Input Output Modeling of Impact of Exchange Rate Fluctuations on Indian Economy.

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Abstract

The paper has used Prakash theorem to develop an input output model to estimate output effect of foreign exchange rate fluctuations through their impact on export earnings and import bills. The study finds that exchange rate has fluctuated a lot from 1990-91 to 2007-8, though the fluctuations lie outside the range of stability for four years of the study period. Indian rupee has depreciated by nearly two thirds of its value in the base year. Fall in the value of rupee has induced exports to rise ahead of income. But import bills have not bee affected significantly by depreciating value of rupee, indicating positively sloped demand curve for imports. Results of decomposition model of export earnings and import bills show the pivotal role of change in exchange rate, though the quantitative dimension is relatively more important in imports than exports. Results lend credence to the input output and decomposition models developed in the study.

Introduction

Immediately after independence, India launched an ambitious program of economic development based on industrialization. The basic objective was long term self reliant and sustained growth, driven basically by the development of heavy and basic goods industries. But public sector was envisaged to assume the commanding heights of the economy. Naturally, Indian economy was a partially closed economy during the era of planned development from 1950-51 to 1989-90. The country adopted import substitution strategy of growth and the exchange rate was an administered price. Foreign exchange transactions were heavily controlled, since the foreign exchange scarcity was one of the serious constraints to growth. Besides foreign exchange, following were major constraints to growth: scarcity of (i) food, (ii) capital, and (iii) advance technology. Development policy addressed all these constraints. The stagnant Indian economy did move on its growth path. The consistent growth of the economy mitigated some of the above constraints. The economy has achieved a development status which warranted the change in strategy (For details, See, Prakash, 1994).

Rationale of Change Policy

In the post 1980 era, strategy of growth has come under close scrutiny. Rapid growth of Asian Tigers induced policy makers and analysts to evaluate the appropriateness of the policy of growth pursued by India. *India, which was most developed Asian country after Japan at the time*

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of independence, has been left behind by Asian Tigers in the race for development in the era of planned development. The growth performance of Indian economy during the perod is considered as measly relative to that of Singapore, South Korea, Malaysia, Thailand and Indonesia. Even after three decades of planned development, the country faced shortages of even the

basic goods like food, sugar, milk, cement, steel and conveniences like LPG and two wheelers. Even though the imports of such heavy and basic goods

as machinery, steel, cement, railway engines, heavy electrical equipment and wagons could be substituted by domestic production, yet the import dependence rather than being reduced was further deepened because both import substitutes and new items of exports embody high import intensity. The goal of self reliant growth was more a mirage than reality. Policy of open economy and export led growth strategy in South East Asia

succeeded much more than the Indian policy of closed economy and import substitution. In 1990- 91, India adopted new economic policy of liberalization, privatization and globalization to open up the partially closed economy. Economic reforms naturally focused primarily on international trade in the first phase with a view to integrate Indian economy into world economy. The policy shift warranted the liberalization of imports, promotion of exports and replacement of administered by market based exchange rate policy. *The degree of success of new policy may be evaluated by the analysis of comparative growth of income, exports and imports in all the above three periods.*

The main objective of the study is the evaluation of impact of foreign exchange rate fluctuations on the economy in general and export earnings and import bills in particular. But exports and imports affect income and its growth both directly and indirectly. Therefore, other objective is the evaluation of output effect of exchange rate fluctuations on different sectors of the economy.

Exchange Rate: Concept

Exchange rate is the combination of two words: rate and exchange. Rate refers to the value/price at which transactions take place, and exchange is the process of buying and selling. The process of buying and selling necessitates determination of price of commodities or service entailed in exchange. Price of money/currency also behaves like commodity prices. Prices of goods and services are determined in terms of money, value of money, in turn, is shown in quantities of goods and services that money can buy. The domestic price of national currency is expressed by its purchasing power of goods and services in the market. Similarly, external value of national currency may be expressed by its purchasing power of in terms of goods and services in foreign market. But currency of one country is not accepted as medium of exchange in other countries. So, domestic currency has to be converted in to foreign currency in foreign exchange market. The conversion rate is defined as exchange rate. Purchasing power of national currency in foreign markets is expressed in foreign currency, generally US dollars, Euro or a basket of 10 currencies. The foreign currency is the medium of exchange in external market. Exchange rate is the external price of domestic currency. Purchasing power of foreign currency in national market is measured in domestic currency.

Each country has commodity, services and financial markets. Foreign Exchange market is one of the financial markets. Capital market deals with the determination of prices of (i) equity or stocks, and (ii) interest rate as the price of loan capital. All markets have two segments: (a) spot market, and (b) futures market. Both segments of the markets are intimately related. This is true for exchange market also. Besides, commodity, real estate, gold, and foreign exchange markets are intimately related with one another. This is especially true for futures' market. It is hypothesized that foreign exchange rate is related to interest rates, stock prices, gold prices and real estate prices. Investment funds are transferred from one to another market under specific conditions. Investment, both domestic and foreign, in stocks, goes as capital into production sectors of the economy. Export earnings and profits received form abroad also constitute a source of capital formation. There is an intricate web of inter relations among all financial markets. Investment in foreign exchange's futures market has to compete with the commodity, gold, real estate and stock's futures market.

