An Empirical Analysis on Total Factor Productivity Growth, Employment & Wages in Indian Basic Metal Industry: 1980-81 to 2010-11

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Abstract

This paper attempts to measure productivity performance of the Indian Basic Metal Industry during the period 1980-81 to 2010-11. To measure total factor productivity growth & various other related performance indicators a non-parametric approach, namely, Malmquist Data Envelopment Analysis has been used. A comparative analysis between the pre (1980-81 to 1990-1991) & post liberalisation (1991-92 to 2010-11) era has also been taken up in this study. The paper also seeks to examine the impact of liberalization on the overall employment scenario in the Indian Basic Metal Industry. From the estimated employment function it is clear that the relationship between real wage rate and employment is negative, as is expected.

1. Introduction

1.1 Since 1991, a series of market-based reforms have been initiated by the Indian Government, which was supposed to bring about noteworthy changes in the industrial sector. Relaxation of the licensing rule, reduction in tariff rates, removal of restriction on import of raw materials and technology, price decontrol, rationalization of customs and excise duty, enhancement of the limit of foreign equity participation etc. are among those which have been introduced in early 90s.

1.2 In this paper, total factor productivity growth, employment estimates and the causal relationship between real wage rate and total factor productivity growth as well as the relationship between real wage rate and the partial labour productivity are presented for Indian Basic Metal industry at aggregate level over the period 1980-81 to 2010-11. A comparative analysis between the pre & post liberalisation era has also been taken up in this study. The pre-reform period is 1980-81 to 1990-1991 & the post-reform period is 1991-92 to 2010-11. This is a sufficiently large number of years that witnessed highly restricted, partially liberalized and fully liberalized regimes,

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with a view to compare meaningfully the growth pattern in total factor productivity (TFP) and employment scenario in the pre-reform period with that of the post-reform period.

1.3 A strong raw material production base, a vast pool of skilled and unskilled personnel, cheap labour, good export potential and low import content are some of the salient features of the Indian Basic Metal industry. This is a traditional, robust, well established industry, enjoying considerable demand in the domestic as well as global markets.

1.4 A Brief Survey of Literature

1.4.1 The concept of technical efficiency indicates the degree of success in the utilization of productive resources. Technical efficiency is considered to be an important determinant of productivity growth and international competitiveness in any economy (Taymaz and Saatci, 1997). There are different schools of thought in estimating the technical efficiency. Technical efficiency consists of maximizing the level of production that can be obtained from a given combination of factors. In the Indian context, number of studies examined the technical efficiency of the manufacturing industry, e.g., Page (1984), Little et al. (1987), Patibandla (1998), Mitra (1999), Agarwal (2001), and Mitra et al. (2002), Bhandari et al. (2007a, 2007b) and many others. Krishna and Mitra (1998) investigate the effects on competition and productivity on the dramatic 1991 trade liberalization in case of Indian manufacturing. Using firm-level data from a variety of industries, they find some evidence of an increase in the growth rate of productivity. Driffield and Kambhampati (2003) estimate frontier production functions for six manufacturing industries. Their findings suggest an increase in overall efficiency in five out of the six manufacturing industries in the post-reform period. Mukherjee and Ray (2005) examine the efficiency dynamics of a 'typical' firm in individual states during the pre and post-reform years. Their findings establish no major change in the efficiency ranking for different states after the reforms was initiated. Using a panel dataset of 121 Indian manufacturing industries from 1981 to 1998, Pattnayak and Thangavelu (2005) find evidence of total factor productivity improvements for most of the industries after the reform period.

1.4.2 While the 1991 economic reform was radical, India adopted a gradualist approach to reform, meaning a frustratingly slow pace of implementation (Ahluwalia, 2002). It suggests that it is more appropriate to examine the effect of liberalization on manufacturing sectors' efficiency using a longer time span for both pre and post-reform. How did this economic reform program shifted Indian manufacturing into global stage and influencing technical and scale economies of major industries? In answering this question, we employ a nonparametric approach in explaining productivity changes, technical progress and scale efficiencies of industries within the sector. In this paper, we examine the impact of liberalization on the technical efficiency of Indian Basic Metal industry by comparing pre and post economic reform periods.

