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# Influence of Exchange Rate Fluctuations on the Growth Rate of Productivity in the Indian Manufacturing Sector - An Empirical Analysis

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***Abstract:*** **It is frequently argued that exchange rate movements can impact productivity. Balassa (1964) and Samuelson (1964) have shown that real exchange rate will appreciate in countries where productivity growth is faster compared to the rest of the world. However, for developing countries one cannot generalize the hypothesis that a real appreciation of one currency will positively impact productivity. The present study estimates productivity growth in Indian organized manufacturing industries with more up to date and comprehensive data for the manufacturing sector of the economy. Tornqvist Productivity Index technique is used to compute total factor productivity and thereafter find total factor productivity growth. Multi-variate regression model is tested between individual industry productivity growth and independent variables.**

***Keywords:*** **real exchange rate, Index technique, Growth Rate, Indian Manufacturing Sector.**

## 1. INTRODUCTION

"Movement of productivity" has been both curiosity and concern for development economists and policy makers. The realization of productivity growth in the industrial sector continues to drive the overall economic performance of the Indian economy. The Indian economy has witnessed more than two decades of wide ranging economic liberalization surrounding many sectors. In order to make India's industrial sectors; both, internally efficient and globally competitive, liberalization of international trade and industrial policies was endeavored. Encouraging results have been seen in the industrial productivity performance; from a turnaround in the mid-1980s to improved performance in the 1990s (Ahluwalia, 1991).

Before the trade liberalization policies of 1991, Indian industries failed to compete in the global market due to uneven resource allocation by government policies such as high custom tariff rates, domestic trade tax and excise duty structure, reservation of production etc. The relationship between trade policy and economic performance is one of the oldest controversies in economic development. The phase of industrialization starting after Indian Government's 1991 policy of trade liberalization; has changed the situation, slowly boosting productivity. In order to make the Indian industrial sector a strong competitor in the international market, various positive alterations have been made in technology-import policy and foreign direct investment policy.

The liberalization of import policy has been accompanied by a substantial depreciation of the exchange rate. The nominal exchange rate depreciated by about 50 per cent between 1990 and 1995 and the real effective exchange rate depreciated by about 24 per cent in this period. The depreciation of exchange rate made imported manufactured goods costlier. It neutralized to some extent the potential effects of lowering of tariff rates and relaxation of quantitative restrictions on imports. There are two mechanism of movements in the exchange rate can have an impact on productivity, one mechanism which focuses on demand side effects, often referred to as the competitiveness[1] approach, emphasizes the export growth impact of exchange rate depreciation and the productivity consequences of that growth. Another heterodox

[1] OECD defines competitiveness as the degree to which a nation can, under free trade and fair market conditions, produce goods and services, which meet the test of international markets, while simultaneously maintaining and expanding the real incomes of its people over the long-term.

stream of literature focuses on the supply side consequences of a sustained real exchange rate depreciation arguing that it can contribute to lower productivity growth and a larger productivity gap between the depreciating country and the leading countries.

Trade has been directly or indirectly favored as an important determinant of growth since the times of Adam Smith. Productivity growth is important for development and structural transformation and also a crucial factor to measure long-run economic performance as per neo classical growth model. Policy makers and economic analysts have given Total Factor Productivity (TFP) a higher acknowledgement, for theoretical relevance as well its distinct status.

As important as the external markets are to growth, Indian industries also face hard competition from these markets. Market force in the economy has increased with the 1991 liberalization of Indian industries. These economic reforms of the 90's are also aimed to increase industrial productivity and input-use efficiency. This was brought about changes in basic factors governing the structure and functioning of Indian industries such as price decontrol, greater and cheaper access to imported know-how, capital goods, intermediate goods and world capital, rationalization of customs and excise duty, relaxing of licensing rule and constraints on various input use and technology choices, extending the limit of foreign equity participation, lowering of tariff rates and removal of restriction on import of raw materials and technology. With these changes, introduction of technological dynamism in industries and increase in competitive pressure by national and world markets, the more efficient firms grow and inefficient ones shut down.

