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Structural Change in the Indian Economy in the 1980s and Some Reflections on early 1990s

S.C. Dhal*

Technical progress leads an economy on sustainable long run growth path. Structuralists have pointed out that the high growth rate of third world economies in the 1980s was achieved largely due to demand pressures rather than any perceptible change in production technology. In view of this , the present paper has estimated the contribution of technical change to output growth of Indian economy in the 1980s and the 1990s so far, within the framework of input-output type structural decomposition approach. The estimations have revealed that contribution of technical change to output growth of Indian economy was negative in the 1980s but positive in the post-reform period in the 1990s so far.

Introduction

Explaining economic growth through technical change has been a topic of great interest to economists for long[1]. In a single production process, technological development manifests in the productivity growth of the primary factors and in the substitution between the intermediate goods and services. As a consequence, the input coefficients corresponding to this production process change in tune with the technological improvement. "In a multi sectoral input-output framework, these two components interact for all sectors simultaneously affecting the entire matrix of input coefficients" (Dietzenbacher, 1995).

In the 1980s, many of the third world countries, including India, experienced high growth rate of their economies. However, a section

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of economists, particularly structuralists have pointed out that observed growth rate of the third world economies in the 1980s was achieved at the expense of inflationary demand shocks rather than through any perceptible and real improvement in production technology and thereby factor productivity[2]. In view of this argument the present paper has made an effort to exemplify the impact of technical change on economic growth of Indian economy in 1980s. An input-output variety structural decomposition approach to analyse economic growth has been followed for this purpose. Section II outlines the structural decomposition approach followed by the empirical model for the 1980s. Section III, makes an effort to analyse the nature of technical change across the sectors during this period. Section IV discusses structural change in the post reform period in 1990s. Section V concludes the paper.

Section II : Structural Decomposition Approach

In the input-output literature, the structural decomposition approach to analyse economic growth has been a fascination for the researchers for the last three decades. The important contributions to this literature are due to Carter (1970), Staglin and Wessels (1972), Forssell (1975, 1980), Nove (1982), Celasun (1983), Round (1985), Wolff (1985, 1994), Feldman *et al* (1987), Urata (1988), Blair and Wyckoff (1989), Kanemitsu and Ohnishi (1989), Skolka (1989), Barker(1990), Afrasiabi and Casler (1991), Fujita and James (1991), Van der linden and Oosterhaven (1993), Miller and Shao (1994), Lin and Polenske (1995), Oosterhaven *et al* (1995). In India, notable efforts in this regard have been due to Rao (1987) for the period 1968-79 to 1978-80, Dhawan and Saxena (1993) for the period 1968-69 to 1983-84, and Mallick (1994) for impact of import liberalisation in the Indian economy during 1973-74 to 1983-84, all based on the input-output tables for India provided by the Central Statistical Organisation (C.S.O).

According to structural decomposition approach, output or value added changes are decomposed into a number of key macro determinants, such as consumption, investment, exports, import substitution and technological change. This constitutes a demand side approach to structural decomposition. From supply side, output or

value added are decomposed into changes in intermediate input coefficients or changes in technology, changes in primary input coefficients i.e., land, labour and capital coefficients, and also changes in factor prices i.e., rents, wage rates, and interest rates, etc. In this paper, it may be noted that a demand side approach has been undertaken in order to decompose changes in gross output of the Indian economy. Such an approach has been perceived to provide a wealth of information to various economic agents and above all the market players at a very disaggregated sector level. In the following we outline a simplest kind of structural decomposition approach.

Algebra of Structural Decomposition

Let us postulate an open economy consisting of n producing sectors and each of the producing sectors characterised by an input-output type technology. The input-output equation system for this economy for the base year can be written, in matrix form, as

$$X = \mathbf{A}X + C + I + G + E - M \qquad (1)$$

where X denotes for a column vector of gross output of the producing sectors, **A** for input-output coefficient matrix, C private consumption, I investment, G government current expenses, E export and M competitive imports. For the sake of simplification, let us denote the sum of the domestic final demand components C, I, and G as F. The equation system (1), can be rewritten as

$$X = \mathbf{A}X + F + E - M \qquad (2)$$

Let us postulate the relationship between imports and domestic demand in the following form

$$Mi = mi\ (\Sigma\, a_{ij}.x_j + Fi) \qquad (3)$$

or in matrix form

$$M = \mathbf{m}\ (\mathbf{A}X + F) \qquad (3.1)$$

Where m is a diagonalised matrix of import coefficients mi. Further, imports substitution parameters denoted by ui are defined as

$$u_i = 1 - m_i \qquad (3.2)$$

Therefore, equation (3) for imports becomes

$$M = (I - \mathbf{U})(AX + F) \qquad (3.3)$$

Where **U** is a diagonalised matrix of import substitution coefficients ui[3]. Now, by substituting the equation (3.3) in the equation (2), we have the basic input-output system as

$$X = \mathbf{UAX} + \mathbf{UF} + E \qquad (4)$$

Then for any future year, denoted by subscript 1, we have

$$X_1 = \mathbf{U}_1 \mathbf{A}_1 X_1 + \mathbf{U}_1 F_1 + E_1 \qquad (5)$$

A variable Y1 pertaining to the future year 1 is defined as the sum of base year quantity Y and an increment Y^. This way, the equation system (5) can be written as

$$X + X^{\wedge} = (\mathbf{U} + U^{\wedge})(\mathbf{A} + A^{\wedge})(X + X^{\wedge})$$

$$+ (\mathbf{U} + U^{\wedge})(F + F^{\wedge}) + E + E^{\wedge} \qquad (5.1)$$

The above equation (5.1) can be expanded and simplified in the following way :

$$\begin{aligned} X_1 &= \mathbf{UAX} + \mathbf{UA}^{\wedge} X_1 + \mathbf{UAX}^{\wedge} + \mathbf{UA}_1 X_1 \\ &\quad + \mathbf{UF} + \mathbf{UF}^{\wedge} + U^{\wedge} F_1 + E + E^{\wedge} \\ &= (\mathbf{UAX} + \mathbf{UF} + E) + \mathbf{UA}^{\wedge} X_1 + \mathbf{UAX}^{\wedge} \\ &\quad + U^{\wedge}(A_1 X_1 + F_1) + \mathbf{UF}^{\wedge} + E^{\wedge} \\ &= X + \mathbf{UAX}^{\wedge} + \mathbf{UA}^{\wedge} X_1 + U^{\wedge}(A_1 X_1 + F_1) + \mathbf{UF}^{\wedge} + E^{\wedge} \end{aligned}$$

Thus taking the X term to the left, we have

$$X^{\wedge} = \mathbf{UAX}^{\wedge} + \mathbf{UA}^{\wedge} X_1 + U^{\wedge}(A_1 X_1 + F_1) + \mathbf{UF}^{\wedge} + E^{\wedge}$$

or

$$X^{\wedge} = \mathbf{RUF}^{\wedge} + \mathbf{RUA}^{\wedge} X_1 + \mathbf{RU}^{\wedge}(A_1 X_1 + F_1) + \mathbf{RE}^{\wedge}$$

where $\mathbf{R} = (\mathbf{I} - \mathbf{U}\,\mathbf{A})^{-1}$. Substituting $F^{\wedge} = C^{\wedge} + I^{\wedge} + G^{\wedge}$, we have

$$X^{\wedge} = \mathbf{RUC}^{\wedge} + \mathbf{RUI}^{\wedge} + \mathbf{RUG}^{\wedge} + \mathbf{RE}^{\wedge} + \mathbf{RUA}^{\wedge} X_1 + \mathbf{RU}^{\wedge} (\mathbf{A}_1 X_1 + F_1) \qquad (6)$$

as the basic structural decomposition equation system used in this study. Therefore, on the left hand side of the equation (6), we have $X^{\wedge}$ indicating the change in output and on the right hand side, this $X^{\wedge}$ is decomposed into six terms, which indicates, in *seriatim,* contribution to output from increased consumption, investment, government expenditure, export, technological change and import substitution.

Data Source

The input-output tables and other data used in this study are the ones provided by the planning commission in their technical notes to the five year plans. For our comparison purpose, these tables have been transformed to the prices of a common year i.e 1984-85. Further, the planning commission provides 60 x 60 input-output tables. Depending on the data constraints for general price level in the year 1984-85, these tables have been aggregated into 46x46 tables. Also, it may be noted that the planning commission prepares these tables by updating the previous table on the basis of well known partial survey type RAS method. In this regard, the empirical results of this paper are subject to the limitations associated with the RAS procedure[4].

Structure and Growth of Production in the Indian Economy in the 1980s

Table 1 shows the structure and growth of production in Indian economy in three years viz., 1979-80, 1984-85, and 1989-90, together with growth rates in respect of 23 major sectors. From this table it can be seen that the growth rate of output of the economy was 5.26 percent on an average during 1979-80 to 1984-85, 9.20 percent during 1984-85 to 1989-90, and in overall 8.44 percent during 1979-80 to 1989-90. The share of primary sectors including agriculture and its allied sectors, and mining & minerals accounted for 25.51 percent of output of the economy in the year 1979-80, with a marginal decline

to 25.22 percent in 1984-85, and increasing again to 25.44 percent in 1979-80. The contribution of the services sector was 41.86 percent in 1979-80 but declined to 39.13 percent in 1984-85, and 37.72 percent in 1989-90. On the other hand, the share of manufacturing sector was 32.63 percent in 1979-80 but increased to 35.65 percent in 1984-85 and 36.84 percent in 1989-90.

Within manufacturing group, textiles, petroleum products, chemicals, electric machinery, electronics equipments, and transport equipment increased their shares in all the three years. Particularly, electric machinery contributed 0.79 percent to gross output of the economy in 1979-80 and increased it nearly by two fold to 1.58 percent in 1989-90. Similarly, the figure in respect of electronics equipment was 0.14 percent in 1979-80 but increased by more than twice to 0.31 percent in 1984-85 and to 0.70 percent in 1989-90. In respect of the chemicals sector, the average growth rate was 7.53 percent during 1979-80 to 1984-85 and increased further to 12.73 percent during 1984-85 to 1989-90. The share of textiles sector in gross output of the economy was 5.03 percent in 1979-80, increased to 6.03 percent in 1984-85, with an average annual growth rate of 10.3 percent during this period, and improved substantially to 9.04 percent in 1989-90, recording an annual growth rate of 23.66 percent. In case of petroleum products, its share in gross output of the economy was 1.92 percent in 1979-80,which increased to 2.73 percent in 1984-85 with an annual growth rate of its production at 16 percent, and further to 2.83 percent in 1989-90 with an annual growth rate of 10.27 percent. Transport equipment shared 1.59 percent of output of the economy in 1979-80 and grew annually at the rate of 13.38 percent to increase its share to 2.10 percent in 1984-85 and maintained it nearly at the same level in 1989-90 with a growth rate of 8.36 percent.

Among other manufacturing sectors, iron and steel sector recorded the highest growth rate of 29 percent during 1979-80 to 1984-85 and thus nearly doubled its contribution to output from 1.96 percent in 1979-80 to 3.86 percent in 1984-85. But this sector recorded a negative growth rate of (–)5.12 percent during 1984-85 to 1989-90 and its share in output of the economy came down to 1.94 percent, a little lower than its position in 1979-80. The non ferrous metals had recorded negative growth rate and declining share during

the 1980s. The cement sector recorded a negative growth rate of (-)1.78 percent in the first period but 9.85 percent in the second period. Food products recorded an annual growth rate of 6.36 percent in the first period and thus increased its share in total output of the economy from 5.87 percent to 6.13 percent in 1984-85 but its growth rate slowed down to 2.03 percent in the second period for which its share declined to 4.62 percent in 1989-90.

In respect of infrastructure and service sectors, only the share of electricity sector's output in the economy increased from 1.85 percent in 1979-80 to 2.11 percent in 1984-85 with a growth rate of 8.74 percent, and further, to 2.67 percent in 1989-90 with a growth rate of 16.94 percent. Contributions to output of the economy by rest of the infrastructure sectors viz., railway, transport, and communications, increased during the period 1979-80 to 1984-85 but declined during 1984-85 to 1989-90. Further, growth rates in many of the infrastructure sectors, except electricity were lower than economy wide growth rate in the 1980s as a whole.

Macro Economic Ratios : Some Trends

Table 2 presents the percentage composition of output into six important indicators such as intermediate demand, private consumption, government expenditure, investment, exports, and imports. From this table it can be seen that the degree of inter-industry intermediation as proportion of gross output[5] declined from 46.81 percent in 1979-80 to 46.63 percent in 1984-85 and further to 45.42 percent in 1989-90. On the contrary, the proportion of consumption increased from 36.02 percent in 1979-80 to 37.10 percent in 1984-85 and to 37.57 percent in 1989-90. Similarly, the proportion of government expenditure increased from 5.93 percent in 1979-80 to 6.31 percent in 1984-85, and to 6,56 percent in 1989-90. The proportion of investment was 11.48 percent in 1979-80, increased to 12.93 percent in 1984-85 but slightly declined to 12.02 percent in 1989-90. Exports increased from 3.46 percent of economy's output in 1979-80 to 3.97 percent in 1984-85 and further to 4.72 percent in 1989-90. Similarly, proportion of imports to output increased from 3.69 percent in 1979-80 to 3.99 percent in 1984-85 and further sharply to 6.28 percent in 1989-90.

Absolute growth rate of above key indicators of the economy indicated that except intermediate demand all others grew at a higher rate than output for the first period i.e., 1979-80 to 1984-85. While in the second period, 1984-85 to 1989-90, growth rate of intermediate demand, and investment were lower than the growth rate of output. Annual growth rates of government expenditure, exports, and imports in the second period were substantially high at 10.33 percent, 14.73 percent, and 25.93 percent and for consumption it was 9.57 percent, a little more than output growth rate of 9.20 percent.

Sources of Output Growth during 1980s

Disaggregation of the sources of growth for the periods 1979-80 to 1984-85, and 1984-85 to 1989-90 , based on the model outlined in section II, is summarised in the Table 3 which shows the percentage contributions of key macro determinants to the change in gross output in the economy. These determinants are private consumption, public consumption, investment, export expansion, import substitution, and technological changes, which are characterised by changes in input-output coefficients. Figures in each row in the Table 3 sum up to 100 percent. Similarly, Table 4.1, and 4.2 provide the estimated impact of changes in key determinants on changes in output at the dissaggregated sector level for the two time periods in 1980s as mentioned above.

It may be noted from the Table 3 that the major source of output change during the first half of 1980s (i.e. 1979-80 to 1984-85) was increase in private consumption, followed by increase in investment and public consumption, with their shares at 66.57 percent, 34.91 percent and 10.26 percent, respectively. Exports contributed 8.98 percent to increase in output during this period. On the other hand, import substitution and technology change had negative contributions to the changes in output by (–)8.67 percent and (–)12.06 percent, respectively during the same period.

The impetus to output growth from the increase in private consumption was as high as 68.21 percent in the second half of 1980s, which was 1.64 percentage points higher than that in the first half. The contribution of increase in government expenditure to increase in output during the second half was estimated at 12.46

percent, which was 2.20 percentage points higher than that in the first half. Contribution of increased investment to output change fell rather sharply to 20.18 percent in the second period from 38.88 percent in the first period, while that of exports increased to 13.36 percent, which was 4.38 points higher than that in the first half of 1980s. The leakage effects of import substitutes increased to (–)9.94 percent during the second period, adding merely (–)1.27 points to the position in the first period. The most notable trend was that the negative impact of technological change on output growth reduced remarkably to (–)4.27 percent during the second half of 1980s, from 12.06 in the first half of 1980s. Overall, during the period 1979-80 to 1989-90, the contributions of increases in private consumption, government expenditure, investment, export, import substitutions, and technological change to increase in output were 61.01 percent, 10.98 percent, 28.52 percent, 7.93 percent, (–)5.30 percent and (–)3.14 percent, respectively.

Thus the salient features of structural change in the Indian economy during 1980s may be summarised in the following :

First, the increasing contribution of private consumption and declining contribution of investment to output growth in the second half of 1980s over the first half of 1980s, indicated that the Indian economy moved away from investment orientation to a consumption led growth.

Secondly, the rising share of exports as well as rising leakage impact of imports indicated that the Indian economy became more outward oriented in this period.

Thirdly, the negative impact of technological change to output growth revealed that the inter-industry linkages declined during the 1980s. This is in contrast to the usual expectation that as producing sectors become more diversified in their activities their inter-industry dependence particularly on domestic producing sectors rises which by intersifying technological change leads to output growth. The unfavourable negative impact of technological changes on output growth was more pronounced during the first half of 1980s than during the second half.

Sector Specific Changes in the Indian Economy

Sector specific study of the impact of changes in key determinants on the changes in output between different time periods involve a wealth of data for analysis. Therefore, this section provides a summary discussion on the sources of output growth across the various important sectors of the economy during 1980s. Contributions to output growth by changes in important macro variables of this study have been reported in the table 4.1 for the period 1979-80 to 1984-85 and in table 4.2 for the period 1984-85 to 1989-90.

Agriculture and allied sectors

For the cereal crops, consumption was the leading source of output growth by contributing 84.58 percent and 70.98 percent, respectively for the first and second period. The second most important source of output growth for this sector was investment (19.37 percent) in the first period but technological change (25.55 percent) in the second period. At the disaggregated level, the major source of output growth in case of fibre crops was import substitution (67.90 percent) followed by consumption (64.85 percent) in the first period. But in the second period, consumption was the leading source (85.96 percent) followed by export (20 percent). Tea and coffee crops had negative output growth in both the period. The most important factor contributing to the decline in output of this sector was technological change (–127.96 percent) in the first period but decline in export (–191.82 percent) in the second period. For miscellaneous crops, technological change was the important source (129.06 percent) of positive output growth of this sector in the first period. Consumption was the second important source (71.91 percent) in the first period but the leading source (117.03 percent) in the second period. Technological change had a substantial negative contribution (–42.07 percent) to output growth of this sector in the second period.

In the allied sectors, technological change was the most important contributing factor (206 percent) to output growth of the animal husbandry sector in the first period, but became a drag on output growth of this sector (–11.97 percent) in the second period. Consumption accounted for 68.80 percent of output change in the first period again emerged in the leading role (80.44 percent) in the

second period. Investment played a relatively minor role by contributing 24.32 percent of the output change in the second period. Forestry and logging sector had negative output change in first period but positive output change in the second period largely due to consumption and technological change.

In the fishing sector, technological change played the key role with 286.94 percent contribution in the output expansion in the first period. Its contribution to growth however, turned negative (-64.59 percent) in the second period. Consumption expansion contributed the largest share of output growth (106 percent) in the second period.

Minerals

Minerals had a very much mixed feature of change during these two periods. In the first period, investment was the crucial source of output change in case of coal and lignite, and other minerals while import substitution was important source of growth for the iron ore and petroleum and natural gas. In the second period, important sources of output change were consumption expansion for coal sector, import substitution for crude petroleum and natural gas, export expansion for iron ore, and technological change for minerals. Technological change also had perceptible positive impact on output change in the mineral sector during the second period.

Food Products

In the food sector, as should be expected, consumption was the key determinant of output change for sugar, and food & beverages in both the periods. The second most important determinant of output change was investment in both the periods. Technological change had a positive, though marginal impact (17 percent) in the first period but perceptible negative impact at 109 percent in the second period.

Agro-based Manufacturing

In the cotton textiles sector, the most important factor of growth was import substitution in the first period but consumption increase in the second period. In woolen textiles, and other textiles sectors, important sources of output change were import substitution and

increase in investment in the first period but increase in consumption and export in the second period. For all these sectors, contributions to output growth by technological change was phenomenally negative in the first period but positive in the second period.

In case of the sectors such as wood, paper, leather, and rubber products, important sources of output expansion were increase in consumption and import substitution in the first period but technological change in the second period. Technological change played a leading role in the growth of the plastic products in both the periods.

Fertiliser, Chemicals and Cement

Import substitution and technological change were two most important sources of output change in the first period. But in case of chemicals, contribution to output change by technology was negative in the second period. In case of cement sector, import substitution followed by public consumption were the important source of negative growth in the first period but positive growth in the second period.

Metals and Machinery

Investment and import substitution had substantially positive contribution to the output growth of many of the metal and machinery sectors in the first period. In the second period, technological change contributed negatively to output growth of the non-electrical machinery and motor vehicles sectors. But technological changes had positive contribution to output growth of the remaining metals and machinery sectors.

Infrastructure

During the first period, increase in consumption and investment were two important sources of output growth of many of the infrastructure sectors including transport services, electricity, and communication. However, the impact of technological change was negative for many of these sectors in the same period. In the second period, increase in public expenditure, and technological change were important source of output change for the transport, and electricity

sectors. But in case of construction, and communication sectors impact of technological change was negative in the same period.

Section III : Technological Changes in 1980s

In the earlier section, impact of key determinants of structural change including technological change was quantified following the structural decomposition approach. This section concentrates more on technological changes in the Indian economy in 1980s.

A pertinent question about technological change is: what factors give rise to technological changes in an economy? Alternatively, to rephrase the question; how does technological changes across the sectors occur in an economy? In this section we address the above question by analysing the technical properties of input-output tables.

As pointed out in the beginning, the planning commission of India prepares the input-output tables with the help of RAS methodology. In order to prepare an input-output table for the current period, this RAS methodology requires detailed input-output information for the previous period and three sets of actual data on (i) gross output, (ii) gross value added or gross intermediate inputs, and (iii) gross intermediate sales or gross final demand at dissaggregated sector level for the current period. In the literature, the RAS methodology evolved by Stone (1969) has been found to be more efficient in capturing technological changes in an economy[6]. Initially, this method was void of any economic theory. Subsequently, subtle theoretical interpretation was given to the RAS methodology by many authors and more recently, Detizbacher (1995) has given a fascinating economic interpretation to RAS method and consequently to the technological changes of a multi sectoral economy. In this context, it is essential to have an elementary review of the methodology before analysing the technical properties of the input-output tables for the Indian economy.