1.4.3 Analysis of technical efficiency of manufacturing industries in developing countries has received considerable attention in the economic literature in recent years. Recent literature includes Onder et al. (2003) for Turkey, Pham et al. (2009) for Vietnam, Margono et al. (2010) for Indonesia, and Mastromarco (2008) for less-developed countries among others. Technical efficiency is concerned with how closely the production unit operates to the frontier for the production possibility set. The historical roots of a rigorous approach to efficiency measurement can be traced to the works of Debreu (1951) and Farrell (1957). Over the past three decades, a variety of approaches, parametric and non-parametric, have been developed to investigate the failure of producers to achieve the same level of efficiency. A detailed survey on such methodologies is seen in Kalirajan and Shand (1999). In parametric models, one specifies an explicit functional form for the frontier and econometrically estimates the parameters using sample data for inputs and output, and hence the accuracy of the derived technical efficiency estimates is sensitive to the nature of the functional form specified. In contrast, the method of Data Envelopment Analysis (DEA) introduced by Charnes et al. (1978) and further generalized by Banker et al. (1984) offers a non-parametric alternative to parametric frontier production function analysis. A production frontier is empirically constructed using linear programming methods from observed input-output data of sample decision making units (DMUs). In this study, we adopt the output-oriented (OO) DEA that seeks the maximum proportional increase in output production, with input levels held fixed. The non-parametric approach entails constructing an envelope of the most productive groups to serve as the frontier for the productive performance of all manufacturing industry groups. Thus, there will be one production frontier for each year of the sample, with differences between the frontiers of any two years representing the technical change between those years. By exploiting the computational strength of DEA, the Malmquist productivity-change index may be decomposed into multiplicative factors that can be attributed to technical change (TC), technical efficiency change (TEC) and scale efficiency change (SEC). Lovell (1996) gives a clear description of how the DEA based Malmquist approach implements such a decomposition.

1.4.4 Kumar (2012) showed that wage rate & labour productivity are inter related to each other and they are positively related in case of long run relationship. Hence Efficiency wage hypothesis has been proved true as real wages determined level of productivity. Klein(2012) examine that the rapid growth of the real wage, which outpaced the labor productivity growth in most of the sectors have played an important role in suppressing employment creation. The paper also found that while there is a co-integrating link between the real wage and labor productivity, the deviations from equilibrium are persistent and thus contribute to a weak link between real wage growth and labor productivity growth in the short term. Nayak & Patra(2013) examine the relationship between wage rate and productivity on manufacturing sector and on the basis of these analysis they argued that wage rate & labour productivity are positively correlated.

1.4.5 The Paper is organized as follows: Section 2 depicts methodology & database. Total Factor Productivity, employment estimates and the causal relationship between real wage rate and total factor productivity growth & real wage rate and partial labour productivity are presented in section 3. Section 4 present concluding remarks.

1.5 Objectives of our study

Main objectives of our study are as follows:

1. To estimate the total factor productivity growth (TFPG) of Indian Basic Metal industry in terms of Malmquist Productivity Index.
2. To evaluate the impact of liberalization on TFPG.
3. To estimate the employment function.
4. To examine the impact of liberalization on employment.
5. To assess the causal relationship between real wage rate and TFPG.

6. To evaluate the causal relationship between real wage rate and partial labour productivity.

2. Methodological Issues

2.1 Description of Data & Measurement of Variables

2.1.1 The present study is based on industry-level time series data taken from several issues of Annual Survey of Industries, National Accounts Statistics, CMIE, Economic Survey, Statistical Abstracts (several issues) & RBI bulletin etc. covering a period of 31 years from 1980-81 to 2010-11. Selection of time period is largely guided by availability of data. The entire period is sub-divided into two phases, 1980-81 to 1990-91 & 1991-92 to 2010-11 (Pre-reform phase and Post-reform phase). Sub-division of total period has been taken logically so as to assess conveniently, the impact of liberalization on total factor productivity growth and employment.