India's poor TFP growth contribution before the industrial liberalization of 1991, was somewhat blamed on the un-relaxed economic policies and weak tax structure. Even the earlier studies on the Indian industry did not convey TFP growth performance satisfactorily. However, the TFP growth situation is expected to change significantly now that new economic reforms have been introduced for a several years.

RBI exchange rate management policy has targeted at maintaining orderly conditions in the foreign exchange market by eliminating uneven demand and supply and preventing speculative activities, without setting a particular exchange rate target. Reserve Bank of India used a combination of tools which including sales and purchase of currency in both the forward and the spot segments of the foreign exchange market, domestic liquidity adjustment through the use of Bank Rate, CRR, Repo rate etc. Movements in exchange rate may have an effect on firm performance through a variety of channels, like price of exports relative to foreign competitors, the cost of imported inputs relative to other factors of production, or the cost of external borrowing. Though the impact on the performance of firms is only one element determining how exchange rate changes affect aggregate economic growth, it can be a crucial and important determinant of the same.

Balassa (1964) and Samuelson (1964) have shown that real exchange rate will appreciate in countries where productivity growth is faster compared to the rest of the world. However, for developing countries one cannot generalize the hypothesis that a real appreciation of one currency will positively impact productivity.

In traditional models, exchange rate depreciations lift imports and export-competing output. Dynamics scale economies and increased capacity utilization of fixed inputs would results in positive productivity consequences of short run output effects. In many macro models of the New-Keynesian variety with nominal inflexibilities, a positive demand shock can increase measured productivity growth through learning-by-doing effects, increased factor utilization or increasing returns to scale. Real exchange rate depreciation, while increasing the demand for tradables, is likely to exhibit parallel effects in that sector.

**Linkage between Exchange Rate and Productivity**

Industrialized countries have experienced large fluctuations of real exchange rates during the last sixty years so that many authors have taken an interest in the link between the level of real exchange rates and productivity growth in these economies. Paul Krugman (1989) recommended that the large appreciation of the dollar between 1979 and 1985 have induced the acceleration of industrial productivity growth in the United States because the rise of the dollar would have pressed firms to increase their productivity. Porter (1990) also argued that an exchange rate overvaluation might contribute to increased productivity. On the contrary the widening productivity gap between US and Canada can lightly be explained by the large real depreciation of the Canadian dollar during the 1990s (Jeanneny and Ping, 2003).

It is frequently argued that exchange rate movements can impact productivity. Nonetheless, the negative potential impact of the real exchange rate appreciation on productivity growth may not be linked exclusively to a reduced export growth or foreign direct investments. Infect, real appreciation hinders import competing products and exports. The competitiveness approach which focuses on demand side effects emphasizes the effect of exchange rate depreciation on export growth and the resultant consequences on productivity. An opposite stream of literature, focusing on the supply-side consequences of persistent real exchange rate depreciation argues that it contributes to reduced productivity growth and increased productivity gap between the depreciating country and the leading countries.

The present study estimates productivity growth in Indian organized manufacturing industries with more up to date and comprehensive data for the manufacturing sector of the economy. It uses the data from 1975-76 to 2016-17 with a view to trace the changing impact of reforms on productivity and output growth. The data is broken up into two periods: The pre (1990s) reform period from 1975-76 to 1990-91 (Period I) and the reform / post-reform period from 1991-92 to 2016-17 (Period II). The present study uses Tornqvist Productivity Index technique is used to compute total factor productivity and thereafter find total factor productivity growth. Multi-variate regression model is tested between individual industry productivity growth and independent variables.

## 2. LITERATURE REVIEW

Ahluwalia's (1991) extensive study attempts to analyse the long-term trends in total factor and partial factor productivities in the organized manufacturing sector in India over the period from 1959-60 to 1985-86. Ahluwalia, in her 1991 study on productivity and growth in Indian manufacturing, came to the conclusion that there was a marked acceleration in total factor productivity growth (TFPG) in Indian manufacturing in the 1980s. According to her estimates, the growth rate of TFP in Indian manufacturing was 3.4 per cent per annum in the period 1980-81 to 1985-86, as against an estimated growth rate of -0.3 per cent per annum for the period 1965 to 1979-80. Her estimates of TFP growth rate were based on the single-deflated value-added method, Balakrishnan and Pushpangadan (1994) and Rao (1996) have pointed out the inadequacies of TFP estimates based on the single-deflated value-added measure of output, and have given strong arguments for using the double-deflated value added method or the gross output function framework.

