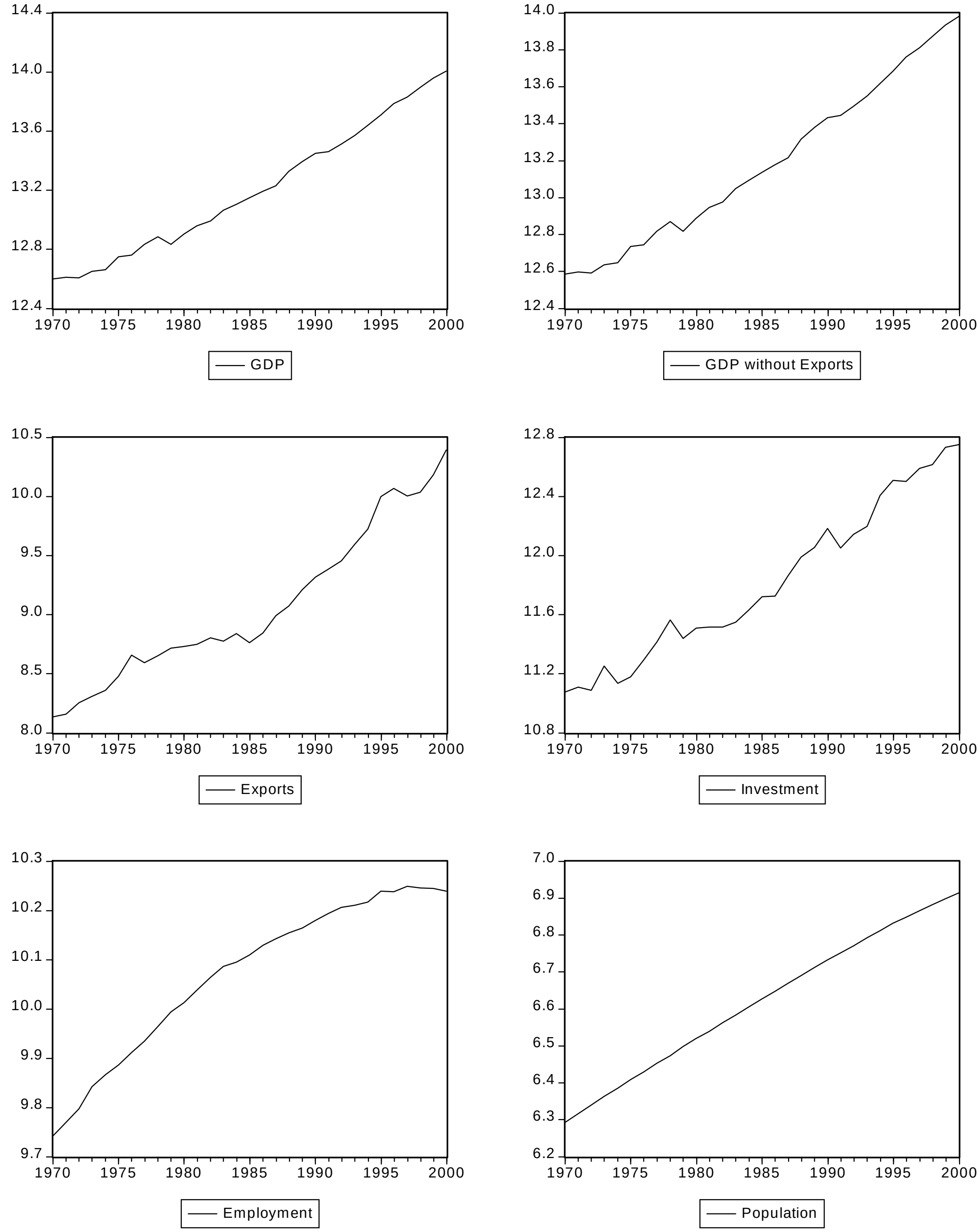
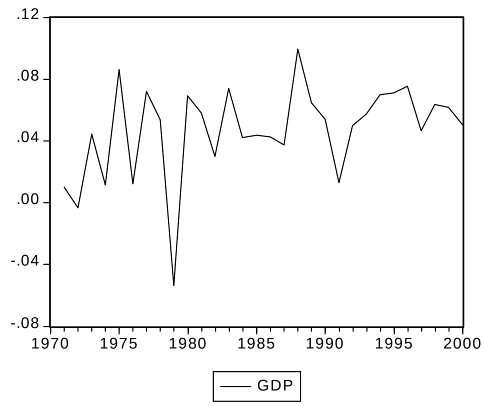
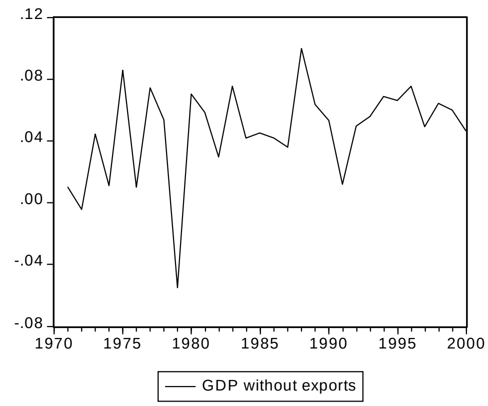
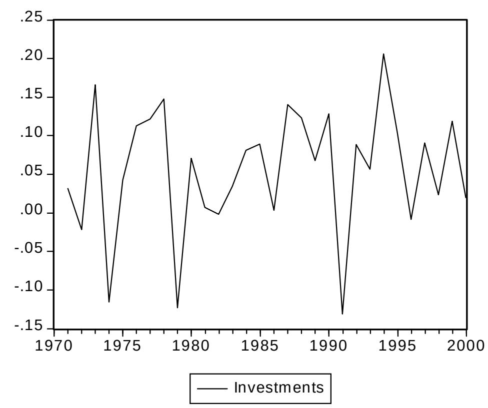
APPENDIX 1: LOGARITHMIC TRANSFORMATIONS OF THE RAW DATA