Determination of Exchange Rate and its Fluctuations

Like other prices, exchange rate also changes with the changes in the state of market. Just as other prices depend on supply and demand, exchange rate also depends on the configuration of forces of supply and demand. However, two important facets have to be noted: (i) Unlike goods and services, foreign exchange has no direct cost of production. It has only opportunity cost. Import bills have to be paid through export earnings. So cost of production of exportable surpluses may be taken to constitute the direct production cost of exports and indirect cost of imports. Opportunity cost is accounted by with drawl of exportable surplus from domestic consumption. Fluctuations are a natural characteristic of foreign exchange rate market, provided that the exchange rate is not an administered price. If exchange rate is an administered price, it is determined administratively by the central bank of the country. Administered foreign exchange rate is generally endowed with stability as both demand for and supply of foreign currency is under the control of central bank.

Exchange rate, on the whole, fluctuates like other prices, which generally varies with change in demand and/or supply. Imports, foreign aid, investment in other countries and remittance of profits abroad are the major sources of demand for foreign exchange. Export earnings, foreign investment in the domestic market, foreign aid from other countries and receipt of remitted profits from other countries, remittance of NRI earnings are the major sources of supply of foreign exchange. A change in any of these brings about a change in supply and demand for foreign currency. But imports and exports are the major sources of demand and supply of foreign exchange. Demand for foreign exchange increases with imports, investment in other countries, profits remitted to other countries and foreign travels etc.

Stability Vs Fluctuations

The adjective 'Fluctuations' is an indicator of instability in foreign exchange market. The concepts of stability and instability are often contrasted. *Classical economists assumed the 'stability of equilibrium' a la Say's Law of Markets.* Thus, they assumed away the facet of

instability of the system. Leo Walras (1874) furnished the first concept of *'stability and associated it with the dynamic process of tattonment with a view to eliminate divergences between demand and supply prices on offer in the market at the given point in time. Adjustment process remains in operation till supply and demand prices coincide. Once the divergence between demand and supply price is eliminated equilibrium prevails in the market.* Obviously, stability is seldom a problem in a stationary or static system. Actual systems are, however, dynamic. Concept of 'stability' has thus a dynamic system as its context.

Difficulty in analyzing di-equilibrium systems has probably discouraged economists to analyse instability empirically. *This may also probably explain the popularity of Computable General Equilibrium Models.* Hicks and Samuelson may be cited as exceptions to general apathy, though they also focused on stability/ instability in the general equilibrium framework.

The two concepts of stability, enunciated by Hicks (1939) and Samuelson (1941), have been related to the general equilibrium. Both Hicks and Samuelson used the ideas of Warals (1874). Hicks states that "a fall in the price of X in terms of the commodity' or numerari 'will make the demand for X greater than the supply". Hicks retains the assumption of static state to allow corrective change in demand through the change in price to restore equilibrium. But 'inverse relation between the derivative of ED (excess demand) is negative at the equilibrium point under smooth demand function for X'. Samuelson's proposition extended the concept of stability to the dynamic system of tattonment of Walras. But such a system requires a new agent like the market secretary or auctioneer, who is in charge of varying the price if demand differs from supply. The process continues till the price that clears demand in the is reached. Auctioneer or Secretary of the market is an artificial construct except the agriculture and auction markets. The dynamics of tattonment not derived from such preferences of individuals as maximize the objective function subject to constraints entailed in the information. perceived by individual agents. These imperfections partly explain the want of interest in the analysis of stability by many economists.

Let us state that we are here concerned with the stability of actual external price of domestic currency rather than the stability of its equilibrium price. The price (exchange rate) stability embodies both conceptual and methodological problems in so far as empirical measurement is concerned. If the exchange rate does not change at all over a period of time, as is the case under administered price mechanism, question of instability does not arise. So instability arises from temporal changes in market based exchange rate. Then, what is the dimension of change, absolute or relative, that may be associated with stable exchange rate? Relative price of national currency may be considered to be the criterion of stability. It may be suggested that the average, calculated by exclusion of extremely high or low changes as outliers, may be acceptable as standard for this purpose.

Then, $\bar{X} \pm \sigma$ may be accepted as admissible range of variation under the conditions of stability. Assumption underlying this is that the temporal changes in exchange rate are normally distributed. In a growing system, excess demand or supply can not be ruled out. So exchange rate can not be envisaged to remain constant through time. Dynamics of stability is, however, associated with the formation of expectations. But expectations not only differ among individuals but individual's expectations also tend to change frequently from time to time. *So, the concept of stability is associated with temporary equilibrium which is embodied in equilibrium of expectation. Stable Equilibrium, therefore, denotes realization of expectations of*

the agents in the market. 'A state in which the expectations of most of the agents have been realized may be defined as equilibrium of expectations' (Cf. Boulding, 1972). It highlights the crucial role of expectations in endowing equilibrium with instability or its characteristic as being temporary in time horizon because it does not last outside the period under consideration due to changing expectations. The series of temporary equilibria embody either excess demand or excess supply that percolates into next period. This is the feature of flex price markets.