In the Das and Kalita study (2009), estimates of TFP growth for 2-digit sectors are derived by aggregating up from the 3-digit industry level estimates, using the Domar measure of aggregate productivity growth. Virmani and Hashim (2011) in their study expected a positive effect on growth as well as total factor productivity, which are expected to broadly follow an S-shape pattern in moving from the lower steady state to a higher steady state level. At more disaggregated level of manufacturing sub-sectors, we would expect a majority of sub-sectors to follow an S-curve pattern, but to also find some sub-sectors that will in fact decline because they are fundamentally non-competitive. The puzzle of India's reforms was that such a pattern was indeed found consequent to the 1980s reforms, but no such pattern or perhaps even an inverse pattern was found after the 1990s reforms. The latter appeared to lend support to the ideological opponents of reforms who related negative effects of productivity to reforms.

The micro-level study by Das (2006), examines the productivity and efficiency of jute mills in India using firm-level data for the organized sector. The effect of reforms on the performance of the jute industrial sector is also examined. The study has used both the conventional production function approach and the non-parametric frontier approach to evaluate the contributions of labour and capital and the level of efficiency and capacity utilization. By applying the conventional production function approach, this study observes that the contribution of labour to output growth in jute industry was much higher than that of capital everywhere in the country.

Choudhri and Schembri (2010) examines whether the mixed results on the Balassa–Samuelson hypothesis can be explained by a variation of the model that introduces differentiation between home and foreign traded goods. A basic modern version of the Balassa–Samuelson model is developed, in which differentiated traded and non-traded goods are produced under monopolistic competition using only one factor, labour. The real exchange rate appreciates in response to an increase in both the relative price and the terms of trade. Improvement in productivity leads to lower terms of trade, appreciate or depreciate in the real exchange rate can depending on whether the relative price effect offsets the terms-of-trade effect or not.

Ghose and Biswas (2012) examine the impacts of real effective exchange rate along with other trade related variables and some technological-socio-economic variables on total -factor-productivity-growth of Indian Manufacturing sector.

Productivity growth is measured by Malmquist-Productivity-Index, using non-parametric Data-Envelopment-Analysis. They found from the period of 1980-81 to 2001-2002, considering 17 industry groups, the average TFPG is reported as 3.90% per annum. The coefficient of Real Effective Exchange Rate (REER) is expected to be positive throughout the regressions and it happens so for four industries - Food Products Industry; Paper, Paper Products Industry; Non -electrical Machinery Industry whereas; the significance level is low for Wood, Wood Products Industry. Notably, with change in each of these variables the magnitude and responsiveness of TFPG vary across industries. Effective rate of protection as a proxy of measure of import liberalization and negative coefficient of ERP implies lowering of ERP has favorable effect on TFPG as shown by two industry groups - Metal Products Industry and Transport Industry.

## 3. RESEARCH METHODOLOGY

In order to avoid these problems, the present study makes use of growth accounting approach for estimation of productivity growth. The Translog Index of Total Factor Productivity (TFP) is a discrete approximation to the Divisia Index of Technical Change. Translog Index Number is symmetric in data of different time periods and also satisfies the factor reversal test approximately. The Translog production function of TFP has been used for the TFP estimates presented in the study, as done earlier by Alhuwalia (1991), Rao (1996), Pradhan and Barik (1998) Das (2003), Goldar and Kumari (2002), Goldar (2003), Das and Kalita (2009) Das et.al. (2010) and Virmani & Hashim (2011). The Translog production function of TFP has been used for the measurement of TFP and the methodology assume perfect competition and constant returns to scale, further, the revenue share of the factor inputs sum to unity. This study concentrates on individual industry productivity rather than aggregate productivity. Consider an aggregate production function with four factors of production.

