CHAPTER 5

TRADE, GROWTH AND PRODUCTIVITY

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5.1 INTRODUCTION

During the post-war period that special attention has been given to a detailed analysis of the sources of economic growth. The empirical evidence emerging from the initial studies on the role of technological advance in the process of growth by assigning it to nearly half of the growth of national income and more than four-fifths of the growth of output per person employed in the United states (Abramoviz[1] & Solow[2]). This findings, as a result led to significant amount of research focusing on quantitative analysis of economic growth in different countries and also on various possible refinements in the methodology for measuring the sources of economic growth. A growing body of research suggests that, even after physical and human capital accumulation are accounted for, something else accounts for the bulk of cross-country differences in the level and growth rate of gross domestic product per capita. Economists typically refer to the something else as total factor productivity. Different theories offer very different conceptions of TFP. These range from changes in technology to the role of externalities, changes in sector composition of production, and the adoption of lower-cost production methods. TFP, which is defined as a residual of output change obtained by subtracting the changes in inputs from output change, is considered to be a "pure" measure of productivity or productivity efficiency. There was a marked contrast in the growth experience of Indian economy during the post-1985 period. The process of economic liberalization that was initiated around mid-eighties and broadly exercised from 1991 onwards brought about a significant change in Indian economy. In February-March 1992, in one step the government eliminated the restrictive and complex licensing system for imports of intermediates and capital goods except for a small negative list.

The removal of quantitative restrictions on imports has been accompanied by a gradual lowering of tariffs. In addition, the government has liberalized the foreign exchange regime. Liberalisation of trade and FDI leads to improvement in productivity by influencing supply-side and demand-side factors of production. The impact of demand-side factors, one can identify that of competitive pressure introduced through liberalization. Turning to supply-side impact of liberalization on trade and FDI.

Trade liberalization enables firms to use high-quality parts, components, and machinery at lower prices resulting in improved productivity. Whereas liberalization of FDI contributes positively to the recipient countries, as multinational enterprises (MNEs) bring in not only technologies and management know how, but also financial resources used for fixed investment. All of these resources, which are in short supply in the recipient countries, contribute to improvement in productivity. Improvement in productivity leads to greater production and greater exports, as it tends to enhance competitiveness. It is important to note that increased production and exports in turn contribute to improvement in productivity through following channels. Increased production enables the firms to exploit benefits accrued from large-scale production. As the level of production increases, the average cost tends to decline because the fixed cost of production is spread over a large quantity leading to higher productivity. With foreign exchange earned from higher exports firms can import high-quality components and equipment resulting in higher productivity. A virtuous circle is formed, liberalization of trade and FDI, improvement in productivity, expansion of exports and output, further improvement in productivity. Success in economic growth and export expansion in turn promote further liberalization in foreign trade and FDI reinforcing the virtuous cycle. There is a widely held view, in the studies of Bhagwati and Desai[3] (1970) and Bhagwati and Srinivasan[4] (1975) that the inward looking development strategy based on the policies of import control and domestic licensing have led to considerable inefficiency in the industrial sector. Further studies by Goldar[5] (1986.b) and Ahluwalia[6] (1991) have investigated the impact of trade orientation on the productivity growth for the Indian Industry during the 1970s and 1980s. Their studies concluded that the prevailing trade policies did play a role in the observed TFP growth rates for Indian manufacturing sector. The Plan of the chapter is as follows. An overview of the literature on trade liberalisation and productivity growth in an Asian and Indian context is presented in Section 2. The

methodology and Data is worked out in the Section 3 The empirical findings are reported in section 4. Conclusion in Section 5.

5.2 TRADE LIBERALISATION AND TFP GROWTH: AN OVERVIEW OF LITERATURE

In post World War II period a number of developing countries after gaining independence, sought economic development by substituting imports with domestic production through import protection. But in most of countries couldn't achieve their objective, as import substitution policies caused inefficient production due to limited competitiveness and limited market size denying the benefits from scale economies.

Hence several countries turned to outward oriented policies. The existence of a positive association between the growth of output and the growth of productivity (Verdoorn's Law[7], when in terms of labour productivity), an argument based on the existence of scale economies and observed especially in manufacturing industries. Expanding the market through trade should therefore increase productivity and lead to cost reduction. Although usually made in terms of export expansion, this argument applies to import substitution as well – in which case the final result should depend on the size and structure of the domestic market. Attempts to establish empirical confirmation of a casual relationship between trade policy and productivity was successfully investigated by Bhagwati-Krueger in the study of trade regimes (see Bhagwati [8]1978; Krueger[9] 1978). The studies on the effect of trade policies on productivity can be divided into two types depending on their methodology and coverage of countries and industries; one type pursues cross-sectoral analysis on a particular country and the other performs cross-country analysis. Examples of the former type include Krueger-Tuncer[10] (1982), examined the effect of protection on productivity in the Turkish manufacturing industries. In the Turkish case, manufacturing sector experienced an overall slowdown in the rate of TFPG as import-substitution policies pushed resources into increasingly inefficient, high-cost, protected industries and also that periods of highly restrictive exchange controls would have been periods of slower growth of factor productivity than periods of relative liberalization. While examples of the latter include Nishimizu and Robinson[11] (1984).

Her paper examine the impact of different development strategies, especially export expansion and import substitution trade policies, on total factor productivity growth in the manufacturing industries. The analysis is based on sectoral total factor productivity in Korea, Turkey, and Yugoslavia, with Japan as a comparator. However these studies have found that trade liberalization improved the productivity, but the relationship between the two was not robust.

5.2.1 The Asian Experience-Selected Countries

Asian countries have exhibited favourable economic performance during the 1980s and 1990s compared to countries in other parts of the world. The character and pace of trade policy reforms differed from country to country reflecting the differences across the Asian countries in the level of development. In many of the East Asian countries, switched to export-promotion policies during the 1950s and 1960s. These policies turned out to be a success, and the four countries achieved rapid export expansion, which in turn led to rapid economic growth. In Korea and Taiwan trade reform policies consolidated in the latter half of 1970s. In Malaysia, it commenced around the beginning of 1980s. For Indonesia and Thailand it started in the second half of 1980s. For Philippines, attempts to consolidate the trade liberalization were derailed by macroeconomic instability and severe debt problems.

Urata[12] in her paper examined the effect of trade liberalization in trade and FDI on productivity in selected Asian countries. To discern the relationship rigorously, a cross-country analysis as well as seven cross-industry studies of individual country (Korea, Taiwan, Thailand, Malaysia, Indonesia, the Philippines, and India) is conducted. In the country studies, the processes of liberalization in trade and FDI are analyzed before carrying out an analysis examining their impact on productivity. Although the specific indicators used differ among the case studies, various quantitative measures are attempted to examine the degree of trade liberalization; i.e. changes in nominal and effective tariff rates, shares of imports and exports in GDP. Given the difficulty in obtaining an indicator showing the degree of liberalization concerning FDI, various shares representing the importance of foreign firms in economic activities of the host countries are used. The results show that the higher the TFP growth, the higher the GDP growth for the period

compared 1970-80 and 1980-90. Although the performance of Asian countries reveals some differences among them. The results of cross-industry studies for the seven countries revealed that the impact of trade liberalization on TFP varies depending on the sample country. The impact of trade liberalization on TFP growth turned out to be positive for five countries: Korea, Thailand, Malaysia, Indonesia, and the Philippines, but their relationship is not always stable or statistically significant. By contrast, trade liberalization was shown to have negatively influenced TFP growth for Taiwan. In case of India TFP growth led to expansion of exports, probably indicating the favourable effect of trade liberalization on productivity.

Kwak[13] aims to examine the impact that import-related trade policies have on the growth of domestic industry based on the experiences of Korea. The government promotion of genuine import liberalisation began only after 1983. The study focuses on the effect of import policies on changes in productivity with several import liberalization indicators being used. They include the effective as well as nominal rate of protection, average tariff rate, comprehensive liberalization rates, import penetration ratio and import output ratio. Additional variables were also added to examine the impact of export as well as domestic competitiveness. A multiple regression analysis of twenty-six manufacturing sectors linking TFP and effective rate of protection and its rate of change was carried out. The cross-section analysis of each industry showed that from the 1980s industries with a low protection rate at the initial stage experienced large increases in TFP. There was a trend in the 1970s by which the higher the rate of protection at the initial stages, the higher the increase in TFP. It was also observed that the more advanced the industry in import liberalisation, the higher was its TFP growth. If we combine this with the effect of protection at the initial stage we can conclude that import liberalisation had a beneficial effect on TFP.