Nature of Technological Change

The RAS method postulates technological changes of an economy occurring at the sector level in terms of two effects such

as, productivity effect and substitution effect. Within input-output framework, a producing sector uses, broadly two kinds of inputs such as intermediate input and primary input (like labour and capital) in order to produce one unit of output. Since data are expressed in value terms, intermediate inputs are represented by intermediate purchases to output coefficients and primary inputs by value added to output coefficients. Technological development such as innovations into products and production processes induce the inputs to be substituted between intermediate inputs and primary inputs. As the productivity of one input improves, less of that input will be used over time. Especially, an improvement in the productivity of primary inputs would lead to use of less of primary inputs and more of intermediate inputs to produce one unit of output. Other things remaining same, productivity growth of primary inputs in value terms would induce a sector to have lower value added coefficient and higher intermediate coefficients per unit value of output (Romer, 1986). Such a process can occur in all the producing sectors. The difference between two input-output coefficient matrices for two periods reflects this course of technological development. Similarly, from the demand side, each producing sector produces two kinds of output for two purposes such as intermediate demand and final demand. With technological changes and growth of the economy, substitution takes place between these two categories at the sectoral level. These two forces interact so as to give rise to a new technology matrix for the future year. In what follows, we examine the RAS procedure which incorporates the above two forces and update a base year technology matrix for an economy.

Let us postulate productivity effect upon the coefficients of the sector 'j' denoted by Vj applying uniformly across the column of this sector. This productivity effect reflects that more output can be produced per unit of joint primary inputs. It can therefore, be interpreted as the productivity change of the joint primary inputs[7]. Similarly, let 'Si'is defined as the substitution effect for a commodity 'i' applying uniformly across the row of its sector.

When both the 'Vj' and 'Si' are applied simultaneously to the base year technology matrix A, we obtain the new technology matrix A_1 as

$$A_1 = SAV \qquad (7)$$

where V and S are the diagonalised matrices of Vj and Si coefficients, respectively. Since both the effects are average effects they should correctly reflect the average effects as they have occurred in each row and column. In other words, they should satisfy the condition that the forecasted column sums (u^j) and row sums (r^i) should be equal to the actual ones. The conditions therefore, are the following :

$$\mathbf{u\hat{}j} = \mathbf{uj}$$

or $\mathbf{eSAV} = \mathbf{uj}$

and

$$\mathbf{r\hat{}\, i} = \mathbf{ri}$$

or $\mathbf{SAV\acute{e}} = \mathbf{ri} \qquad (8)$

where **é** is unit column vector and **é** is transpose of **e**. Given the actual data on **uj** and **ri** only, the equation system (8) entails a set of 2n equations to solve for 2n elements of V^ j and S^ i. The model may be solved iteratively, until the actual and forecasted row and column sums are equal. In practice, this may not happen or else may require a large number of iterations. Therefore, some convergence criterion, usually an error of five percent between the actual and forecasted column and row sums can be imposed on the model.

From empirical point of view, the initial approximations to the productivity effect Vj for a sector j is taken as the ratio of average intermediate input (i.e column sums of input coefficients) for the current year to that of the base year and similarly for the substitution effect Si as the ratio of average intermediate sales (row sums) of the current year to that of the base year.

$$Vj = \mathbf{ui,t} \,/\, \mathbf{ui,o} = \mathbf{bj}$$

and

$$Si = \mathbf{ri,t} \,/\, \mathbf{ri,o} = \mathbf{ai} \qquad (9)$$

Since, we have information pertaining to the gross output, gross value added and / or gross intermediate input, and gross final demand

and/or gross sales for two periods, we know **bj** and **ai**. Thus the base year technology matrix (i.e the input coefficient matrix) can be updated on the basis of postulated productivity effect **bj** and substitution effect **ai**. On the basis of above theory, we have studied the properties of input -output technology matrix in terms of productivity and substitution effects at the sectoral level.

Productivity and Substitution Effects

The extent of productivity and substitution effects across the sectors have been reported in Table 5 in percentage terms as 100(Vj-1) and 100(Si-1), respectively. A comparison between the signs of growth rate, contribution of technological changes, productivity and substitution effects will give us some useful insights about the importance of productivity and substitution effects on technological changes in major growth oriented sectors. It may be noted that the productivity and substitution effects could move in the same direction or in the opposite direction to each other. When they move in the same direction, they reinforce each other. When they move in opposite direction, they tend to neutralise each other (Dhal and Saxena,1996). Largely, the direction and strength of these two effects would decide the sign and extent of contribution of technological changes on output change(or growth) of various sectors. Positive productivity effect for a sector *i* implies technical change by that sector itself while positive substitution effect implies technical change in rest of the sectors in favour of sector *i*. Further, positive productivity effect arise when a sector experiences productivity growth of primary inputs and therefore, that sector changes its technology by using less of primary input and more of intermediate inputs. As a result that sector becomes more dependent on the rest of the sectors in the economy. On the other hand, positive substitution effect for a sector takes place when this sector is found more useful by the rest of the sectors and therefore, increasing their dependence on that sector. In the following, we have discussed about the technological changes in the major sectors which have experienced positive growth rate in the two periods of 1980s.

From table 5, it can be seen that during first half of 1980s, chemicals, iron and steel, non electrical machinery, electrical machinery, electronics equipments, motor vehicles, other transport equipment and communications sectors had achieved growth rate more

than the economy wide growth rate and contribution by technological changes was also positive for all these sectors. Positive contribution to output change by technological change was associated with both positive productivity and substitution effects in these sectors. However, during the second half of 1980s, the situation was different. Positive growth rate and contribution of technological change was associated with positive productivity effect in case of electrical machinery, rail transport, road transport and electricity sectors but positive substitution effect in non electrical machinery and equipments, transport equipments, other manufacturing, and communications sectors. The implications of these productivity and substitution effects have been pointed out earlier.

The iron and steel sector had positive output growth but negative technological changes associated with both negative productivity and substitution effects. In case of the non ferrous metal sector, positive growth of output and the contribution of technological change was associated with positive productivity and negative substitution effects in the first period but diametrically opposite negative productivity and positive substitution effect in the second period.

Electricity sector had positive output growth and technological change associated with positive productivity and negative substitution effects in the first period but negative productivity and positive substitution effects in the second period.

In the textiles group, positive output growth but negative technological changes were associated with both negative productivity and substitution effects in the cotton textiles sector while these effects were positive in the silk textiles sector. In the case of Woolen textiles positive output growth and technological changes were associated with both positive productivity and substitution effect but in case of other textiles negative productivity effect was very pronounced. In 1980s, except woollen textiles, rest of the three textiles group had positive output and technological change associated with both positive productivity and substitution effects.

In case of energy sector such as petroleum products, the positive output and technological change were associated with positive substitution effect and negative productivity effect in the first period

but positive productivity and negative substitution effects in the second period.

In case of agriculture and allied sectors, cereals experienced positive output but negative technological change associated with negative productivity and positive substitution effects in the first period but improved to all positive change in the second period.

Section IV : Structural Change in the Indian Economy in the 1990s

Against the backdrop of the results obtained for the 1980s, an attempt has been made in this section to throw preliminary insights on the possible structural changes in the Indian economy in the post-reform period. For this purpose, the period choosen is 1989-90 to 1996-97.

In 1991, the problems of mounting fiscal deficits, balance of payment crisis, inflationary pressures, unfavourable technological change and above all the unsustainable growth realised in the 1980s led the Government of India to pronounce a New Economic policy. The New Economic Policy (1991) has aimed at two broad measures, one pertaining to structural reforms, and other to stabilisation measures with the objective of improving productivity and efficiency in the economy. Accordingly, a large number of government induced entry restrictions, licensing requirements and other regulations in factor and product markets, and the external sector have been simplified and liberalised in order to improve productivity , induce efficiency and strengthen the long run growth prospects of the economy. Although it is premature to draw any firm conclusion by drawing on the experience so far, the analysis conducted in this exercise tries to pick up the early signals on technological change in the post-reform period within the framework of input-output system.

Before, elaborating on the results, a caveat is in order. The input-output data used in this section have been drawn from the planning commission's Technical Note to the Eighth Five Year Plan which provides the projected input-output tables for the terminal year of the Eighth Five Year Plan i.e. 1996-97. It may be noted that the

projected input-output tables for the Eighth Plan are based on certain historical trends, actual developments in initial year of structural reforms, and future targets and perceptions in regard to macro-economic variables as well as microeconomic developments in the economy. Therefore, our results and conclusions are only reflective in nature and spirit. Besides, it is worth to analyse the changes in the structure of the economy as perceived by the planning experts of our country. Such an analysis could facilitate our effort to compare the macro and micro projections with the actual developments as and when detailed data are available on them.

On the basis of basic input-output data for the year 1996-97, the annual average growth rate of gross output of the economy has been estimated at 8.13 percent, more or less similar to that in the 1980s (see table 2). The degree of intermediation represented by inter-industry demand as proportion of gross output for the year 1996-97 has been worked out to be 50.38 percent, an increase of 4.96 percentage points from that in the year 1989-90 with an average annual growth rate at 10.84 percent. With respect to macro economic indicators, the share of private consumption has been estimated at 35.63 percent in gross output in 1996-97, with an average annual growth rate of 6.85 percent. Government expenditure for 1996-97 has been estimated at 6.95 percent with average growth rate of 9.63percent, a little less than that in 1980s. But the share of investment in gross output is estimated to come down to 8.08 percent, nearly 4 percentage points less than that in 1980s. On the otherhand, export could go up from 4.72 percent of gross output in 1989-90 to 7.70 percent of gross output in 1996-97, with an average growth rate of 23.80 perecent. Similarly, imports could increase their share to 8.99 percent of gross output in 1996-97, compared to 6.28 percent in 1989-90, with average growth rate of 18.82 percent during 1989-90 to 1996-97. Estimates of sector wise growth rate of output have been provided in table 1. In the following we analyse the results of the decomposition analysis.

The results reveal some notable features of structural change in the Indian economy during 1990s (i.e. 1989-90 to 1996-97). No doubt, private consumption has still remained as the major source of output growth during this period by contributing 62.65 percent (table 3).

The share of increased investment to output growth has been reduced to half of that in 1980s i.e. 14 percent. On the other hand, contributions to output growth by increased public expenditure (10.41 percent) and export (8.44 percent) have remained more or less unchanged from those in the 1980s. But the most welcome development has been with regard to import substitution and technological change. The negative impact of import substitution has come down to 1 percent in 1990s, from -9.94 percent in the second half of 1980s.. The contribution to output growth due to technological change has been estimated positive at 5.66 percent, compared to its negative contributions in the 1980s.

It may be noted that across the various sectors, contributions to output growth by private consumption, government expenditure, and investment has been positive for all the sectors (table 4.3). In case of exports, its contributions to output growth has been positive for all but two sectors such as cement, and non metallic minerals. Positive contribution to output growth due to import substitution was notably in some of the minerals, basic metals, and machinery sectors.

Positive contributions of technological change were estimated in respect of crude petroleum and natural gas, and miscellaneous minerals, some of the agro-processing industries such as wood products, rubber products, plastic products, leather products, basic metals, and machinery.

Further, technological changes in metals and machinery sector have been accompanied by both positive productivity and substitution effects in the 1990s so far (table 5). This shows that technological change in the Indian economy has moved in favour of capital intensive metal and machinery sectors which is an essential element of the strategy to high growth path. Such a course of technological development across the sectors have been analysed by Kuznets (1966) and Chenery (1968).

Section V : Conclusion

The results of this paper support the structuralist's contention that technological change could not have been an important source of output growth in the Indian economy in 1980s. In fact, the estimates

revealed that impact of technological change as a source of output growth was negative in the Indian economy during the 1980s. The negative impact was substantially higher at 12 percent in the first half period but reduced to one third of this figure i.e 4 percent in the second half period of the 1980s. In view of sector-wise developments, broad conclusion is that positive output growth and contribution of technological changes were associated with both positive productivity and substitution effect in metal and machinery sectors. The rest of the sectors did not have perceptible technological changes and consequently the economy wide contribution of technological change to output growth was substantially negative in the first period. In the second period, the positive output growth and contribution of technological changes in the metal and machinery sectors were largely due to positive substitution effect indicating technological change in rest of the sectors in favour of the metal products and machinery sectors. However, the course of this change was not sufficient to offset the economy wide negative impact of technological change on output growth in the economy. Further research into sector specific input intensity changes can answer clearly the way the sectoral developments took place in the 1980s.

In the 1990s, so far two notable developments have been the marginalisation of negative impact of imports, on the one hand, and positive impact of technological change on output growth of the Indian economy, on the other. It may be pointed out that positive technological change in favour of growth oriented capital machinery and metal product industries leads to strengthening of inter-industry linkages and implies better long run growth prospects for the economy. However, our results and conclusion are only reflective because of the very nature of the input-output data relating to the year 1996-97.

As far as the limitations of this study are concerned, they are related to planning commission's input-output tables which are only partial in coverage in respect of the actual development in the economy. Secondly, since the input-output models are cast in cross section framework, our study is subject to all the limitations of cross section analysis. In future, such an exercise can be carried out when actual input-output tables compiled on the basis of four digit level detailed factory sector data are available from the Central Statistical Organisation.

Notes

1. Seminal publications in this field include Solow (1956), Kuznets (1966), Chenery (1968) and Romer (1986).

2. For such a view see Krueger (1992). She gives an excellent account of basic real world problems relating to transport services, telephone lines, gas distribution, water supply, road maintenance and so on in developing countries including India. A transport undertaking can increase its income in real terms not by changing technology and by improving the quality of it's service but by increasing the freight rates more than that warranted by increase in cost of fuels and general price level. Dhawan and Saxena (1992) have also found the insignificant contribution of technological change to output growth of the Indian economy in 1968-69 to 1983-84.

3. By simplification, it can be seen that this import substitution parameter is nothing but the ratio of domestic supply to domestic demand for a commodity. This is the standard way of postulating competitive imports which have been considered, for instance, by Forsseell (1985), Urata (1988) and Fujita and James (1991).

4. For a critical examination of the economic background of RAS approach see Lecomber (1975), Miernyk (1977), Lynch (1986), Rose (1989) etc.

5. Gross Output in Input-Output terminology need not be confused with macro-economic terms such as GDP or GNP.

6. See Morrison and Smith (1969) for the efficiency of RAS procedure.

7. Additional information on sector specific labour and capital coefficients can decompose productivity growth in a sector further into the productivity of labour and capital inputs.

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Table – 1

Structure and Growth of Production in Indian Economy

Sectors	*Gross Output (Rs. crore)* years*				*% share in gross output years*				*Annual average growth rate of production*			
	1979-80	*1984-85*	*1989-90*	*1996-97*	*1979-80*	*1984-85*	*1989-90*	*1996-97*	*1980s- Ist half*	*1980s- IInd half*	*1980s- total*	*1990s**
(1) (2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
1. Cereals	239952	341478	459506	548644	8.17	9.21	8.49	6.81	8.46	6.91	9.15	3.23
2. Fibre Crops	30817	32396	58608	42854	1.05	0.87	1.08	0.53	1.02	16.18	9.02	-4.48
3. Tea & Coffee	35734	11774	16648	27899	1.22	0.32	0.31	0.35	-13.41	8.24	-5.34	11.26
4. Other Crops	217490	275129	428309	446076	7.41	7.42	7.91	5.54	5.30	11.14	9.69	0.69
Sub-total	523994	660777	963072	1065473	17.85	17.82	17.79	13.23	5.22	9.15	8.38	1.77
5. Animal Husbandry	142625	165040	283216	314790	4.86	4.45	5.23	3.91	3.14	14.32	9.86	1.86
6. Forestry & Logging	28162	17079	65227	72754	0.96	0.46	1.20	0.90	-7.87	56.38	13.16	1.92
7. Fishing	16081	17121	25641	38288	0.55	0.46	0.47	0.48	1.29	9.95	5.94	8.22
Sub-total	186868	199241	374084	425832	6.38	5.37	6.91	5.29	1.32	17.55	10.02	2.31
8. Coal & Lignite	25706	31202	43078	54934	0.88	0.84	0.80	0.68	4.28	7.61	6.76	4.59
9. Crude Petroleum & N.C.	3661	32721	28549	101584	0.12	0.88	0.53	1.26	158.78	-2.55	67.99	42.64
10. Iron Ore	1664	2563	3093	3249	0.06	0.07	0.06	0.04	10.80	4.14	8.59	0.84

Table – 1 *(Contd.)*

(1) (2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
11. Other Minerals	7019	8799	14315	31533	0.24	0.24	0.26	0.39	5.07	12.54	10.39	20.05
Sub total	38050	75285	89035	191300	1.30	2.03	1.64	2.37	19.57	3.65	13.40	19.14
12. Sugar	17702	25963	37669	61775	0.60	0.70	0.70	0.77	9.33	9.02	11.28	10.67
13. Khandsari, Gur & Boor	21716	32991	17299	13880	0.74	0.89	0.32	0.17	10.38	-9.51	-2.03	-3.29
14. Other Food & Beverag	132935	168242	195235	248305	4.53	4.54	3.61	3.08	5.31	3.21	4.69	4.53
Sub-total	172352	227196	250203	323959	5.87	6.13	4.62	4.02	6.36	2.03	4.52	4.91
15. Cotton Textiles	83825	97320	158953	261623	2.85	2.62	2.94	3.25	3.22	12.67	8.96	10.77
16. Art Silk & Synth. Textiles	8730	30182	148023	178526	0.30	0.81	2.73	2.22	49.14	78.09	159.55	3.43
17. Woollen Textiles	6481	5292	14245	22549	0.22	0.14	0.26	0.28	-3.67	33.84	11.98	9.72
18. Other Textiles	48611	91312	167986	154757	1.66	2.46	3.10	1.92	17.57	16.79	24.56	-1.31
Sub-total	147647	224106	489208	617456	5.03	6.04	9.04	7.67	10.36	23.66	23.13	4.37
19. Wood & Wood Product	28497	19687	22140	55373	0.97	0.53	0.41	0.69	-6.18	2.49	-2.23	25.02
20. Paper & Paper Product	24944	39280	54298	64554	0.85	1.06	1.00	0.80	11.49	7.65	11.77	3.15
21. Leathre & Leather Product	16410	19039	20847	82238	0.56	0.51	0.39	1.02	3.20	1.90	2.70	49.08

Table – 1 *(Contd.)*

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
22.	Rubber Products	19702	23065	35233	87306	0.67	0.62	0.65	1.08	3.41	10.55	7.88	24.63
23.	Plastic Prtoducts	11895	10423	9740	23857	0.41	0.28	0.18	0.30	-2.47	-1.31	-1.81	24.15
	Sub-total	101448	111494	142260	313329	3.46	3.01	2.63	3.89	1.98	5.52	4.02	20.04
24.	Petroleum Products	47638	85861	138280	187530	1.62	2.32	2.55	2.33	16.05	12.21	19.03	5.94
25.	Coal Tar Products	8686	15545	15215	17824	0.30	0.42	0.28	0.35	15.79	-0.43	7.52	13.81
	Sub total	56324	101407	153495	215354	1.92	2.73	2.84	2.67	16.01	10.27	17.25	6.72
26.	Fertilisers	42875	36250	67869	80646	1.46	0.98	1.25	1.00	-3.09	17.45	5.83	3.14
27.	Pesticides	3713	4379	9063	12340	0.13	0.12	0.17	0.15	3.59	21.39	14.41	6.03
	Sub-total	46588	40629	76933	92986	1.59	1.10	1.42	1.15	-2.56	17.87	6.51	3.48
28.	Synth. Fibre & Resin	49618	16073	23967	65940	1.69	0.43	0.44	0.82	-13.52	9.82	-5.17	29.19
29.	Other Chemicals	26614	88875	147795	257971	0.91	2.40	2.73	3.20	46.79	13.26	45.53	12.42
	Sub-total	76233	104948	171762	323911	2.60	2.83	3.17	4.02	7.53	12.73	12.53	14.76
30.	Cement	9893	8768	28213	48145	0.34	0.24	0.52	0.60	-2.27	44.35	18.52	11.78
31.	Other Non Met. Minera	48228	44187	50812	60004	1.64	1.19	0.94	0.74	-1.68	3.00	0.54	3.02
	Sub-total	58120	52955	79025	108149	1.98	1.43	1.46	1.34	-1.78	9.85	3.60	6.14
32.	Iron & Steel	57516	141033	104939	268022	1.96	3.80	1.94	3.33	29.04	-5.12	8.25	25.90