$$Y = F(L, K, R, E, T) \qquad \text{Equation (1)}$$

To derive the Translog measure of Total Factor Productivity Growth.

$$\text{Ln}\left(\frac{TFP_t}{TFP_{t-1}}\right) = \left[Ln\left(\frac{Y_t}{Y_{t-1}}\right)\right] - V_K\left[Ln\left(\frac{K_t}{K_{t-1}}\right)\right] - V_K\left[Ln\left(\frac{L_t}{L_{t-1}}\right)\right] - V_K\left[Ln\left(\frac{M_t}{M_{t-1}}\right)\right] - V_K\left[Ln\left(\frac{E_t}{E_{t-1}}\right)\right]$$

Equation (2)

Using the equation 2, the growth rates of TFP have been calculated for each year. These have then been used to obtain an index of TFP in the following way. Let index of TFP is denoted by A. The index for the base year, $A_0$, is taken as 100. Then, the index for subsequent years is calculated using the following equation:

$$\left(\frac{A_t}{A_{t-1}}\right) = \exp(\square\square \ln TFP_t) \qquad \text{Equation (3)}$$

Having obtained the TFP index for different years, estimates of TFP growth rate have been made for two sub-periods, 1975-76 to 2016-17.

**Multi-variate Regression Analysis between TFPG and Independent Variables**

Multi-variate regression analysis is applied to analyze the variation in TFPG of different industry groups. Productivity Growth Rates (PGR) are computed for twenty-two industry groups during 1975-76 to 2016-17 and treated as dependent variable. The regression equation specified as follows:

$TFPG_t = F(Y/N_t, CR_t, K/L_t, NP_t, W_t, ERP_t, ICR_t, IPR_t, REER_t, u_t)$

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Where t = time period. Total number of Indian manufacturing industries = 22

$Y/N_t$ is output per factory is taken as a measure of firm size.

$CR_t$ is concentration ration of a particular industry group captures the effect of market structure on TFPG.

$K/L_t$ is the capital-labour ratio serves as technological variable.

$NP_t$ is the non-production employee per production worker is also a technological variable and is related to the composition of work force.

$W_t$ is the real wage rate

$ERP_t$ is the effective rate of protection

$ICR_t$ is the import coverage ration

$IPR_t$ is the Import Penetration Ratio

$REER_t$ is the Real Effective Exchange Rate

**Data Sources:**

The data of Output per factory, Real wages to worker, Capital-Labour ratio, Non-production employee per production worker, Number of factories and concentration ratio, used in this study is taken from the Annual Survey of Industries (ASI). For the construction of the time series of import penetration ratio, exports and imports of manufactures (in Rs.) has been taken from Economic and Political Weekly Research Foundation. I got the data at disaggregate level and therefore made some adjustments. The real effective exchange rate (REER) has been taken from a publication of the Reserve Bank of India. Das (2003) has calculated import coverage ratio for various 3-digit manufacturing industries for the years 1980-85, 1986-90, 1991-95 and 1996-00, present study extrapolates the series.

## 4. DATA ANALYSIS

Focusing a competitiveness tactic, there are certain scenarios which will make productivity growth faster during real rate exchange depreciations through lift in imports and export-competing output. Productivity results of short run output effects will be positive through actively flexible scale economies and higher capacity utilization of fixed inputs.

**Table: 1 - Determinants of Productivity Growth of Manufacturing Industries Dependent Variable: TFP; Time period of study: 1975-76 to 1990-91**