No concept of stability has been imported into the analysis of financial markets in general and stock and exchange markets in particular, a few studies of volatility of stock markets notwithstanding. Foreign exchange market is no exception to this. If, however, we distinguish between spot and futures trading in these markets, this may easily be imported into the analysis of financial markets, including foreign exchange market.

Two Mechanisms of Rate Determination

The mechanism of determination of exchange rate may be distinguished broadly into two categories: administered and market based. Besides, in second category, outflows of exchange may be under full convertibility on revenue and/or capital account. Under administered price regime, fluctuations in exchange rate are not associated with the official rate; black market rate does show fluctuations. In market oriented exchange rate regimes, central bank may be induced to intervene if the rate moves in a non-acceptable band. The intervention occurs through the sale and purchase of foreign currencies by the central bank in the market. Subject to this limitation, market based exchange rate fluctuates on day to day basis. These changes comprise both benefits and losses to individuals, organizations, and economy. International travelers, for example, will gain if the value of their domestic currency falls, while an appreciation will inflict loss. Export and Import houses and service providers for international business, such as shipping, insurance and banking companies also loose or gain in the market due to rate fluctuations. The companies, making huge investment in international business, may loose or gain relatively more. Quantum of in and outflows of foreign investment will naturally be directly affected by rate fluctuations which, in turn, will affect stock market. Fortune of the corporate houses in general and export and import houses in particular is affected directly.

If the Indian rupee appreciates, it will have diametrically opposite effects. Gross terms of trade and exchange earnings will rise per unit of exports. However, overall export earnings may be adversely affected as Indian exports may loose an edge in international market due to rise in prices. It may ultimately become counter productive. All such changes, taken together, affect the economy, business and growth. The study focuses specially on the effect of exchange rate fluctuations on export earnings, imports and output of different sectors of the economy..

Models

The objectives of the study warrant formulation of more than one model. The study comprises three complementary models: (i) Regression model to furnish estimates of rates of growth of income, export earnings and import bills; (ii) Decomposition Model for decoupling of the of

change in rates that emanate from different sources; and (iii) Input Output Model to examine the effect of change in exchange rate on sector wise output of the economy.

Growth Function

For analyzing growth of income, export earnings and import bills, the following growth curve has been fitted to time series data of the variables:

$\log Y = a + b \, X + u$…………………..(1)

where Y is the variable growth of which is estimated, X is time, its duration being one year, and u is random error.

Decomposition Model

For decoupling the effect of exchange rate and quantity changes, the following decomposition models have been used. In order to study the problem systematically in a scientific manner, a mathematical model to decompose the sources of changes in export earnings and import bills has been developed. The preferred model has then been applied to Indian Trade data. Econometric tools have also been used for empirical analysis.

Decomposition of Export Earnings

Export earnings depend crucially on three variables: quantity of export, price and exchange rate. Change in any one of these shall alter export earnings. Generally, two or more variables change simultaneously. Decomposition Model of Changes in Export Earnings attempts to isolate change due to each of these three factors that affect export earnings. The model is outlined below:

$E(x) = \{P(x) \, Q(x)\} \, R(t)$ …………(2)

Above relation may be logarithmically transformed for smoothing non- linearity. The log transformation will also furnish a direct estimate of rate of change in earnings due to each of these three factors:

$\log E(x) = \log P(x) + \log Q(x) + \log R(t)$ (3)

Where P(x) is price of export goods, x in US dollars, Q(x) is quantity of exports, E(x) shows the total value/earnings from the export of goods/services in Indian rupees, R(t) is exchange rate and t stands for time. All variables are dated at time t in this equation. For simplifying notation, we have not attached t to each variable and its annual change. The earnings in rupee prices need conversion in US dollars through multiplication by exchange rate as is shown in relation 2.

In order to isolate the impact of change in exchange rate on export earnings, first we have identified three different sources of change in earnings: prices, which may partly be accounted by inflation, and partly by cost and duties, and finally, by exchange rate. Second source of change is the quantum of goods exported, which changes in response to changes in demand, while other component of change is interaction effect of price and quantity or exchange rate.

Price and quantity changes are often inversely related. But in a rapidly growing economy, direction of interaction effect may be reinforcing and positive. Thus, each of these three components will account only partially for overall change in export earnings. Exchange rate fluctuations will compound the change due to price and quantity. Therefore, we have to work out export earnings first in national currency in order to convert the same subsequently into US currency in order to capture the effect of exchange rate fluctuations. Overall impact/effect of a given change in export price, quantity and corresponding change in foreign exchange earnings may be derived from partial differencing:

$$\Delta E(x) = \{\Delta P(x).Q(x) + \Delta Q(x).P(x) + \Delta P(x)\Delta Q(x)\}\Delta R(t) \qquad \ldots\ldots\ldots\ldots..(4)$$

Δ stands for change per annum. As financial year is taken as the duration of time, corresponding figures shall be aggregates and averages of the year. In order to isolate impact of change in one variable, we allow only one variable to change at a time. This amounts to partial differencing of variables. Obviously, *results will conceal the impact of intra year exchange rate fluctuations*. But these results will furnish a rough idea about the nature/direction and magnitude of impact of intra year variation also. All the terms in parenthesis show the effect of either price or quantity change on export earnings independent of any change in exchange rate. Relation 4 shows partial impounding of change either in price, or quantity or their interaction independent of any change in exchange rate. Last term furnishes an estimate of the interaction effect of changes in price and quantity; it generally tends to be marginal.