Table – 1 *(Contd.)*

(1) (2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
33. Non Ferrous Metals	61757	36797	14554	34388	2.10	0.99	0.27	0.43	-8.08	-12.09	-7.64	22.71
34. Non Electrical Mach.	57427	78958	90385	174849	1.96	2.13	1.67	2.17	7.50	2.89	5.74	15.57
35. Electrical Machinery	23171	53744	85610	161648	0.79	1.45	1.58	2.01	26.39	11.86	26.95	14.80
36. Rail Equipments	10091	12281	31661	70228	0.34	0.33	0.58	0.87	4.34	31.56	21.38	20.30
37. Motor Vehicles	23709	42643	50233	122232	0.81	1.15	0.93	1.52	15.97	3.56	11.19	23.89
38. Other Transport Equip.	12813	22870	28421	39982	0.44	0.62	0.52	0.50	15.70	4.85	12.18	6.78
Sub-total	46613	77793	110315	232441	1.59	2.10	2.04	2.89	13.38	8.36	13.67	18.45
39. Electronic & Comm. Equip.	4077	11339	37849	119948	0.14	0.31	0.70	1.49	35.63	46.76	82.83	36.15
40. Other Manufacturing	48687	59757	142971	248170	1.66	1.61	2.64	3.08	4.55	27.85	19.37	12.26
41. Rail Transport Service	39234	53687	65428	72109	1.34	1.45	1.21	0.90	7.37	4.37	6.68	1.70
42. Other Transport Service	115444	167984	209345	325589	3.93	4.53	3.87	4.04	9.10	4.92	8.13	9.25
43. Electricity	54454	78250	144519	211788	1.85	2.11	2.67	2.63	8.74	16.94	16.54	7.76
44. Construction	240826	292467	340997	514896	8.20	7.89	6.30	6.39	4.29	3.32	4.16	8.50
45. Communication	12676	17306	20974	36444	0.43	0.47	0.39	0.45	7.30	4.24	6.55	12.29
46. Other Services	76658	840844	1257118	1976998	26.11	22.68	23.22	24.54	1.94	9.90	6.40	9.54
Gross Output	2936163	3707995	5414082	8055038	100	100	100	100	5.26	9.20	8.44	8.13

Note : Figures at 1984-85 prices

Table – 2

Macro Economic Trends in Indian Economy (in per cent)

Macro variables	*Absolute Figures (Rs. crore) years*				*% share in gross output years*				*Average annual growth rate periods*			
	1979-80	*1984-85*	*1989-90*	*1996-97*	*1979-80*	*1984-85*	*1989-90*	*1996-97*	*1979-80 to 1984-85*	*1984-85 to 1989-90*	*1980s*	*1989-90 to 1996-97*
(1) (2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
1. Intermediate demand	1374411	1729211	2458901	4058280	46.81	46.63	45.42	50.38	5.16	8.44	7.89	10.84
2. Private Consumption	1057598	1375641	2034155	2869967	36.02	37.10	37.57	35.63	6.01	9.57	9.23	6.85
3. Government expenditure	173987	234136	355085	560164	5.93	6.31	6.56	6.95	6.91	10.33	10.41	9.63
4. Investment	337105	479270	650536	650995	11.48	12.93	12.02	8.08	8.43	7.15	9.30	0.01
5. Exports	101533	147114	255475	620304	3.46	3.97	4.72	7.70	9.98	14.73	15.16	23.80
6. Imports	-108471	-148086	-340070	-724069	-3.69	-3.99	-6.28	-8.99	7.30	25.93	21.35	18.82
7. Domestic Demand	1561752	2088076	2955182	3977984	53.19	56.31	54.58	49.39	6.74	8.31	8.92	5.77
8. Gross Output	2936163	3707995	5414082	8055038	100.00	102.95	100.00	100.00	5.26	9.20	8.44	8.13

Table – 3

Determinants of Output Growth (in per cent)

Macro Variables

Time Period		Private Consumption	Government Expenditure	Investment	Export Expansion	Import Substitution	Technoligical Changes	Total
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1.	1979-80 to 1984-85	66.57	10.26	34.91	8.98	-8.67	-12.06	100
2.	1984-85 to 1989-90	68.21	12.46	20.18	13.35	-9.94	-4.27	100
3.	1979-80 to 1989-90	61.01	10.98	28.52	7.93	-5.3	-3.14	100
4.	1989-90 to 1996-97	62.65	10.41	14	8.44	-1.18	5.66	100

Table – 4.1

Decomposition of output change between 1979-80 to 1984-85 (in per cent)

Sectors	*Private consump-tion*	*Govt. expen-diture*	*Invest-ment*	*Export*	*Import Substi-tution*	*Techno-logical Changes*	*Total*
(1) (2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1. Cereals	84.58	0.96	19.37	-0.87	2.62	-6.67	100
2. Fibre Crops	64.85	-14.21	3.88	2.78	67.90	-25.21	100
3. Tea & Coffee	-31.26	-0.55	-4.88	-28.38	37.81	127.26	100
4. Other Crops	71.91	0.36	9.34	-3.18	-107.49	129.06	100
5. Animal Husbandry	68.80	2.34	6.45	-1.32	-182.50	206.24	100
6. Forestry & Logging	88.30	0.56	-56.11	0.22	9.08	57.95	100
7. Fishing	-229.72	5.39	15.74	3.41	18.24	286.94	100
8. Coal & Lignite	74.05	18.74	120.20	14.37	-20.92	-106.45	100
9. Crude Petroleum & N.C.	7.76	1.43	1.32	23.92	67.14	-1.57	100
10. Iron Ore	2.10	-0.64	1.97	-10.05	95.07	11.54	100
11. Other Minerals	16.69	-1.98	111.35	15.79	-102.20	60.36	100
12. Sugar	149.42	1.95	-33.73	-3.80	1.00	-14.84	100
13. Khandsari, Gur & Boor	83.97	0.04	2.65	-0.08	15.24	-1.82	100
14. Other Food & Beverag	87.01	1.68	28.53	-27.21	-7.10	17.09	100
15. Cotton Textiles	-2.57	-21.09	-41.18	2.40	207.86	-45.42	100
16. Art Silk & Synth. Textiles	73.26	-0.18	-3.48	-0.82	35.15	-3.94	100
17. Woollen Textiles	-82.50	-93.30	118.17	23.80	224.34	-90.52	100
18. Other Textiles	60.94	-2.71	-11.58	8.45	44.51	0.40	100
19. Wood & Wood Product	33.04	-10.88	-126.43	-0.47	352.22	-147.49	100
20. Paper & Paper Product	42.47	11.19	4.68	6.23	84.40	-48.97	100
21. Leathre & Leather Product	85.65	5.02	-63.91	14.35	107.43	-48.54	100
22. Rubber Products	106.67	-5.87	45.35	20.11	-1.09	-65.17	100
23. Plastic Prtoducts	-323.39	25.79	-35.47	41.41	-708.91	1100.57	100
24. Petroleum Products	64.12	11.74	8.17	6.19	-33.30	43.09	100
25. Coal Tar Products	16.51	2.07	44.45	3.30	49.53	-15.87	100
26. Fertilisers	-166.53	0.22	-79.39	-28.37	8.03	366.03	100
27. Pesticides	11927.30	189.81	-212.42	5099.70	-12239.24	-4665.15	100
28. Synth. Fibre & Resin	1.71	-7.47	-4.43	0.91	-17.58	126.85	100
29. Other Chemicals	22.66	-1.37	9.56	6.61	-22.10	84.63	100
30. Cement	-33.03	19.48	-473.19	-41.53	844.02	-215.75	100
31. Other Non Met. Minera	266.64	16.51	-370.78	-350.70	270.67	267.65	100
32. Iron & Steel	3.03	-0.92	16.36	-1.04	33.02	49.54	100
33. Non Ferrous Metals	2.06	3.22	-0.28	11.62	-86.66	170.04	100
34. Non Electrical Mach.	4.90	0.03	62.20	5.93	0.13	26.82	100
35. Electrical Machinery	9.91	0.08	34.76	-0.04	26.59	28.69	100
36. Rail Equipments	84.21	-6.57	-88.08	-19.00	176.70	-47.26	100
37. Motor Vehicles	10.11	-24.38	67.99	3.19	-0.90	43.98	100
38. Other Transport Equip.	33.82	-6.77	36.12	-1.48	29.49	8.82	100
39. Electronic & Comm. Equip.	50.53	12.58	16.75	-0.81	18.52	2.43	100
40. Other Manufacturing	-89.35	88.42	60.93	-64.73	-107.57	212.30	100
41. Rail Transport Service	106.63	-8.32	24.71	10.50	-18.39	-15.12	100
42. Other Transport Service	124.93	-1.62	17.14	17.23	3.53	-61.20	100
43. Electricity	48.33	36.65	18.46	6.25	-24.11	14.42	100
44. Construction	22.84	-8.68	168.72	3.63	-16.45	-70.06	100
45. Communication	20.28	94.43	5.76	7.02	-42.67	15.18	100
46. Other Services	138.91	81.45	39.12	52.54	-41.26	-170.77	100
Total for economy	66.57	10.26	34.91	8.98	-8.67	-12.05694	100

Table – 4.2

Decomposition of output change between 1984-85 to 1989-90 (in per cent)

Sectors	*Private consump-tion*	*Govt. expen-diture*	*Invest-ment*	*Export*	*Import Substi-tution*	*Techno-logical Changes*	*Total*
(1) (2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1. Cereals	70.98	-0.60	1.20	1.35	1.52	25.55	100.00
2. Fibre Crops	85.96	0.33	-5.72	20.00	0.12	-0.68	100.00
3. Tea & Coffee	-97.39	-1.06	23.38	191.82	-25.22	8.46	100.00
4. Other Crops	117.03	3.46	3.29	12.35	5.94	-42.07	100.00
5. Animal Husbandry	80.44	3.50	24.32	5.64	-1.94	-11.97	100.00
6. Forestry & Logging	78.57	1.54	-5.51	-2.13	-3.11	30.62	100.00
7. Fishing	105.91	7.35	2.61	47.02	1.69	-64.59	100.00
8. Coal & Lignite	84.83	27.10	-25.05	25.80	-56.85	44.17	100.00
9. Crude Petroleum & N.C.	-18.35	-3.15	-4.51	4.10	109.19	12.72	100.00
10. Iron Ore	6.36	3.30	11.30	85.37	-16.81	10.48	100.00
11. Other Minerals	14.95	5.87	19.27	31.15	-5.88	34.64	100.00
12. Sugar	66.27	-0.11	26.44	-0.59	7.20	0.80	100.00
13. Khandsari, Gur & Boor	187.76	-0.05	2.28	-0.04	-0.08	-89.87	100.00
14. Other Food & Beverag	197.39	2.14	-47.11	5.43	51.11	-108.95	100.00
15. Cotton Textiles	68.38	-0.10	2.51	5.51	0.08	23.62	100.00
16. Art Silk & Synth. Textiles	47.71	0.00	8.58	2.12	2.14	39.45	100.00
17. Woollen Textiles	106.56	-10.01	9.19	16.94	-2.48	-20.20	100.00
18. Other Textiles	23.92	1.46	18.91	48.04	1.13	6.54	100.00
19. Wood & Wood Product	-24.33	-4.59	4.93	-7.14	7.99	123.14	100.00
20. Paper & Paper Product	30.87	15.32	1.40	5.17	15.64	31.61	100.00
21. Leathre & Leather Product	-45.40	-4.51	4.89	106.53	-1.75	40.23	100.00
22. Rubber Products	76.90	6.46	11.43	40.60	-3.11	-32.27	100.00
23. Plastic Prtoducts	-26.31	0.35	50.15	12.26	-1.06	64.61	100.00
24. Petroleum Products	71.12	12.01	19.93	24.93	-31.09	3.71	100.00
25. Coal Tar Products	42.62	24.61	-44.22	16.44	-81.69	142.25	100.00
26. Fertilisers	12.93	1.12	-2.81	0.64	38.14	49.99	100.00
27. Pesticides	12.73	-0.02	0.80	5.41	5.41	75.68	100.00
28. Synth. Fibre & Resin	38.88	0.28	59.15	4.95	12.62	-15.87	100.00
29. Other Chemicals	136.64	16.55	4.04	21.33	-5.05	-73.52	100.00
30. Cement	14.21	15.49	-1.95	9.37	3.48	59.40	100.00
31. Other Non Met. Minera	-497.00	-140.89	10.53	-957.06	57.92	1626.51	100.00
32. Iron & Steel	-52.14	-27.06	-142.96	-25.05	138.11	209.10	100.00
33. Non Ferrous Metals	446.73	101.11	524.48	228.36	-1533.11	332.43	100.00
34. Non Electrical Mach.	20.39	11.68	212.71	29.80	-142.59	-31.99	100.00
35. Electrical Machinery	0.43	1.71	61.06	5.94	-10.03	41.76	100.00
36. Rail Equipments	0.61	0.92	34.03	1.73	0.77	61.93	100.00
37. Motor Vehicles	33.74	24.08	157.69	19.32	-24.75	-110.08	100.00
38. Other Transport Equip.	42.48	5.07	165.96	33.87	-103.70	-43.69	100.00
39. Electronic & Comm. Equip.	16.26	-2.03	69.35	10.57.	2.00	3.85	100.00
40. Other Manufacturing	45.78	8.36	30.16	3.16	-13.08	24.86	100.00
41. Rail Transport Service	12.78	27.99	32.57	46.39	-18.56	-1.17	100.00
42. Other Transport Service	27.18	6.99	4.27	15.44	-18.87	64.98	100.00
43. Electricity	37.63	10.18	12.10	7.62	-4.40	36.87	100.00
44. Construction	43.10	62.90	35.13	6.42	-2.34	-45.21	100.00
45. Communication	202.80	-91.38	17.58	33.56	-35.74	-26.82	100.00
46. Other Services	72.89	26.96	12.39	8.86	-1.56	-19.55	100.00
Total	68.2125	12.4575	20.1833	13.3517	-9.9371	-4.2679	100.0000

Table – 4.3

Decomposition of output change between 1989-90 to 1996-97 (in per cent)

Sectors		*Private consump-tion*	*Govt. expen-diture*	*Invest-ment*	*Export*	*Import Substi-tution*	*Techno-logical Changes*	*Total*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1.	Cereals	100.79	1.24	1.13	0.95	-0.39	-3.73	100.00
2.	Fibre Crops	171.59	1.29	9.02	34.13	-1.92	-144.12	100.00
3.	Tea & Coffee	68.44	0.64	0.83	0.95	22.95	6.19	100.00
4.	Other Crops	118.48	1.52	4.55	5.70	-1.95	-28.29	100.00
5.	Animal Husbandry	106.77	1.36	4.63	2.81	-0.31	-15.26	100.00
6.	Forestry & Logging	67.75	6.38	6.17	3.45	-7.42	23.67	100.00
7.	Fishing	82.14	2.32	0.63	18.00	-1.17	-1.92	100.00
8.	Coal & Lignite	68.59	12.43	66.84	7.01	14.10	-68.97	100.00
9.	Crude Petroleum & N.Gas	23.66	3.72	3.62	2.34	51.56	15.11	100.00
10.	Iron Ore	26.00	10.34	39.95	58.21	21.73	-56.23	100.00
11.	Other Minerals	19.08	4.66	7.25	13.46	-92.72	148.27	100.00
12.	Sugar	87.74	0.58	0.23	0.89	0.63	9.93	100.00
13.	Khandsari, Gur & Boor	157.18	1.10	1.44	1.76	-2.55	-58.93	100.00
14.	Other Food & Beverage	97.57	0.91	1.19	1.42	-2.16	1.08	100.00
15.	Cotton Textiles	71.25	0.38	4.11	12.03	-0.43	12.65	100.00
16.	Art Silk & Synth. Textiles	109.25	0.20	2.51	6.92	-2.13	-16.75	100.00
17.	Woollen Textiles	92.33	0.26	0.69	4.23	-4.38	6.87	100.00
18.	Other Textiles	79.71	4.21	9.62	45.03	-4.55	-34.02	100.00
19.	Wood & Wood Product	21.85	6.21	7.69	3.13	-0.81	61.93	100.00
20.	Paper & Paper Product	70.15	35.78	14.97	10.52	-16.58	-14.85	100.00
21.	Leathre & Leather Product	23.87	0.04	21.71	39.27	0.10	15.01	100.00
22.	Rubber Products	29.44	3.00	38.25	12.58	-1.35	18.09	100.00
23.	Plastic Prtoducts	40.37	2.18	6.52	7.87	0.11	42.94	100.00
24.	Petroleum Products	74.92	12.00	10.86	7.49	-24.04	18.77	100.00
25.	Coal Tar Products	22.38	6.92	14.05	5.14	40.89	10.62	100.00
26.	Fertilisers	110.30	2.10	2.98	5.07	-23.21	2.75	100.00
27.	Pesticides	92.10	1.41	5.72	23.93	-9.67	-13.49	100.00
28.	Synth. Fibre & Resin	22.67	0.32	4.85	5.50	-16.67	83.34	100.00
29.	Other Chemicals	59.76	7.20	12.64	23.51	-2.51	0.61	100.00
30.	Cement	19.57	8.03	2.75	-1.32	0.42	70.55	100.00
31.	Other Non Met. Mineral	63.01	6.31	6.78	-73.08	4.66	92.31	100.00
32.	Iron & Steel	13.86	5.48	21.86	7.52	14.52	36.75	100.00
33.	Non Ferrous Metals	19.81	6.04	26.62	15.20	31.28	1.05	100.00
34.	Non Electrical Mach.	7.93	2.93	60.14	6.01	2.21	20.77	100.00
35.	Electrical Machinery	16.80	2.91	49.66	6.13	-21.51	46.01	100.00
36.	Rail Equipments	18.87	3.54	34.41	5.00	-0.37	38.56	100.00
37.	Motor Vehicles	25.15	10.50	34.75	3.47	-0.92	27.05	100.00
38.	Other Transport Equip.	44.70	1.90	41.74	7.00	-14.05	18.71	100.00
39.	Electronic & Comm. Equip.	25.96	1.14	23.50	19.52	17.70	12.18	100.00
40.	Other Manufacturing	37.06	16.79	21.84	50.35	-2.48	-23.57	100.00
41.	Rail Transport Service	79.53	13.08	22.79	12.34	1.34	-29.09	100.00
42.	Other Transport Service	79.04	9.80	6.91	5.35	-6.69	5.58	100.00
43.	Electricity	47.92	14.26	130.48	7.18	-0.50	-99.33	100.00
44.	Construction	23.73	11.14	2.26	1.22	0.13	61.53	100.00
45.	Communication	66.76	18.38	7.78	5.41	-1.82	3.49	100.00
46.	Other Services	58.36	24.54	6.04	7.49	-1.35	4.92	100.00
	Total	62.6499	10.4057	14.0348	8.4366	-1.1853	5.6584	100.0000

Table – 5

Productivity and Substitution Effects (in per cent)

Sectors	Period 1979-80 to 1984-85		Period 1984-85 to 1989-90		Period 1989-90 to 1996-97	
	Productivity effect	*Substitution effect*	*Productivity effect*	*Substitution effect*	*Productivity effect*	*Substitution effect*
(1) (2)	(3)	(4)	(5)	(6)	(7)	(8)
1. Cereals	8.77	-25.57	37.31	38.20	30.01	-11.82
2. Fibre Crops	83.04	3.7	103.12	-9.50	57.62	33.81
3. Tea & Coffee	-56.85	-83.73	-49.76	11.06	22.37	7.45
4. Other Crops	43.97	42.89	148.32	-22.99	-36.76	-62.58
5. Animal Husbandry	0.69	114.02	-8.42	-27.88	21.58	-42.30
6. Forestry & Logging	-25.56	-31.87	-18.41	344.54	-17.66	-17.47
7. Fishing	-54.05	-9.80	-23.98	-34.25	208.26	34.44
8. Coal & Lignite	-29.16	-27.28	128.55	3.69	-36.42	47.40
9. Crude Petroleum & N. Gas	-68.59	-21.59	120.92	-14.56	-16.09	32.11
10. Iron Ore	-71.58	-19.51	80.41	63.82	36.52	-60.27
11. Other Minerals	-64.31	37.23	78.27	40.69	6.41	122.77
12. Sugar	-2.80	-69.89	1.14	155.57	-34.53	122.40
13. Khandsari, Gur & Boora	-13.15	-25.59	-3.76	434 10	-23.58	-61.74
14. Other Food & Beverage Inc.	-4.75	-51.43	0.85	-45.58	22.53	14.36
15. Cotton Textiles	-11.88	-11.47	12.57	56.08	-4.74	41.86
16. Art Silk & Synth. Textiles	83.48	1.70	11.04	1351.70	-20.99	-29.53
17. Woollen Textiles	12.61	44.20	-17.66	4.73	-18.21	13.17
18. Other Textiles	-19.29	2.66	3.10	12.23	1.05	-52.84
19. Wood & Wood Products	39.47	404.24	1.99	-83.06	-11.99	91.49
20. Paper & Paper Products	24.37	41.08	-14.37	57.15	10.29	-22.13
21. Leather & Leather Products	-11.39	-34.30	5.46	63.34	6.68	68.60
22. Rubber Products	-6.81	85.25	-4.46	-28.01	-36.15	8.71
23. Plastic Products	5.28	-94.00	-12.79	236.92	71.10	38.78
24. Petroleum Products	-14.31	29.36	7.46	-2.19	29.17	16.61
25. Coal Tar Products	0.90	-25.48	12.53	5.23	-40.92	-34.38
26. Fertilisers	27.46	-48.17	2.89	33.65	-11.67	28.87
27. Pesticides	13.33	18.97	-17.39	-23.28	-8.35	20.02
28. Synth. Fibre & Resin	0.49	-44.64	-8.93	-34.23	-38.74	300.91
29. Other Chemicals	30.39	41.63	-12.50	14.34	-12.01	-19.87
30. Cement	7.77	9.20	-23.18	52.74	6.18	28.55
31. Other Non-Met. Mineral Products	12.66	-2.52	-17.46	-50.52	5.19	72.16
32. Iron & Steel	10.75	84.36	-13.97	-35.38	24.61	21.86
33. Non-Ferrous Metals	37.05	-73.39	-8.75	1.12	37.29	-6.47
34. Non-Electrical Machinery	21.26	29.22	-6.59	-27.20	16.32	72.50
35. Electrical Machinery	8.49	32.30	-27.17	123.15	20.63	67.48
36. Rail Equipments	-8.24	-34.31	-29.82	169.68	-46.21	85.50
37. Motor Vehicles	8.26	265.24	-11.68	-53.67	-7.73	52.46
38. Other Transport Equipment	34.88	49.06	-40.96	-10.84	66.50	43.87
39. Electronic & Common Equipment	16.06	38.51	-21.26	2.46	18.84	78.24
40. Other Manufacturing	24.19	1181.06	-6.70	36.21	0.26	-39.09
41. Rail Transport Service	25.39	-1.37	3.04	-2.39	76.94	-44.19
42 Other Transport Service	-33.70	-34.59	20.79	51.24	44.91	-12.92
43 Electricity	-10.14	42.54	23.79	-3.89	43.60	-91.19
44 Construction	-15.25	-61.85	-4.95	-6 05	20.31	610.83
45 Communication	49.68	13.66	-11.91	357.63	209.44	-11.65
46 Other Services	-7.86	-4.33	-30.83	-21.04	10.53	-13.33

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Movements in Exchange Rate of Rupee — Market Behaviour

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The objectives of this paper are to examine the causes of sharp movements in exchange rate during the last quarter of 1995. This paper has tried to test the hypotheses of (i) no shift in volatility of exchange rate and (ii) no shift in billing pattern of exports. The statistical methods employed for testing these hypotheses are the non-parametric test and the chi square test (contingency table). The volatility test based on daily Rupee - Dollar exchange rate and monthly REER reveal that there was a significant increase in volatility during September 1995 to December 1995 as compared with the earlier period. This was coincided with a significant shift in export billing pattern towards collection.