Okuda[14] focuses on Taiwan's manufacturing sector and evaluates the effects of trade and Foreign Direct Investment policies enforced after the mid 1970s on productivity growth. The period of study extends from 1979 till 1991. The TFP growth for manufacturing as a whole was 2.6% per annum for the period 1978-91. Amongst the sub-sectors, electronics, fibers and machinery showed the best performance. It should be mentioned that the electronics and machinery industries maintained high TFP growth

even after the domestic markets were opened wide. The relationship between TFP and trade and FDI liberalisation policies was examined using a panel regression analysis. Import penetration ratio and export ratio were considered as measures of trade policy. The import penetration coefficient was negative and statistically significant. This implied that the increasing presence of imported goods in the Taiwanese markets lowered the productivity of competing sectors. The estimated coefficients for the export ratio variable were negative as well as insignificant. Improvement in Taiwan's manufacturing productivity was achieved in sectors that first, had more foreign investment, second, was less capital intensive and third, had less import penetration.

In the study by Urata and Yokota[15] an attempt was made to examine empirically the determinants of TFP growth in Thai manufacturing industries focusing on the effects of trade policies for the period 1970s and 1980s. Trade policies in Thailand underwent through shift from import substitution in the 1970s to export promotion 1980s. A regression analysis of the factors determining TFP with particular focus on the effect of trade policy using four digit cross section data was carried out for two time periods 1976-82 and 1982-88. Several measures of trade policy (1) imported capital input ratio; (2) imported intermediate input ratio; (3) effective rate of protection, were used to assess the impact of trade policy changes for the Thai manufacturing industries.

The results for the time period 1976-82 show that the variables for the degree of trade liberalisation, initial Effective Rate of Protection (ERP), imported-intermediate input ratio have the expected sign. The fact that the estimates on the degree of trade liberalisation and initial ERP have positive and negative signs suggest that in industries where protection was initially high, the rapid progress in trade liberalisation caused a rise in production efficiency, but these coefficients were statistically insignificant. In the second period 1982-88 also, the variable that doesn't show the expected sign was the imported capital-input ratio. The observation on the effect of imported-intermediate input ratio seems to indicate that trade liberalisation led to an improvement in productivity since it expanded the choice of intermediate goods for the industry. The analysis of the results showed that during the years 1982-88, as trade liberalisation advanced, the factors that contributed to TFPG were: (1) intensity of competitive pressure both domestic as well as overseas; (2) wider choice of intermediate goods available as

trade occurred; and (4) industry-specific factors (expansion of output and R & D expenditure).

Okamata's[16] paper shows to what extent trade and FDI liberalisation policies contributed the high economic performance of Malaysia with a special focus on the manufacturing sector, given that the importance of productivity growth is tremendous for rapid industrial development.

The analysis is carried out by two methods; (1) annual rates of productivity growth are calculated by industry groups and related to policy variables using regression analysis; and (2) comparing the impact of FDI liberalisation on the level of productivity by comparing local and foreign companies. Outward oriented development strategy initiated in Malaysia in the 1970s receded at the beginning of the 1980s because the government launched the second round of the import substitution strategy. However in the mid 1980's, Malaysia introduced more liberal economic policies. As part of the new industrialization strategy, import and FDI liberalisation policies were introduced. A cross-industry multiple regression analysis was carried out to evaluate the impact of each liberalisation policy on productivity growth. The result shows that although the import liberalisation tends to improve TFP growth, a definite conclusion cannot be drawn.

Osada[17] attempted to measure the changes in productivity in Indonesia's industrial sectors since the mid-1980s and to examine the impact of the import liberalisation and FDI policies on such productivity change. For a quantative assessment of the impact of policies on Indonesian TFP growth, a cross-industry regression analysis was carried out to explain sectoral differences in TFP growth using sectoral differences in the indicators of policy changes. A cross-industry study for 1987-90 showed that TFP growth benefited more from reduction of effective rates of protection. This suggests that import liberalisation and FDI policies were beneficial in improving the TFP of the manufacturing sector.

Kajiwara's[18] study attempts to investigate whether or not liberalisation is the key to economic recovery in the Philippines. The results of the regression analysis suggests that for Philippines, even though the TFP growth in the manufacturing sector during the

1970s and 1980s was negative, there was improvement bought about by market competition caused by trade liberalisation.

5.2.2 Indian Studies

There is hardly any research on Indian Industry, which tried to focus on the impact of trade policies on industrial productivity growth as the core of the study. However, Goldar[19] (1986 a, b) and Ahluwalia[20] (1991) in their researches on TFP growth in Indian Industry did attempt to explore the impact of trade policy on TFP growth.

Goldar (1986 a) in his analysis of inter-industrial differences in TFP growth during the period 1960-70 used the effective rate of protection as an indicator of trade policy. Using a multiple regression equation, his results showed that there was a negative (but statistically significant) link between his measure of trade policy and observed TFP growth rates for 20 industry groups. He concluded that the observed results could be due to measurement errors in computing ERP, and as well as to the fact that ERP rates vary over time and may not represent the degree of protection accorded to a particular industry. In another study, Goldar (1986 b) attempted using a different variable to represent import substitution. Using the estimates of import substitution from Bokil, Chitre and Murthy (1981) in a regression analysis linking TFP growth for three different studies and time period, it was found that there was a significant negative relationship between TFP growth and import substitution.

Ahluwalia (1991) makes a detailed study of the trends in productivity growth in the Indian manufacturing sector. Her study covers the period from 1959-60 till 1985-86. She computed the Chenery measures of the contribution of import substitution to growth for 62 industry groups of manufacturing. Using this measure as an explanatory variable in an equation explaining growth in productivity, she addresses the question of whether TFP growth across the industry groups is systematically related to the degree of import substitution of these industries. The study established a negative relationship between TFPG and a Chenery measure of import substitution. She concludes that the protective impact of import substitution dominates any market-expanding impact on productivity growth.

Fujita's[21] main objective is to evaluate the effectiveness of liberalisation policies in India. Productivity growth rates of manufacturing industries in India were computed for the period 1981-82 to 1987-88. It was observed that productivity growth rates of most labour-intensive were higher than those of capital-intensive ones.

Since the TFP growth appeared to be affected by liberalisation policies, an attempt was made to test the hypothesis of association between liberalisation policies and TFP growth. The share of public sector in value added was used as a proxy for trade policy, as the increase in the share usually reflects restrictions in attempts at liberalisation. A negative relationship was obtained and the conclusion drawn was that TFP growth decreased with the increased in the share of public sector.

These limited studies attempted to explore the impact of trade orientation on TFP growth and have shown that their respective measures of trade policy were linked to TFP. This confirms thereby that trade policies are important, even, though it is only one element in the overall policy regime in India.

However, according to Pack[22] (1988) purely domestic factors have much to contribute to productivity growth even when the trade environment has significant impact. The theorists of economic growth have debated the causes of wide variation in growth rates between countries. The rate of capital accumulation and growth of labour force, could partly explain the level of economic growth' an equally important factor is 'Total Factor Productivity'. There are two distinct approaches to study on the relative contributions of factor inputs and technical progress to economic growth. One is to estimate the rate of technical progress and the marginal contribution of the individual factors to output growth by using econometric methods. The second approach is the use of factor shares in national income as weights to combine the individual factor inputs and forming an index of total factor input. Then to denote that part of output growth that cannot be explained by increases in factor inputs as total factor productivity or technical progress.

This approach has the advantage that results are less sensitive to the type of data and methods used. The analysis of Total Factor Productivity, which separates the effect

of increase in the use of inputs from the other factor that influences the growth of output. Total Factor Productivity Growth encompasses not only the effect of technical progress but also the effect of increase in efficiency with which resources are utilised.

TFP[23] may be defined as the ratio of output to a weighted combination of inputs. Various Total Factor Productivity indexes suggested differ from one another with regard to the weighting scheme involved. In most empirical studies either the Kendrick Index or the Solow index has been used. The translog index which is an approximation to the Divisia index was introduced by Christensen and Jorgenson (1970) and has been used in a number of recent productivity studies including Gollop and Jorgenson (1980) and Christensen, Cummings and Jorgenson (1980).

An interpretation on patterns of sources of growth by Edward K.Y. Chen[24] (1977) "that in developed countries there is a close association between the rate of growth of output and total factor productivity i.e. countries experiencing higher TFP are also those with higher rate of growth of output. In developing countries, on the other hand, it is the factor inputs contribute to the growth. However among the developing nations, the countries that have enjoyed faster rates of growth are those with a higher contribution of total factor productivity to growth." The major component of Total Factor productivity in developing countries should be advances of technical knowledge and gains from resource allocation rather than economies of scale. The results suggest that while Total Factor Productivity could be both necessary and sufficient for rapid growth in developing nations, it is only necessary for developing countries. For the individual sectors; there are striking differences in the source-of-growth patterns. In agriculture sector, the variations in the rate of output growth are largely due to variations in TFP. In manufacturing units, the rate of growth of input, in particular labour inputs. Whereas in service sector, TFP determines the rate of growth of output and to a lesser extent by the rate of growth of capital. The influence is that, if agriculture and services sector are large in developing countries, the rate of growth of output can be increased most effectively by promoting Total Factor Productivity. Whereas in manufacturing sector, Total Factor Productivity should become increasingly important as the process of sophistication of products takes place.