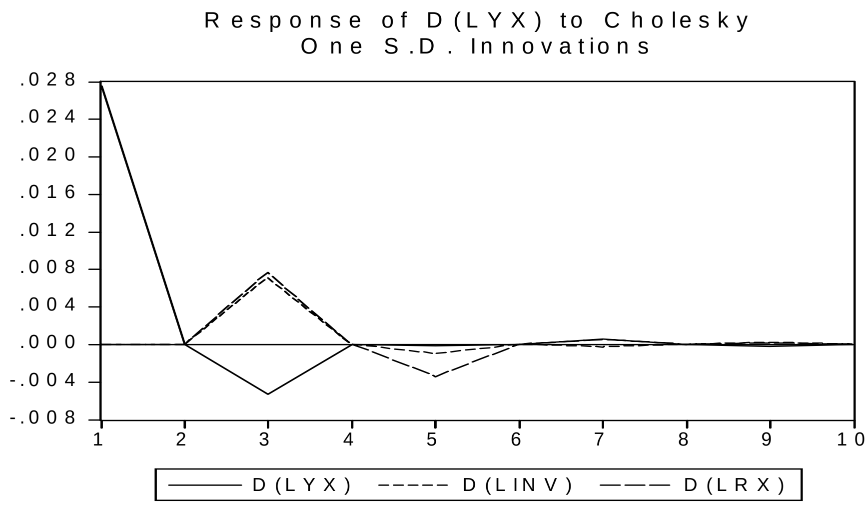
APPENDIX 2: FIRST DIFFERENCES OF THE DATA