Introduction

The Indian Rupee was allowed to float in the foreign exchange market since March 1, 1993 under the modified Liberalised Exchange Rate Management System (LERMS). From the same date, the Reserve Bank of India (RBI), stopped quoting the official exchange rate of the Rupee. India also accepted the article VIII obligations of International Monetary Fund in August 1994, thereby making the currency convertible on current account. The value of Rupee *vis-a-vis* major international currencies remained fairly stable since the beginning of 1993 till the middle of August 1995. Thereafter, the Rupee began to depreciate sharply. RBI intervention in the market coupled with monetary policy measures stemmed the depreciation for some time but the slide began once again in December 1995,

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requiring further RBI intervention and policy measures. Sharp variation in exchange rate over a short period of time has undesirable economic consequences. It affects the profitability of the businesses having foreign exchange exposure, such as importers, exporters, investors and borrowers. With growing integration of financial markets in India, shocks in one segment of the market affect the other segments thereby influencing the domestic commercial activity. Stability of exchange rate is important for growth of foreign trade and investment inflows. Maintaining stable external value of Rupee is also one of the prime objectives of RBI. This paper attempts to examine the causes of sharp movements in exchange rate in India in the recent period. The paper also tests the hypotheses of no shift in volatility in the year 1995 and no shift in billing pattern of exports during the two sets of period under study which could be interrelated as a change in billing pattern is expected to cause a change in realisation pattern as well.

According to the exchange control regulations, an exporter has to declare the exports in the prescribed forms viz. GR / PP / VP / COD / SOFTEX as may be appropriate; the first two forms contain an undertaking of the exporter to repatriate the proceeds within the prescribed period i.e. six months from the date of shipment or the due date, whichever is earlier. Exporters can realise their export proceeds by surrendering their export bills with the banker for negotiation under letter of credit, for purchase of their sight bills or discounting of their usance bills. Under the L/C arrangement there is no involvement of bank funds. However, in the case of discounting / purchase of the bill the credit angle assumes significant importance. Alternatively, the exporter may send the bill for collection through his banker wherein there is no involvement of bank funds unlike the bill discounted / purchased. This method of billing gives flexibility to the exporter to realise bills according to his convenience. While in the case of export bills negotiated, purchased or discounted, the credit is immediately given to the customers' account pending realisation of the relative bills, in the cases of collection, the customers' account is credited only after the realisation of proceeds. The exchange risk in the latter case is borne by the exporter. The existing provision of 180 days for realisation of the proceeds provides an indirect opportunity to the exporter to maximise his gains

out of exchange rate movements depending on his perception of future exchange rate. The time limits for realisation of export proceeds in some selected countries who have accepted article VIII obligations but impose some restrictions on export proceeds are presented in Appendix I and a list of India's export competitors in major commodities is given in Appendix II. The provision of post shipment credit at concessional rates provided yet another arbitrage opportunity to exporters if the forward premium was higher than the subsidised interest rate.

This paper has seven sections. Next section discusses the data used in this paper. Section III discusses certain developments in the external sector depicting foreign trade position and policy measures taken by RBI during the volatile period. The section IV discusses various economic theories of exchange rate determination and gives a brief survey of existing literature on volatility. In section V, methodology for the present study is explained. The empirical findings are discussed in section VI and conclusions are presented in section VII.

Section II : Data Source

The data on foreign exchange reserves, Nominal Effective Exchange Rate (NEER) and Real Effective Exchange Rate (REER) indices and daily Rupee-Dollar exchange rate were collected from the various issues of RBI Bulletin. The data on foreign trade were collected from monthly publications of Directorate General of Commercial Intelligence and Statistics (DGCI&S). The analysis of export billing pattern was based on the sample data of some of the branches of authorised dealers (A.D.) in foreign exchange. The A.D.s were chosen on the basis of their export business during April-September 1994. The sample branches of the selected A.D.s chosen in the study account for approximately one-fourth of the total export realisation in the country. The data culled out from these branches for the period from September 1995 to December 1995 and the corresponding period of 1994 were processed to test the hypothesis of no shift in billing pattern and also to analyse their trends.

Section III : Recent Trends in External Payments Situation and Exchange Rate

The foreign capital inflows on account of Global Depository Receipts (GDRs), Foreign Currency Convertible Bonds (FCCBs) and portfolio investment by Foreign Institutional Investors (FIIs) which came in substantial order in 1993 and till October 1994 started falling from November 1994 onwards mainly due to slump in the domestic capital market. During this period, the Reserve Bank had to resort to purchase of surplus foreign exchange in the market with a view to preventing appreciation of the Rupee with the objective of maintaining the competitiveness of India's exports in the international market. This resulted in almost a stable exchange rate during this period. However, due to inflation rate differential between India and its major trading partners, the real effective exchange rate (REER) index showed some appreciation (graph 1).

Graph – 1

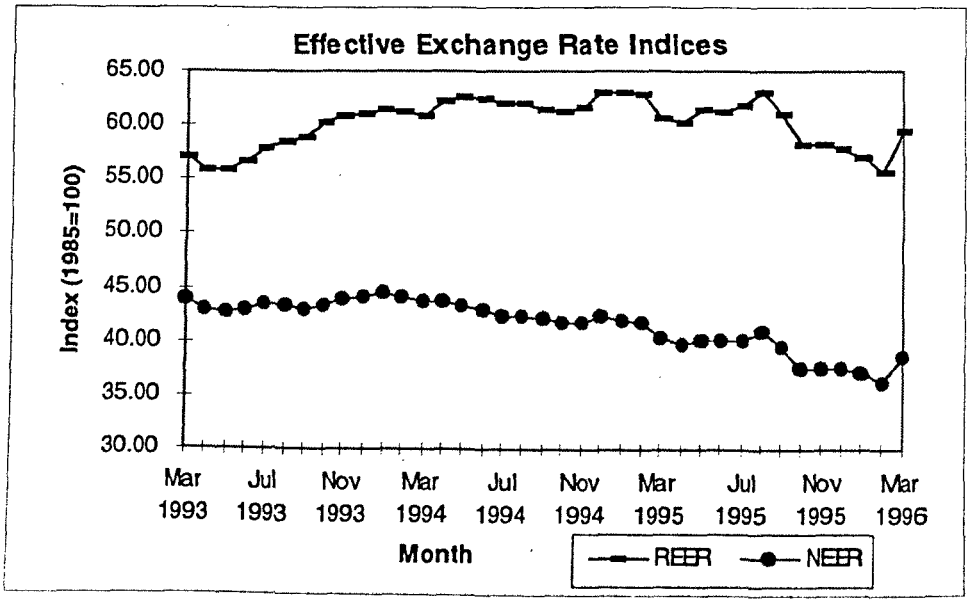

Table 1: India's Foreign Trade and FII Investments

(Rs. Crore)

Month	*Exports**	*Imports**	*Trade Balance*	*Net FII Investments*
April 1994	6395	6362	33	511
May 1994	5729	6113	-384	896
June 1994	5864	6457	-593	810
July 1994	5951	6933	-982	254
August 1994	6898	7291	-393	415
September 1994	6665	7675	-1010	714
October 1994	7124	8244	-1120	567
November 1994	6519	7417	-898	30
December 1994	7309	8275	-966	48
January 1995	7314	7440	-126	165
February 1995	7319	7438	-119	202
March 1995	9251	9062	189	183
April 1995	7894	7734	160	186
May 1995	7478	9309	-1831	212
June 1995	7617	9276	-1659	367
July 1995	7884	9681	-1797	658
August 1995	8141	9511	-1370	562
September 1995	7957	9647	-1690	406
October 1995	8662	9680	-1018	323
November 1995	9272	11269	-1997	169
December 1995	10273	10964	-691	420
January 1996	9484	12071	-2587	997
February 1996	9778	10765	-987	1566
March 1996	12023	11740	283	1074

**Source* : Directorate General of Commercial Intelligence and Statistics.

In May 1995, with a deterioration in trade account (trade deficit of Rs.1831 crore as against the trade surplus of Rs.160 crore in April 1995) there was a reversal of market sentiment. As the Rupee started depreciating, importers were expected to have prepaid their usance bills and resorted to more advance payments, thereby adding pressure to the normal demand. The expected depreciation resulted in increased demand for forward cover, which pushed up the forward

premia on foreign currencies. The high forward premia further encouraged the exporters to postpone realisation of export proceeds and thereby worsened the demand and supply imbalance. FII net inflow also came down from Rs.323 crore in October 1995 to Rs.169 crore in November 1995, which was the lowest since January 1995. This trend reversed only in January 1996 when net investment by FII increased to Rs.997 crore as compared with only Rs.169 crore in November 1995 (Table 1). The FII net investment further increased to Rs.1566 by February 1996 which improved the supply position in the foreign exchange market and helped stabilise the exchange rate of Rupee.

In order to stem the slide of Rupee, the RBI announced a series of measures in the nature of removing the concessional rates of interest on export credit under Post Shipment Credit in Foreign Currency (PSCFC) and by imposing surcharge on imports financed by banks. These measures helped to cool down the market to a certain extent. However, with the decline in FII investment due to the sluggish stock market and a general increase in exchange demand, Rupee continued to slide *vis-a-vis* other foreign currencies. A number of other factors which could have played a role in this episode were; lack of depth in the forex market, a prolonged period of stable exchange rate which might have encouraged importers to keep their exposure unhedged, increase in gold import, and the decision to meet exchange requirement for debt service payments from the market. The depreciation of Rupee continued for a few weeks until RBI announced a package of measures to stemie speculation in the market. Some of the specific measures were; increase in the interest rate on NRE deposits from 10 to 12 per cent, exemption of banks from maintaining CRR on Foreign Currency Non-Resident (Banks) and Non-Resident (Non-Repatriable) Rupee deposits, reduction of CRR requirement on NRE deposits from 14 to 10 percent, restriction on export credit refinance, freeing of interest rate on the post shipment credit denominated in Rupee, introduction of surcharge of 15 per cent on all imports financed by banks, and closer monitoring of forward contracts.

While the above policy measures helped to improve the realisation of export proceeds, RBI also intervened in the forex market in order to reverse the slide of Rupee. India's foreign exchange reserves including gold and Special Drawing Rights (SDRs) stood at

$21.55 billion on January 5, 1996 as against a level of $23.26 billion a year ago. The foreign currency assets also fell to $17.08 billion on January 5, 1996 as compared with $19.22 billion a year ago. The intervention by RBI led to sharp increase in call money rates (refer graphs 4 and 5) indicating the linkage between the forex market and the money market.

Section IV: Theoretical Framework

Exchange rate of a currency is a price, which is determined by demand and supply of that currency. Exchange rate fluctuates due to various factors. Some of the factors can change rapidly depending on expectations of market participants and therefore can cause sharp changes in the exchange rate in the short run. These factors may be temporary in nature and may have little relevance for a longer time planning horizon. In this paper the focus is on the short term analysis wherein demand – supply gap and market news/ information play a crucial role in the determination of exchange rate of currency. The traditional theories based on trade flows and purchasing power parity are important in explaining exchange rate movements in the long run. Modern exchange rate theories, viz. monetary approach and portfolio balance approach, instead focus on the importance of capital markets and international capital flows to explain the short run volatility of exchange rate and its tendency to overshoot the long run equilibrium level. Monetary approach lays stress on the role of money in the determination of exchange rate and ignores trade factors as the important determinants of exchange rate. The portfolio balance theory differs from the monetary approach in that domestic and foreign bonds are assumed to be imperfect substitutes and the exchange rate is determined in the process of equilibrium between the total demand and supply of financial assets (of which money is only one) in each country. Starting from a position of portfolio of financial and trade balance, the portfolio balance approach postulates that an increase in home country's money supply leads to a decline in interest rate and a demand shift from domestic bonds and currency to foreign bonds. This causes a depreciation of the home currency, leading to improvement in trade balance, and which in turn sets a reverse trend of exchange rate appreciation. Thus, the portfolio balance approach also explains the overshooting phenomenon, but in contrast

to the monetary approach, it does so by explicitly bringing trade adjustments into the picture.

It is essential at this stage to differentiate between volatility and misalignment in exchange rate. As Williamson (1985) has mentioned, volatility is a *high frequency* concept referring to a large change in exchange rate over a comparatively short period of time. Misalignment, on the other hand, refers to a state when exchange rate departs from its fundamental equilibrium value (however defined) over a protracted period of time. This theoretical distinction needs to be empirically ascertained before examining the factors which lead to exchange rate volatility.

Domowitz and Hakkio (1985) investigated the existence of risk premium in foreign exchange market based on conditional variance of market forecast errors. They assumed that the forecast errors follow the autoregressive conditional heteroscedasticity (ARCH) process introduced by Engle (1982). This approach emphasizes on distinguishing between inefficient market and a market where risk premium is a function of time. ARCH models capture the two aspects of exchange rate, periods of quiescence followed by periods of turbulence, and fat tails (Friedman and Vandersteel (1982)). Among the various tests suggested in literature, non-parametric tests provide an efficient empirical framework to study the exchange rate behaviour. Diebold and Nason (1990) emphasized that conditional heteroscedasticity is frequently found in the prediction errors of linear exchange rate model. However, it was not clear whether such conditional heteroscedasticity is a characteristic of a data generating process, or whether it indicates misspecification associated with linear conditional mean representations. They addressed the question that "while statistically significant rejections of linearity in exchange rates routinely occur, no non-linear model has been found that can significantly outperform even the simplest linear model in out-of-sample forecasting". A number of explanations could be offered for this purpose. First, the non-linearities present may be in the nature of even-ordered conditional moments, and therefore, are not useful for point prediction. Second, in–sample non-linearities, such as outliers and structural shifts may be present in the series which may lead various linearity tests to reject the null, while, being of no use

for out-of-sample forecasting. Lately a large number of parametric non-linear models (e.g. bilinear, threshold, exponential autoregressive) that have been tried as a plausible non-linear data generating process (DGP) are in fact a very small subset of class of non-linear DGPs. To resolve this puzzle, Diebold and Nason (1990) have underlined the importance of non-parametric models for studying the behaviour of exchange rate.

The importance of non-parametric test for study of volatility arises from the fact that we are uncertain about the statistical distribution of exchange rate changes. It is a stylized fact that percentage change in exchange rate tend to follow leptokurtic (fat tailed, highly peaked) distributions. Westerfield (1977), for example, finds that the stable paretian distribution, with characteristic exponent less than two, fits the logarithm change of spot exchange rates better than the normal distribution. In a similar vein, Rogalski & Vinso (1977) suggest student's t distribution as a good approximation. It may well be that the distribution of exchange rate changes is normal but the variance shifts through time – perhaps according to the amount of news. This would give the exchange rates series in precentage change term the appearance of a stable leptokurtic distribution. Some evidence for such behaviour is provided by Boothe & Glassman (1987), who find that mixtures of normal distributions provide some of the best fits. Nachane and Ray (1993) have tested the hypotheses for Gaussianity and linearity using Subba Rao – Gabr tests. They observed that both these hypotheses were strongly rejected confirming leptokurtic and non-linear behaviour of exchange rates. Further, Nachane and Ray (1993) have suggested the use of non-parametric frequency domain approach. This approach imbues the relevant series with a proper time series structure by treating each observation as a realisation from the distribution of a distinct random variable.

Artis & Taylor (1994) stressed the importance of the distributional properties of exchange rate changes in any volatility study. Studies that rely on simple variance measures implicitly invoke a normality assumption, the legitimacy of which is being challenged by growing number of studies (Boothe & Glassman, 1987). For example, it is conceivable that exchange rate changes at a certain frequency have Cauchy distribution, for which no finite moments of any order exist. To circumvent some of these problems, Artis & Taylor

(1994) employed non-parametric tests for volatility shifts, which do not require estimation of distributional parameters. Instead, exchange rate changes are ranked by size, and inferences are drawn with respect to the shape of the ranking. Intuitively, if a significant number of upper ranked percentage changes are recorded in the latter half of the sample period, an increase in volatility is indicated. Note, however, that although the test procedure is non-parametric in the sense that no volatility measures are actually estimated, we have to choose an appropriate distribution for exogenous disturbances.

Section V : The Methodology

(a) **Test for volatility :** Let e_t = logarithm of exchange rate at time t.

In order to ensure an appropriate model specification for e_t we first tried linear model in e_t with a shift variable z_t, defined as

$z_t = 1$ for $t \leq N$, 0 otherwise.

Although, this model was found to outperform other linear models for sample data, the time series e_t was found to be non-stationary with the coefficient of e_{t-1} being estimated to be equal to unity. Taking first order difference series i.e. Δe_t we found that it is stationary, indicating that e_t is an I(1) process with a break at time N. However, while plotting Δe_t values, it was found that a linear model would not provide a good fit which prompted us to go for a non-linear shift model. Under the circumstances, the following model as suggested by Artis and Taylor (1994) was chosen for the purpose of testing the shift in volatility of exchange rate. Therefore, for testing the hypothesis of no shift in volatility the hypothesis is,

$$\Delta e_t = \mu + \sigma_t \varepsilon_t \qquad (1)$$

$$\sigma_t = \exp(\alpha + \beta . z_t) \qquad (2)$$

where Δe_t is change in the logarithm of the exchange rate at time t; μ, α & β are unknown constant scalars, ε_t is independently and identically distributed with distribution function F and density function f,

and z_t is a binary variable reflecting the hypothesized shift in volatility at time N + 1.

Given equation (1), the null hypothesis of no shift in volatility is

$$H_0 : \beta = 0 \tag{3}$$

The test statistic takes the form

$$\varsigma = \sum_{t=1}^{T} (z_t - \bar{z})\alpha(u_t) \tag{4}$$

where $\bar{z}$ is the arithmetic mean of z_t sequence of T observations and u_t is defined as follows. Let r() be the rank of Δe_i- that is, $r(\Delta e_i)$ is the $r(\Delta e_i)^{th}$ smallest absolute change in the total sequence considered. Then

$$u_t = r(\Delta e_t) / (T + 1) \tag{5}$$

Clearly, u_t must lie in the closed interval [1/(T+1), T/(T+1)], for no ties in rank. The function $\alpha(.)$ in equation (4) is a score function and as defined by Hajek and Sidak (1967) it depends on the assumed density of ε_t. Hajek and Sidak (1967) define a class of functions that can be used in place of the score function in large samples, since $\alpha(.)$ may be difficult to evaluate in practice. If F is the assumed distribution function of ε_t,

$$F(x) = \int_{-\infty}^{x} f(u)du \tag{6}$$

and if $F^{-1}(u)$ is the inverse of F,

$$F^{-1}(u) = \text{Infimum}\{x|F(x) \geq u\} \tag{7}$$

then the asymptotic score function, $\psi(.)$ is defined (Hajek & Sidak, 1967) as

$$\psi : (0,1) \rightarrow R \tag{8}$$

$$\psi(u) = -F^{-1}(u)\left[\frac{f'\{F^{-1}(u)\}}{f\{F^{-1}(u)\}}\right] - 1.0 \tag{9}$$

Under equation (1), the statistic

$$\eta = \sum_{t=1}^{T} (z_t - \bar{z})\psi(u_t) \qquad (10)$$

where $\psi(.)$ will be asymptotically normally distributed.

Under the null hypothesis, η will have a zero mean and variance ρ^2 (Hajek and Sidak (1967)).

$$\rho^2 = \left\{\sum_{t=1}^{T} (z_t - \bar{z})^2\right\} \int_0^1 \{\psi(u) - \bar{\psi}\}^2 \, du \qquad (11)$$

where

$$\bar{\psi} = \int_0^1 \psi(u)du$$

Thus, for a given choice of F, the statistic (η/ρ) will be asymptotically standard normal under the null hypothesis of no shift in volatility. Significantly negative values of η reflect a negative value for β in equation (2) implying an increase in volatility after the shift point while significant positive value of η imply a reduction in volatility. Although this test procedure is non-parametric in the sense that no volatility measures are actually estimated, we have to choose an appropriate distribution for ε_t in implementing above procedure. To minimise the risk of choosing an inappropriate distribution, Artis & Taylor (1994) used four well known kinds of distributions and assumed that the true distribution will be close to one of them. Artis & Taylor (1994) believed that if quantitatively similar non-parametric results are obtained for a range of assumed distributions, then the results may be said to be robust to this uncertainty. The four densities correspond to normal, logistic, double exponential and Cauchy distributions. The density and asymptotic score functions as defined in equation (9) for these distributions are given in the Appendix III. All of the chosen distributions were symmetric and both the double exponential and Cauchy distributions have fat tails. Further, all the four densities gave similar results. In view of this observation, we have chosen only one distribution viz., Cauchy distribution for ε_t.