Relations 2 and 4 have to be satisfied as identities, random deviations not withstanding. Another relation may be derived from relations 2 and 4. Dividing both sides of 4 by E(x) and substitution of its value, P(x) Q(x) yields following relation among different growth rates (relation 5 leaves R aside in order to estimate growth in rupees) :

$$G(E) = \{G(P) + G(Q) + G(P)G(Q)\} \qquad\qquad \ldots\ldots\ldots\ldots\ldots..(5)$$

For conversion of 5 into US dollars, R.H.S. of 5 is multiplied by G(R):

$$G(E) = \{G(P) + G(Q) + G(P).G(Q)\}\, G(R) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots..(6)$$

Dividing both sides by G(R), we get

$$G(E)/G(R) = G(P) + G(Q) + G(P).G(Q) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots..(7)$$

Since expressions in parenthesis of right hand side of 5 identically equal rupee export earnings in terms of exchange rate changes, multiplication by rate of change in exchange rate is needed for transformation from rupee to dollar earnings.

If we overlook the interaction effect, and difference relation 3, we shall get

$$G(E) = G(P) + G(Q) + G(R) \dots\dots\dots\dots\dots\dots\dots\dots (6)$$

$$G(E) - G(R) \quad = G(P) + G(Q) = G \qquad\qquad\qquad (7)$$

Where G(P) + G(Q) = G, Then,

$$G(E) = G+G(R) \qquad\qquad\qquad\qquad\qquad (8)$$

Dividing both sides of 6 by G(E), we get

$$\frac{G(R)}{G(E)} + \frac{G}{G(E)} = 1 \qquad\qquad\qquad\qquad (9)$$

Second term of 9 on left hand side shows the proportion of total change in export earnings accounted by exchange rate changes.

Decomposition Model for Import Bills

The impact of exchange rate fluctuations on import bills may be depicted by a decomposition model similar to the above model.

$$M(y) = \{P(y).Q(y)\}. R(t) \qquad\qquad\qquad \dots\dots\dots\dots (10)$$

Where M(y) refers to import bill, P(y) is unit price of imports INR, R(t) is exchange rate. Dollars will be dearer with every fall in the price of rupee in exchange market, while dollar will become cheaper with an appreciation of rupee. The changes in variables will be as follows:

$$\Delta M(y) = \{\Delta P(y)Q(y)+P(y) \Delta Q(y)+ \Delta P(y) \Delta Q(y)\} \Delta R \qquad \dots\dots\dots (11)$$

Model of Output Effect of Exchange Rate Fluctuations

The comprehensive accounting of output effect of exchange rate fluctuations through changing export earnings and import bills has been worked out by an input output model. IO model will supplement the decomposition model.

Leontief standard static model is given below:

$$X= (I-A)^{-1} f \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots.(12)$$

Where X is gross output vector, $(I-A)^{-1}$ is Leontief inverse, and f is the final demand vector. The model equation 12 is modified in order to estimate output effect of export earnings and import bills under

changing exchange rate. First modification is that we incorporate net trade as the only non-zero elements of final demand vector f. The new vector is denoted by f(1). Then, trade is decomposed into export earnings and import bills to formulate two other final demand vectors: f(2) and f(3). Final demand vector, f(2) has export earnings as the only non zero elements, rest of the elements being zero in order to isolate the impact on output of export earnings under changing exchange rates. Similarly, import bills are the only non zero elements in final demand vector f (3). Both export earnings and import bills will be estimated at different exchange rates for the same year. The following will be modified versions of model 12:

$$X(1) = (I-A)^{-1} f(1)\ldots\ldots..(13)$$

$$X(2) = (I-A)^{-1} f(2)\ldots \qquad (14)$$

$$X(3) = (I-A)^{-1} f(3)\ldots \qquad (15)$$

The above models will furnish an estimate of gain/loss of earnings from exports and imports caused by exchange rate fluctuations. The net gain or net loss from these changes will then be incorporated in the model solutions based on models 12, 13, 14 and 15.

The difference between X, X_1, X_2 and X_3 will give us the net gain or loss due to change in exchange rate.

$X - X_1 = x_1$, $X - X_2 = x_{2, \text{ and}}$ $X - X_3 = x_{3, \text{ show}}$ the gain or loss to the economy due to exchange rate fluctuations.

Empirical Results

Empirical results have been organized thematically. First we examine the degree of instability of exchange rate. Secondly, growth performance of the economy, exports and imports from 1990-91, the year of adoption and implementation of New Economic Policy, to 2006-07 has been examined in order to evaluate growth of exports and imports. Decomposition model has been evaluated by growth rates. Lastly, output effect of exchange rate fluctuations through exports and imports has been evaluated.