2.1.2 In the present paper we have tried to estimate the trend in TFPG and Employment for the Indian Basic Metal industry at 2-digit level of Industrial Classification.

2.1.3 Now, output in this context is measured as real gross value added. The GDP deflator has been used as the deflator of gross value added.

2.1.4 In this study Labour index is formed as a weighted sum of number of heads in two groups (Workers & Other employees), weights being the relative group remunerations. Relevant data are obtained from ASI & Indian Labour Statistics.

2.1.5 So far as capital input is concerned we have taken into account the perpetual inventory method. In our study, real gross fixed capital stock is taken as the measure of capital input. Deflator used is obtained from data on GFCF at current and constant prices. Data for the above purpose are obtained from various issues of ASI & NAS published by CSO.

2.1.6 So far as price index is concerned, to calculate real wage rate, we have taken up consumer price index (CPI) for industrial labourers (IL). Data for CPI is obtained from Handbook of Statistics on the Indian Economy published by RBI.

2.2 Econometric Specification of Malmquist Productivity Index

2.2.1 The conventional setup of Färe et al. (1992) is adopted in modelling the problem as transformation of a vector of inputs $x^t \in R_+^n$ into a vector of output $y^t \in R_+^m$ .The production technology at each time period t, denoted S^t, is identified as the set of all technologically feasible input-output combinations at time t (Lovell, 1996). It is constructed from the data as:

$$S^t = \{(x^t, y^t) | x^t \text{ can produce } y^t\} \quad (1)$$

Fare, Grosskopf, Noriss & Zhang (1994) followed Shephard (1970) to define the output distance function at time 'τ' as:

$$D_0^t (x^t, y^t) = \inf\{\theta \mid (x^t, y^t / \theta) \in S^t\} = (\sup\{\theta \mid (x^t, \theta y^t) \in S^t\})^{-1} \quad (2)$$

The subscript '0' is used to denote the output based distance function. Note that, $D_0^t (x^t, y^t) \leq 1$; if and only if $(x^t, y^t) \in S^t$, & $D_0^t (x^t, y^t) = 1$; if and only if (x^t, y^t) is on the frontier of the technology. In the latter case, Farrell (1957) argued that the firm is technically efficient.

To define the Malmquist index, Fare et al. (1994) defined distance function with respect to two different time periods:

$$D_0^t (x^{t+1}, y^{t+1}) = \inf\{\theta \mid (x^{t+1}, y^{t+1} / \theta) \in S^t\} \quad (3)$$

&

$$D_0^{t+1} (x^t, y^t) = \inf\{\theta \mid (x^t, y^t / \theta) \in S^{t+1}\} \quad (4)$$

The distance function in (3) measures the maximal proportional change in output required to make (x^{t+1}, y^{t+1}) feasible in relation to technology at time 't'. Similarly, the distance function in (4) measures the maximal proportional change in output required to make (x^t, y^t) feasible in relation to technology at time (t+1). The output-based Malmquist TFP productivity index can then be expressed as:

$$M_0 (x^{t+1}, y^{t+1}, x^t, y^t) = \frac{D_0^{t+1} (x^{t+1}, y^{t+1})}{D_0^t (x^t, y^t)} \left[\frac{D_0^t (x^{t+1}, y^{t+1})}{D_0^{t+1} (x^{t+1}, y^{t+1})} \frac{D_0^t (x^t, y^t)}{D_0^{t+1} (x^t, y^t)}\right]^{\frac{1}{2}}$$

The term outside the brackets shows the change in technical efficiency while the geometric mean of the two ratios inside the brackets measures the shift in technology between the two period 't' & 't+1'; this could be called technological progress. So :

$$\text{Efficiency change} = \frac{D_0^{t+1}(x^{t+1}, y^{t+1})}{D_0^{t}(x^{t}, y^{t})} \tag{6}$$

$$\text{Technical change} = \left[\frac{D_0^{t}(x^{t+1}, y^{t+1})}{D_0^{t+1}(x^{t+1}, y^{t+1})} \frac{D_0^{t}(x^{t}, y^{t})}{D_0^{t+1}(x^{t}, y^{t})}\right]^{\frac{1}{2}} \tag{7}$$

In each of the formulas i.e., equation(6) & (7) , a value greater than one indicates a positive growth of TFP (an improvement) from a period 't' to 't+1' and a value smaller than one represents deteriorations in performance over time.