| Sr. No. | NIC Code 1998 | K/L Ratio | CR | ERP | ICR | IPR | NPWPE | Y/N | REER | RW | $R^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0.048 | 2.594 | 0.387 | -0.986 | -0.04 | 0.181 | 0.307 | | 0.214 | |
| 1 | 15 | 0.512 | 2.639 | 2.114 | -1.315 | -1.06 | 1.034 | 2.433 | | 1.212 | 0.95 |
| | | | ** | *** | | | | *** | | | |
| | | -0.11 | -1.48 | -0.44 | | | -0.029 | 0.334 | -0.29 | 0.623 | |
| 2 | 16 | -2.41 | -1.07 | -1.98 | | | -4.332 | 4.544 | -1.105 | 6.19 | 0.951 |
| | | ** | | *** | | | * | * | | * | |
| | | | 4.709 | 2.617 | | | | -0.15 | -0.48 | 0.292 | |
| 3 | 17 | | 3.389 | 3.619 | | | | -0.86 | -1.84 | 1.212 | 0.727 |
| | | | * | * | | | | | *** | | |
| | | 0.073 | 4.096 | -20.6 | | -0.33 | 0.125 | 0.36 | | 0.327 | |
| 4 | 18 | 0.334 | 1.671 | -2.28 | | -2.21 | 0.335 | 1.95 | | 2.07 | 0.841 |
| | | | | *** | | *** | | *** | | *** | |
| | | -0.02 | 6.78 | 0.694 | | -0.09 | -0.072 | 0.963 | 0.247 | 0.526 | |
| 5 | 19 | -0.16 | 0.966 | 0.254 | | -2.12 | -0.286 | 2.513 | 0.322 | 0.659 | 0.942 |
| | | | | | | *** | | ** | | | |
| | | -0.02 | | 0.705 | | | | 0.426 | | | |
| 6 | 20 | -0.25 | | 2.576 | | | | 2.16 | | | 0.557 |
| | | | | ** | | | | ** | | | |

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| Sr. No. | NIC Code 1998 | K/L Ratio | CR | ERP | ICR | IPR | NPWPE | Y/N | REER | RW | R2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0 | 1.212 | -0.04 | 1.657 | 0.169 | 0.165 | 0.558 | -0.616 | -0.16 | |
| 7 | 21 | 0.003 | 2.227 | -0.25 | 1.263 | 4.666 | 1.122 | 9.149 | -3.836 | -1.14 | 0.978 |
| | | | *** | | | * | | * | * | | |
| | | | 3.783 | 1.48 | | | | | | 0.475 | |
| 8 | 22 | | 2.304 | 0.887 | | | | | | 2.276 | 0.578 |
| | | | ** | | | | | | | ** | |
| | | | | 0.854 | | 0.106 | | 0.279 | -0.943 | | |
| 9 | 23 | | | 2.28 | | 0.829 | | 2.992 | -1.839 | | 0.602 |
| | | | | ** | | | | * | *** | | |
| | | 0.126 | 2.415 | -0.17 | | | | | | 0.262 | |
| 10 | 24 | 1.153 | 2.329 | -1.94 | | | | | | 1.551 | 0.607 |
| | | | ** | *** | | | | | | | |
| | | | | 0.857 | | 0.17 | | | | 0.873 | |
| 11 | 25 | | | 2.009 | | 2.622 | | | | 2.351 | 0.446 |
| | | | | *** | | ** | | | | ** | |
| | | -0.17 | 0.432 | | | | | | -0.361 | -0.24 | |
| 12 | 26 | -0.95 | 2.398 | | | | | | -1.244 | -2.21 | 0.41 |
| | | | ** | | | | | | | *** | |
| | | -0.48 | -1.48 | | | | | 0.518 | -0.187 | 0.056 | |
| 13 | 27 | -1.62 | -0.87 | | | | | 3.338 | -0.766 | 0.255 | 0.7 |
| | | | | | | | | * | | | |
| | | -0.13 | | -0.27 | | | | | | 0.566 | |
| 14 | 28 | -0.66 | | -0.39 | | | | | | 2.82 | 0.486 |
| | | | | | | | | | | ** | |
| | | 0.434 | | 0.548 | 1.528 | -0.26 | | | | 0.399 | |
| 15 | 29 | 1.788 | | 2.672 | 3.835 | -1.46 | | | | 1.96 | 0.753 |
| | | | | ** | * | | | | | *** | |
| | | 0.186 | 2.685 | -2.62 | -0.85 | -0.21 | -0.027 | | | 0.5 | |
| 16 | 30 | 2.862 | 2.626 | -1.39 | -1.29 | -4.48 | -0.416 | | | 8.546 | 0.983 |
| | | ** | ** | | | * | | | | * | |
| | | | 1.667 | | 0.378 | -0.22 | | 0.503 | | 0.317 | |
| 17 | 31 | | 0.884 | | 1.022 | -2.43 | | 2.022 | | 1.362 | 0.781 |
| | | | | | | ** | | *** | | | |
| | | 0.049 | | 1.874 | -0.79 | -0.18 | 0.199 | | | 0.417 | |
| 18 | 32 | 0.212 | | 1.785 | -1.97 | -1.15 | 0.521 | | | 2.286 | 0.834 |
| | | | | | *** | | | | | | |
| | | -0.21 | | | 0.087 | | -0.267 | | | | |
| 19 | 33 | -1.56 | | | 0.785 | | -1.784 | | | | 0.536 |
| | | | | | | | *** | | | | |
| | | 0.215 | 1.995 | | | -0.09 | | 0.254 | | 0.436 | |
| 20 | 34 | 1.004 | 1.742 | | | -1.85 | | 1.924 | | 2.458 | 0.77 |
| | | | | | | *** | | *** | | ** | |
| | | -0.11 | -3.45 | | | | | 0.448 | | | |
| 21 | 35 | -1.23 | -1.28 | | | | | 2.001 | | | 0.332 |
| | | | | | | | | *** | | | |
| | | -0.573 | 5.529 | | | | | | | 0.944 | |
| 22 | 36 | -1.658 | 1.442 | | | | | | | 3.168 | 0.351 |
| | | | | | | | | | | * | |