For Cauchy distribution, the score function ψ(u) takes the following form.

$$\psi(u) = \frac{2\tan^2\left\{\pi\left(u-\frac{1}{2}\right)\right\}}{1+\tan^2\left\{\pi\left(u-\frac{1}{2}\right)\right\}} - 1 \qquad (12)$$

After simplifying,

$$\psi(u) = -\cos[2\pi(u-1/2)] \qquad (13)$$

After substituting the function ψ(u) in equations (10) and (11), we get,

$$\eta = \sum_{t=1}^{T}(z_t - \bar{z})(-\cos 2\pi(u_t - 1/2))$$

and

$$\rho^2 = \frac{1}{2}\left[\sum_{t=1}^{T}(z_t - \bar{z})^2\right]$$

The test statistic (η/ρ) can then be computed with the help of these expressions.

(b) **Test for shift in Export billing pattern :** The data compiled from A.D. sources contains information on the manner in which the export proceeds are to be realised. These indicate whether the bill was negotiated, purchased, discounted or sent for collection. In the first three methods of billing, the exchange rate is determined at the time of recording the transaction. However, in a case where the bill is sent for collection, the exchange rate is determined on realisation of export proceeds. Exporters are free to enter into a forward contract to hedge against the exchange rate risk.

It is expected that if an exporter intends to take advantage of the likely depreciation of the Rupee, he would delay the realisation of export proceeds by sending the bill for collection rather than negotiating / discounting the bill with the banker. This phenomenon is sought to be investigated in the present study. For this purpose, the billing pattern during the period September 1995 to December 1995

was compared with that of the corresponding months of 1994. In order to test the hypothesis of no shift in billing pattern, we constructed 2 x 4 contingency table for each month with 'year' as one attribute and 'type of bill' as another. The hypothesis was then tested using Chi - square test. A typical contingency table is as follows :

Period \ Bill type	*Discount*	*Collection*	*Negotiation*	*Purchase*	*Total*
1994	O_{11}	O_{12}	O_{13}	O_{14}	$O_{1.}$
1995	O_{21}	O_{22}	O_{23}	O_{24}	$O_{2.}$
Total	$O_{.1}$	$O_{.2}$	$O_{.3}$	$O_{.4}$	$O_{..}$

H_0 : There is no difference in billing pattern during the two time periods.

Under the null hypothesis, the expected frequencies are computed as

$$E_{ij} = \frac{O_{i.} O_{.j}}{O_{..}}, \; i = 1,2; \; j = 1, 2, 3, 4$$

If O_{ij} is the observed frequency in the $(i,j)^{th}$ cell and E_{ij} is the corresponding expected frequency, the test statistic is

$$\chi^2 = \sum_{i=1}^{m} \sum_{j=1}^{n} \frac{(O_{ij} - E_{ij})^2}{E_{ij}} \sim \chi^2 (3), \; m = 2, \; n = 4$$

If $\chi^2_{cal} > \chi^2_{tab}(3)$ null hypothesis is rejected, which would indicate that the billing patterns differ at the given level of significance. We have tested these hypotheses at 5 percent level of significance.

Section VI : Empirical Findings

The results of the testing of hypotheses of shift in volatility and billing pattern are discussed below :

(a) **Test of shift in volatility :** We applied the volatility test to the Rupee-Dollar daily rate in the year 1995. The z_t was defined using September 1, 1995 as the shift point. Under the null hypothesis of no shift in volatility, the test statistics (η/ρ) follows asymp-

totic standard normal distribution. The value of test statistic for daily exchange rate worked out to -6.76 indicating the rejection of null hypothesis. The negative value indicated that there was sufficient reason to believe that the volatility has increased since the shift point, i.e., September 1, 1995.

The non-parametric test procedure for volatility as discussed earlier was also applied to the NEER and REER indices computed using export based weights. For this purpose, we collected monthly data from March 1993 to March 1996 for these indices. March 1993 was chosen as the starting point since the decision to allow the Rupee to float was implemented from that month. September 1995 was considered as the break point to test whether the exchange rate has become more volatile afterwards. The value of test statistic (η/ρ) worked out to -2.12 for export weighted REER indicating the rejection of the null hypothesis of no shift in volatility. The negatively significant value of test statistic leads to the conclusion that there was a significant shift in the volatility after September 1995 as compared with the earlier period.

The value of test statistic for export weighted monthly NEER was -1.49 indicating acceptance of null hypothesis (at 5 percent level of significance) of no shift in volatility, indicating that efforts to contain the Rupee slide did succeed to even out fluctuations in exchange rate on a monthly basis.

(b) **Test for shift in export billing pattern :** From the table 2 it is observed that the amount of export bills negotiated to the total amount of export bills handled by the sample A.D.s in the months of September to December 1995 (Volatile period) declined substantially to 22.8%, 16.2%, 22.5% and 24.7% from 30.5%, 20.9%, 31.6% and 24.8% respectively, in the corresponding months of the previous year. The export bills sent on collection basis went up to 50.8%, 59.3%, 57.0% and 51.9% during this relatively volatile period as compared with 48.3%, 59.0%, 46.4% and 43.0% respectively, during the normal period. This clearly indicates that there was a shift in billing pattern adopted by exporters during the respective months of the two years. As the export bills sent for collection lead to realisation of export proceeds at a later date (i.e. due date or six months whichever is earlier), it shows the preference of the exporters to postpone

realisation of export proceeds leading to supply pressure in the spot market. The fact that the forward premium on US Dollar (annualised) was consistently higher than interest rates on export credit during the volatile period made the exporters to further delay their export proceeds. During September 1995, the shift was towards collection, when exporters tended to speculate on the likely level of Rupee. The billing pattern for November 1995 indicate a large and significant shift towards collection i.e., from under 50 percent to almost two-thirds of the total number of bills.

Table 2 : Billing Pattern of Exports for Sample A.D. Branches

(Rs. Crore)

Month	*Discount*		*Collection*		*Negotiation*		*Purchase*		*Total*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
September 1994	91.2	(11.2)	393.7	(48.3)	248.7	(30.5)	82.1	(10.1)	815.6
October 1994	128.5	(11.4)	667.0	(59.0)	236.5	(20.9)	98.7	(8.7)	1130.8
November 1994	142.8	(14.6)	452.6	(46.4)	308.1	(31.6)	72.1	(7.4)	975.6
December 1994	54.9	(17.1)	138.0	(43.0)	79.8	(24.8)	48.4	(15.1)	321.2
Sepember 1995	189.3	(14.8)	648.3	(50.8)	290.7	(22.8)	148.3	(11.6)	1276.7
October 1995	198.9	(13.3)	885.6	(59.3)	242.1	(16.2)	167.9	(11.2)	1494.5
November 1995	166.8	(11.5)	823.2	(57.0)	325.8	(22.5)	129.1	(8.9)	1444.8
December 1995	129.8	(13.1)	513.9	(51.9)	244.7	(24.7)	102.2	(10.3)	990.6

Note : Figures in brackets indicate percentage to the total.

While testing the shift in billing pattern of exports using chi-square contingency table, it is observed that the shift in billing pattern was highly significant; as the calculated value of chi-square is much higher than the value of chi-square for 3 degrees of freedom at 5% level of significance. Results of the chi-square test are presented in Appendix IV. Further, the shift in the billing pattern was highest in the months of November 1995 and December 1995 as the bills sent on collection basis went up to 57.0% and 51.9% in value terms as compared with 46.4% and 43.0% respectively in the corresponding months of the previous year, indicating some speculative

behaviour on the part of exporters. Further, from Appendix IV it is clear that bills sent on collection by exporters rose to 55 per cent during September 1995 to December 1995 as compared with 51 per cent in the corresponding period of the previous year. At the same time, the bills negotiated came down to 21 per cent from 27 per cent earlier resulting in shortage of supply of forex in the market in the short run. These evidences suggested that the shift in billing pattern had a significant impact on the forex market, during the recent past.

Section VII : Conclusions

The statistical tests conducted in this study showed that the exchange rate of Rupee witnessed a significant shift in volatility during the period September to December 1995, which coincided with a shift in export billing pattern towards collection.

While these two developments are expected to be interrelated, with expectation of exchange rate exerting a significant influence on the export billing pattern, in the periods of volatile movement of exchange rate, the causal process is often blunted due to the lead and lag relationship between the two. A shift in export billing pattern while being an effect of the expectations of currency depreciation may also lead to a self-fulfilling process of speculation leading to further depreciation of currency in the exchange market. This highlights the importance of policy to stemie expectations and correct the imbalance between the demand and supply forces in the market.

In the recent period, a number of measures have been initiated by Government and RBI to improve the exchange market operations and to smooth out the demand and supply imbalances in the market. These are in the nature of removing the ceiling on overnight position of banks and permitting financial institutions to bring foreign exchange under lines of credit for Rupee lending. The management of short term debt is also being given due importance in correcting the seasonal imbalances in the forex market.

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Appendix – I

Time Limit for realisation of Export proceeds*

Up to 30 days	*31-60 days*	*61-90 days*	*91-120 days*	*121-180 days*	*More than 180 days*	*No time limit specified*
Dominican Republic	El Salvador	Guatemala	Bangladesh	Bahamas, The	Chile	Argentina
Surinam	Nicaragua	Indonesia	Honduras	Barbados	Israel	Bolivia
Tunisia	Croatia	Kenya	Pakistan	Belize		Cyprus
	Ghana	Soloman Is.	Paraguay	Ecuador		Dominica
	Poland	Western Samoa		Fiji		Estonia
				Greece		Grenada
		Zimbabwe		India		Guyana
				Libya		Haiti
				Malaysia		Iceland
				Malta		Korea
				Mauritius		Kuwait
				Moldova		Kyrgyz
				Morocco		Latvia
				Niger		Lebanon
				Papua New Guinea		Lithuania
						Mexico
				South Africa		Oman
				Thailand		Qatar
				Turkey		Seychelles
						Sri Lanka
						The Gambia
						Uganda
						Uruguay
						Venezuela

* Refers to countries who have accepted Article VIII obligation but are having some restrictions on exports/export proceeds.

Source : Exchange Arrangements and Exchange Restrictions, Annual Report 1995, IMF.

Appendix – II

India's Export Competitors for Major Commodities in the year 1993*

Spices	*Garments*	*Oilseeds*	*Cotton Yarn*	*Leather*	*Fishery*	*Tobacco*	*Iron Ore*	*Tea*	*Rice*	*Coffee*	*All Textiles*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Indonesia	Hong Kong	USA	Pakistan	Italy	USA	USA	Australia	Sri Lanka	Thailand	Brazil	Germany
India	China	Argentina	China	Hong Kong	Thailand	Brazil	Brazil	China	USA	Colombia	Hong Kong
Singapore	Italy	Malaysia	India	Germany	Norway	Zimbabwe	India	Kenya	Vietnam	Indonesia	Italy
China	Germany	Brazil	Italy	USA	Denmark	Italy	USSR (Former)	India	Pakistan	Cote d'Ivoire	China
Madagascar	South Korea	Germany	Egypt	South Korea	Canada	Greece	Canada	Indonesia	China	Guatemala	South Korea
Germany	France	Netherlands	Germany	India	China	Malawi	Sweden	Malawi	Italy	Mexico	Taiwan
Spain	USA	France	Greece	Argentina	Netherlands	Turkey	Venezuela	Argentina	India	Costa Rica	Japan
Hong Kong	Turkey	Canada	Spain	Brazil	South Korea	India	Mauritania	UK	Australia	Germany	Belgium
USA	Taiwan	Belgium	Brazil	France	Iceland	China	Chile	Bangla Desh	Uruguay	El Salvador	France
Netherlands	Portugal	Italy	Indonesia	UK	Chile	Thailand	USA	Hong Kong	Spain	Uganda	USA
Turkey	Thailand	Indonesia	South Korea	Spain	Taiwan	Argentina	Philipines	Tanzania	Myanmar	Cameroon	UK
Brazil	UK	India	Switzerland	China	Indonesia	Canada		Netherlands	UAE	India	Pakistan
Guatemala	Indonesia	Singapore	Turkey	Thailand	UK	Indonesia		Rwanda	Egypt	Zaire	Netherlands

Appendix – II *(Contd.)*

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Sri Lanka	India	Philippines	Belgium	Pakistan	USSR (Former)	Philippines		Vietnam	Argentina	Vietnam	Indonesia
UAE	Netherlands	Greece	France	Japan	France	Colombia				Honduras	India
Malaysia	Belgium	Spain	Thailand	Netherlands	Japan	Yugoslavia				Kenya	Switzerland
Pakistan	Malaysia	UK	UK	Austria	Spain	Germany				Equador	Austria
Vietnam	Singapore		Austria	Australia	Germany					Singapore	Spain
Thailand	Greece			Portugal	New Zealand					Thailand	Turkey
France	Tunisia			Hungary	Australia					Peru	Portugal
	Pakistan				Hong Kong						Thailand
	Austria				India						Singapore
					Equador						
					Argentina						
					Morocco						
					Singapore						
					Peru						
					Facroe Is.						
					Philippines						

* Countries are listed in the descending order of their share in world's total exports.
Source : World Economy and India's Place in it, CMIE, October 1994.

Appendix – III

Density and Asymptotic Score Functions

Distribution	*Density function, f(x)*	*Asymptotic score function, ψ(u)*
Normal	$\frac{1}{\sqrt{2\pi}}\exp\left(-\frac{1}{2}x^2\right)$	$\left\{\Phi^{-1}(u)\right\}^2 - 1$
Logistic	$e^{-x}\left(1+e^{-x}\right)^{-2}$	$(2u-1)\ln\left(u/(1-u)\right) - 1$
Double exponential	$\frac{1}{2}\exp(-\lvert x\rvert)$	-ln(1-|2u-1|)-1
Cauchy	$\frac{1}{\pi(1+x^2)}$	$\frac{2\tan^2\left\{\pi\left(u-\frac{1}{2}\right)\right\}}{1+\tan^2\left\{\pi\left(u-\frac{1}{2}\right)\right\}} - 1$

Note : $\Phi(u) = \int_{-\infty}^{u} f(x)dx$ is the cumulative distribution function of a standard normal variate.

Appendix – IV

Chi Square test results

Month \ Type of Bill	*Discount*	*Collection*	*Negotiation*	*Purchase*	*Total*
September-94	1012	5100	2039	958	9109
September-95	1436	4052	1815	1540	8843
Total	2448	9152	3854	2498	17952
Chi Square =	338.2				

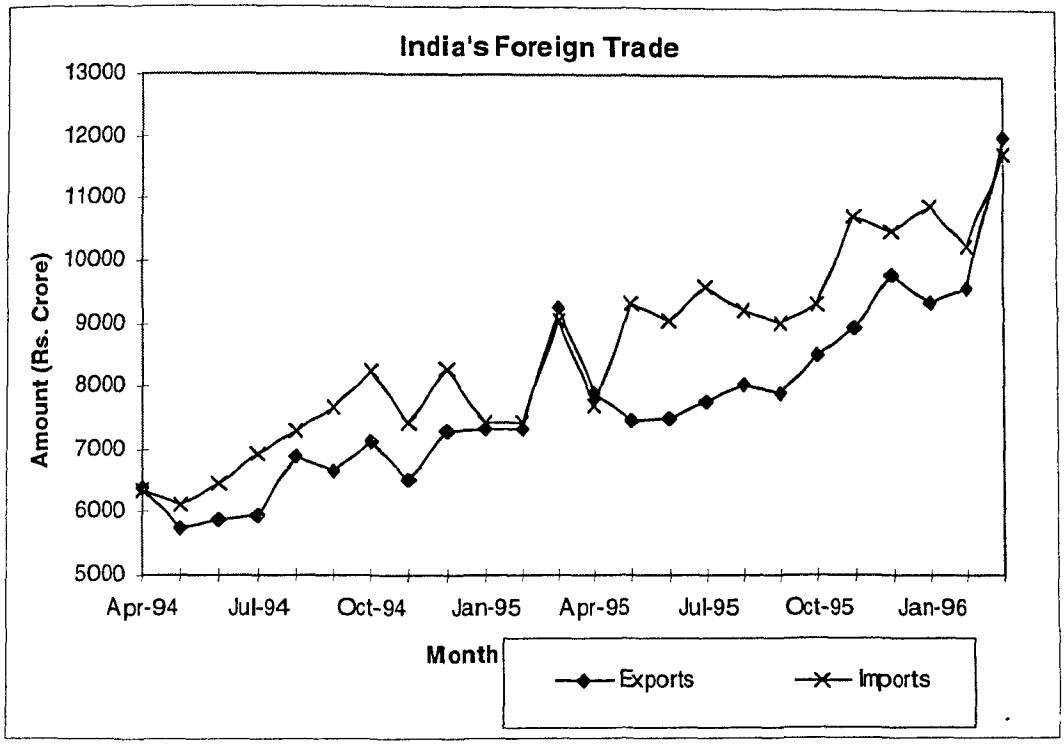
Month \ Type of Bill	*Discount*	*Collection*	*Negotiation*	*Purchase*	*Total*
October-94	1102	6025	2217	949	10293
October-95	1476	4835	1406	1258	8975
Total	2578	10860	3623	2207	19268
Chi Square =	320.8				

Month \ Type of Bill	*Discount*	*Collection*	*Negotiation*	*Purchase*	*Total*
November-94	1014	3718	2144	910	7786
November-95	1446	8783	1716	1474	13419
Total	2460	12501	3860	2384	21205
Chi Square =	874.2				

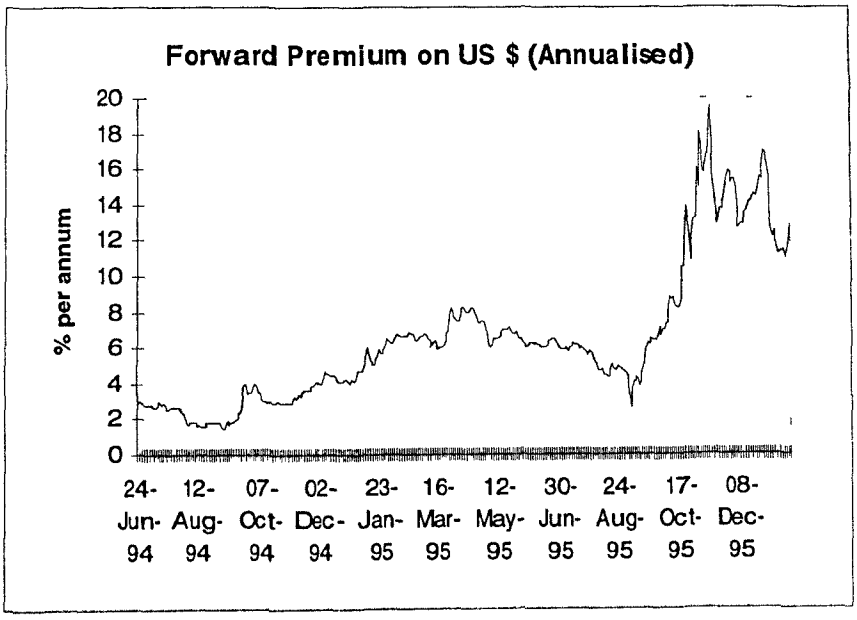
Month \ Type of Bill	*Discount*	*Collection*	*Negotiation*	*Purchase*	*Total*
December-94	406	1187	841	623	3057
December-95	992	3375	1618	1166	7151
Total	1398	4562	2459	1789	10208
Chi Square =	75.6				

Year \ Type of Bill	*Discount*	*Collection*	*Negotiation*	*Purchase*	*Total*
1994	3534	16030	7241	3440	30245
1995	5350	21045	6555	5438	38388
Total	8884	37075	13796	8878	68633
Chi Square =	575.3				