We can decompose the total factor productivity growth in following way as well:

MTFPI = Technical Efficiency change X Technical Change

(Catching up effect) (Frontier effect)

2.2.2 MTFPI is the product of measure of efficiency change (catching up effect) at current period 't' and previous period 's' (averaged geometrically) and a technical change (frontier effect) as measured by shift in a frontier over the same period. The catching up effect measures that a firm is how much close to the frontier by capturing extent of diffusion of technology or knowledge of technology use. On the other side frontier effect measures the movement of frontier between two periods with regards to rate of technology adoption. In DEA-Malmquist TFP Index does not assume all the firms or sectors are efficient so therefore any firm or sector can be performing less than the efficient frontier. In this methodology we will use the output oriented analysis because most of the firms and sectors have their objective to maximize output in the form of revenue or profit. It is also assumed that there is constant return to scale (CRS) technology to estimate distance function for calculating Malmquist TFP index and if technology exhibits constant return to scale (CRS), the input based and output based Malmquist TFP Index will provide the same measure of productivity change.

2.3 The Employment Function

2.3.1 In this paper, employment generated in the concerned industry is obtained by estimating the employment function which shows the relationship between employment, output and real wage rate (real cost of labour). The specification of employment function frequently used in empirical studies is given below:

$$\log(L) = a + b\log(w/p) + c\log(Y) + m\log(L_{-1}) + \alpha\,DT + u$$

Where, 'L' implies labour, 'Y' is the real value added output, '(w/p)' is the real wage rate (nominal wage deflated by the consumer price index), 'L_{-1}' is the labour with one year lag and 'u' is the random error term. One period lag of the dependent variable is considered here to capture the impact of past real wages on employment. The coefficient of 'log (w/p)' is expected to be negative since an increase in real wage rate (labour cost) should reduce employment. Again, we may state that the coefficient of 'log (Y)' may be expected to be positive because an increase in output should increase employment. It may further be added that the lagged structure underlying the above model requires the coefficients of 'log (L -1)' to lie between '0' and '1'. The short run elasticity of employment with regard to the real wage rate is given by 'b' and the long run elasticity by '[b/ (1-m)]'. Again the short run elasticity of employment with regard to output is given by 'c' and the long run elasticity by '[c/ (1-m)]'. DT is the intercept dummy which is time variant and it is used to catch the impact of liberalization on employment of the Indian Basic Metal industry.

3. Empirical Results of MTFP Growth

In this section, we have presented the estimates of total factor productivity growth and its components using Malmquist Productivity Index under two inputs- labour & capital and one output framework. Estimation of annual TFP growth rate of Indian Basic Metal industry for the pre and post-reform period at aggregate level are presented in Table: 3.1 & Table: 3.2 respectively.

Since the technical change is more than unity for both the pre and post reform period so we can say that there is an overall improvement in technical change.

We also found that the entire period (1980-81 to 2010-11) shows a positive

TFP growth and it is 3.6%. Now, From Table 3.1, it is seen that, during the pre-reform period, the Indian Basic Metal industry experienced an overall positive TFP growth of 4.3%. During the post reform period, from Table 3.2, we can clearly see that the overall growth of TFP is positive and it is 3.3% indicates that the total factor productivity growth fall form pre to post reform period. This result reveals that in post reform period, decline in the industry's TFPG is due to its productivity based frontier capability.