* - Significant at 1%, ** - Significant at 5% and *** - Significant at 10%-

**Table: 2 - Determinants of Productivity Growth of Manufacturing Industries Dependent Variable: TFP; Time period of study: 1991-92 to 2016-17**

| Sr. No. | NIC Code 1998 | K/L Ratio | CR | ERP | ICR | IPR | NPWPE | Y/N | REER | RW | $R^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 0.069 | -0.11 | 0.192 | 0.422 | 0.161 | 0.377 | |
| 1 | 15 | | | | 1.221 | -2.02 | 1.662 | 2.842 | 0.792 | 1.92 | 0.572 |
| | | | | | | ** | *** | *** | | *** | |
| | | 0.161 | | | | 0.007 | -0.02 | 0.321 | -0.29 | 0.787 | |
| 2 | 16 | 1.01 | | | | 0.582 | -0.584 | 2.584 | -0.65 | 2.682 | 0.585 |
| | | | | | | | | ** | | * | |
| | | 0.334 | 0.785 | -0.26 | 0.81 | | 0.083 | | | 0.354 | |
| 3 | 17 | 2.125 | 0.914 | -2.29 | 2.55 | | 0.845 | | | 2.277 | 0.394 |
| | | ** | | ** | * | | | | | ** | |
| | | 0.239 | | -0.02 | 0.725 | | 0.088 | 0.613 | -0.91 | 0.071 | |
| 4 | 18 | 1.21 | | -0.05 | 1.416 | | 0.268 | 3.879 | -2.47 | 0.258 | 0.72 |
| | | | | | | | | * | ** | | |
| | | | | -0.02 | -0.623 | 0.041 | 0.125 | 0.466 | 1.21 | | |
| 5 | 19 | | | -0.06 | -0.782 | 0.924 | 0.425 | 2.625 | 3.214 | | 0.595 |
| | | | | | | | | ** | * | | |
| | | 0.027 | -4.29 | 0.004 | | 0.523 | -0.589 | 1.312 | 0.711 | 0.066 | |
| 6 | 20 | 0.096 | -1.28 | 0.009 | | 0.895 | -1.158 | 2.805 | 0.965 | 0.115 | 0.72 |
| | | | | | | | | * | | | |
| | | 0.178 | | 0.029 | 0.017 | -0.15 | 0.295 | 0.498 | | 0.367 | |
| 7 | 21 | 2.125 | | 0.42 | 0.186 | -0.82 | 1.254 | 2.622 | | 2.314 | 0.736 |
| | | *** | | | | | | ** | | ** | |
| | | 0.157 | | -0.21 | -0.011 | -0.23 | 0.365 | 0.119 | 0.448 | 0.323 | |
| 8 | 22 | 1.183 | | -1.32 | -0.452 | -1.55 | 1.459 | 0.694 | 1.654 | 2.554 | 0.584 |
| | | | | | | *** | | | *** | ** | |
| | | -0.082 | 1.225 | 0.025 | -0.174 | -0.48 | 0.082 | 0.788 | 1.392 | -0.23 | |
| 9 | 23 | -0.732 | 0.665 | 0.121 | -0.922 | -2.69 | 0.63 | 4.411 | 2.788 | -0.81 | 0.811 |
| | | | | | | * | | * | ** | | |
| | | 0.165 | | 0.004 | | -0.05 | | 0.566 | 0.452 | | |
| 10 | 24 | 0.922 | | 0.074 | | -0.26 | | 3.045 | 1.472 | | 0.575 |
| | | | | | | | | * | *** | | |
| | | 0.077 | -0.76 | -0.16 | | 0.029 | 0.061 | 0.641 | | 0.005 | |
| 11 | 25 | 0.662 | -0.71 | -1.74 | | 0.182 | 0.701 | 3.356 | | 0.054 | 0.662 |
| | | | | *** | | | | * | | | |
| | | -0.071 | 0.492 | | | | -0.082 | | 0.535 | -0.07 | |
| 12 | 26 | -0.702 | 3.902 | | | | -0.552 | | 1.542 | -0.56 | 0.502 |
| | | | * | | | | | | | | |