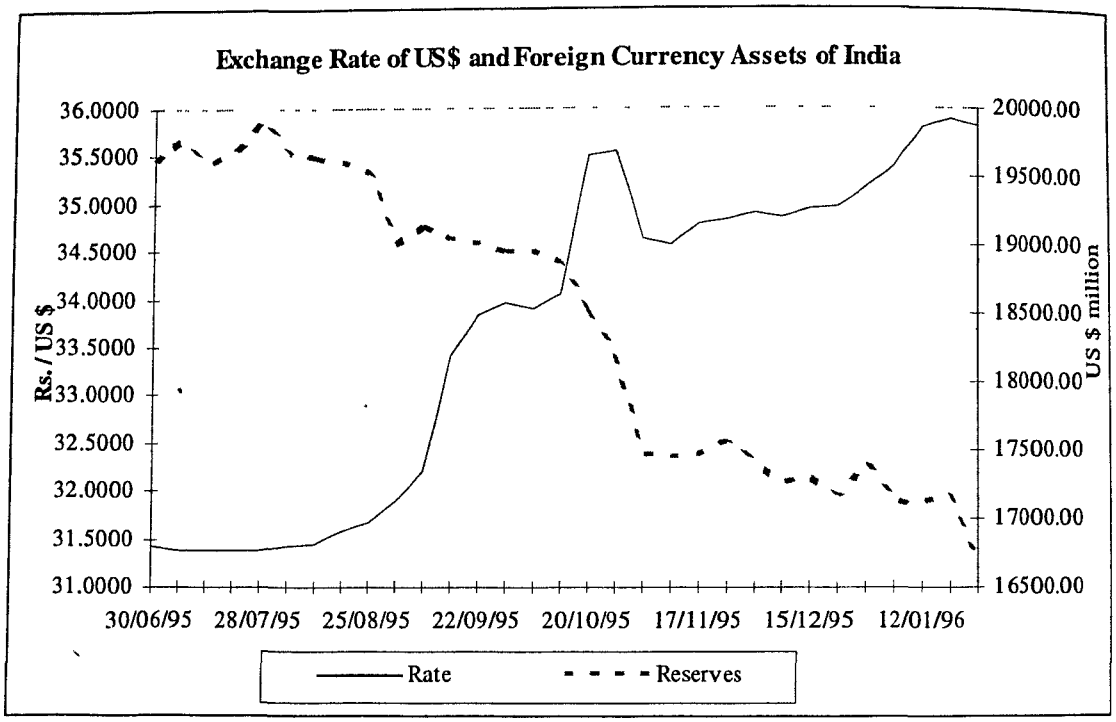
Graph – 2



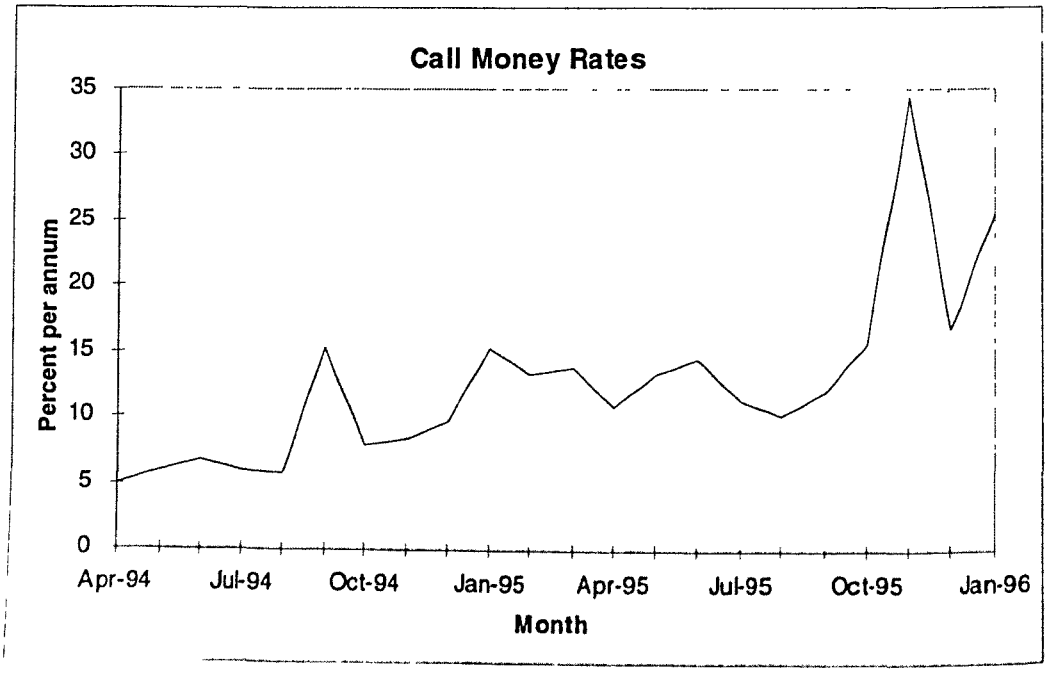
Graph – 3



Graph – 4



Graph – 5



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Probabilistic Neural Networks : An Illustration of the New Tool for Classification and Pattern Recognition

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This paper discusses Probabilistic Neural Networks which is a revival of the statistical technique of kernel discriminant analysis. It briefly discusses the statistical theory behind Probabilistic Neural Networks and gives an exposition of its computational implementation. Finally a sample classification application between two normal distributions is presented as an illustration of the technique.

Section I : Introduction

In the last decade, Artificial Neural Networks have emerged as a class of powerful techniques for pattern recognition, classification and function appromixation. In Section II, a brief introduction to the field of Artificial Neural Networks is presented. It gives an overview of the important class of Artificial Neural Networks known as Multi Layer Perceptrons. A quick summary of some current applications is followed by a brief survey of the interesting parallels between Artificial Neural Networks and conventional statistical methods. After this introduction to Artificial Neural Networks, the rest of the paper is devoted to Probabilistic Neural Networks. Section III begins with a theoretical overview of Probabilistic Neural Networks, after which the compositional structure of the network is discussed. Here we see how kernel discriminant analysis is cast as an Artificial Neural Network. Finally, in Section IV a classification problem between two normal distributions is discussed with simulated data as an illustrative application of Probabilistic Neural Networks.

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Section II : Artificial Neural Networks

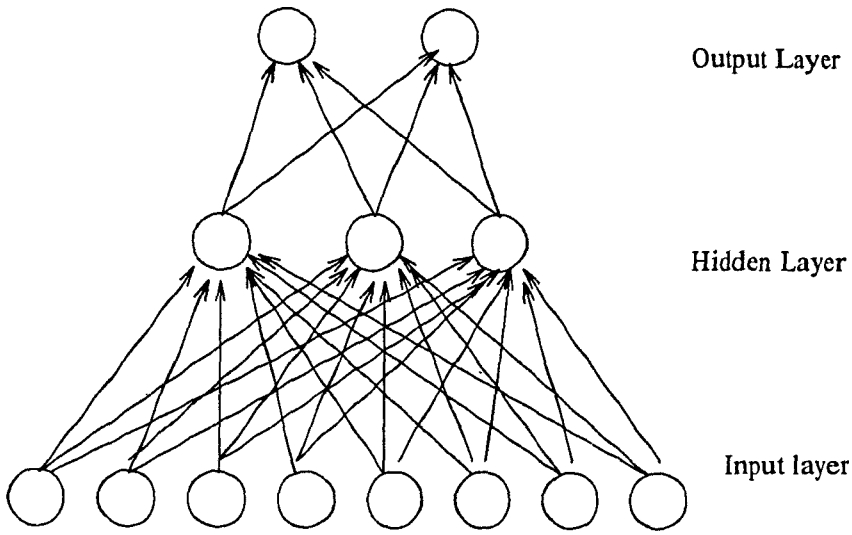
Neural networks are computational models designed after the functioning of the brain. Hence we usually talk about Artificial Neural Networks (ANNs) as opposed to their biological ideal. There has been a surge of interest in this area in the past ten years or so, largely due to their ability to solve seemingly intractable problems. It was more than a happy coincidence that this was happening when a revolution was taking place in the area of high speed computation at low cost. For, ANNs are computationally intensive models with many processing elements, usually referred to as neurons, interconnected in a networked fashion. Typically, each such neuron accepts inputs from some neurons, performs some computation, and passes the result on to other neurons, through the network connections. The strength of these connections, *i.e.*, the connections of neurons carrying their inputs to other neurons and the connections passing on their outputs to other neurons as inputs to them, determines the state of the network. ANNs usually have a training phase where the connection weights are computed in some manner, that minimizes some error measure of the network output on the basis of the input data. For many networks this is the most crucial and time consuming aspect. After the training, the network has acquired a stable set of connection weights, with a (hopefully) minimum error for the patterns presented during training.

In theory, ANNs can compute any computable function. Anything that can be expressed as a mapping between vector spaces can be approximated to arbitrary precision by ANNs. They are especially useful for mapping problems, such as in signal processing, pattern recognition, speech synthesis, adaptive systems, etc., and of late for forecasting and modelling.

Multi Layer Perceptrons (MLPs)

There is one class of networks that has gained popularity in many fields, including econometrics, and has rightfully earned the reputation of being 'the neural network'. That particular class is known as multilayer perceptrons. The architecture of the network is given below. Neurons are organized into layers. Inputs are presented to neurons in the bottom-most layer, called the input layer, and outputs

are collected from neurons in the top-most layer, called the output layer. Between the input and output layers, there may be intermediate layers whose neurons accept input from the preceding layer and pass on output to the succeeding layer. The intermediate layers are known as hidden layers.



A Multilayer Perceptron

The above diagram shows a three-layer network. The input units are labelled I_k, hidden units a_j and the output units O_i. We can represent the weights W_{kj}^{h} connecting the input units to the hidden units by arrows from each input unit to units in the hidden layer. Similarly, weights $W_{j,i}^{o}$ connecting units in the hidden layer to the output layer units are shown as arrows between pairs in the two layers.

A neuron is a simple computational unit that accepts input from all connections reaching it carrying input from neurons in the layer below, does a summation of the input signals and applies a transfer function such as the sigmoid $(1+e^{-x})^{-1}$ or the hyperbolic tangent *tanh(x)*. This transfer function is known as the activation function of the neuron and determines its output.

Input signals presented to the network are processed by neurons in the bottom most layer. Their activation levels, appropriately weighted are passed on to the next higher layer neurons. This contin-

ues until the signals reach the topmost layer neurons as their inputs. The output of the topmost layer is the final output of the network.

For instance, the hidden layer neuron a_j has inputs coming from the input layer neurons.

$$\text{The total input reaching hidden neuron } a_j = \sum_k W^h_{k,j} I_k$$

The neuron applies the transfer function to the input to compute its output or activation level. For a simple sigmoid activation function,

$$\text{The output of neuron } aj,\ \phi(a_j) = \frac{1}{1+e^{-\sum_k I_k W^h_{k,j}}}$$

The output of the hidden layer neurons are fed as input to the output neurons.

$$\text{The input reaching output neuron } O_i = \sum W^o_{j,i}\, \phi(a_j)$$

The activation function is applied to this input by the neuron to get the output.

$$\text{The output of neuron } O_i,\ \phi(O_i) = \frac{1}{1+e^{-\sum_j W^o_{j,i}\phi(a_j)}}$$

In terms of network inputs and weights,

$$\phi(O_i) = \frac{1}{1+e^{-\sum_j W^o_{j,i}\{1/(1+e^{-\sum_k W^h_{k,j} I_k})\}}}$$

The quality of the network output is determined by the weights in the network connections. Therefore, the crucial point is estimation of optimal weights of the network that can capture the mapping between input and output, for a given set of data. This is also known as network training. Several algorithms are being used such as gradient descent methods, simulated annealing and genetic algorithms. A good

reference for various types of networks and training algorithms is (Haykins, 1994).

Current Applications

A mapping from $\mathbb{R}^n \rightarrow \mathbb{R}^p$ can be approximated to arbitrary precision by a three layer network with sufficient number of neurons in the middle layer, activated using a sigmoid type function, and enough training data. By tweaking the parameters of a network and training the network on enough data researchers could tackle problems that defied solutions earlier by other methods, *i.e.*, at least in a reasonable amount of time.

Many ANNs are inherently excellent classifiers. Any task that can be handled by traditional discriminant analysis can be done at least as well by neural networks. One of the first major commercial applications of neural networks have been in determining the creditworthiness of loan applicants (Masters, 1993).

An ANN can be trained to recognize a number of patterns. If a noise corrupted version of one of these patterns is presented to a properly trained network, the network can separate the noise and the signal (original pattern) and generate as output the original pattern. This technique has been successfully applied to image restoration problems, handwritten character recognition, data retrieval etc. Researchers are now applying these techniques to model stock market prices.

The nonlinear nature of ANNs coupled with their tolerance to noise have made them a favourite in forecasting physical and economic variables. If the data exhibit significant unpredictable nonlinearity, the data may not fit the traditional time-series models such as ARIMA and Kalman filters. Neural networks are highly flexible nonlinear structures. They do not try to model the data, but try to act as universal approximators. A fairly thorough treatment of the subject from the standpoint of econometrics is given by Kuan and White (1993).

ANNs vs. Statistics

Artificial Neural Networks that learn to generalize from noisy data are similar or identical to statistical techniques :

1. MLPs are generalized (nonlinear) models.

While MLPs do not explicitly model stochastic elements, the techniques for estimating optimal network weights subject to minimal output error work under the same distributional assumptions as any statistical model. Further, instead of estimating a model the network tries to approximate the observed mapping from input to output. This process would give statistically valid results as long as the usual distributional assumptions of the error term hold. Unfortunately some early workers in neural network failed to appreciate this fact. Recent neural network researchers acknowledge the underlying statistics and work under a valid framework.

2. MLPs with one hidden layer are close to projection pursuit regression models.

It is easy to see that the example network given above is close to projection pursuit regression (Friedman and Stuetzle, 1981) which allows for projections (linear combinations) of variables in a generalized additive model. To see this, we simply make the activation of the output neurons to be linear,

$$\text{Output of neuron } O_i = \sum_j W^o_{j,i} \quad \frac{1}{1+e^{-\sum_k I_k W^h_{k,j}}}$$

3. Probabilistic Neural Networks are known to statisticians as kernel discriminant analysis (Specht, 1990).

4. Adaptive vector quantization networks are very similar to *k*-means cluster analysis (Sarle, 1994).

5. Hebbian learning is very closely related to principal component analysis (Sarle, 1994).

6. Functional link networks (Pao, 1989) are networks that process transformations of input data. Polynomial regression can be seen as a functional link network with the output activation being linear and input data transformed to polynomial terms.

In the following we take a look at Probabilistic Neural Networks (PNN), mainly for two reasons. First, kernel methods have

found only limited applicability in the past owing to their extensive computational and storage requirements, which has begun to change in its new form as a neural network. Second, unlike other ANNs, the theory behind PNNs has been well understood for decades with strong mathematical foundations. It is even possible to have sound confidence intervals for the estimates, which is unthinkable for other ANNs. This fact alone is known to have made Probabilistic Neural Networks the network of choice in many applications.

Section III : Probabilistic Neural Networks

The network described here is actually a statistical technique, known as kernel discriminant analysis. It is described in (Meisel, 1972), although it existed in other related forms even earlier. Even as its theoretical and practical power was known at that time, the state of computer technology precluded its widespread use. Moderate size problems required memory and CPU speed far beyond what was available then. In recent times, the technique was reinvented twice in the neural network literature, by Specht, (1990) and by Schioler and Hartmann, (1992). Specht dubbed the network a probabilistic neural network in homage to its root in probability theory. He showed that by organizing the flow of operations into layers, and assigning primitive operations to individual neurons in each layer, the algorithm can be made to resemble a four-layer feedforward network with exponential activation functions.

We will discuss here the original Probabilistic Neural Network (PNN), which is basically a classifier. It has also been easily extended to generate continuous mappings through regression *viz,* Generalized Regression Neural Networks. Since both are technically kernel methods we will only discuss here the Probabilistic Neural Network in its original form. Its extension to the other case is trivial.

Theoretical Overview

The PNN is fundamentally a classifier, though it can be modified to generate continuous mappings. We start by formally stating the general classification problem. We sample a p-component multivariate random vector $X = [x_1,.....,x_p]$. The K populations from which

our samples are drawn are indexed by k, $k = 1, \ldots, K$. The prior probability of an unknown sample being drawn from population k is h_k. The cost associated with misclassifying a sample from population k is c_k. In many applications, the priors h_k are treated as being equal (and hence ignored). The same is true for c_k. The training set consists of n_1 samples known to be from population 1, n_2 samples known to be from population 2, and so on through n_k samples known to be from population K. The task is to devise an algorithm for determining the population from which an unknown sample is taken. Our algorithm is said to be *Bayes Optimal* if its expected misclassification cost is less than or equal to that of any other algorithm.

If we know the probability density functions $f_k(X)$ for all populations, the Bayes optimal decision rule is to classify X into population i if

$$h_i c_i f_i(X) > h_j c_j f_j(X) \tag{1}$$

for all populations $j \neq i$. Usually, we are not fortuitous enough to have knowledge of the probability density functions $f_k(X)$. If safe assumptions can be made about the family of distributions to which the samples belong, the sample points are used to estimate the parameters of the distributions. But all too often, we have no knowledge of the shape of the distribution or the distribution could be multimodal (have more than one area where samples are clustered). Then we are left with no option, but to estimate the population density functions $f_k(X)$ from the training samples. Rosenblatt (1956) showed how to estimate a univariate probability density function from a random sample; Cacoullos (1966) extended the method to the multivariate case. It is shown that the estimated density converges asymptotically to the true density as the sample size increases. We use Rosenblatt's technique on the training sample to find estimates, $g_k(X)$ of density functions $f_k(X)$ for each population. Then classify an unknown X into population i if

$$h_i c_i g_i(X) > h_j c_j g_j(X) \tag{2}$$

for all $j \neq i$, h_i and c_i being prior probabilities and error costs.

Rosenblatt's estimator of the probability density function (pdf)

is a *sphere-of-influence* weighting function which, in neural net parlance is called a *radial basis function*. A weight function is used that has its largest values for small distances between the unknown and the training sample points, and decreases rapidly to zero as the distance increases. The pdf estimator is a scaled average of that function across the training set. For a single population whose sample size is n, the estimated density function is

$$g(X) = \frac{1}{n\sigma} \sum_{i=0}^{n-1} W\left\{\frac{X - X_i}{\sigma}\right\}$$

The parameter σ dictates the area around a sample point under its influence (and would typically be small for large sample sizes).

A convenient choice for the weighting function is the Gaussian function. This choice has nothing to do with assumptions of normality of the pdf. The multivariate estimator of the pdf is (using Gaussian weighting function)

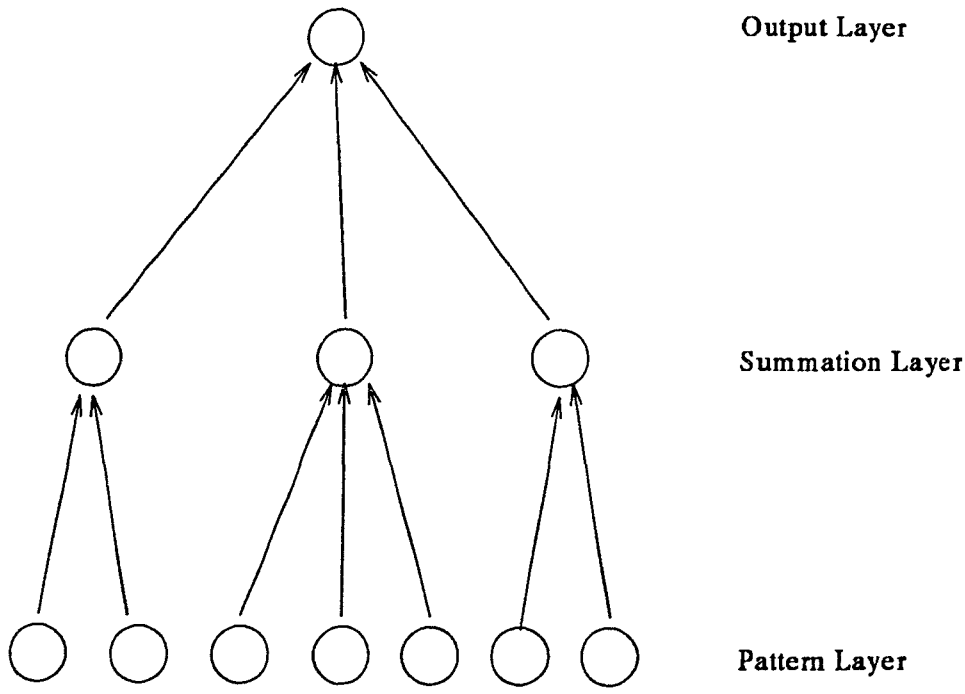
$$g(X) = \frac{1}{(2\Pi)^{p/2}\, n\sigma^{p}} \sum_{i=0}^{n-1} e^{\frac{-\| X - Xi \|^2}{2\sigma^2}}$$

It can easily be seen that the above expression is nothing but the average of multivariate normal distributions, one for each training sample. The population density is estimated separately for each training sample.

A few words about the parameter σ. Its choice is usually subjective. (Every algorithm has some fly in the ointment!) There do exist techniques, such as jackknifing, for automating the choice of the scale parameter σ. Cross-validation, where the error of misclassification is determined for various values of σ and minimized through a standard error minimization technique, for units in the training data set through a policy of leave-one-out offer an easy alternative. In more complex models there could be multiple σ parameters, one for each population. In multivariate cases, different variables could also have different σ values.

Architecture of the PNN

The following figure shows a small PNN with seven pattern neurons, three summation neurons, and an output neuron. The pattern neurons are typically multidimensional vectors. The pattern layer contains one neuron for each training case. The summation layer has one neuron for each class. Each pattern neuron has a connection to one neuron in the summation layer. Every neuron in the summation layer corresponds to a single population, just as every pattern layer neuron corresponds to a training case.



Structure of a Probabilistic Neural Network

Execution starts by simultaneously presenting the input vector to all pattern layer neurons. Each pattern layer neuron computes a distance $\|X - X_i\|$ measure between the input and the training case represented by that neuron. It then subjects that distance measure to the neuron's activation function, which is essentially the window, *viz.*,

$$\frac{1}{\sigma\sqrt{2\pi}} e^{-\|x - x_i\|^2 / 2\sigma^2}$$

The following layer contains summation units that have a modest task. Each summation unit sums the pattern layer neurons corresponding to members of that summation neuron's class (equation 4). The attained activation of summation neuron k is the estimated density function value of population k. The output neuron is a trivial threshold discriminator. It decides which of its inputs from the summation units is the maximum (equation 2).

The PNN architecture is elegantly simple, yet capable of extremely high-speed operation if the pattern units can be operated in parallel. Alternatively, each summation neuron, along with the pattern layer neurons corresponding to it could form a separate computational unit or processing element which is dedicated to pdf estimation relating to its own class. These processing elements could easily be executing on a loosely coupled set of processors, or on a cluster of networked computers, communicating through message passing.

Section IV : Sample Application

For illustrative purposes, we apply a PNN to a classification problem between two simulated normal distributions.

Fifty samples each are generated from two normal distributions, *N(5,1)* and *N(7.5, 1)*. The network is presented with this data initially which it simply stores in pattern neurons organised under two summation neurons, one for each population. Points from each distribution were given an equal sphere of influence, σ, of unity.