3.1 Empirical results from estimated Employment Function for the Indian Basic Metal Industry:-

3.1.1 Now, as stated in Methodology, the employment function is given by,

$$\text{Log } L = a + b \text{ Log } (w/p) + c \text{ Log } (Y) + m \text{ Log } (L_{-1}) + \alpha \, DT + u$$

So far as Basic Metal industry is concerned, the estimated employment function is given by,

$$\text{Log } L = 0.80 - 0.629 \text{ Log } (w/p) + 0.209 \text{ Log } (Y) + 0.543 \text{ Log } (L_{-1}) + 0.016DT$$

$$(6.037)^* \quad (-5.221)^* \quad (2.856)^* \quad (6.836)^* \quad (3.864)^*$$

Here, t-statistics are given in the parenthesis and the model is summarised as, $R^2 = 0.995$ and $\bar{R}^2 = 0.993$, F= 1401.598. The coefficient of 'Log (w/p)' is expected to be negative since an increase in teal wage rate should reduce the employment. Here, the coefficient of 'Log (w/p)' is negative, as it is expected. The coefficient of 'Log (Y)' is positive as is expected and it is 0.209 implies that increase in output should increase the employment. The coefficient of 'Log (L_{-1})' also lies between '0' and '1' as is expected and it is highly significant, indicating a significant lag in the adjustment of actual employment to its desired level. The Coefficient of 'DT' is positive and it is also highly significant implying a positive impact of liberalization on employment generation of the Indian Basic Metal industry. Here, the short run elasticity of employment with respect to real wage rate is 0.629 and that of the long run elasticity is 0.457. Similarly, the short run elasticity of employment with regard to output is 0.209 and that of the long run it is 0.457.

3.2 Empirical results from the causal relationship between real wage rate and total factor productivity growth for the Indian Basic Metal Industry:-

3.2.1 From unit root testing, we have the following results as presented in Table 3.2.1, 3.2.3 & 3.2.4.

3.2.2 The result of ADF unit root tests is presented in Table-3.2.1. Each variable is tested in their level, first difference and second difference with intercept only and trend & intercept. It is found that the null hypothesis of unit roots cannot be rejected at conventional significance levels for real wage rate (W/P). Therefore it can be concluded that all series are stationary at first difference i.e., all the series are I(1). Now at the first difference of the ADF test, the optimum lag selection is based on Schwartz Information Criteria (SIC). Table 3.2.2 suggest that the appropriate lag length is 2 for the considering variables.

3.2.3 The result of Phillips-Perron unit root tests is presented in Table-3.2.3. Each variable is tested in their level, first difference and second difference with intercept only and trend & intercept. It is found that the null hypothesis of unit roots cannot be rejected at conventional significance levels for real wage rate (W/P). Therefore it can be concluded that all series are stationary at first difference i.e., all the series are I(1).

3.2.4 The result of DF-GLS detrending unit root tests is presented in Table-3.2.4. Each variable is tested in their level, first difference and second difference with intercept only and trend & intercept. It is found that the null hypothesis of unit roots cannot be rejected at conventional significance levels for real wage rate (W/P). Therefore it can be concluded that all series are stationary at first difference i.e., all the series are I(1).

Results from Cointegration Test :

3.2.5 Having established the time series properties of the data, the test for presence of long-run relationship between the variables using the Johansen Cointegration test was conducted. The Johansen approach can determine the number of cointigration vectors for any given number of non-stationary variables of the same order. The results reported in Table-3.2.5 suggest that the null hypothesis of no cointegrating vectors can be rejected at 1% level of significance. It can be seen from the trace statistics that we have one co-integration equation at both 1% and 5% level.

3.2.6 From Johansen Cointegration test result the normalized cointegration equation can be written as:

$$W/P = \underset{(1.85^{***})}{-8.62} + \underset{(5.27^{*})}{7.01}\ TFP$$

From the above normalized cointegration equation we can say that one unit change in TFP leads to 7.01 unit change in real wage rate for the Indian Basic Metal industry. t-statistics are given in the parenthesis which are also significant at 10% (***) and 1% (*) level of significance. Thus we can say that there is a long-run relationship between real wage rate and total factor productivity growth.