5.2.3 Empiricial Survey on the Measure of Total Factor Productivity in Indian Manufacturing Sector

India since 1950-51 adopted rapid industrialisation and import-substitution strategy. Increase in the rate of gross domestic saving from 10.4% of GDP in 1950-51 to 21.2% in 1980-81, enabled rapid capital accumulation. The real GDP registered a high growth rate of 5.1% in 1980's, but the annual average growth rate worked out to 3.7% for period 1950-51 to 1988-89. There is somewhat sluggish long-term growth of Indian Economy. Often this is attributed to increase in capital output ratio or sluggishness in growth of output per labour employed. These ratios would capture factor substitution as well as changes in productive efficiency. It is changes in TFP ratio indicate the net savings achieved in the use of basic factors per unit of net output and thus increase in productive efficiency.

The Indian Government has been undertaking policy reforms since 1980's. In this background the study has been attempted to understand whether the reforms in any way influenced Total Factor productivity being transformed into higher GDP and thereby higher exports. Or increase in Exports and Imports contribute the changes in Total Factor Productivity, translating into higher growth of GDP.

The earlier studies on productivity trends in Indian manufacturing industry at the aggregate level were done by Banerji[25] (1975) and Hashim and Dadi[26] (1973). The former covered the period 1946-64, found an average annual rate of fall of 1.6% in the Solow Index of Total Factor Productivity. Whereas the latter covering the same period reported, a rise in the average annual rate of 2.8% in the Solow index of TFP. Findings similar to those of Banerji have been reported by Reddy and Rao[27] (1962) for 1947-57, Singh[28] (1966) for in 1951-83, Shivamaggi, Rajagopalan and Venkatachalam[29] (1963) for 1951-61, and Raj Krishna[30] (1968) for 1946-66. On the other hand, a significant rising trend in TFP has been reported by Narasimham and Fabrycy[31] (1974) for 1949-58 and Oommen and Evenson[32] (1977) for 1959-68.

The earlier studies cover by and large the time period from the mid-forties and the mid-sixties, and that no definite conclusion emerges from the earlier studies with regard to the rate and direction of TFP growth during the period.

Bishwanath Goldar[33](1983), estimated TFP of small scale registered manufacturing industries for the period 1951-65, the results indicate a sluggish but significantly positive growth in TFP. He also estimated TFP for the period 1959-78 by using Solow index and Translog index, which showed a significant gain in TFP in Indian Manufacturing industry.

P.R.Brahmanda's[34] (1982) estimated the TFP for registered and unregistered manufacturing sector for the period 1950 to 1980 by using Kendrick index. The results showed a decreasing trend of –0.2% per annum and –1% per annum respectively.

Mehta, S.S[35] (1980), estimated TFP of large Scale manufacturing Sector for the period 1959-70. The Solow index showed a decline of –1.6% per annum and Kendrick index showed a greater decline of –2.55 per annum.

Isher J. Ahluwalia[36] (1991) used Translog index to estimate TFP for the manufacturing sector covering the period 1959-60 to 1985-86. The TFP in the manufacturing sector grew at a rate of 3.4% per annum in the first half of the eighties composed with, no growth in the preceding decade and a half; indeed, a sight decline at the rate of 0.3% per annum.

Mohanty [37](1992), used aggregate production function model to measure TFP growth for fourteen major economic activities, for the period 1970-71 to 1988-89. He concluded that the accelerated economic growth of the 1980" has not been accompanied by any improvement in TFP growth. The slow growth of employment in agriculture and industry, in a way, may indicate that the economy undergoing the process of readjustment of its factor endowments is yet to translate it into any appreciable productivity gains.

P. Balakrishnan and K. Pushpangadan[38] (1994.a, 1995.b), Dholakia. B and R. Dholakia[39] (1994) used Divisia Tornquist approximation for the calculation of TFPG in

manufacturing sector for the period 1970-71 to 1988-89. The results indicate that, productivity growth in 1980's may actually, have been slower than in the earlier decade.

J. Mohan Rao[40](1996), estimated productivity of the manufacturing industry for the period 1970-71 to 1992-93 by using econometric estimation of the production function. The substantive results of the study were at variance with the perception of an improvement in industrial performance in the 1980's as compared with the previous fifteen years.

Dholakia H. Ravindra and Bakul H. Dholakia[41] (1993) estimated Total Factor Productivity for Agricultutre for the period 1950-51 to 198-89 by using a concept of autonomous disembodied neutral technical progress as defined by Hicks (1963) and Harrod (1973).

Hajra, S. and Vasudeva, V. [42] (1993) estimated Total Factor Productivity of the Indian Economy and Indian Manufacturing Sector for the period 1970-71 to 1987-88. The concept of TFP defined as output per unit of the combined factor inputs, viz., labour and capital.

Tarlok Singh[43] (2000-2001), computed TFP by Solow index method for a sample set of ten industries in the manufacturing sector for period 1973-94. These industries constitute 70% in total real GDP. The results show that TFP recorded improvements in all the sample industries, except for the basic metals industries in which the TFP witnessed a declining trend during 1973-94.

5.3 DATA AND METHODOLOGY

Since our objective is to investigate the relationship between the output growth, Total Factor Productivity Growth and Trade Performance of India. We instead of calculating the Total Factor productivity have relied on the TFP calculated by few of the following authors with reference to Indian Economy.

(i) TFP calculated by Isher .Ahluwalia (1991) for the manufacturing sector for the period 1960-61 to 1985-86.

(ii) TFP for the manufacturing sector calculated by P. Balakrishnan and K. Pushpangadan (1994, 1995), and the recalculated series of Dholakia. B and R. Dholakia (1994) by the above mentioned authors, for the period 1970-71 to 1988-89.

(iii) TFP calculated by J.M. Rao (1996) for the manufacturing sector for the period 1973-74 to 1992-93.

(iv) TFP calculated for the Manufacturing sector and the Indian Economy by Hajra, S. and Vasudeva, V. (1993) for the period 1970-71 to 1987-88.

(v) The TFP calculated for the Agriculture sector by Dholakia. B and R. Dholakia (1993) for the period 1950-51 to 1988-89.

(vi) The TFP calculated by Tarloksing (2000) for the ten different industries for the period 1974-75 to 1993-94.

The TFP data sourced from various authors mentioned above was converted to the base year 1978-79, since the data on exports and imports in real terms was made uniform with the base year 1978-79 for the period 1960-61 to 1995-96. The data on GDP was also converted to the base year 1978-79.

The TFP calculated for chemical sector by Singh, Tarlok was used to test the causality between imports and exports of the chemical sector (section 5) SITC Classification. Further the TFP calculated by the same author for Non-electrical machinery tools and parts, Electrical machinery, and Transport equipment was made compatible to Machinery and Transport equipment (section 7).

The geometric mean of the data on TFP for the above three category was arrived and converted to the base year 1978-79 to test the causality between Exports and Imports of Machinery and Transport equipment (section 7). The TFP for Agricultural sector calculated by Dholakia-Dholakia was tested for causality with exports and imports of section 0. We also try to examine the causality between TFP manufacturing sector with exports (real terms), i.e. Total of section 5 to 8, (SITC .Revision-2) and with Imports in real terms, GDP in real terms.

The technique used to test the causality was the Test of Integration, Co-integration, and Error-Correction Mechanism.

5.4 THE EMPIRICAL FINDINGS

5.4.1 TFP Calculated by Isher Ahluwalia (1991) for the Manufacturing Sector for the Period 1960-61 to 1985-86.

As stated above the attempt is made to determine the causality between the Total Factor Productivity and Exports, Total Factor Productivity and Imports, Total Factor Productivity and Gross Domestic Product, Exports and Imports, Gross Domestic Product and Exports, and Gross Domestic Product and Imports. The period covered is 1960-61 to 1985-86, since I have used the TFP series worked out by Ahluwalia, I J (1991: Productivity and Growth in Indian Manufacturing, Oxford University Press Delhi) for the manufacturing sector covering the period 1960-61 to 1985-86. The time series on Exports, Imports and Gross Domestic Product is expressed in real terms with the base year 1978-79. The technique used is Test of Integration, Co-Integration and Error Correction Mechanism.

We begin our empirical investigation by examining the basic properties of the time series of TFP of Manufacturing calculated by Isher Ahluwalia, Exports/ Imports of manufacturers (section 5 to section 8), and GDP $_{MP}$, representing the period 1960-61 to 1985-86. The main reason for this is that the integration and cointegration properties of the data are critical in the subsequent analysis.

We summarize the findings of the stationary test in the table II.61, Table II.62, Table II.63, Table II.64. The D.F test is reported in column 8 of the table. The Table II.61 shows that the series of TFP at first-order differenced series was non-stationary, hence the series was second-order differenced, which had the properties of stationarity at 5% significance level. Similarly in table II.63 Exports of manufacturers was found to be integrated of order zero, and significant at 5% level significance when the series was second-order differenced. The results of Table II.64 shows that the series of GDP $_{MP}$, also

had to be second-order differenced to establish the stationary properties and is significant at 5% level. However the series of Imports in table II.65 even after second-order difference could yield non-stationarity.