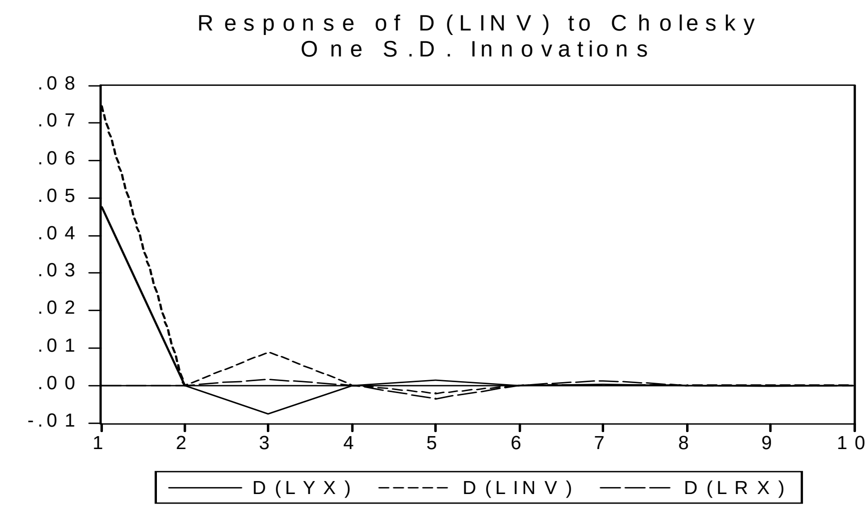


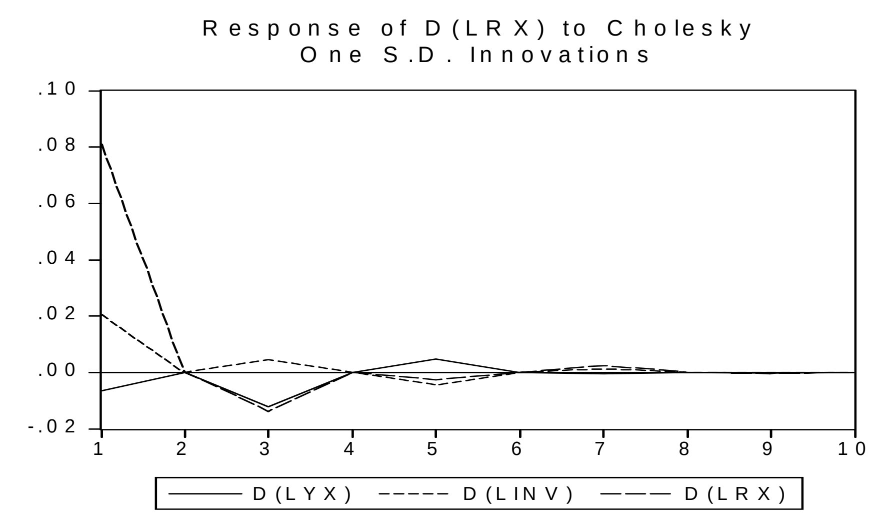




APPENDIX 3: IMPULSE RESPONSE FUNCTIONS







APPENDIX 4: FEDER'S (1982) APPROACH

Following Feder (1982), the economy can be divided into two sectors, export and nonexport. We separate the 'economic influence' of exports on output from that incorporated in the 'growth accounting' relationship by using a measure of GDP (Y) that nets out exports (YX).

More formally, consider the following simple model [10]:

(1) $\dot{Y} = a_0 + a_1\dot{X} + u$

where dots denote proportional rates of change and Y stands for GDP while X stands for exports. Then define

$N = Y - X = YX$ = GDP net of exports

Also $\dot{Y} \equiv \alpha\dot{X} + (1-\alpha)\dot{N}$ where $\alpha = X/Y$ and $(1-\alpha) = N/Y$.

By substitution we obtain

(2) $(1-\alpha) = a_0 + b\,\dot{X} + u$ where $b = (a_1 - \alpha)$.

Thus b provides an estimate of the 'economic effect' as opposed to the sum of the accounting and economic effect obtained from a_1 in (1). In general we can state

(3) $(1-\alpha)\,\dot{N} = a_0 + b\,\dot{X} + c\,Z + u$ where Z is the vector of additional determinants of $\dot{Y}$.

APPENDIX 5 : ADDITIONAL RESULTS (FOR THE REFEREES ONLY)

Table 5: Summary Statistics of the series (level)

	LY	LYX	LRX	LINV	LEMPL	LPOP
Mean	13.20391	13.18728	9.072351	11.81628	10.06980	6.620037
Median	13.14996	13.13747	8.841619	11.72086	10.10961	6.626718
Maximum	14.00757	13.98028	10.39279	12.75223	10.24867	6.914731
Minimum	12.59905	12.58747	8.134956	11.07656	9.741968	6.293419
Std. Dev.	0.445755	0.442233	0.652056	0.534779	0.158814	0.190728
Skewness	0.269418	0.261525	0.493783	0.287907	-0.612975	-0.097580
Kurtosis	1.819444	1.811683	2.092534	1.824270	2.109404	1.777611
Jarque-Bera	2.175241	2.177336	2.323425	2.213791	2.965815	1.979249
Probability	0.337017	0.336665	0.312950	0.330584	0.226977	0.371716
Sum	409.3212	408.8056	281.2429	366.3046	312.1640	205.2211
Sum Sq. Dev.	5.960921	5.867090	12.75531	8.579645	0.756655	1.091317
Observations	31	31	31	31	31	31

Table 6: Summary statistics (First Differences)