Findings from Granger Causality Test :

3.2.7 The results of Pairwise Granger Causality between real wage rate (W/P) and total factor productivity growth (TFPG) for the Indian Basic Metal industry are presented in Table-3.2.6. The results reveal that there is a unidirectional causal relationship between TFPG and real wage rate (W/P). Our result confirms that TFP is the Granger cause of (W/P) at lag 2, 3 & 4.

3.2.8 The finding from our study, is quite natural and is in conformity with the studies made by Rath. B. N and Madheswaran. S (2007).

3.3 Empirical results from the causal relationship between real wage rate and partial labour productivity growth for the Indian Basic Metal Industry:-

3.3.1 The results of unit root testing are presented in Table 3.3.1, 3.3.3 and 3.3.4.

3.3.2 The result of ADF unit root tests is presented in Table-3.3.1. Each variable is tested in their level, first difference and second difference with intercept only as well as trend & intercept. It is found that the null hypothesis of unit roots cannot be rejected at conventional significance levels for both the variables and therefore it can be concluded that all series are stationary at first difference i.e., all the series are I(1). Now as all the series are stationary after first difference we can proceed to the granger causality test to check the causal relation between the variables. For the ADF test, the optimum lag selection is based on Schwartz Information Criterion.

Table-3.3.2 suggest that the appropriate lag length is 1 for the partial labour productivity and for real wages the appropriate lag length is 2.

3.3.3 The result of Phillips-Perron unit root tests is presented in Table-3.3.3. Each variable is tested in their level, first difference and second difference with intercept only and trend & intercept. It is found that the null hypothesis of unit roots cannot be rejected at conventional significance levels for both real wage rate (W/P) and partial labour productivity (Y/L). Therefore it can be concluded that all series are stationary at first difference i.e., all the series are I(1).

3.3.4 The result of DF-GLS detrending unit root tests is presented in Table-3.3.4. Each variable is tested in their level, first difference and second difference with intercept only and trend & intercept. It is found that the null hypothesis of unit roots cannot be rejected at conventional significance levels for both the variables. Therefore it can be concluded that all series are stationary at first difference i.e., all the series are I(1).

Results from Cointegration Test :

3.3.5 Having established the time series properties of the data, the test for presence of long-run relationship between the variables using the Johansen Cointegration test is conducted. The Johansen approach can determine the number of cointigration vectors for any given number of non-stationary variables of the same order. The results reported in Table-3.3.5. suggest that the null hypothesis of no cointegrating vectors can be rejected at 1% level of significance. It can be seen from the trace statistics that we have one co-integration equation at both 1% and 5% level.

3.3.6 From Johansen Cointegration test result the normalized cointegration equation can be written as:

$$W/P = \underset{(4.12^{*})}{-\,0.2889} + \underset{(3.01^{*})}{0.027051}\ (Y/L)$$

From the above normalized cointegration equation we can say that one unit change in (Y/L) leads to 0.027 unit change in real wage rate for the Indian Basic Metal industry. t-statistics are given in the parenthesis which are also significant at 1% (*) level of significance. Thus we can say that there is a long-run relationship between real wage rate and partial labour productivity.

Findings from Granger Causality Test :

3.3.7 The results of Pairwise Granger Causality between real wage rate (W/P) and partial labour productivity for the Indian Basic Metal industry are presented in Table-3.3.6. The results reveal that there is a unidirectional causal relationship between partial and real wage rate (W/P). Our result confirms that partial labour productivity is the Granger cause of (W/P) at lag 2, 3 & 4.

3.3.8 This result is also the conformity of the study made by Klein (2012) & Kumar (2012).

4. Conclusions

The following are the major findings of our study:

First, the result on the overall productivity displays there is a declining trend of MTFPG in post reform period as compared to pre reform period for the Indian Basic Metal industry.

Second, the result from estimated employment function depicts the negative relationship between employment and real wage rate.

Third, from employment function estimation for the Indian Basic Metal industry, we observe a positive relation between output growth and employment.

Fourth, there is an increase in employment, for the concerned industry due to liberalization policies.

Fifth, there is a positive and long-run causal relationship between real wage and total factor productivity growth for the Indian Basic Metal industry. The direction of causality is from total factor productivity to real wage rate.