Given the properties of stationarity for the series of TFP, Exports of manufacturers, and GDP_{MP}, it is important to assess whether the variables are also cointegrated. The residuals of the cointegration regressions are tested for stationarity.

The findings of the test for cointegration are provided in the table II.65, the 2 & 3 rows report the results of co-integration equations relating TFP and Exports of manufacturers and vice-versa. The rows 3 & 4 show the results of co-integration equations relating GDP_{MP} and TFP and vice-versa. Finally the rows 5 & 6 exhibit the results of co-integration equations Exports and GDP_{MP} and vice-versa. The column 9 presents the results of the ADF test were the calculated value is less than the table value at 1% and 5% level significance. Hence we accept the null hypothesis of no-cointegration for the above series mentioned. Therefore, there is no possibility of examining the causation between the series by applying error-correction models that requires the two series to be cointegrated of same order with stationary residuals.

Table II.61

Time Series Properties of Total Factor Productivity (converted at base year 78-79) of the Manufacturing Sector Calculated by Isher Ahluwalia 1960-61 to 1985-86

ADF Test

No. of Lags	Dependent Variable	Constant	$\Delta\Delta P_{t-1}$	ΔP_{t-1}	P_{t-1}	t	R^2	1st Differences
1	ΔP	68.33		0 38	-0.68	-0.19	0.35	
				(0.21)	(0.21)	(0.16)		
	ΔP	-0.31		0.027			0 00082	
				(0.20)				5 13
1	$\Delta\Delta P$	-1.51	0.26	-1.21		0.12	0.52	
			(0.20)	(0.30)		(0.15)		
	$\Delta\Delta P$	0.14	-0.32				0 11	
			(0.19)					9.89*

The figures in the parenthesis are Standard Error.

* 5% level of significance

** 1% level of significance.

Table II.62
Time Series Properties of Manufactured Exports (78-79) for the 1960-61 to 1985-86. ADF Test

No of Lags	Dependent Variable	Constant	$\Delta\Delta X_{t-1}$	ΔX_{t-1}	X_{t-1}	t	R^2	1st Differences
1	ΔX	409.84		0.32	-0.35	44.59	0.24	
				(0.20)	(0.15)	(19.59)		
	ΔX	87.32		0 16			0 027	
				(0.21)				2.80
1	$\Delta\Delta X$	116.89	0.38	-1.14		-0.08	0 48	
			(0.23)	(0.28)		(7.05)		
	$\Delta\Delta X$	0.60	-0.22				0.04	
			(0.22)					7.96*

The figures in the parenthesis are Standard Error.

* 5% level of significance

** 1% level of significance.

Table II.63
Time Series Properties of Manufactured Imports (Base: 1978-79=100) for the 1960-61 to 1985-86 ADF Test

No. of Lags	Dependent Variable	Constant	$\Delta\Delta M_{t-1}$	ΔM_{t-1}	M_{t-1}	t	R^2	1st Differences
1	ΔM	-144.06		-0.34	-0 06	59.84	0 25	
				(0.22)	(0.12)	(30 52)		
	ΔM	282.14		-0.25			0.05	
				(0.22)				2.60
1	$\Delta\Delta M$	-316.20	0.15	-1.56		60.94	0.67	
			(0.29)	(0.41)		(28 54)		
	$\Delta\Delta M$	19.75	-0 78				0.40	
			(0.19)					6.93

The figures in the parenthesis are Standard Error.

* 5% level of significance

** 1% level of significance.

Table II.64

Time Series Properties of GDP_{MP} (Base: 78-79 = 100) for the 1960-61 to 1985-86

ADF Test

No. of Lags	Dependent Variable	Constant	$\Delta\Delta Y_{t-1}$	ΔY_{t-1}	Y_{t-1}	t	R^2	1st Differences
1	ΔY	4169.79		-0 18	-0 05	366.11	0.19	
				(0 25)	(0 18)	(547.11)		
	ΔY	3606.07		-0.05			0.003	
				(0.21)				2 30
1	$\Delta\Delta Y$	1996.87	0.22	-1 49		296.43	0.57	
			(0.22)	(0.35)		(123.88)		
	$\Delta\Delta Y$	230.29	-0.52				0.27	
			(0.19)					8 63*

The figures in the parenthesis are Standard Error.

* 5% level of significance

** 1% level of significance.

Table II.65
Cointegration test between Total Factor Productivity and Exports
(Base: 1978-79=100)

Time Period	No. of Lags	Dependent Variable	Constant	Δe_{t-1}	e_{t-1}	t	R^2	1st Differences
1960-61 to 1985-86 TFP regressed on Exports	1	Δe	-0 83	0 39	-0 71	0 043	0 38	
				(0 21)	(0 21)	(0 12)		
		Δe	-0 018	0.021			0.0004	
				0.20				6.12
1960-61 to 1985-86 Exports regressed on TFP	1	Δe	-753 68	0 35	-0.66	67 26	0.38	
				(0 20)	(0 19)	(20 08)		
		Δe	75 13	0 029			0 0008	
				(0.21)				6 11
1960-61 to 1985-86 GDP regressed on TFP	1	Δe	-13594 9	0 30	-0.42	1304.5	0.26	
				(0.23)	(0.20)	(500 03)		
		Δe	2578 37	0 096			0.0094	
				(0.21)				3 38
1960-61 to 1985-86 TFP regressed on GDP	1	Δe	-0.46	0.37	-0.63	0 013	0 33	
				(0 21)	(0 21)	(0.13)		
		Δe	-0.012	0 04			0 002	
				(0 20)				5 09
1960-61 to 1985-86 GDP regressed on Exports	1	Δe	-1149.85	0.10	-0.20	165.41	0 09	
				(0 24)	(0.17)	(174 91)		
		Δe	928.39	0 0027			0 000007 1	
				(0.22)				1.06
1960-61 to 1985-86 Exports regressed on GDP	1	Δe	19 01	0 13	-0.22	-2 40	0 10	
				(0.23)	(0 17)	(7 50)		
		Δe	-20.80	0 02			0 00054	
				(0.21)				1.16

The figures in the parenthesis are Standard Error.

* 5% level of significance

** 1% level of significance.

5.4.2 TFP for the Manufacturing Sector Calculated by P. Balakrishnan and K. Pushpangadan (1994, 1995), and the Recalculated Series of Dholakia. B and R. Dholakia (1994) for the Period 1970-71 to 1988-89

We begin the determination of casualty issue by examining the basic properties of the time series of TFP of Manufacturing recalculated series of Dholakia-Dholakia, by Balakrishnan P and Pushpangandan , and the series originally calculated by Balakrishnan P and Pushpangandan K, Exports/Imports of Manufacturers (section 5 to section 8), and GDP $_{MP}$, representing the period 1970-71 to 1988-89. The main reason for this is that the integration and cointegration properties of the data are critical in the analyzing the causal relationship. If cointegration is not accounted for, our regression models are misspecified and standard causality tests become invalid in principle.

We summarize the findings of the stationary test in the table II.66, Table II.67, Table II.68, Table II.69 and Table II.70. The results of DF test are reported in column 8 of the table. The Table II.66 shows that the series of TFP (representing Dholakia and Dholakia) of manufacturing sector, at first-order differenced series was non-stationary, hence the series was second-order differenced, which had the properties of stationarity at 1% significance level. Whereas the results in table II.67 shows the TFP series of manufacturing sector calculated by (B-P) at first order differenced series was stationary at 5% level significance, but since cointegration regression is estimated using variables with the same order of integration. Hence the series was second-order differenced and was found to be stationary at 5% level significance. In the table II.68 exports of manufacturers (section 5 to section 8) was found to be non-stationary at 1% and 5% level, even when second-order differenced. The results in Table II.69 shows that the series of imports of manufacturers, had to be second-order differenced to establish the stationary properties and is significant at 5% level. However the series of GDP $_{MP}$ in Table II.70 shows that even after second-order difference could yield non-stationarity. Therefore, test of cointegration is possible between the TFP series of (D-D) with imports, similarly the TFP series of (B-P) with imports.

Given the properties of stationarity for the series of TFP(B-P and D-D) and Imports of Manufacturers, it is important to assess whether the variables are also cointegrated. The residuals of the cointegration regressions are tested for stationarity. The findings of the test for cointegration for the TFP series (D-D) are provided in the table II.71, the 2 & 3 rows report the results of co-integration equations relating TFP and Imports and vice-versa. Similarly in Table II. 71 the rows 2 & 3 show the results of co-integration equations relating TFP (B-P) and Imports and vice-versa. The column 9 presents the results of the ADF test were the calculated value is less than the table value at 1% and 5% level significance. Hence we accept the null hypothesis of no-cointegration for the above series mentioned. Therefore, there is no possibility of examining the causation between the series by applying error-correction models that requires the two series to be cointegrated of same order with stationary residuals.