For comparative purpose, study period has been divided into three periods: First period is the composite period from 1990-91 to 2007; second period is from 1990-91 to 1999-00, and third period is from 2000-01 to 2006-07.

Instability of Exchange Rate

Stability or instability is a matter of degree rather than an observational attribute. Stability may also refer to fixity of the rate without there being any change over a specified period of time in a static state, which is a hypothetical case. *But it furnishes a standard for comparison.* Alternatively, stability may refer to gradual change over a period of time, or change at a constant

marginal rate. *A scientific and objective method of estimating instability may be to work on the basis of trend.* The trend may be captured either by year to year changes in exchange rate with the given or shifting base. First refers to an estimate of trend from changes on a fixed base, second may examine changes from link relatives. We have used both these approaches. Estimate of annual compound rate of growth on shifting base may be derived from regression/ growth curve. We have examined fluctuations in exchange rate and their impact on export earnings and import bills. Year to year changes in exchange rate are reported in the table given below.

Year to Year Percentage Change in Exchange Rate

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Actual rate of change	--	7.77	37.490	17.49	8.30	0.11	6.52	6.14	4.69	13.20	3.0

Year	2001	2002	2003	2004	2005	2006	2007	2008	AVG	SD
Actual rate of change	5.43	4.4	1.48	-5.1	-2.22	-1.47	2.21	-10.70	5.35	10.22

A feature of year to year changes is that changes in same direction in exchange rates are cumulative. The table reveals that (i) Indian rupee started depreciating in 1991 and it continued till 2003; (ii) degree of depreciation of the rupee varied greatly between the years. Highest depreciation occurred in 1992, while the lowest fall in value took place in 1995. The depreciation of rupee in 1995 is so negligible as warrants leaving it out of accounting; (iii) 2003 is another year when rupee showed a marginal decline of 1.48 per cent in its value; (iv) !992, 1993 and 1999 recorded high degree of depreciation in the range of 13.2 to 37.49 per cent; (v) In other years of rupee depreciation, rates of decline range from 3 to 8.3 per cent; (vi) The year 2004 witnessed reversal of the trend of falling value of Indian rupee, when it started appreciating. *Highest degree of appreciation occurred only in 2008. In other years, appreciation rate remained, on the whole, well below the rate of depreciation.* Average annual compound rate (statistically significant) of fall in rupee value, derived from growth curve, has been 5.35 per cent. *It implies that (a) Appreciation of rupee in four years since 2004 has not been totally swamped by its falling value over a period of 13 years but it also left the value falling at a significantly high rate through out the period taken as a whole*, and (b) Inter temporal changes in exchange rate have been highly marked. The second inference is supported by CV which has a value of 52.35 per cent. Thus, exchange rate fluctuations have been highly marked. *However, only one depreciation rate and three appreciation rates lie outside the range of acceptable change outside the stability zone:*

$\bar{X}$ +-O.

We may probably have a more comprehensive view for the period as a whole by analysing changes in exchange rate on fixed base of 1990-91.

Fixed Base Indices of Exchange Rate Changes

The following table shows the fixed base indices of changes in exchange rate while 1990-91 has been taken as the based year.

1991-92	1992-93	1993-94	1994-95	1995-96	1996-97	1998-99	1999-00	1999-00	2000-01
72.78263	61.9504	57.20411	57.1431	53.64365	50.54277	48.27776	42.64787		
41.40593	39.27455	37.62183	37.07453	39.04666	39.93241	40.52697	39.65184	44.40426	

The table shows that the value of rupee in first twelve years of the period of study has fallen to 37 per cent of its base value. Even after a few years bout of appreciation, value of rupee is only 44 per cent of its base value. These results lend much stronger credence to the thesis of sharp exchange rate fluctuations. These changes need a little bit more analysis for having a comprehensive view of the period as a whole. This has been carried out by means of OLS estimates of growth curves of exchange rate for different periods.

Growth Curve of Exchange Rates- **Period I : Composite**

OLS estimate of growth curve of exchange rate for all three periods have been obtained. The growth curve for composite period is reported below:

$$\log Z (1) = 1.12030 + 0.0118 X$$
t   103.9423,   44.10315
$R^2 = 0.99234$,   F=1945.088, F*= 2.733

Where Z denotes exchange rate, 1, 2, and 3 denote time period to which Z relates, and X is time. The value of Indian rupee has been falling consistently over the years at a statistically significant annual compound rate of 1.18 per cent. Thus, value of rupee has fallen by about 36 per cent of its base year value. But the composite period comprises two distinct periods each of which will affect the growth rate. So we move to consider the growth in each of the two sub-periods.

II - Period : 1990-2000

The estimated growth curve for second period is given below:

$$\log Z(2) = 1.1017 + 0.0124 X$$
t   73.8910   29.958
$R^2 =$ 0.99116,   F=897489, F*=1.67196

The trend of depreciation of rupee not only emanated in this period but it seems to have percolated into third period also. Statistically significant annual compound rate of decline in rupee value is 1.24 per cent. Depreciation rate of rupee is thus marginally higher than that in the composite period. This suggests that the process of depreciation might have slackened during the third period. This can be directly examined by the growth curve of the third period.