Last, but not the least, our result also confirms a significant causal and long-run relationship between real wage rate and partial labour productivity for the Indian Basic Metal industry. The direction of causality is from partial labour productivity to real wage rate.

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Table: 3.1 – Malmquist Index Summary of Annual Means for Pre-reform Period

Year	EFFCH	TECHCH	PECH	SECH	MTFPCH
1980-81	-	-	-	-	-
1981-82	1.000	1.333	1.000	1.000	1.333
1982-83	1.000	0.825	1.000	1.000	0.825
1983-84	1.000	0.913	1.000	1.000	0.913
1984-85	1.000	0.916	1.000	1.000	0.916
1985-86	1.000	1.308	1.000	1.000	1.308
1986-87	1.000	0.705	1.000	1.000	0.705
1987-88	1.000	1.350	1.000	1.000	1.350
1988-89	1.000	1.126	1.000	1.000	1.126
1989-90	1.000	1.001	1.000	1.000	1.001
1990-91	1.000	1.179	1.000	1.000	1.179
Mean	**1.000**	**1.043**	**1.000**	**1.000**	**1.043**

Source: Authors own estimate by using DEAP software, version 2.1

Table: 3.2 – Malmquist Index Summary of Annual Means for Post-reform Period

Year	EFFCH	TECHCH	PECH	SECH	MTFPCH
1991-92	1.000	0.971	1.000	1.000	0.971
1992-93	1.000	1.065	1.000	1.000	1.065
1993-94	1.000	1.013	1.000	1.000	1.013
1994-95	1.000	1.317	1.000	1.000	1.317
1995-96	1.000	0.877	1.000	1.000	0.877
1996-97	1.000	0.856	1.000	1.000	0.856
1997-98	1.000	1.322	1.000	1.000	1.322
1998-99	1.000	0.939	1.000	1.000	0.939
1999-2000	1.000	1.281	1.000	1.000	1.281
2000-01	1.000	0.683	1.000	1.000	0.683
2001-02	1.000	0.497	1.000	1.000	0.497
2002-03	1.000	1.071	1.000	1.000	1.071
2003-04	1.000	2.778	1.000	1.000	2.778
2004-05	1.000	1.029	1.000	1.000	1.029
2005-06	1.000	0.914	1.000	1.000	0.914
2006-07	1.000	1.136	1.000	1.000	1.136
2007-08	1.000	1.114	1.000	1.000	1.114
2008-09	1.000	1.020	1.000	1.000	1.020
2009-10	1.000	1.033	1.000	1.000	1.033
2010-11	1.000	0.922	1.000	1.000	0.922
Mean	**1.000**	**1.033**	**1.000**	**1.000**	**1.033**

Source: Authors own estimate by using DEAP software version 2.1

Table 3.2.1: Results from ADF Unit Root Test

Variables	Intercept Only			Trend & Intercept		
	Level	1st Difference	2nd Difference	Level	1st Difference	2nd Difference
TFP	-5.59*	-5.89*	-3.40*	-5.56*	-5.76*	-4.31**
W/P	2.71	-4.32*	-7.28*	0.95	-5.36*	-7.56*

Source: Authors own estimate. (*, **, *** represents the significance level at 1%, 5% & 10% respectively)

Table 3.2.2: Selection of Appropriate Lag Length by SIC

Lags	SIC			
	TFP		W/P	
	Intercept Only	Trend & Intercept	Intercept Only	Trend & Intercept
1	10.97607	11.09738	4.256444	4.197497
2	10.92124*	11.04383*	4.235239*	4.172746*

Source: Authors own estimate

The asterisks (*) in the table 3.2.2 indicates the best (that is, minimized) values of the SIC.