| Sr. No. | NIC Code 1998 | K/L Ratio | CR | ERP | ICR | IPR | NPWPE | Y/N | REER | RW | $R^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0.056 | -0.91 | 0.038 | -0.002 | 0.036 | -0.112 | 0.742 | 0.161 | 0.053 | |
| 13 | 27 | 0.322 | -0.68 | 0.554 | -0.046 | 0.291 | -0.422 | 5.325 | 0.422 | 0.363 | 0.848 |
| | | | | | | | | * | | | |
| | | 0.324 | 0.622 | -0.02 | -0.019 | | -0.179 | 0.551 | 0.634 | 0.285 | |
| 14 | 28 | 2.105 | 0.566 | -0.11 | -0.398 | | -0.652 | 2.82 | 1.712 | 2.121 | 0.762 |
| | | *** | | | | | | ** | *** | *** | |
| | | | | 0.052 | | | -0.036 | | 0.821 | 0.677 | |
| 15 | 29 | | | 0.245 | | | -0.121 | | 1.863 | 2.225 | 0.395 |
| | | | | | | | | | *** | ** | |
| | | 0.142 | -1.62 | 0.082 | | | 0.092 | | 0.662 | 0.852 | |
| 16 | 30 | 0.636 | -0.54 | 0.332 | | | 0.382 | | 0.692 | 4.055 | 0.592 |
| | | | | | | | | | | * | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 17 | 31 | 0.21 | -1.61 | -0.19 | | -0.04 | 0.131 | 0.666 | 0.081 | 0.192 | 0.811 |
| | | 1.811 | -1.45 | -1.88 | | -0.26 | 0.521 | 5.072 | 0.245 | 0.973 | |
| | | ** | | ** | | | | * | | | |
| 18 | 32 | 0.044 | -1.74 | | 0.166 | -0.29 | 0.268 | 0.721 | 0.389 | -0.03 | 0.738 |
| | | 0.192 | -0.82 | | 1.179 | -1.32 | 2.115 | 3.682 | 0.832 | -0.19 | |
| | | | | | | | *** | * | | | |
| 19 | 33 | -0.21 | | 0.068 | 0.042 | -0.62 | | 0.439 | 0.329 | 0.522 | 0.796 |
| | | -1.76 | | 1.163 | 1.749 | -2.72 | | 2.585 | 0.948 | 2.471 | |
| | | | | | *** | * | | ** | | ** | |
| 20 | 34 | 0.071 | -0.48 | 0.075 | | -0.16 | | 0.562 | 0.192 | 0.452 | 0.831 |
| | | 0.826 | -0.32 | 0.816 | | -1.26 | | 4.255 | 0.392 | 1.913 | |
| | | | | | | | | * | | *** | |
| 21 | 35 | 0.089 | -3.16 | 0.112 | | | 0.35 | | | 0.276 | 0.512 |
| | | 0.854 | -2.51 | 1.225 | | | 1.552 | | | 2.439 | |
| | | | ** | | | | | | | ** | |
| 22 | 36 | 0.236 | | 0.352 | -0.131 | 0.011 | -0.662 | 0.73 | 1.178 | 0.571 | 0.781 |
| | | 1.395 | | 1.423 | -1.475 | 0.09 | -1.911 | 2.129 | 2.36 | 2.339 | |
| | | | | | | | *** | ** | ** | ** | |