In marked contrast to a Multi Layer Perceptron, wherein the network estimates optimal weights of the network connections during the training phase, there is no computational phase that can be called the training phase for a Probabilistic Neural Network. In the former, the weights of the connections form the parameters of the network whereas in the latter the neurons, *i.e.,* the input data stored as neurons, determine the network.

When a test data is presented to the PNN, each neuron computes its window function for the test data and passes the value on

to the respective summation neuron. Each summation neuron adds up the inputs received from pattern neurons (each pattern neuron feeds input only to one summation neuron). Thus for each test data, two values are computed, one by each summation neuron. The relative strengths of these values determine the class to which the test data belongs. The activations of the summation neurons can be normalized to unity to give the relative probability that the test data belongs to one or the other population.

A set of 25 test data is generated in the range (3.0, 9.5), covering the 2σ limits of both distributions. It is easy to observe that the distributions have a fair amount of overlap.

The results of the classification by the network is given in the table below.

Test data	p_1	p_2
3.59	1.00	0.00
3.71	1.00	0.00
4.31	1.00	0.00
4.32	0.99	0.01
4.46	0.99	0.01
4.54	0.99	0.01
4.62	0.98	0.02
4.70	0.98	0.02
4.94	0.95	0.05
4.97	0.95	0.05
5.16	0.92	0.08
5.25	0.90	0.10
6.14	0.50	0.50
6.60	0.30	0.70
6.74	0.26	0.74
6.75	0.26	0.74
6.90	0.22	0.78
6.91	0.22	0.78
6.97	0.21	0.79
7.00	0.20	0.80
7.82	0.05	0.85
8.13	0.02	0.98
8.66	0.00	1.00
9.22	0.00	1.00
9.45	0.00	1.00

Classification of data between N(5,1) and N(7.5,1)

p_1 = Probability that the test data belongs to N(5,1)

p_2 = Probability that the test data belongs to N(7.5,1)

The technique can be very effective when used for classification between more than two populations. The distribution is not required to be unimodal. In fact, kernel methods are extremely useful in classification problems involving multi-modal distributions, and in cases where the data do not follow any known theoretical distribution.

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NOTE

Economic Crimes in the context of the Evolving Economic Policies

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The focus of the paper is on the need for law to adequately arm itself to deal with hi-tech economic offences. The challenge of the growing crime scene involving use of sophisticated equipment could be met effectively and efficiently only when strides of law keep pace with the latest developments in the field of crime. This calls for not only new laws or amendments to existing laws but also for retraining of investigators, prosecutors and judges in their methods and reorientation in their attitudes necessitating giving up of traditional concepts of justice and jurisprudence.

Introduction

The basic objective of economic reform measures is to promote productive efficiency through competition and in the process, to unleash the market signals and market forces and optimise the level of State intervention. While reforms in the real sector in particular industry and foreign trade have been undertaken, the major emphasis of reforms has so far been confined to the financial sector. The strategic aspects of the latter area of reforms relate to fiscal policy, monetary policy, banking and other financial institutions and arrangements and exchange rates and trade and the industrial policy.

In the areas of banking and capital market, prudential norms and regulatory practices are being put in place. A Board for Financial Supervision has been set up, along with the introduction of prudential norms for banks, financial institutions and non-banking financial companies. The Securities and Exchange Board of India (SEBI)has

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been vested with requisite powers to regulate the Capital market and to take steps towards setting-up of Central Depositories for Capital market instruments to smoothen the delivery and settlement mechanisms. National Stock Exchange has brought about an automated screen based trading system in securities.

Reforms in regard to the exchange sector include progressive reduction of tariffs, liberalisation of import licensing, removal of exchange restrictions on trade and services, introduction of convertibility of the Rupee in external current account and a series of measures to promote foreign, direct as well as portfolio, investments.

Concomitant with liberalisation and competition in the domestic market and globalisation of markets, there have been rapid strides in information technology, affording quicker communications. The latter aspect has changed the whole financial market environment turning it into a round-the-clock market with cross-border flows of funds.

A fall-out of economic reforms and info-tech revolution is the increase in risks at both the macro level and micro level, leading to a variety of hedging products in commodities as well as securities. The nature of contracts and the evidence in courts of law have undergone a sea change. Investor protection in an uncertain and volatile financial environment has assumed a lot of significance.

As the economy opens up, it is becoming increasingly clear that the spectrum of issues arising from reform require to be addressed by new and amended set of statutes. Adjustments and reforms in the legal system would be imperative. Many of the existing statutes, in the context of reforms, have become anachronistic and conversely there are now many areas for which legislation is simply non-existing or to use the legal term *'non est'*. Some commercial and economic laws are ambiguous and inconsistent as they suffer from bad drafting or the existence of overlapping pieces of legislation. Procedures and regulations are exasperatingly complex often pushing up the costs of compliance with law. Non-compliance is not made costly: it has as a result become enticingly lucrative to those who believe that law could be circumvented. The conspicuous absence of a market friendly law calls for not only new set of procedures and regulations but also a new set of investigation and adjudication machinery to deal with hi-

tech economic offences effectively and efficiently. What is also needed is an altogether new legislative, administrative and judicial rethinking or, to put it simply, a new criminal jurisprudence.

Nature and Scope of Economic Crimes :

Economic crimes often referred to as white collar crimes were defined by Sutherland as crimes committed by a person of respectability and high social status in the course of his occupation . Such crimes are primarily limited to such acts as promulgating false or misleading advertising, illegal exploitation of employees, wrong labelling of goods, violation of weights and measures statutes, conspiring to fix prices,selling adulterated foodstuffs and evading corporate taxes. Subsequently, they also include bribery and corruption, black marketing, profiteering and hoarding, smuggling, violations of foreign exchange regulations and such other violations by men in professions. Now with the economic reforms measures and the opening up of the economy, the economic offences are no longer limited in nature and scope. Different types of frauds are committed by different groups and perpetrated on different target groups like investors, banks and other financial institutions, pension and provident funds, creditors of companies. Manipulation of financial markets and frauds involving Central and State Governments are also commonly seen . Frauds in the financial sector have also assumed unrecognisable proportion, in view of the growing computerised environment and the absence of legal provisions to take their cognizance and properly punish such fraudulent acts appropriately.

Among the frauds in banks, the following three elements have been found to be common.

- Active involvement of the staff, both supervisory and clerical.
- Failure on the part of bank's staff to follow the meticulously laid down instructions and guidelines; and
- External elements perpetrating frauds on banks by cleverly done forgeries or manipulations of cheques/drafts and other instruments. (Bhalla, 1993)

Frauds in the capital or stock market have been found to be on account of absence of regulation on matters like, bad deliveries, insider

trading, and shares switching or issue of duplicate shares and on account of lack of infrastructure facilities like availability of depositories.

As regards crimes committed in computer environment, in a recent publication on the subject, the following acts have been described (Goyal and Pawar, 1994)

- Unauthorised attempt to access, alter, add, delete or hide data.
- Unauthorised attempt to access, alter, add, delete or hide program or system.
- Stealing of data or programmes in any manner.
- Unauthorised (physical and/or logical) entry into computer work environment.
- Change or alteration of the defined systems.

On the basis of the above description computer crimes are classified into three broad categories :

- Data related crimes.
- Software related crimes.
- Physical crimes.

In the UK, computer crimes are dealt with under two enactments. The UK Counterfeiting Act of 1981, contains a special section defining forged "instrument" as including "any disc, tape, sound track or other device on or in which information is recorded or stored by mechanical electronic or other means". All crimes against documents are thus extended to electronic data. Further, the U.K. Computer Misuse Act, 1990, for the first time defined three distinct computer crimes and provided for punishment varying from six months to five years imprisonment. The offences defined under this Act are :

(i) Unauthorised access to computer material;

(ii) Unauthorised access with intent to commit or facilitate commission of further offence; and

(iii) Unauthorised modification of computer material. In all the above offences an element of "intent" is required.

The United States provides a much more comprehensive criminal law in regard to computer crimes. The Counterfeit Access Device and Computer Fraud and Abuse Act, 1984, is a complete code. But most of the offences under this Act are directed against computer systems operated for or on behalf of the Government.

Shere Committee (1996) has observed that advent of electronic funds transfer (EFT) may open up new issues in bank frauds. Special statutory provisions to provide for criminal liability for unauthorised access and fraud, without requiring proof of the elements of *mens rea* as in the traditional criminal liability principle, may have to be provided. It also recommended that in the long term, offences in regard to computer misuse and penalty may be defined on the lines of the UK Computer Misuse Act, 1990.

In the light of the above, the relevance of new criminal jurisprudence could be examined *vis-a-vis* accepted notions of innocence of the accused and its relationship to *mens rea*. Punishments and the concept of the burden of proof must be suitably changed to meet needs of the times.

Innocence of the Accused

The common notion of criminal justice in several countries is that a hundred guilty persons can escape but one innocent person should not suffer. The general good and well being of an individual demanding maximum liberty and freedom from interference was the basis underlying this concept. Too much reliance on such concepts is sure to sound the death knell of the rule of law. It has to be recognised that one wrong and undeserved acquittal has no less bad repercussions in society than a wrong conviction. Every guilty person and culprit who escapes punishment is latent threat to the peace and morale of the society and confidence in the institutions of law and justice, since the escaped would continue to be in pursuit of new victims. Jeremy Bentham (1896), in his Theory of Legislation has observed that "to acquit a criminal is to commit by his hands all the offences of which he is afterwards guilty".

The emerging economic criminality observed lately in high finance, capital and money markets is the handiwork of professional

people, including the industrialists and businessmen. The crime is committed often because of their expert command over the scientific and technological know-how. Therefore, the new approach should emphasise more on the harmful conduct of the accused than on his individual guilt. A review in this context is called for, of not only the legislative provisions but also the questions relating to their cognisance, investigation, prosecution and punishment. Framing new laws is only a first step. What is required is effective enforcement and compliance. The investigators, prosecutors and the judges must therefore ensure against wrongful acquittals no less than against wrongful convictions.

Criminal Liability and *mens rea*

The maxim *'actus non facit reum, nisi mens sit rea'* incorporates the concept of criminal liability arising under the English Common Law. The maxim requires two conditions viz., a wrong act and a guilty mind to coexist. Mere doing of a wrong and prohibited act is not enough in itself to fix a criminal liability; the guilty intention must simultaneously exist. Requirement of *mens rea* became universal in most of the legal systems in course of time, as strict or absolute liability was either nonexistent or an exception and offences carrying strict liability were few and limited to minor offences.

According to Jerome Hall "the meaning of strict liability is derived by opposing it to liability for fault.In problems relevant to criminal law, strict liability means liability to punitive sanctions despite lack of *mens rea*". Existence of penal liability independently of proof of guilty mind or intention or wrongful state of mind is termed as strict liability. Such a liability is also sometimes called absolute liability, even though the expression 'strict liability' is commonly employed. The courts have often insisted that the statute creating a socio-economic offence must specifically or by necessary implication exclude the element of *mens rea* and the exclusion cannot be presumed merely because the offence was public welfare offence or socio-economic offence. Where the subject matter of the statute is the regulation for the public welfare of a particular activity, as in the case of use of negotiable instruments[1], it can be inferred that the legislation intended that such activities could be carried out under conditions of strict liability. The presumption is that the statute or statutory instrument

can be effectively enforced only when the ordinary presumption of *mens rea* is displaced. *Mens rea* by necessary implication may be excluded by the statute only where it is absolutely clear that the implementation of the object of the statute would otherwise be defeated.

The Indian courts are prepared to dispense with *mens rea* if the legislative enactment has so expressed or intended. The courts start with initial presumption in favour of the need for *mens rea* but are prepared to dispense with it, if it can be gathered from the language coupled with objects and purposes of the legislative enactment. It is therefore necessary that any new legislation to deal with the emerging economic criminality be forthright in excluding the ingredient of *mens rea.*

Burden of Proof

The new pattern of economic offences emerging out of high technology also deserve to be considered from another important aspect of criminal law namely, the burden of proof. In the context of criminal cases it means the duty to prove the guilt of the accused. Under the Indian Criminal Law, the burden of proving the guilt of the accused is always upon the prosecution and until so proved, the accused is presumed to be innocent. It is reiterated every now and then that it is not for the accused to prove his innocence, since his innocence is presumed and the prosecution must be under obligation to prove the guilt of the accused beyond all reasonable doubt and that prosecution can succeed merely on the balance of probabilities. The maxim *'nellum crimen sine lege'* is the cardinal principle which implied that penal statutes should be always construed in favour of the citizen and that no man could be put to peril on ambiguity. Fitzgerald has observed that "no rule of criminal law is of more importance than that which requires prosecution to prove the accused's guilt beyond reasonable doubt." Section 101-114 of the Indian Evidence Act of 1872 dealing with Burden of Proof substantially incorporates the principle that the onus of proving the guilt beyond reasonable doubt never changes and it always rests on prosecution and that suspicion however grave can never take the place of proof.

It is necessary to consider in respect of cases of economic offences whether a different approach is called for in view of their

many peculiarities. The hi-tech economic crimes which transcend the visibility of ordinary crimes are a menacing threat to the national economy which may even result in economic bankruptcy and cause political insecurity. Such crimes cannot be dealt with by anachronistic and outdated rules of evidence as to burden of proof, which would not only cause untold misery to the people but also undermine people's faith in the court of justice. These offences call for concerted corrective action .These offences do not admit of strict proof and therefore, it is vital to dilute the vigour of principles like Burden of Proof and presumption of innocence of the accused. The only way to secure convictions of the guilty offenders is to make necessary provisions in the new statutes creating presumptions in law against the accused and relating to the rules of evidence regarding burden of proof.

Punishment

Every criminal wrong or crime creates a liability which is always penal and is commonly known as punishment. The purpose of all punishments is fourfold, namely; deterrence, prevention, reformation and retribution. However the primary and principal purpose has always been deterrence. The economic offences, unlike traditional crime, are associated with upper class people and often committed by well-to-do men in industry, trade and profession through fraud, misappropriation and misrepresentation. These offences have a tendency to undermine the political, social and economic stability of state and therefore, calls for strict and effective handling. The only way to bring the effect of punishment in these cases is through the punishment of imprisonment, as no amount of fine howsoever high or exorbitant would serve the purpose if the offenders have money in plenty and they could be corporation and companies in many cases. Further, no stigma is attached to these offences and these offenders are not looked down upon in society, nay in some cases they are adored by sections of the public. The Legislature must therefore provide imprisonment as minimum punishment to provide to an extent the element of stigma of jail to offenders. Legislature should not be content with only providing maximum punishment but should go further providing for mandatory minimum imprisonment[2].

Confiscation is a recognised form of punishment. The power to confiscate goods in the cases of fraudulent economic gains should be provided for. For instance in cases of drug trafficking, such punishment is also necessary to keep harmful articles like drugs out of circulation by confiscation. Apart from confiscation, an effective punishment in specific cases of economic offences could be by provision of forfeiture of properties of persons convicted of certain offences. Pending conviction, properties of the accused which are likely to be disposed off or transferred could be also attached by giving sufficient power to the investigating or adjudicating agencies.

Investigation and Trial

Detection and investigation of economic offences is not an easy job. Complex and varied methods employed in the perpetration of these crimes require adoption of new scientific and technologically advanced techniques in their investigation. Special investigating agencies equipped with competent staff possessing the required expertise and technical knowhow of modern electronic gadgets need to be created for this purpose.

It would be useful to have a specialised agency on the lines of a Serious Fraud Office (SFO) of U.K. established in order to ensure that where serious criminal offences like frauds involving the manipulations of financial markets or scams in banks and financial institutions are suspected, they will be investigated, and if the evidence is available, prosecuted notwithstanding their complexity. The SFO plays a key role in the maintenance of confidence of the financial institutions of the U.K.

The distinctive feature of the SFO's approach to investigation is its use of multidisciplinary teams. When a case is accepted, a team of lawyers, accountants, police officers and support staff is appointed. The team is headed by a senior lawyer, who as case controller is responsible for ensuring an expeditious and effective investigation and for any ensuing prosecution. The case controller is assisted by a case secretary who provides administrative assistance and controls the distribution of case papers. For unravelling frauds, SFO is required to examine vast quantities of documents and evaluate the information thereunder through specialists like computer experts, bankers, stock-

brokers etc. so that the information can be presented in Court in a compact and coherent form. Police officers attached to SFO, work closely with accountants and lawyers but more or less maintain their constitutional independence, accountability and command structure. Powers of the Director of SFO and police are designed to complement each other. Police are represented on SFO Senior Management Board and at SFO by senior police liaison officers.

The investigating teams supporting SFO heavily rely upon advanced information technology like forensic computing. The fraud investigations include the seizure of computers and securing data for use as evidence. The technology is used to meet the problems of capturing, controlling and analysing vast volumes of material associated with all fraud investigations. Optical scanning technique is used to capture the text of statements, exhibits and other documents on to computer for subsequent analysis and retrieval. An agency may be created in India to make an innovative use of technology as an aid to simplifying and shortening trials. Various techniques can be used such as computer generated graphics to explain concepts like the mechanisms of company take-overs complex money flows and company structures. Screen based multimedia presentations can be built up to focus on the point being made and to display material, thereby reducing the number of documents that are often shown to the Court in hard copy.

Suggestions

Time and again different agencies have voiced a need for Special Court at all major centres for hearing cases of frauds in the banks. It is often observed that after detection of frauds, criminal cases take long time to succeed before the offenders are punished. Also, due to delay in settling the issues under the present legal system, banks are constrained to compromise with their recalcitrant borrowers, who have committed fraudulent transactions. It is therefore necessary to simplify the legal process and to have confiscation or freezing of the assets as measures for execution of the claims of the banks against the offending borrowers. The delays in the courts fall within the domain of administration of criminal justice and has various angles. Expeditious dispensation of punishment to economic offenders or persons indulging in bank frauds would also require

expeditious detection and investigation as also special procedure to ensure expeditious disposal of such cases. While for expeditious detection and investigation, a special investigating agency on the lines of Serious Frauds Office (SFO) of U.K. can be considered, there should be Special Courts or Tribunals to deal with frauds in banks.

The setting up of Special Courts, special investigating agency as also special procedures can be undertaken through a separate legislative enactment which should also define *inter-alia* as to what is a "bank fraud" or "a financial fraud". It is essential that the element of *mens rea* be dispensed with while defining such fraud and make it a statutory offence of "strict liability".

The proposed legislation for setting up of the Special Court or Tribunal should of course pass the test of "reasonable classification" under Article 14 of the Constitution. Mere necessity for speedy trial has been held by the Supreme Court[3] to be too vague, uncertain and illusive a criteria to form a rational basis for classification, which is the first requirement to pass the test of reasonableness. In the light of the principles applied by the Supreme Court, banks and financial institutions could be considered as a separate class and frauds involving them could qualify for speedier treatment through a Special Court. There may be no infringement of Article 14, if the offence of "bank fraud" or "financial fraud", is clearly defined and is prescribed to be triable by the Special Court and under special procedure according to a reasonable basis of classification. However, jurisdiction of the Special Court or tribunal in relation to territory, peculiar limits if any, institutions to be covered etc. will have to provided. The proposed legislation should also provide for special powers and special procedures. Also special presumptions of evidence will have to be clearly set out. It would also be possible to empower such Court or Tribunal to confiscate or freeze the assets of offenders found guilty of bank fraud. There are provisions in several existing laws like Customs Act, Foreign Exchange Regulation Act empowering enforcement agencies thereunder to seize and confiscate assets of offenders. However, such authorities have powers only to seize and no powers to freeze or attach the assets, pending investigation of alleged assets.

As regards seizure by investigating agency, Section 102 of Criminal Procedure Code, 1973 empowers a police officer to seize any

property which is found under circumstances to create suspicion of commission of offence. However seizure of property would not include attachment or freezing of assets. It has been held by Guwahati High Court[4] that it is not permissible for a police officer to direct the bank not to allow the accused to withdraw money or property from accounts and locker held by him. The proposed legislation should therefore be specific, while empowering the special investigating agency to attach/freeze assets of offenders pending investigation. Such a provision could be on the lines of Section 281B of the Income Tax Act, 1961, in terms of which during the pendency of any proceedings for the assessment of income the Assessing Officer is of the opinion that for the purpose of protecting the interests of the revenue, it is necessary so to do, he may with the previous approval of the Chief Commissioner or Commissioner by order in writing, attach provisionally any property belonging to the assessee. The proposed provision should however define the ground on which and the purpose for which the power can be exercised. It should also specify the authorities by whom the power can be exercised. The proposed legislation could also provide for acts like diversion of funds, multiple finance against the same security and tampering with the security or removal of goods hypothecated with the banks as cognizable offences.

Undoubtedly, a serious consideration needs to be given for putting in place a new law to deal with the economic offences especially in the banking and financial sector. However, enactment of a new law can only be a first step. Its effectiveness will depend a great deal on the way the Courts handle these cases, upon the promptness of despatch, a proper appreciation of the purport and spirit of the enacted law. Delay must be curtailed and to curtail the delay rights of appeal must change. One right of appeal and a revision only on substantive law should meet the ends of justice. Provisions of more appeals is no guarantee to a more just decision. The innate quality and merit of judgement rather than higher status of a Court go to make the judgement correct. A time limit should be strictly adhered to by original as well as appellate Court. There is a need for having trained Courts to deal with the new criminality, as most of these crimes involve a great measure of expertise on the part of the criminals. In short, the investigators, the prosecutors and the judges must essentially acquire the requisite expertise for handling and controlling these crimes.