	DLY	DLYX	DLRX	DLRM	DLINV	DLEMPL	DLPOP
Mean	0.046951	0.046427	0.075261	0.077544	0.055856	0.016552	0.020710
Median	0.052069	0.051486	0.067513	0.090370	0.069365	0.017002	0.021267
Maximum	0.099615	0.099860	0.273112	0.261169	0.206339	0.045771	0.024391
Minimum	-0.053417	-0.055211	-0.080921	-0.171972	-0.131435	-0.005457	0.016016
Std. Dev.	0.030652	0.031046	0.079009	0.107383	0.082422	0.011467	0.002321
Skewness	-1.216515	-1.215546	0.126341	-0.312823	-0.680248	0.025837	-0.684318
Kurtosis	5.126589	5.131107	3.298891	2.428674	3.157842	3.046108	2.489601
Jarque-Bera	13.05252	13.06478	0.191481	0.897307	2.344832	0.005995	2.667091
Probability	0.001464	0.001456	0.908700	0.638487	0.309618	0.997007	0.263541
Sum	1.408520	1.392810	2.257834	2.326332	1.675669	0.496562	0.621312
Sum Sq. Dev.	0.027247	0.027951	0.181031	0.334404	0.197010	0.003814	0.000156
Observations	30	30	30	30	30	30	30

Note: D denotes first differences. LY stands for ln (GDP), LYX is ln (GDP without exports), LRX is ln (Real Exports), LRM is ln (Real Imports), LINV is ln (Real Investments), LEMP is ln (Employment) and LPOP is ln (Population).

Table 7: Correlations

	DLY	DLYX	DLRX	DLINV	DLPOP	DLEMP
DLY	1.000000	0.998767	0.033239	0.566570	-0.385175	-0.389413
DLYX	0.998767	1.000000	-0.015131	0.562383	-0.377988	-0.377839
DLRX	0.033239	-0.015131	1.000000	0.115646	-0.118101	-0.224527
DLINV	0.566570	0.562383	0.115646	1.000000	-0.128639	-0.048750
DLPOP	-0.385175	-0.377988	-0.118101	-0.128639	1.000000	0.750722
DLEMP	-0.389413	-0.377839	-0.224527	-0.048750	0.750722	1.000000

Table 8: Unrestricted VAR

Vector Autoregression Estimates – Sample (adjusted): 1973 2000	D(LYX)	D(LINV)	D(LRX)
D(LYX(-2))	-0.289392	-0.468357	-0.669023
	(0.23087)	(0.74149)	(0.70260)
	[-1.25347]	[-0.63164]	[-0.95221]
D(LINV(-2))	0.068733	0.114886	0.109052
	(0.07931)	(0.25472)	(0.24136)
	[0.86664]	[0.45104]	[0.45183]
D(LRX(-2))	0.094643	0.018302	-0.171577
	(0.07114)	(0.22847)	(0.21648)
	[1.33045]	[0.08011]	[-0.79257]
C	0.062214	0.063227	0.151108
	(0.01532)	(0.04921)	(0.04662)
	[4.06078]	[1.28496]	[3.24097]
DLEMPL	-1.086763	-0.603292	-2.100592
	(0.50659)	(1.62702)	(1.54167)
	[-2.14525]	[-0.37080]	[-1.36255]
D(LRM)	0.098101	0.255811	-0.068151
	(0.05327)	(0.17107)	(0.16210)
	[1.84174]	[1.49534]	[-0.42043]
R-squared	0.297597	0.094438	0.131640
Adj. R-squared	0.137960	-0.111371	-0.065715
S.E. equation	0.027540	0.088450	0.083811
F-statistic	1.864213	0.458862	0.667021
Log likelihood	64.22520	31.55475	33.06349
Akaike AIC	-4.158943	-1.825339	-1.933106
Schwarz SC	-3.873470	-1.539867	-1.647634
Determinant Residual Covariance		2.76E-08	
Log Likelihood (d.f. adjusted)		124.4829	
Akaike Information Criteria		-7.605925	
Schwarz Criteria		-6.749507	

Note: Standard Errors in ( ) and t-statistics in [ ].

Table 9: Diagnostic Tests

VAR Residual Serial Correlation LM Tests H0: no serial correlation at lag order h Sample: 1970 2000		
Lags	LM-Stat	Prob
1	5.194100	0.8171
2	12.24707	0.1997
Probs from chi-square with 9 df.		