III Period : 2001-2008

Growth curve for the period is given hereunder.
log Z(3) =   1.6967 -   0.0104 X
t   148.117   (-4.05034)
R2 = 0.7664 , F= 16.4053, F*= 0.009821

The trend of depreciation of Indian rupee was reversed in this period. Trend reversal occurred in2004 when rupee started appreciating. The appreciation of Indian rupee occurred at a statistically significant annual compound rate of 1.04 per cent. **Thus,** *exchange rate fluctuations have occurred in both directions. If we keep the depreciation of second period in mind, we may infer that (i) oscillations of exchange rate about the mean were explosive in first 8 years, which slackened in some years of III period before the reversal of trend. But the trend reversal occurred twice during the third period. We may, therefore, designate these oscillations as damped.*

These exchange rate changes have serious implications for exports, imports and output. Fluctuations in exchange rate suggest that export earnings and import bills, estimated on two different rates of exchange, should differ significantly. For discussing this facet, we shall first discuss growth of exports and imports so as to have an idea about the impact of exchange rate fluctuations on these variables.

Growth of Exports and Imports

Growth of exports and imports is discussed separately.

Changing Exchange Rate and Export Earnings

In the fixed base case, 1990-91 has been taken as the base year to estimate simple index of year to year change in exchange rate. Table II furnishes estimates of this index, export earnings and import bills on fixed base index. This series is compared with the observed series of values. *The working or null hypothesis is that the changes in export earnings in different periods are not statistically significant. It implies that either exports are inelastic with respect to exchange rate or quantities have unit elasticity with respect to change in prices entailed in exchange rate change.* For the evaluation of this thesis, we have estimated two log linear regression equations with index of exchange rate as an explanatory variable and exports and imports as the dependent variables. Besides,   t and Z tests of significance of two means and variances have been used to evaluate the impact of exchange rate fluctuations..   The OLS estimates of two regression functions are reported below:

log E = 11.9172 - 3.4568 log X, R^2 = 0.7102,
        t = (12.53167) (-6.06271),   F=36.75648

E denotes observed export earnings, and X stands for index of exchange rate.

log M = 8.1528 -2.1378 log X, R^2=0.5249,
 t =   (9.31)   (-4.1),   F=16.572

M depicts observed values of imports.

The function shows that there is an inverse relation between export earnings and dollar value of Indian rupee. Export earnings are highly elastic with respect to exchange rate fluctuations; elasticity is as high as 3.46. Thus, corresponding to 100 per cent fall in the value of rupee, export earnings rise by 346 per cent. The elasticity coefficient is statistically significant. Besides, 71 per cent of changes in exports are explained by the function.

The import function also reveals an inverse relation between exchange rate and imports. Lower the fall in the value of rupee, greater are the import bills. Corresponding to 100 fall in the value of rupee, imports rise by 213 per cent. Besides, the function explains 52.5 per cent of total change in imports. Remaining proportion is explained by other factors. But this result is at variance with the theoretical prediction that higher value of imports should lead to a fall in import bills.

The results lend very strong support to the thesis that the exchange rate plays a pivotal role in exports and imports.

Impact of exchange rate fluctuations on exports and imports has also been examined by t and Z tests. If the exchange rate had remained at 1990-91 level, average export earnings would have been only Rs. 933201.97 million. But the average export earnings in current rate are Rs 2186908.24 million in 2003-04. The difference between the means of two series for the same year is Rs. 1253706.3 million. Standard deviation of two samples, taken together, is as high as 1067.48. This depicts high degree of variability of the exchange rate from 1990-01 to 2003-04. This value of mean difference indicates extremely high rupee depreciation from 1990-01 to 2006-07. The value of rupee fell to slightly more than two thirds of its initial value in US dollars. The value of t of the mean difference is as high as 6643.73, which is many times more than the corresponding table value. Mean difference is statistically highly significant. The value of F is also as high as …… It indicates significant difference between the variance of two series. Constant rate series depicts much lower degree of variability the export earnings in current rates. *Obviously, there is no empirical support for the null hypothesis that the changing exchange rate does not affect export earnings. In fact, exchange rate fluctuations have significantly affected the export earnings. The exchange rate fluctuations led to the depreciation of Indian rupee during most of the years of the study, which made export earnings grow. Cheaper rupee exercised a positive impact on export earnings. The lower dollar prices boosted demand for Indian exports to an extent which has more than neutralized the impact of lower prices on earnings by quantity growth in the international market.* These results suggest that the export earnings should have grown substantially during the observed period. This is examined by growth curves.

Growth of Export Earnings

The growth curves of export earnings both in rupees and dollars for II and III periods are reported below.

Period II: 1990-2000

$\log E = 5.4073 + 0.07837.X$
t 171.538, 16.862
F = 284.35> F* = 4.07, R2 = 0.969

Where E denotes export earnings and X it time.