Table II.66

Time Series Properties of Total Factor Productivity of the Manufacturing Sector with the (Converted at the Base: 1978-79 = 100) Recalculated Series of Dholakia-Dholakia, by Balakrishnan P and Pushpangandan K for the Period 1970-71 to 1988-89 ADF Test

No. of Lags	Dependent Variable	Constant	$\Delta\Delta P_{t-1}$	ΔP_{t-1}	P_{t-1}	t	R^2	1st Differences
1	ΔP	54.06		0.39	-0.73	1.52	0 39	
				(0.22)	(0.26)	(0.79)		
	ΔP	2.15		0.029			0 0011	
				(0 22)				4 14
1	$\Delta\Delta P$	7.48	0.42	-1.50		-0.60	0.67	
			(0.20)	(0 31)		(0.47)		
	$\Delta\Delta P$	0.54	-0.19				0.04	
			(0.24)					11 43**

The figures in the parenthesis are Standard Error.

* 5% level of significance

** 1% level of significance.

Table II.67

Time Series Properties of Total Factor Productivity of the Manufacturing Sector with the (Base: 1978-79 = 100) Calculated by Balakrishnan P and Pushpangandan K for the Period 1970-71 to 1988-89 ADF Test

No of Lags	Dependent Variable	Constant	$\Delta\Delta P_{t-1}$	ΔP_{t-1}	P_{t-1}	T	R^2	1st Differences
1	ΔP	68.51		0.58	-1.14	2.74	0.57	
				(0.21)	(0.27)	(0.81)		
	ΔP	1.91		0.04			0.0018	
				(0.24)				8 58*
1	$\Delta\Delta P$	4.24	0.51	-1.47		-0.16	0.63	
			(0 20)	(0.31)		(0.58)		
	$\Delta\Delta P$	-0.04	-0 18				0.035	
			(0.25)					9.64*

The figures in the parenthesis are Standard Error.

* 5% level of significance

** 1% level of significance.

Table II.68

Time Series Properties of Manufactured Exports (Base: 1978-79 = 100) for the Period 1970-71 to 1988-89 ADF Test

No. of Lags	Dependent Variable	Constant	$\Delta\Delta X_{t-1}$	ΔX_{t-1}	X_{t-1}	t	R^2	1st Differences
1	ΔX	890.95		0.68	-0.44	81.28	0.36	
				(0.29)	(0.25)	(40.51)		
	ΔX	154.90		0.43			0.16	
				(0.25)				2.04
1	$\Delta\Delta X$	54.06	0.20	-0.77		17.87	0.32	
			(0.34)	(0.38)		(19 41)		
	$\Delta\Delta X$	49.86	-0.25				0.06	
			(0 26)					2.77

The figures in the parenthesis are Standard Error.

* 5% level of significance

** 1% level of significance.

Table II.69

Time Series Properties of Manufactured Imports (Base: 1978-79 = 100) for the Period 1970-71 to 1988-89 ADF Test

No. of Lags	Dependent Variable	Constant	$\Delta\Delta M_{t-1}$	ΔM_{t-1}	M_{t-1}	t	R^2	1st Differences
1	ΔM	-771 28		-0 10	-0.50	294.10	0.37	
				(0.24)	(0.23)	(120.13)		
	ΔM	524 25		-0 28			0.083	
				(0 24)				2 99
1	$\Delta\Delta M$	195 79	0.52	-2.02		93.58	0.66	
			(0.30)	(0.47)		(57.87)		
	$\Delta\Delta M$	-19.31	-0.58				0.31	
			(0.22)					8.63*

The figures in the parenthesis are Standard Error.

* 5% level of significance

** 1% level of significance.

Table II.70

Time Series Properties of GDP_{MP} (Base: 1978-79 = 100) for the period 1970-71 to 1988-89 ADF Test

No. of Lags	Dependent Variable	Constant	$\Delta\Delta Y_{t-1}$	ΔY_{t-1}	Y_{t-1}	t	R^2	1st Differences
1	ΔY	3219.47		-0.37	-0.02	783.4	0.43	
				(0 30)	(0.21)	(949.20)		
	ΔY	4638.47		0.08			0 005	
				(0.30)				4.84
1	$\Delta\Delta Y$	195.79	0.52	-2.02		93.58	0.66	
			(0.30)	(0.47)		(57.87)		
	$\Delta\Delta Y$	1162	-0.59				0.31	
			(0.23)					6.17

The figures in the parenthesis are Standard Error.

* 5% level of significance

** 1% level of significance.

Table II.71
Cointegration Test Between Total Factor Productivity (Recalculated Series of Dholakia-Dholakia) and Imports (Base:1978-79=100)

Time Period	No. of Lags	Dependent Variable	Constant	Δe_{t-1}	e_{t-1}	t	R^2	1st Differences
1970-71 to 1988-89	1	Δe	1.0005	0 25	-0.62	-0.008	0 34	
TFP regressed on Imports				(0 24)	(0 26)	(0.52)		
		Δe	0 66	-0.056			0 0039	
				0.22				3 36
1970-71 to 1988-89	1	Δe	-1332.97	0.12	-0 54	174 006	0 32	
Imports regressed on TFP				(0.24)	(0 25)	(86.92)		
		Δe	236.3	-0 16			0 029	
				(0 26)				2 87

The figures in the parenthesis are Standard Error.

* 5% level of significance

** 1% level of significance.

Table II.72
Cointegration Test Between Total Factor Productivity (Balakrishnan. P and Pushpangandan. K) and Imports (Base: 1978-79=100)

Time Period	No. of Lags	Dependent Variable	Constant	Δe_{t-1}	e_{t-1}	t	R^2	1st Differences
1970-71 to 1988-89	1	Δe	-0.89	0 46	-0 84	0 18	0 45	
TFP regressed on Imports				(0 23)	(0 26)	(0.50)		
		Δe	0.35	0 048			0 0025	
				0 24				5.28
1970-71 to 1988-89	1	Δe	-1264 04	0 34	-0.67	161 98	0 37	
Imports regressed on TFP				(0.24)	(0 25)	(83.51)		
		Δe	144 40	0 0057			0 00003	
				(0 24)				3.89

The figures in the parenthesis are Standard Error.

* 5% level of significance

** 1% level of significance.

5.4.3 TFP Calculated by J.M. Rao (1996) for the Manufacturing Sector for the Period 1973-74 to 1992-93

We begin our empirical investigation into the relationship between output growth, Total Factor Productivity and Trade Performance. Our purpose is to reconsider the causality issue with the aid of co-integration and error-correction modeling. Each of the time series, TFP of Manufacturing sector calculated by Rao, J.M., Exports/Imports of Manufacturing Group (section 5 to section 8), and GDP $_{MP}$, representing the period 1970-71 to 1992-93, are examined for the probable order of difference stationarity. The cointegration and error-correction equations require the use of stationary variables.

We conclude the findings of the stationary test in the table II.73, table II.74, Table II.75, Table II.76, Table II.69 and Table II.70. The results of DF test are reported in column 8 of the table. The Table II.73 shows the results for the series of TFP, table II.74 for exports of manufactures and table II.76 reports the results for GDP_{MP}. The DF test is reported in column 8 of the table. These series were first-order differenced but resulted non-stationary, hence the series was second-order differenced, however once again it failed to reject the hypothesis of non-stationarity at 1% and 5% level. However in case of Imports of manufacturers, the results presented in Table II.75, although the time series properties were non-stationary at first-order difference, but proved to be stationary at 1% level of significance. Therefore, test of cointegration is not possible since no other series other than imports is stationary. The cointegration regression is estimated using variables with the same order of integration.

Table II.73

Time Series Properties of Total Factor Productivity of the Manufacturing Sector with the (Base: 1978-79 = 100) Calculated by Rao, J.M for the Period 1973-74 to 1992-93 ADF Test

No. of Lags	Dependent Variable	Constant	$\Delta\Delta P_{t-1}$	ΔP_{t-1}	P_{t-1}	t	R^2	1st Differences
1	ΔP	62.83		0 43	-0.7	1.04	0.41	
				(0.23)	(0.23)	(0 38)		
	ΔP	0.85		0.07			0.005	
				(0.24)				4.99
1	$\Delta\Delta P$	1.35	0.40	-1.28		0.04	0.54	
			(0.27)	(0.36)		(0.30)		
	$\Delta\Delta P$	0.11	-0.30				0.08	
			(0.25)					6.40

The figures in the parenthesis are Standard Error.

* 5% level of significance

** 1% level of significance.

Table II.74

Time Series Properties of Manufactured Exports (78-79) for the Period 1973-74 to 1992-93 ADF Test

No. of Lags	Dependent Variable	Constant	$\Delta\Delta X_{t-1}$	ΔX_{t-1}	X_{t-1}	t	R^2	1st Differences
1	ΔX	80.47		0.42	-0.02	33.88	0.41	
				(0.29)	(0.12)	(33.55)		
	ΔX	187.62		0.57			0.31	
				(0.21)				1.18
1	$\Delta\Delta X$	-0.83	0.03	-0.64		32.63	0.32	
			(0.27)	(0 30)		(20.64)		
	$\Delta\Delta X$	49 05	-0.28				0.08	
			(0 24)					2.26

The figures in the parenthesis are Standard Error.