* - Significant at 1%, ** - Significant at 5% and *** - Significant at 10%-

15- Manufacture of Food Products and Beverages; 16- Manufacture of Tobacco Products; 17- Manufacture of Textiles; 18- Manufacture of Wearing Apparel Dressing and Dyeing of Fur; 19- Tanning and Dressing of Leather; 20- Manufacture of Wood and Products of Wood; 21- Manufacture of Paper and Paper Products; 22- Publishing, Printing and Reproduction of Recorded Media; 23- Manufacture of Coke, Refined Petroleum Products; 24- Manufacture of Chemicals and Products; 25- Manufacture of Rubber and Plastic Products; 26- Manufacture of Other Non-Metallic Mineral Products; 27- Manufacture of Basic Metals; 28- Manufacture of Fabricated Metal Products; 29- Manufacture of Machinery and Equipments; 30- Manufacture of Office, Accounting and Computing Machinery; 31- Manufacture of Electrical Machinery and Apparatus N.E.C.; 32- Manufacture of Radio, Television &Communication; 33- Manufacture of Medical, Precision and Optical; 34- Manufacture of Motor Vehicles, Trailers and Semi-Trailers; 35- Manufacture of Other Transport Equipment; 36- Manufacture of Furniture.

The coefficient of REER is negative and statistically significant at 1% for paper & paper products industry whereas negative and statistically significant at 5% level for machinery and equipment industry. The coefficient is negative and statistically significant at 10% level for textile, petroleum and medical, precision and optical industries. Domestic price level and import demand all have an inverse relationship with exchange rate. The elasticity of total factor productivity with respect to exchange rate is -0.48 for textile industry, -0.62 for paper and paper product industry, -0.94 for coke and petroleum industry, -0.98 for machinery & equipment industry and -0.60 for medical and optical industry.

The coefficient of REER is positive and statistically significant at 1% for leather industry and 5% level for Coke, Refined Petroleum and furniture industries. Further, the coefficient is negative and statistically significant at 10% level for printing & reproduction of recorded media, chemical, fabricated metal and machinery & equipment industries.

The coefficient of REER is observed to be negative and statistically significant at 5% level for wearing apparel dressing industry. The supply side consequences of a sustained real exchange rate depreciation argues that it can contribute to lower productivity growth and a larger productivity gap between the depreciating country and the leading countries. Domestic price level and import demand all have an inverse relationship with exchange rate. During this period, elasticity of total factor productivity growth with respect to real effective exchange rate is -0.80 for wearing apparel dressing industry, 0.47 for publishing and printing industry, 1.34 for coke and petroleum industry, 0.47 for chemicals industry, 0.62 for fabricated metal industry, 0.92 for machinery and equipment industry and 1.20 for furniture industry.

## 5. CONCLUSION

Exchange rate depreciations lift imports and export-competing output. Dynamic scale economies and increased capacity utilization of fixed inputs would result in positive productivity consequences of short run output effects. In many macro models of the New-Keynesian variety with nominal inflexibilities, a positive demand shock can increase measured productivity growth through learning-by-doing effects, increased factor utilization or increasing returns to scale. The demand for commodities of trade increases with a real exchange rate depreciation and such depreciation would be inclined to have similar effects. These are among the situations which make productivity growth faster during real exchange rate depreciations as emphasized by competitiveness approach. The supply side consequences of a sustained real exchange rate depreciation argues that it can contribute to lower productivity growth and a larger productivity gap between the depreciating country and the leading countries.

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