Export Earnings in US $ (million)

$\log E = 4.16645 + 0.0393 X$
t 164.333, 10.5156
F = 110.58> F* = 2.36, R2 =0.92

The estimated curves reveal the following interesting facets of growth of export earnings: (i) Export earnings both in rupees and dollars have grown at statistically significant annual compound rates of 7.84 and 3.93 per cent;

(ii) The growth rate in rupees is twice as large as the dollar rate, signifying depreciation of rupee in US dollars. The difference between the two growth rates may be attributed to exchange rate fluctuations. *It may be inferred that the fluctuations of exchange rate accounts for 3.91 per cent growth of export earnings in rupees. Thus, fifty percent of growth of total export earnings is accounted by the depreciation of Indian rupee. The remaining fifty percent is imputable to the growth of quantity and decline in price, the factors related to demand;*

(iii) Growth of exports in rupees is almost 1.6 times the growth of GNP at 4.9 per cent during the same period.

*Above results lend credence to the thesis that Indian growth in post globalization era has partly been driven by the growth of exports. Growth of exports has itself been partly driven by the depreciation of Indian rupee. **So the thesis that India switched over from import substitution to export led growth seems to be supported by above results. Besides, the results also lend credence to the thesis that trade is an engine of growth.***

Period III: 2001-2007

The following curve shows the growth of exports during III period.

Export Earnings in Rs (Million)

log E $=$ 6.2262 $+$ 0.0649 X
t   140.94,   7.42
F= 55.013>   F* = 0.0031, R2 =0.90

Export Earnings in US $ (Million)

log E = 4.5376 $+$ 0.0722 X
t   115.2338,   9.256986
F = 85.69>   F* = 8.98, R2 = 0.934

Growth curves fit the data well during this period also. The following inferences may be drawn from these results:

(i) Export earnings continued to grow at statistically significant rates both in rupees and dollars during this period. But export earnings have grown ahead of income during this period also. Thus, exports continued to lead the growth of the economy;

(ii) Growth in rupees decelerated quite a bit, while growth in dollars accelerated. Growth in dollars has almost been doubled during this period over the preceding period.. It is explained by the fact that the depreciation of rupee has not only been halted but the rupee appreciated quite a bit;

(iii) Earnings in dollars have registered higher growth than rupees, leaving exchange rate to contribute negatively to the growth of earnings in rupees;

(iv) Quantities rather than prices seem to have gained prominence in pushing the growth of Indian exports during this period;

(v) Quantitative growth accounts for 4.78 per cent of over all growth of export earnings.

This moves us to examine growth profile of imports.

Import Bills under Changing Exchange Rate
Paradox of Falling Rupee and Rising Imports

It is hypothesized that the depreciation of Indian rupee would have slowed down the growth of imports; growth of imports would also be expected to lag behind the growth of both income and exports. But the imports rose. Had the exchange rate remained stable at 1990-91 level, average import bill during the period would have been Rs 2807847.3 million. Average import bill, however, increased to Rs. 2882408.824 million due partly to rate fluctuations. *The theory predicts that the depreciation of national currency in exchange market discourages imports. The above figures belie the expectation, since in spite of rising dollar prices, imports have been growing. Results also show direct rather than inverse relationship between price and imports. Demand curve for imports is positively sloped. Imports behave as superior goods in Indian economy.* Average values of imports in both exchange rates are much higher than average export

earnings. It shows high trade imbalance. Two factors may account for this behavior of imports. Indian imports basically comprise three categories: (i) essential intermediate inputs shortage of which will lower growth; (ii) machinery and equipment which are necessitated by (a) capacity expansion, (b) creation of production facility of goods not hitherto fore produced in the economy, (c) machinery and equipment, embodying more advance technology, and (d) consumer goods for higher income groups that are price inelastic.

But the question is whether mean difference of imports at current and constant exchange rate statistically significant. Mean difference is Rs. 74562 million. It is statistically not significant; t value is 0.5179. Thus, this result does not contradict theoretical prediction in so far as rise in imports is statistically not significant.

Let us examine the proposition further by the analysis of growth of imports during second and third periods. The estimated growth curves are reported below:

Growth of Imports

Growth of imports has also been estimated by growth curves for second and third periods.

Period II: 1990-01-1999-00

Estimated curve for second period is given below:

Imports in Million Rs

$$\log M = 5.4723 + 0.0802 X$$
$$t \qquad 322.87 \qquad 32.1$$
$$F = 1029, \quad F^* = 1.37, \ R2 = 0.99$$

Import in Million US $

$$\log M = 5.2315 + 0.0412 X$$
$$t \qquad 156.26 \qquad 8.33$$
$$F = \quad 69.33 > \quad F^* = 1.76, \ R2 = 0.885$$

Growth of imports in rupees, like that of exports, has been twice as fast as growth in US dollars during this period; annual compound rates of growth of imports being 8.02 and 4.12 per cent respectively. But growth of imports has been slightly more rapid than that of exports. Thus, liberalization seems to have opened up the economy much more for imports than exports. Naturally, discarding of import substitution strategy of growth has been more successful than the strategy of export led growth. This is not surprising. Liberalization of imports is the function of domestic policy. But growth of exports depends not only on domestic policy of export promotion but also on the state of international market and import policies of importing countries. *It is ironic that the developed countries, which exert pressure on countries of the third world to open*

up their markets for imports from developed countries, themselves restrict imports to protect their jobs.