* 5% level of significance

** 1% level of significance.

Table. II.75

Time Series Properties of Manufactured Imports (Base : 1978-79 = 100) for the period 1973-74 to 1992-93. ADF Test.

No. of Lags	Dependent Variable	Constant	DDM_{t-1}	DM_{t-1}	M_{t-1}	t	R^2	1st Differences
1	DM	2509.03		0.17	-1.15	687.48	0.54	
				(0.24)	(0.31)	(184.92)		
	DM	709.25		-0.34			0.103	
				(0.25)				6.63
1	DDM	977.01	0.50	-2.06		17.31	0.75	
			(0.24)	(0.39)		(45.39)		
	DDM	160.57	-0.52				0.24	
			(0.23)					13.21**

The figures in the parenthesis are Standard Error.

* 5% level of significance

** 1% level of significance.

Table II.76

Time Series Properties of GDP_{MP} (Base:1978-79 = 100) for the period 1973-74 to 1992-93. ADF Test

No. of Lags	Dependent Variable	Constant	DDY_{t-1}	DY_{t-1}	Y_{t-1}	t	R^2	1st Differences
1	DY	14701		-0.13	-0.14	1253.26	0.23	
				(0.25)	(0.14)	(915.25)		
	DY	6324.78		.00005			0.003	
				(0.24)				3.4
1	DDY	4182.44	0.25	-1.46		612.38	0.62	
			(0.30)	(0.44)		(287.76)		
	DDY	125.88	-0.57				0.30	
			(0.22)					5.33

The figures in the parenthesis are Standard Error.

* 5% level of significance

** 1% level of significance.

5.4.4 TFP Calculated for the Manufacturing Sector and the Indian Economy by Hajra, S. and Vasudeva, V. (1993) for the Period 1970-71 to 1987-88

In another attempt we examined the causal nexus between Total Factor Productivity of the manufacturing sector for the period 1970-71 to 1987-88 (calculated by Hajra S. and V. Vasudeva) and exports/imports manufacturers and GDP $_{MP}$ with the aid of co-integration and error-correction modeling. This requires knowing the probable order of difference stationarity. The cointegration and error-correction equations require the use of stationary variables.

We present the results of the findings of the stationary test in the table II.77 (TFP of the manufacturing sector), table II.82 (Export of Manufacturers), Table II.83 (Imports of Manufacturers), Table II.84 (GDP $_{MP}$). The results of DF test are reported in column 8 of the table.

The inference is that only in case of Total Imports, the series observed stationarity at second-order difference and is significant at 5% level. Therefore, the test of cointegration is not possible since no other series other than imports is stationary. The cointegration regression is estimated using variables with the same order of integration.

Further we used the data published by the same author and attempted to examine the causal nexus between Total Factor Productivity of the Indian Economy for the period 1970-71 to 1987-88 (calculated by Hajra S. and V. Vasudeva) and Total Exports/Total Imports and GDP $_{MP}$ with the aid of co-integration and error-correction modeling. This requires to ascertain that the respective series confirm the for the probable order of difference stationarity. The cointegration and error-correction equations require the use of stationary variables.

We present the results of the findings of the stationary test in the table II.81 (TFP of Indian Economy), table II.82 (Total Exports). Table II.83 (Total Imports), Table II.84 (GDP $_{MP}$). The results of DF test are reported in column 8 of the table. The inference is

that only in case of imports of manufacturers, the series observed stationarity at second-order difference and is significant at 5% level. Therefore, the test of cointegration is not possible since no other series other than imports is stationary The cointegration regression is estimated using variables with the same order of integration

Table II.77

Time Series Properties of Total Factor Productivity of the Manufacturing Sector with the (Base: 1978-79 = 100) Calculated by Hajra S. and V. Vasudeva for the Period 1970-71 to 1987-88 ADF Test

No. of Lags	Dependent Variable	Constant	$\Delta\Delta P_{t-1}$	ΔP_{t-1}	P_{t-1}	t	R^2	1st Differences
1	ΔP	27 14		0.17	-0.31	0 57	0 26	
				(0.31)	(0.23)	(0.28)		
	ΔP	1 10		0 12			0.01	
				(0.26)				2.02
1	$\Delta\Delta P$	-1.61	0.25	-1.30		0.46	0.55	2nd Differences
			(0 29)	(0.41)		(0.29)		
	$\Delta\Delta P$	0.30	-0.39				0.15	
			(0.25)					4.88

The figures in the parenthesis are Standard Error.

* 5% level of significance

** 1% level of significance.

Table II.78

Time Series Properties of Manufactured Exports (Base: 1978-79 = 100) for the Period 1970-71 to 1987-88 ADF Test

No. of Lags	Dependent Variable	Constant	$\Delta\Delta X_{t-1}$	ΔX_{t-1}	X_{t-1}	t	R^2	1st Differences
1	ΔX	1061 03		0.58	-0.50	85.48	0 31	
				(0.32)	(0.26)	(41.36)		
	ΔX	163.18		0.32			0.06	
				(0.32)				2.17
1	$\Delta\Delta X$	89.01	0.24	-0.88		14.43	0.30	2nd Differences
			(0.37)	(0.50)		(22.25)		
	$\Delta\Delta X$	60 35	-0 20				0 03	
			(0 28)					2.12

The figures in the parenthesis are Standard Error.

* 5% level of significance

** 1% level of significance.

Table II.79

Time Series Properties of Manufactured Imports (78-79) for the Period 1970-71 to 1987-88 ADF Test

No of Lags	Dependent Variable	Constant	$\Delta\Delta M_{t-1}$	ΔM_{t-1}	M_{t-1}	t	R^2	1st Differences
1	ΔM	704 86		-0 16	-0 48	292.28	0 37	
				(0 30)	(0 24)	(124.39)		
	ΔM	547.61		-0.31			0.08	
				(0 27)				2.76
1	ΔΔM	99.06	0 51	-2.14		120.94	0.72	2nd Differences
			(0.30)	(0 50)		(67.50)		
	ΔΔM	-16.25	-0.57				0.25	
			(0.28)					9.23*

The figures in the parenthesis are Standard Error.

* 5% level of significance

** 1% level of significance.

Table II.80

Time Series Properties of GDP_{MP} (Base: 1978-79 = 100) for the Period 1970-71 to 1988-89 ADF Test

No of Lags	Dependent Variable	Constant	$\Delta\Delta Y_{t-1}$	ΔY_{t-1}	Y_{t-1}	t	R^2	1st Differences
1	ΔY	21456.72		-0.23	-0.27	1625.78	0.41	
				(0.27)	(0.21)	(895.30)		
	ΔY	4553.75		-0.03			0 001	
				(0.26)				4.15
1	ΔΔY	3476.001	0.28	-1.75		620.86	0.71	2nd Differences
			(0.28)	(0.46)		(271.24)		
	ΔΔY	694.06	-0 58				0.35	
			(0.22)					6.82

The figures in the parenthesis are Standard Error.

* 5% level of significance

** 1% level of significance.

Table II.81

Time Series Properties of Total Factor Productivity of the Indian Economy with the (Base: 1978-79 = 100) Calculated by Hajra S. and V. Vasudeva for the Period 1970-71 to 1987-88 ADF Test

No of Lags	Dependent Variable	Constant	$\Delta\Delta P_{t-1}$	ΔP_{t-1}	P_{t-1}	t	R^2	1st Differences
1	ΔP	78 88		-0.009	-0 88	0.94	0 49	
				(0.25)	(0.32)	(0.31)		
	ΔP	1.03		-0 33			0 11	
				(0.24)				4.47
1	ΔΔP	0 46	0 23	-1.76		0.17	0.74	2nd Differences
			(0.27)	(0 46)		(0.23)		
	ΔΔP	0 41	-0 63				0.41	
			(0.21)					7 61

The figures in the parenthesis are Standard Error.

* 5% level of significance

** 1% level of significance.

Table II.82

Time Series Properties of Total Exports (Base: 1978-79 = 100) for the Period 1970-71 to 1987-88 ADF Test

No. of Lags	Dependent Variable	Constant	$\Delta\Delta X_{t-1}$	ΔX_{t-1}	X_{t-1}	t	R^2	1st Differences
1	ΔX	3018.38		0.08	-0.71	168.20	0.33	
				(0.32)	(0.33)	(81.49)		
	ΔX	350.67		-0.29			0.06	
				(0.32)				2.41
1	ΔΔX	766.07	0.71	-2.40		-27 16	0 67	2nd Differences
			(0.38)	(0.67)		(30.26)		
	ΔΔX	66.48	-0.51				0.25	
			(0.24)					7

The figures in the parenthesis are Standard Error.