Notes

1. Negotiable Instruments Act, 1881, Section 138.
2. Please see Prevention of Corruption Act, 1988 where the discretion vested in the Court under the old Act to impose a sentence of less than one year has been deleted. In other words, in the case of conviction of a police servant under section 13(2) and 46, a minimum sentence of one year has to be necessarily imposed.
3. The decision of the Guwahati High Court in M/s. Purbanchal Road Services v. The State, reported in (1991) Cr. LJ 297.
4. The Special Courts Bill, 1978, (AIR) 1979 S.C. (478), (Decision of Seven Judges Bench).

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BOOK REVIEWS

***Institutions and Monetary Policy: Credibility, Flexibility and Central Bank Independence*, Eric Schaling, Edward Elgar Publishing Limited, UK, 1995, pp. 252, £ 49.95.**

The book under review delves into the case for independence of central bank in the matters of the conduct of monetary policy, in particular, the rules versus discretion debate. The subject is topical in the context of the European union, which is the principal focus of analysis, as the Maastricht Treaty envisages a full commitment to price stability by the European Central Bank in 1997. Traditionally, the concept of autonomy of central banks rested on the presumption that political authorities are myopic while monetary stability required continuity of a long-term policy which could be ensured only by some insulation of the central bank from political interference. The idea of central bank independence appeared after the demise of the fixed exchange rate regime, when the domestic monetary regimes and consequently, price stability became vulnerable to political pressures. This idea has since gathered momentum, as price stability is being espoused by central bankers and academicians alike as the only legitimate goal of monetary policy and central bank independence is perceived as an important means to pursue it.

The author traces the arguments that show the undesirability of discretion in monetary policy to Milton Friedman who warned that policymakers not bound by a rule would indulge in excess activism, destabilising rather than stabilising the economy. The second strand of arguments, cast in a game-theoretic framework, advocates a monetary rule to neutralize the inherent inflationary bias of monetary policy, based on the problem of 'dynamic inconsistency', i.e., a future policy decision which is part of an optimal (monetary) plan at an initial date does not remain so even if no new relevant information has appeared in the meanwhile and the central bank has an incentive to deviate ex post from its announced plan. Another way to resolve the problem of 'dynamic inconsistency' is to have independent central banks.

Part I of the book analyses how the structure of monetary institutions, in particular the central bank, impinges upon the choice of policy and economic performance. Schaling compares the central bank independence in twelve industrial countries, using quantitative indices built up on a number of legal attributes from the central bank laws. In fact, the author after examining the indices as available in the literature, proposes a new index of central bank independence, called the Eijffinger-Schaling (ES) Index. The Index, similar to Grilli, Masciandaro and Tabellini (GMT) Index, uses three criteria to evaluate policy independence, viz.,

(1) Is the bank the sole final policy authority? (2) Is there no government official on the board? and (3) Are more than half of the board appointments made independent of the government?

The ES index differs from GMT index in the sense that the features are assessed in conjunction, not separately, and are asymmetrically weighted. According to this index, the central bank independence, for instance, is diluted where other objectives in addition to price stability are specified, or where the price stability is not an objective at all. Understandably, the ES index rates the Deutche Bundesbank, the cynosure of all central banks, as the most independent central bank alongwith De Nederlandsche Bank and the Schweizerische Nationalbank.

The author defines central bank independence as the strength of the 'conservative bias' of the central bank as embodied in law - the *'legislative approach'* to price stability. Modifying Rogoff Model, the propositions regarding the relationship between central bank independence and (the variance of) inflation and output growth are derived and tested, using the indices of central bank independence, for the same set of countries for the period 1972-1991. The results confirm the well-known inverse relationship between the degree of central bank independence and the level of inflation, corroborating the findings of Alesina (1988, 1989) Cukierman, Webb and Neyapti(1992) et al. However, the higher independence of the central bank does not seem to lower the variability of inflation, contradicting the earlier empirical results of Grilli, Masciandaro and Tabellini (1991) and Alesina and Summers (1993). Central bank independence is also not related to growth, implying that the attainment and maintenance of

low inflation by an independent central bank does not lead to large costs or benefits in terms of economic growth, an empirical result which is in agreement with the prediction made by Grilli, Masciandaro and Tabellini. In the author's words, "The absence of a long-term trade off between inflation and growth implies that the establishment of central bank independence is a free lunch." Moreover, the independence of central bank does not cause more variable economic growth in the short-run, refuting Rogoff's proposition of a positive relation between the two. As the author puts it rather succinctly, " ..... inflation-averse central banks do not bear the costs of triggering recessions nor do politically sensitive central banks reap the benefits of avoiding them."

The author shows that the inflationary bias of governments stems from their employment motive, i.e., trading price stability for temporary increases in employment, off an expectations-augmented Phillips Curve, or from the revenue motive, i.e., using central bank's capacity to create seignorage to finance expenditure that the government is unwilling to finance out of current or future taxation. Hence, constraints on the credit that the government can demand from the central bank would be a vital ingredient of central bank independence. Schaling contends that lower monetary accommodation of government budget deficits does reduce inflation persistence, a corollary of the inverse relationship between central bank independence and the level of inflation. Thus, apart from political independence (capacity to choose goals of the monetary policy), economic independence (nature of the monetary instruments under the control of the central bank, e.g., discount rate, open-market operations and the terms and extent of monetary accommodation of the government) of the central bank is also pertinent, particularly in the case of less developed countries with rudimentary financial markets. In a state of fiscal dominance, treasury sets the deficit which if not financed by new bond sales, needs to be met by monetary accommodation by the central bank. Under monetary dominance, or economic independence of the central bank, treasury must set the deficit that can be met by bond sales to public and the permissible level of (what Manuel Guitian would call 'legitimate', i.e., justified by increase in demand for money) seignorage revenue. Hence, domestic monetary regime, i.e., co-ordination of fiscal

and monetary policy, becomes an important determinant, apart from exchange rate regime, of inflation persistence.

Schaling, after Rogoff, establishes a role for stabilising activist feedback policy, despite dynamic inconsistency. Rogoff had demonstrated that by choosing an agent as central banker, who places a greater (but not infinite) weight on inflation stabilisation ('conservative bias') than is implicit in the social loss function, society can make itself better off. But as the central bank has private information about productivity shocks, society would be better off by letting central bank take care of these shocks before they lead to inflation and unemployment. In sum, the optimal degree of central bank independence is a trade-off between the credibility gains associated with a lower average inflation versus the loss of flexibility on account of a distorted response to output shocks.

Part II of the book analyses the normative issue of how central banks and monetary regimes themselves change and evolve in response to society's preferences and strategies. Using a graphical method, the author specifies the upper and lower bounds of the interval containing the optimal degree of central bank independence in terms of the structural parameters of the model. The author demonstrates that assuming a negative supply side effect of inflation on growth in the longer term would reduce the inflationary bias of discretionary monetary policy, alleviating society's credibility problem. On the other hand, if this supply side effect is high, lower would be the implied optimal central bank independence.

In last chapter, the monetary policy game with private information, is integrated with labour union behaviour à la New-Keynesian bargaining theories of unemployment, thus, endogenizing the natural rate of unemployment. Wage-setting is discussed in a totally unionized economy under a constant money supply rule, GNP targeting, full commitment to a simple zero inflation rule, a discretionary regime and an independent central bank as an agent for social welfare. Using a game-theoretic model, the author finds that the more aggressive the union, the higher the inflationary bias of discretionary monetary policy and the more difficult the society's credibility problem.

Thus, the optimal degree of central bank independence, as an institutional device to meet time consistency, increases with the aggression of the union. As the union becomes more aggressive, society moves from a fully discretionary regime to a nominal income rule. With a higher weight on the real wage target, a nominal income rule is dominated by the independent central bank regime. With an even higher weight placed on the real wage target, the independent central bank regime is dominated by an inflation-targeting regime. And the author does not fail to add as a note of caution, "With society's optimal central banking institution being contingent on the labour market regime, ... independence should be viewed as a *preventive* rather than a remedial device. Once high inflation has been allowed to develop, central bank independence alone does not suffice to extirpate it." (italics added)

Any study in institution arrangement has to be context specific and the author not aspiring to find any such universal arrangement, confines himself to 12 industrial countries. While this may not be a shortcoming, it would have been rewarding had the esoteric models been applied to developing countries as well to see how they fare.

To recall Cukierman, the applicability of the quantitative indices of central bank independence to developing countries is limited by the gap between the de jure status of their central banks and their de facto position, which could have yielded lack of correlation between the average rate of inflation and central bank independence in developing countries in his study. One wishes that Schaling had spent some more time on detailing the components of central bank independence, i.e., what kind of objectives and variables other than price stability impinge upon the independence. In particular, he has not listed two other important motives which could rock monetary stability, perhaps more so in developing countries, apart from the revenue and employment motives, the balance of payments motive (surprise devaluations for improving balance of payments, which again gives rise to time-inconsistency) and the financial stability motive (controlling interest rates so as not to harm the profitability of commercial banks, especially the state-owned ones).

The universality of Schaling's ES Index and of the empirical findings based on it are circumscribed by his leaving out attributes of instrument independence. The latter certainly has more relevance for central banks outside Schaling's rather limited sample, especially for the central banks in developing countries. Instrument independence, by providing some means of pursuing credibility to these central banks, could be a half-way house for them on their way to full-fledged policy independence.

Of the variables which would have implications for central bank independence especially in developing countries, the ones that need to be included are the exchange rate stabilisation, the relation of government and central banks in the conduct of exchange rate policy and the responsibility for its burden, the foreign exchange guarantees, the financial independence of the central bank, the separation of bank supervision from monetary and forex operations, the responsibility for debt management, the accountability norms (reporting requirements, audit). The author has only briefly touched upon these issues, given his focus of enquiry.

As the degree of unionisation in developing countries may not be high, one would have to think of impulses to inflation in terms other than the nominal wage contracts. In this context, apart from exchange rate movements, the government and public sector deficits spurred by subsidies and employment motive assume special significance. In fact, a tight monetary policy is unsustainable in the face of a lax fiscal policy. Chapter 5 of the book in fact discusses these issues, giving valuable leads for further research. Placing a limit on deficit, or on government borrowing as well as a cap on recourse of government to central bank credit could be important constituents of central bank independence in this context. In fact, compelling government to place its debt at market determined rates imparts economic/ instrument independence to the central bank by making its open market operations viable while limiting monetary accommodation of deficits at the same time.

None of the above observations, however, should detract from the usefulness of this contribution to the central bank independence

literature. The author, himself a central banker, has assiduously kept up objectivity in his analysis. As the theme of the book is the central bank independence with reference to the industrial world, it would be unjust to expect an universal application of the points that emerge from the study.

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Capital Controls, Exchange Rates and Monetary Policy in the World Economy **edited by Sebastian Edwards, Cambridge, New York, 1995, pp. viii + 436, Price £ 35.**

The growing openness in the world economy in the last two decades as evidenced in the expansion in trade, the internationalisation of production, the improvements in communications and the legalisation of foreign currency instruments in a number of countries has created a ground for openness of capital account. The removal of restrictions on capital controls in many industrialised countries since the 1980s created an international order in which individuals and firms started accessing the international financial markets freely, without the intermediation of national Governments to balance the differences in world saving and investment. In recent years, many developing countries, realising the inefficiencies embedded in a regime of capital control, and with the aid of the multilateral organisations like the IMF, World Bank, OECD and the European Union, have attempted to promote capital account liberalisation. This brought in its wake a wide array of concerns relating to the appropriateness of controls on capital movements in the changing context of the world economy. The book under review is an attempt to unite the ideas and experiences in this area with the help of some broad theoretical chains. The volume contains contributions from the well known experts like Robert Mundell, Jeffrey Frankel, Manuel Guitian and Sebastian Edwards. A blend of theory, policy and experience is the hallmark of the book which obviously stakes a claim to be a good research work on international capital mobility and monetary policy.

The presentations in the book revolve round three basic themes, *viz.*, a) the impact of capital mobility on the macro economy, b) the sequencing of the process of liberalisation, and c) the effectiveness of capital controls in achieving their intended objectives. Though the authors discuss these issues taking into account the socio-economic contexts of the countries concerned, certain broad lessons could still be derived.

The practical policy problems in capital account liberalisation and the resultant loss of control on domestic monetary policy are widely recognised because there is a perceived threat that removal of capital controls is likely to increase the vulnerability of domestic economy to external shocks, which may destabilise the economy and in some cases result in over-borrowing eventually leading to a debt problem, loss of confidence and capital flight. How do various countries address these issues while liberalising their capital account? Are macroeconomic stabilisation objectives consistent with capital account convertibility? These questions are important and are faced by policy makers in developing countries at regular intervals.

Macro economic reform process in many developing countries has significantly moderated domestic inflation rates in recent years and attracted capital inflows from abroad. The dilemma of protecting real exchange rate from appreciation, on the one hand, and ensuring domestic price stability on the other, has posed difficult policy challenges for these countries, which, while treading cautiously towards capital account liberalisation, seek to keep their sights fixed on the stabilisation objective. Country experiences in this regard are helpful. For instance, Mundell shows how the Korean stabilisation policy in the 1980s successfully tackled the issue of coordination of capital inflows, domestic inflation and exchange rate appreciation, through a combination of measures which strengthened the structure of the macro economy, put in place an appropriate exchange rate and reduced pressures on the interest rate. While fortuitous external environment played a major role in the Korean success in dealing with the capital inflow, what, however, emerged triumphant is the policy authority's resolve to balance the budget and apply monetary restraint.

Frankel's contribution on the experiences of the newly industrialised economies of Asia highlights the importance of the integration of monetary policy and exchange rate management in dealing with capital inflows. Frankel suggests that a flexible exchange rate system with nominal anchors seems to be the best policy option if capital account is to be liberalised. Appropriate monetary policy will in such case be determined by structural constraints of the economy.

Minford shares a different perspective on whether exchange rate should have a nominal anchor, with a high degree of capital mobility.

He examines the issue in the context of the exchange rate management in the European Union. Minford demonstrates that a system of flexible exchange rates leads to a more stable economy than an ERM-type target zone approach, particularly when there is lack of co-ordination among member countries.

What are the experiences of OECD countries with regard to capital account liberalisation? The context of the question stems from the fact that, for one reason or the other, most of the OECD countries did not favour liberalisation of capital account till the 1980s, in view of the abortive attempts towards liberalisation in the 1960s and the early 1970s. Tracing the history of capital account liberalisation in these countries, Shafer argues that while capital controls in a macroeconomic context enable the authorities to achieve inconsistent short-run objectives, they inevitably build up imbalances and raise the question of credibility in the market which may necessitate "brutal adjustments when it becomes impossible to sustain it". Shafer notes that the trend towards liberalisation in the capital account in the OECD countries was influenced by the concern that costs of a `command and control' approach could be high in terms of inefficient allocation of savings. An important lesson that Shafer drives home is that removal of capital controls must be accompanied by fundamental reorientation of monetary policy to control inflation, as it happened in the OECD countries. Indeed, if it were not for deregulation of capital transactions, the OECD countries' resolve to ensure long run price stability could not have been as bold as it has turned out to be now.

Unified views on the capital account liberalisation, however, cannot be got, going by the experiences of Asia-Pacific countries in relation to capital account liberalisation and macroeconomic policy. Discussing the experiences of Korea, Park and Park note that increased capital flow is more likely to produce higher growth at the cost of higher inflation and deterioration of balance of payments – a concern that is shared in many developing countries. Relating the real asset speculation in Korea to capital account liberalisation, Park and Park caution that real asset prices may jump as a result of disequilibrium in the domestic and external markets and this was evident in the second half of the 1980s, when Korea witnessed exchange rate appreciation and a huge trade surplus. The fact that Korea has so far

viewed capital account liberalisation with a tinge of aversion and scepticism is a testimony to what could be termed as an 'over cautious' approach to financial market deregulation when fundamentals are not all that sound. In contrast to Korea's overcautious approach, deregulation of capital account in Japan was guided by the trade situation in that country – relaxation of controls to encourage capital inflow when trade deficit was high and yen was depreciating, and withdrawal of controls to encourage capital outflow when trade surplus was rising and yen was appreciating. Fukuda examines the determinants of capital controls in Japan and the distributional effects of deregulation for the Japanese economy. An important finding by him is that while regulations of capital inflow helped the Japanese Multinational Trading companies to exploit the arbitrage opportunities in the forward exchange market and increase their exports, particularly to South-East Asian economies, they had adverse welfare implications for the Japanese economy in terms of distortion in resource allocation.

The book contains two very competent contributions - one by Sebastian Edwards and the other by Calvo *et al* – on the macroeconomic implications of capital account liberalisation for Latin American economies, which face an altogether different economic environment and have a history of prolonged economic instability. Sebastian Edwards explores the experiences of Latin American countries with fixed exchange rate regimes. He argues that the crises in the fixed exchange rate system of Latin American economies stemmed from the desire to override financial discipline with the help of foreign debt. While this is an important finding, Edwards has not addressed the implications of capital account liberalisation for the exchange rate regime, which is the principal focus of this volume. Calvo, Leiderman and Reinhart revisit the episodes of liberalisation in Latin American countries and argue that the recent surge in capital inflow to these countries might see a reversal due to external factors and the policy authorities may have to face an entirely different set of questions than at present, which are mostly in the nature of tackling the problems of exchange rate appreciation and higher domestic inflation. A major concern expressed by them is that capital inflows into Latin American economies are mostly of 'Hot Money' variety which can reverse at short notice and may cause domestic financial

crises. The loss of exports due to exchange rate appreciation resulting from capital inflows is also a cause of concern. In this context, Calvo *et al* explore alternative policy options for Latin American countries to deal with capital inflow - tax on capital imports, export subsidies, fiscal tightening, sterilised and non-sterilised intervention by central banks and other measures such as increase in marginal reserve requirement on banks and regulation on bank investment in equity and real estate markets. While Calvo *et al* are strongly against the sterilised intervention on the ground that it might increase interest rate differential and imply higher fiscal burden, they seem to prefer policy measures like taxing short term capital imports, raising the marginal reserve requirements on banks and increasing the scope of exchange rate flexibility. They are not, however, convinced that these measures will dramatically change the behaviour of exchange rates and interest rates in these countries, although they might help to reduce the vulnerability of a possible capital flight.

Apart from the question whether a country should deregulate capital transactions, the problem of sequencing has also assumed importance in this context. Mckinnon shows that liberalisation of trade accounts generates a depreciation in the exchange rate while relaxation in the capital account results in an appreciation of the exchange rate. This problem of competition of instruments is resolved by delaying the capital account liberalisation until the removal of trade distortions through adjustments in the real sector. A number of studies have noted that with a significant presence of trade distortions, opening up of the capital account controls may reduce welfare instead of increasing it. The book seems to suggest a consensus in the sequencing pattern, starting from trade reform and proceeding towards financial reform. It has also been noted that once trade reforms are put in place, the channels of erosion of capital controls are numerous with the result that the effectiveness of capital controls significantly wanes. This lends some inevitability to the sequencing process where trade reform increases the costs of control in the financial markets, ultimately opening the way for financial deregulation. Another major concern associated with the liberalisation of capital account is the erosion of the domestic tax base for the Government. This makes fiscal consolidation an essential pre-requisite for capital account liberalisation. Manuel Guitian, Hansen, and Park and Park

deal explicitly with the sequencing debate. Guitian's survey emphasises the need for sequencing and a stable macro economy before relaxing capital controls. Park and Park favour a gradual approach instead of rapid liberalisation . Hansen has stressed the importance of having a sound domestic financial system in the transition to an open capital account. In discussing the sequencing pattern of capital account deregulation in different countries, the book recognises the existence of synergism in the liberalisation process by which reform measures in various sectors reinforce each other to produce efficient outcomes for the economy as a whole. A typical trade liberalisation process requires exchange rate depreciation on a sustained basis for a considerably long period of time alongwith macroeconomic stability assuming a primary responsibility towards stabilisation at the early stages of reform. These conditions are of crucial importance to absorb the negative outcomes that the capital account liberalisation may produce for the trade and monetary sector.

The third issue which has been discussed at length in this book is the efficacy of controls. Many economists have tended to argue that controls would be ineffective as there can exist a number of channels through which controls could be evaded . Besides, the rapid growth in liquid international funds and increasing globalisation of production have made capital controls costlier. Growth of offshore markets has eroded national financial barriers and has enhanced the capacity of firms to develop evasion strategies. The sustained growth of multinational firms has led to potentially rapid capital movement which is difficult to be brought under capital controls. Once current accounts are made free, in a world of integrated capital markets, ensuring the efficacy of capital controls could turn out to be costly.

A number of empirical studies have revealed that controls slow down the process of convergence of domestic and international interest rates by introducing divergences in the interest rate parity conditions. It is also argued that if domestic saving is found to be highly correlated with the domestic investment, capital controls could have effectively blocked the external influence on investor preferences. The book has succinctly presented these arguments and analysed the efficacy of capital controls in meeting their intended objectives in the context of various economies.

Though the volume has generated high quality discussions on a number of interesting issues in capital account liberalisation, certain other issues which have been gaining prominence in the recent years have not been given enough attention. The impact of capital mobility on intersectoral as well as intertemporal consumption and investment pattern has not received due place in the book. Again, the possibility of speculative attacks and their consequences have also not been discussed. In reality, investors are prone to rumours and in spite of all the information technologies, speculative forces tend to have bandwagon effects and influence capital flows . It is in this context one appreciates the Tobin proposal to stem the speculative forces by imposing a transaction tax on capital,'throwing sand in the wheel'. Others have emphasised the need to accommodate private reaction to controls for an improved understanding of the implication of controls.

Notwithstanding these limitations, the book is outstanding for its ideal balance of theory, practice and quantitative analysis, and for its simple and straightforward message of the issues that policy makers need to consider before undertaking such a vital policy measure as capital account liberalisation.

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