Period III: 2001-07

The following are the two growth curves of the III period:

Imports in Million Rs

$\log M = 6.2492 + 0.0852 X$
t   127.52,   8.78
F = 77.0 >   F* = 0.0001, R2 = 0.928

Imports in Million US $

$\log M = 5.5607 + 0.0924 X$
t   121.63   10.21
F = 104.27 >   F* = 5.14, R2 = 0.946

The curves reveal that (i) growth of imports both in rupees and dollars during this period has been accelerated; (ii) Like the growth of exports, growth of imports in dollars in this period has exceeded growth in rupees. But the difference between two rates is only 0.72. These results are in conformity with those of earlier period.

Output Effect

Both exports and imports are directly related to income/output. Any change in exports or imports is, therefore, expected to have a direct bearing upon output and its growth. But any change in an economic variable exercises both direct and indirect influence on other variables. Changes in exports and imports under the impact of changing exchange rate will also exercise direct and indirect effect on output. This has been estimated by an input output model. Results are reported hereunder.

Output Effect of Exports

The average output effect of exports in 2003-04 *at contemporary exchange rate* is Rs. 2716.93 crore. The sector Miscellaneous Manufactures shows the highest output effect of Rs. 58088.8671 crore. But carpet weaving has the lowest output effect of Rs. 0.1113 crore. *The miscellaneous manufacturing sector has many items of export and carpet weaving is single product for export.* This may account for such great difference between the maximum and minimum output effect. Output effect varies greatly in this range among 130 sectors. Degree of inter- sector variation, as shown by CV, is 42.529 per cent. *Thus, inter-sector differentials of output effect are quite marked. Another feature is that export industries depict much higher output effect than non-export goods sectors for which final demand is zero in our model.* Output effect of export

industries is directly related to the quantum of output of an industry that is exported. Low exports generate low and high exports generate high output effect. Output effect of non export sectors is derived from backward and forward linkages with export sectors. Results lend support to Prakash thesis (1988) that the sector(s) having non-zero final demand grow more than the sectors for which final demand is zero in the modified model of Leontief Static Trajectory. Inter sector variation of output effect may be explained by two factors: (i) Output of only 24 industries is exported and these industries are classified even in fewer sectors of the economy; (ii) Both quantities and prices of exported goods vary greatly both of which contribute to inter sector variation of output effect of exports; (iii) Output effect of export industries is more pronounced than that of non export industries.

Exchange Rate Fluctuations and Output Effect of Exports

If exchange rate of 1991 had remained operative in 2003-4, average output effect would have been only Rs. 1239.6078 crore. Thus, average output effect of exports in constant exchange rate is only 41 per cent of mean value of output effect of exports in current exchange rate. Highest output effect is Rs. 31.65692 crore for Gems and Jewelry and lowest output effect is Rs. 0.215273 for Bajara sector. Thus, output effect varies among sectors in this case also. But inter sector variation is much less marked than that at current exchange rate, value of CV being only 33.3%. *It means that lower mean value of output effect embodies lower inter sector variation and higher mean value of output effect of exports encompasses higher inter sector variation..*

Difference of means of output effect of constant and current is Rs.12.3941 crore. The total as well as average output effect of exports in current and constant exchange rates differs significantly, value of t of mean difference is as high as 169.0778.

Output Effect of Imports

The average output effect of imports in current exchange rate is Rs. 219201.54 crore. Highest output effect of imports is Rs. 5796324.992 crore for Crude Petroleum sector, a major item of import. Lowest output effect is Rs 0.43194 crore for carpet weaving sector which does has relatively low import intensity. Output effect of imports in contemporary exchange rate varies in this range; coefficient of variation has a value of 30 percent.

Output Effect of Imports under Stable Exchange Rate

If exchange rate of 1991 is applied on imports of 2003-2004, average output effect is Rs. 9384058.174 crore. Highest output effect is Rs. 2515605.717 crore in this case also for crude petroleum sector. Lowest output effect is Rs. 10.14594 crore for tea. Output effect varies in this range. Output effect of imports among different sectors shows variation of 28 percent.

Difference of means of output effect of imports in constant and current exchange rates is Rs. And the corresponding value of t statistics is which is /not significant.

Conclusions

The main findings of the study are as follows. Results lend credence to the input output and decomposition models developed in the study. Exchange rate has fluctuated a lot from 1990-91 to 2007-8, though fluctuations lie outside the range of stability only for four out of 18 years of the study period. Indian rupee in the terminal year has depreciated by nearly two thirds of its value in the base year. Fall in the value of rupee has induced exports to rise ahead of income. The export earnings in current exchange rate, absolute as well average, significantly differ from earnings in the base year rate. But average import bills in two rates do not differ significantly. Imports have not been significantly affected by depreciating value of rupee, indicating positively sloped demand curve for imports. Results of decomposition model of export earnings and import bills show the

pivotal role of change in exchange rate, though the quantitative dimension is relatively more important in imports than exports.

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