* 5% level of significance

** 1% level of significance.

Table II.83

Time Series Properties of Total Imports (Base: 1978-79 = 100) for the Period 1970-71 to 1987-88 ADF Test

No. of Lags	Dependent Variable	Constant	$\Delta\Delta M_{t-1}$	ΔM_{t-1}	M_{t-1}	t	R^2	1st Differences
1	ΔM	1950.006		-0.15	-0.50	387.53	0.39	
				(0.28)	(0.27)	(174 63)		
	ΔM	792.27		-0.33			0.11	
				(0 25)				2.75
1	ΔΔM	332.43	0.36	-1.94		120.42	0 74	2nd Differences
			(0.29)	(0.48)		(76.7)		
	ΔΔM	52 96	-0.61				0.35	
			(0.23)					9.75*

The figures in the parenthesis are Standard Error.

* 5% level of significance

** 1% level of significance.

Table II.84

Time Series Properties of GDP_{MP} (Base: 1978-79 = 100) for the Period 1970-71 to 1988-89 ADF Test

No. of Lags	Dependent Variable	Constant	$\Delta\Delta Y_{t-1}$	ΔY_{t-1}	Y_{t-1}	t	R^2	1st Differences
1	ΔY	21456.72		-0.23	-0.27	1625.78	0.41	
				(0.27)	(0.21)	(895.30)		
	ΔY	4553.75		-0.03			0.001	
				(0.26)				4.15
1	ΔΔY	3476.001	0.28	-1.75		620.86	0.71	2nd Differences
			(0.28)	(0.46)		(271.24)		
	ΔΔY	694.06	-0.58				0 35	
			(0.22)					6.82

The figures in the parenthesis are Standard Error.

* 5% level of significance

** 1% level of significance.

5.4.5 The TFP calculated for the Agriculture sector by Dholakia. B and R. Dholakia (1993) for the Period 1950-51 to 1988-89

After examining the causal relationship between TFP of Manufacturers and of the Indian economy. Export/Import of the Manufacturers, and GDP_{MP} We present an empirical exercise to determine the causal relationship between Total Factor Productivity for Agriculture (calculated by Dholakia-Dholakia) and Agricutural Exports (i.e. section 0+section 1) and Agricutural Imports (i.e. section 0 + section 1).

We begin our empirical exercise by first examining for the probable order of difference stationarity. because cointegration and error-correction can be estimated by the stationary variables. We summarize the findings of the stationary test in the following tables, in table II. 85 (TFP Agriculture), Table II.86 (Exports of Agriculture) and in Table II.87 (Imports of Agriculture). The DF test is presented in the column 8 of the tables. It can be seen that only TFP of Agriculture and Agriculture Exports were found to be stationary and integrated of order zero at second order difference. The results are significance at 1% level. However in case of Agriculture Imports, for first-order and second-order difference the null hypothesis of no stationarity was accepted at 1% and 5% level.

Given the property of stationarity for TFP and Exports of Agriculture, it is important assess whether the variables are cointegrated, then we must include error-correction to determine the causality. In the table II.88 the 2 and 3 rows report the cointegrating equations relating to TFP and Exports of Agriculture and vice-versa. To check for cointegration, the residuals from these regressions are tested for stationarity. However the ADF test shows that the calculated value is less than the D.F. critical value, hence we accept the null hypothesis no cointegration. Thereby the scope of error correction does not arise in this case.

Table II.85

Time Series Properties of Total Factor Productivity for Agriculture with the (Base: 1978-79 = 100) Calculated by Dholakia-Dholakia (Period considered 1960-61 to 1988-89) The ADF Test

No. of Lags	Dependent Variable	Constant	$\Delta\Delta P_{t-1}$	ΔP_{t-1}	P_{t-1}	t	R^2	1st Differences
1	ΔP	96.56		0.15	-1.15	0.95	0 48	
				(0.21)	(0.30)	(0.24)		
	ΔP	1.19		-0.38			0.12	
				(0.20)				7.88
1	$\Delta\Delta P$	-0.22	0.47	-2.06		0.15	0 73	
			(0.20)	(0.34)		(0 15)		
	$\Delta\Delta P$	0.70	-0.55				0.28	
			(0.17)					18.08**

The figures in the parenthesis are Standard Error.

* 5% level of significance

** 1% level of significance.

Table II.86

Time Series Properties of Agriculture Exports (Section 0 + Section 1) with the (Base: 1978-79 = 100) for the Period Considered 1960-61 to 1988-89 ADF Test

No. of Lags	Dependent Variable	Constant	$\Delta\Delta P_{t-1}$	ΔP_{t-1}	P_{t-1}	T	R^2	1st Differences
1	ΔP	430.27		-0.10	-0.43	15 21	0.24	
				(0.21)	(0.21)	(9.55)		
	ΔP	39.02		-0.32			0.10	
				(0.18)				2.06
1	$\Delta\Delta P$	70.42	0.36	-1.8		-1.55	0 71	
			(0.19)	(0.32)		(4.82)		
	$\Delta\Delta P$	-7.52	-0.54				0.29	
			(0.17)					15.93**

The figures in the parenthesis are Standard Error.

* 5% level of significance

** 1% level of significance.

Table II.87

Time series properties of Agriculture Imports (section 0 + section 1) with the (Base:1978-79=100) for the period considered 1960-61 to 1988-89. ADF Test

No. of Lags	Dependent Variable	Constant	DDP_{t-1}	DP_{t-1}	P_{t-1}	t	R^2	1st Differences
1	DP	654.90		0.49	-0.52	13.61	0.36	
				(0.18)	(0.15)	(8.90)		
	DP	20.96		0.24			0.05	
				(0.20)				5.57
1	DDP	-17.60	0.16	-0.87		2.39	0.71	
			(0.21)	(0.26)		(10.12)		
	DDP	17.80	-0.26				0.07	
			(0.19)					5.23

The figures in the parenthesis are Standard Error.

* 5% level of significance

** 1% level of significance.

Table II.88

Cointegration test between Total Factor Productivity of Agriculture with the (Base : 1978-79 = 100) and Agriculture Exports.

Time Period	No. of Lags	Dependent Variable	Constant	De_{t-1}	e_{t-1}	t	R^2	1st Differences
1970-71 to 1988-89	1	De	-2.93	0.063	-0.61	0.24	0.26	
TFP regressed on Exports				(0.23)	(0.25)	(0.14)		
		De	0.60	-0.20			0.035	
				(0.21)				3.57
1970-71 to 1988-89	1	De	-12.58	0.094	-0.37	1.46	0.16	
Imports regressed on TFP				(0.23)	(0.20)	(6.56)		
		De	-0.8	-0.07			0.004	
				(0.21)				2.26

The figures in the parenthesis are Standard Error.

* 5% level of significance

** 1% level of significance.

5.4.6 The TFP Calculated by Tarloksing (2000) for the Ten Different Industries for the Period 1974-75 to 1993-94

In continuation of the empirical findings of causal links at disaggregate level. We present an empirical exercise to determine the causal relationship between Total Factor Productivity of Chemical sector and Machinery and Transport equipment (calculated by Tarlok Singh for the period 1973-74 to 1993-94) and Exports/Imports of Chemical (section 5) and Machinery and Transport (section 7).

We begin our empirical exercise by first examining for the probable order of difference stationarity, because cointegration and error-correction can be estimated by the stationary variables. We summarize the findings of the stationary test in the following tables, in table II. 89 (TFP chemical sector), Table II.90 (Exports of chemical) and in Table II.91 (Imports of chemical), Table II.92 (TFP of Machinery and Transport Equipment), Table II. 93 (Exports of Machinery and Transport Equipment), Table II.94 (Import of Machinery and Transport Equipment). The DF test is presented in the column 8 of the tables. It can be seen that the TFP of Chemical sector, Chemical exports/imports, failed to reject the null hypothesis of no-stationarity at first/second order difference and at 1% and 5% level significance. Similarly the TFP of Machinery and Transport equipment sector, Export/Import of Machinery and Transport equipment tested non-stationary at first/second order difference. Thereby there is no possibility of cointegration and error-correction mechanism, which requires the stationary properties of the variables.

Table II.89

Time Series Properties of Total Factor Productivity (Converted at Base Year 1978-79) of the Chemical Sector Calculated by Tarlok Singh for the Period 1973-74 to 1993-94 ADF Test

No. of Lags	Dependent Variable	Constant	$\Delta\Delta P_{t-1}$	ΔP_{t-1}	P_{t-1}	t	R^2	1st Differences
1	ΔP	43.16		0.17	-0.51	0.20	0.24	
				(0.27)	(0.24)	(0.32)		
	ΔP	0.29		-0.08			0.0075	
				(0 25)				2.14
1	$\Delta\Delta P$	-1.62	0.26	-1.37		0.22	0 55	
			(0.27)	(0.40)		(0.39)		
	$\Delta\Delta P$	-0.48	-0.41				0.16	
			(0.23)					5 63

The figures in the parenthesis are Standard Error.