VAR Residual Heteroskedasticity Tests: No Cross Terms (only levels and squares) Sample: 1970 2000 Included observations: 28		
Joint test:		
Chi-sq	df	Prob.
55.54808	60	0.6389

TABLE 1: UNIT ROOT TESTS

	Level		First Differences	
	ADF test statistic	PP test statistic	ADF test statistic	PP test statistic
GDP without Exports	2.997654	3.28349	-6.930733	-6.073826
Exports	1.384008	1.74475	-4.170023	-4.057615
Imports	0.282610	0.411271	-6.315673	-6.264815
Investments	0.307718	2.060068	-6.796392	-7.717273
Employment (Trend and Intercept)	0.456111	2.684556	-6.098662	-7.705912
Population (Trend and Intercept)	2.794295	8.502312	-4.569926	-4.638073
1% Critical Value	-3.711457	-3.67017	-3.679322	-3.679322
1% Critical Value (Trend and Intercept)	-4.296729	-4.296729	-4.309824	-4.309824

Note: ADF is the Augmented Dickey-Fuller Test for unit roots, PP is the Phillips-Perron Unit Root Test. The lag length is based on the Schwarz Information Criterion.

Table 2: Testing for Cointegration

ln (GDP) = 7.102 + 0.672 ln (Exports)	ln(GDP less X) = 7.13 + 0.66 ln (Exports)
(34.34) (29.58)	(33.9) (28.79)
R^2 = 0.96, F-statistic = 875.12	R^2 = 0.96, F-statistic = 829.17
t-statistics in parentheses.	t-statistics in parentheses.
Unit Root Test in the Residuals	Unit Root Test in the Residuals
ADF test statistic -2.013 [-2.963]	ADF test statistic -2.008 [-2.963]
PP -1.980 [-2.963]	PP -1.975 [-2.963]
Critical values at the 5% S.L. in [ ].	Critical values at the 5% S.L. in [ ].

Table 3: Johansen's Test Results

Series: ln(GDP), ln (Exports), ln (Imports)

r	Eigenvalue	Trace Statistic	5% CV	1% CV	Max-Eigen Statistic	5% CV	1% CV
None	0.548	37.69	42.44	48.45	23.04	25.54	30.34
At most 1	0.279	14.65	25.32	30.45	9.51	18.96	23.65
At most 2	0.162	5.14	12.25	16.26	5.14	12.25	16.26

Series: ln(GDP less X), ln (Exports), ln (Imports)

r	Eigenvalue	Trace Statistic	5% CV	1% CV	Max-Eigen Statistic	5% CV	1% CV
None	0.547	37.62	42.44	48.45	22.98	25.54	30.34
At most 1	0.279	14.64	25.32	30.45	9.51	18.96	23.65
At most 2	0.162	5.12	12.25	16.26	5.12	12.25	16.26

r is the number of cointegration vectors under the null hypothesis. We are assuming a linear deterministic trend. Both the trace test and the max-eigenvalue test indicate no cointegration at both 5% and 1% level.

Table 4a: Granger causality (YX: GDP without exports)

Pairwise Granger Causality Tests
Sample: 1970 2000 Lags: 1

Null Hypothesis:	Obs	F-Statistic	Probability
DLRX does not Granger Cause DLYX	29	1.10466	0.30292
DLYX does not Granger Cause DLRX		2.90922	0.10000

Table 4b: Granger causality (Y: GDP)

Pairwise Granger Causality Tests
Sample: 1970 2000 Lags: 1

Null Hypothesis:	Obs	F-Statistic	Probability
DLRX does not Granger Cause DLY	29	1.27541	0.26907
DLY does not Granger Cause DLRX		2.92185	**0.09930**

Table 4c: Granger causality (INV)

Pairwise Granger Causality Tests
Sample: 1970 2000 Lags: 1

Null Hypothesis:	Obs	F-Statistic	Probability
DLRX does not Granger Cause DLINV	29	0.94789	0.33923
DLINV does not Granger Cause DLRX		1.06585	0.31139

Endnotes

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[1] Acknowledgements: We would like to thank the participants of the EEFS Annual Conference in Bologna, May 2003 and Mike Dietrich, David Chappell, Costas Milas and Jonathan Perraton for their useful comments. The usual disclaimers apply.

[2] For an interesting account of Nehruvian policy making, see Khilnani, S. (1997), *The Idea of India*, London: Penguin.

[3] Dore calls this SRACI (self reliance as categorical imperative) [Dore (1984)].

[4] This issue is addressed in more detail in section 3.2.

[5] International Trade Centre (Geneva), Harmonised System.

[6] This data is available online at www.rbi.org.in.

[7] In this paper we use the symbols X and RX interchangeably: both refer to real exports.

[8] This method has been used by Ghatak and Price (1997) and Ghatak et al (1997), amongst others. See also Appendix 4.

[9] We will have analogous equations for YX and X.

[10] See also Greenaway et al (1994).