* 5% level of significance

** 1% level of significance.

Table II.90

Time Series Properties of Chemical Exports (Base: 1978-79 = 100) for the Period 1973-74 to 1993-94 ADF Test

No. of Lags	Dependent Variable	Constant	$\Delta\Delta X_{t-1}$	ΔX_{t-1}	X_{t-1}	t	R^2	1st Differences
1	ΔX	-22.62		-0.14	-0.38	29.52	0.26	
				(0.26)	(0.23)	(16.04)		
	ΔX	72.77		-0.30			0.087	
				(0.24)				1.70
1	$\Delta\Delta X$	-1.99	0.35	-1.72		13.67	0.66	
			(0.64)	(0.77)		(15.25)		
	$\Delta\Delta X$	-15.29	-0.92				0.50	
			(0.23)					3.05

The figures in the parenthesis are Standard Error.

* 5% level of significance

** 1% level of significance.

Table II.91

Time Series Properties of Chemical Imports (with the Base: 1978-79 = 100) for the Period 1973-74 to 1993-94 ADF Test

No of Lags	Dependent Variable	Constant	$\Delta\Delta M_{t-1}$	ΔM_{t-1}	M_{t-1}	t	R^2	1st Differences
1	ΔM	363 31		0 13	-0.89	91 10	0 40	
				(0.27)	(0.35)	(33 04)		
	ΔM	128 89		-0.29			0 08	
				(0.23)				3.81
1	$\Delta\Delta M$	50 10	-0.04	-1.26		11.48	0 66	
			(0.27)	(0.44)		(19.67)		
	$\Delta\Delta M$	27.86	-0.67				0.45	
			(0.18)					4.01

The figures in the parenthesis are Standard Error.

* 5% level of significance

** 1% level of significance.

Table II.92

Time Series Properties of Total Factor Productivity (Converted at Base: 1978-79 = 100) of the Machinery and Transport Equipment Calculated by Tarlok Singh for the Period 1973-74 to 1993-94 ADF Test

No. of Lags	Dependent Variable	Constant	$\Delta\Delta P_{t-1}$	ΔP_{t-1}	P_{t-1}	t	R^2	1st Differences
1	ΔP	45 83		0.47	-0.49	0.89	0.24	
				(0.30)	(0.29)	(0.75)		
	ΔP	0.55		0.21			0.03	
				(0.26)				1.87
1	$\Delta\Delta P$	1.73	-0.08	-0.75		-0.20	0.40	
			(0.29)	(0.39)		(0.35)		
	$\Delta\Delta P$	-1.28	-0.47				0.23	
			(0.22)					1.84

The figures in the parenthesis are Standard Error.

* 5% level of significance

** 1% level of significance.

Table II.93

Time Series Properties of the Machinery and Transport Equipment Exports (Base: 1978-79 = 100) for the Period 1973-74 to 1993-94 ADF Test

No of Lags	Dependent Variable	Constant	$\Delta\Delta X_{t-1}$	ΔX_{t-1}	X_{t-1}	t	R^2	1st Differences
1	ΔX	41 19		0 16	-0 21	18 08	0 20	
				(0.26)	(0 16)	(10 62)		
	ΔX	55 28		0.17			0.03	
				(0.24)				1.58
1	$\Delta\Delta X$	7.77	0.15	-1.04		7.4	0 46	
			(0 27)	(0 37)		(5.74)		
	$\Delta\Delta X$	11 77	-0.36				0 13	
			(0 24)					3.91

The figures in the parenthesis are Standard Error.

* 5% level of significance

** 1% level of significance.

Table II.94

Time Series Properties of of the Machinery and Transport Equipment Imports (with the Base: 1978-79 = 100) for the Period 1973-74 to 1993-94 ADF Test

No. of Lags	Dependent Variable	Constant	$\Delta\Delta M_{t-1}$	ΔM_{t-1}	M_{t-1}	t	R^2	1st Differences
1	ΔM	638.59		0.05	-1.10	368.03	0.52	
				(0.25)	(0 34)	(106.69)		
	ΔM	418.68		-0.38			0.11	
				(0.26)				5.87
1	$\Delta\Delta M$	249.43	0.63	-2.31		53.59	0.79	
			(0.23)	(0.38)		(32 71)		
	$\Delta\Delta M$	113.73	-0.50				0.21	
			(0.24)					17.82*

The figures in the parenthesis are Standard Error.

* 5% level of significance

** 1% level of significance.

5.5 CONCLUSION

We have used the model of Integration, cointegration and error-correction, to analyse the causal relationship between Productivity growth, output growth and trade performance. We used the TFP calculated by various authors to examine the patterns of causation with that of exports, imports and GDP_{MP}. We offer following conclusions.

(i) The TFP calculated by Isher .Ahluwalia (1991) for the manufacturing sector for the period 1960-61 to 1985-86, and exports were found to be integrated of order I(2). Further by taking these stationary properties we tested for cointegration but couldn't reject the null hypothesis of no-cointegration. A point has to be added that in case of imports and GDP_{MP}, we could not find stationary properties.

(ii) The TFP for the manufacturing calculated by P. Balakrishnan and K. Pushpangadan (1994, 1995), and the recalculated series of Dholakia. B and R. Dholakia (1994) by the above mentioned authors, for the period 1970-71 to 1988-89 and imports were found to be integrated of order I (2). Further by taking these stationary properties we tested for cointegration but couldn't reject the null hypothesis of no-cointegration. Further, the results of DF test shows that in case of exports and GDP_{MP}, were found to be of non-stationary properties.

(iii) TFP calculated by J.M. Rao (1996) for the period 1973-74 to 1992-93, exports and GDP_{MP}, were found to be of non-stationary properties. Only the imports were found to be integrated of order I (2). For cointegration test two variables has to be integrated of same order.

(iv) TFP calculated for the Manufacturing sector and the Indian Economy by Hajra, S. and Vasudeva, V. (1993) for the period 1970-71 to 1987-88, the exports of manufacturers /Total exports and GDP_{MP}, shows that the results of DF test to be of non-stationary properties and imports of Manufacturers and Total imports were found to be integrated of order I(2). For cointegration test two variables has to be integrated of same order.

(v) The TFP calculated for the Agriculture sector by Dholakia. B and R. Dholakia (1993) for the period 1950-51 to 1988-89 and exports of agriculture were found to be integrated of order I(2). Further by taking these stationary properties we tested for cointegration but couldn't reject the null hypothesis of no-cointegration. However we could not find, the imports of agriculture to be non-stationary.

(vi) The TFP calculated by Singh. Tarlok (2000) for the Chemical sector and Machinery and Transport equipment sectors for the period 1974-75 to 1993-94, exports and imports were found to be non-stationary.

The above mentioned results shows that when longer duration period is considered Total Factor Productivity and Exports do test stationary but for short period duration TFP and Imports test stationary. Moreover in some of the cases of short period duration only Imports tested stationary. But in none of the above cases examined none of the variables were found to have steady state long run equilibrium. Moreover the study failed to establish any causal relationship between Productivity, Output, and Trade Performance in case of India.

Our results are consistence with the findings of Ahluwalia (1991). Her study covers the period 1959-60 till 1985-86. She by computing the Chenery measures of the contribution of import substitution to growth for 63 industry groups of manufacturing of India. Using this measures as an explanatory variable in an equation explaining growth and productivity. The study established a negative relationship between Total Factor Productivity Growth and a Chenery measure of import substitution. In another study, Goldar (1986) found that there was a significant negative relationship between TFP growth and import substitution.

The finding summarized in our study above has incorporated the export/import variables are from the period when import substitution was pursued hence the link between productivity and trade performance was difficult to be ascertained.
Further evidence can be sighted from the study of Fujita (1994). Productivity growth rates of manufacturing industries in India were computed for the period 1981-82 to 1987-88. It was observed that productivity growth rates of most labour-intensive industries

were higher than those of capital-intensive ones. Further the share of public sector was used as a trade policy, as the increase in the share usually reflects restrictions in attempts at liberalisation. Therefore a negative relationship was obtained between liberalization policies and TFP growth. In another study by Bishwanath Goldar (1983) shows that growth in TFP during the period 1951-78 was rather sluggish and its contribution to output growth quite small. In a study by Isher Ahluwalia (1991) notes that the Total Factor Productivity Growth estimates for aggregate manufacturing, a simple average of the trend growth rates of total factor productivity of the 63 industry groups of manufacturing is also negative and negligible over the period from 1959-60 to 1985-86.

Further in a study by Deepak Mohanty (1992), he measures the TFP growth for fourteen major economic activities, besides aggregate net domestic product for the period 1970-71 to 1988-88 the empirical evidence suggests that the accelerated growth of the eighties has not been accompanied by any statistical significant improvement in TFP growth.

It is obvious that in our study we have considered manufacturing exports and imports and even when the Total exports and imports were considered, the period of study above are of 70's and 80's, were the share of Manufactured exports (section 5 to 8) was greater than primary exports (section 0 to 4). Moreover the privatization of public sector was initiated from 1990 onwards and till the end of the decade the reforms has to not been substantially and far reaching. Thereby it is rather difficult to establish a causal relationship between Trade performance and Total Factor Productivity.

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