Table 3.2.3: Results from Phillips-Perron Unit Root Test

Variables	Intercept Only			Trend & Intercept		
	Level	1st Difference	2nd Difference	Level	1st Difference	2nd Difference
TFP	-8.546580*	-18.60614*	-24.69985*	-10.95804*	-17.60549*	-24.07862*
W/P	3.432757	-4.631864*	-21.38441*	1.255157	-5.400801*	-33.99322*

Source: Authors own estimate. (*, **, *** represents the significance level at 1%, 5% & 10% respectively)

Table 3.2.4: Results from DF- GLS detrending Unit Root Test

Variables	Intercept Only			Trend & Intercept		
	Level	1st Difference	2nd Difference	Level	1st Difference	2nd Difference
TFP	-5.404652*	-7.079355*	-9.154866*	-5.642743*	-7.575941*	-5.798021*
W/P	2.444572	-4.382769*	-7.433553*	-2.185829	-5.509402*	-7.884532*

Source: Authors own estimate. (*, **, *** represents the significance level at 1%, 5% & 10% respectively)

Table 3.2.5: Johansen Cointegration Test Results

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	5 Percent Critical Value	1 Percent Critical Value
None **	0.5423718362759643	30.74536953571982	25.32	30.45
At most 1	0.2711961262303088	8.857817297819248	12.25	16.26

Trace test indicates 1 cointegrating equation(s) at both 5% and 1% levels

*(**) denotes rejection of the hypothesis at the 5%(1%) level

Table 3.2.6: Granger Causality test Results

Null Hypothesis	Lag	Observations	F-Statistics	Probability	Decision
TFP does not Granger Cause Real wage rate	1	29	2.11071	0.1578	Accept
	2	28	3.94444	0.0330	Reject
	3	27	3.25069	0.0422	Reject
	4	26	3.53909	0.0268	Reject
Real wage rate does not Granger Cause TFP	1	29	0.68525	0.4150	Accept
	2	28	0.24766	0.7826	Accept
	3	26	0.31707	0.8129	Accept
	4	27	1.12451	0.3760	Accept

Source: Authors own estimate.

Table 3.3.1: Results from ADF Unit Root Test

Variables	Intercept Only			Trend & Intercept		
	Level	1st Difference	2nd Difference	Level	1st Difference	2nd Difference
Y/L	-0.14	-6.40*	-4.24*	-2.75	-3.91**	-4.32**
W/P	2.71	-4.32*	-7.28*	0.95	-5.36*	-7.56*

Source: Authors own estimate. (*, **, *** represents the significance level at 1%, 5% & 10% respectively)

Table 3.3.2: Selection of Appropriate Lag Length by SIC

Lags	SIC			
	Y/L		W/P	
	Intercept Only	Trend & Intercept	Intercept Only	Trend & Intercept
1	6.015457*	5.967715*	4.256444	4.197497
2	6.129633	6.050285	4.235239*	4.172746*

Source: Authors own estimate

The asterisks (*) in the table 3.3.2 indicates the best (that is, minimized) values of the SIC.

Table 3.3.3: Results from Phillips-Perron Unit Root Test

Variables	Intercept Only			Trend & Intercept		
	Level	1st Difference	2nd Difference	Level	1st Difference	2nd Difference
Y/L	0.747532	-7.696103*	-25.78026*	-2.560786	-16.31150*	-25.54813*
W/P	3.432757	-4.631864*	-21.38441*	1.255157	-5.400801*	-33.99322*

Source: Authors own estimate. (*, **, *** represents the significance level at 1%, 5% & 10% respectively)

Table 3.3.4: Results from DF- GLS detrending Unit Root Test

Variables	Intercept Only			Trend & Intercept		
	Level	1st Difference	2nd Difference	Level	1st Difference	2nd Difference
Y/L	0.126185	-6.495927*	-1.541922	-2.707495	-3.159232***	-2.383759
W/P	2.444572	-4.382769*	-7.433553*	-2.185829	-5.509402*	-7.884532*

Source: Authors own estimate. (*, **, *** represents the significance level at 1%, 5% & 10% respectively)

Table 3.3.5: Johansen Cointegration Test Results

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	5 Percent Critical Value	1 Percent Critical Value
None **	0.3566944491219758	32.43499713622686	25.32	30.45
At most 1	0.1767983454583746	9.642068452648944	12.25	16.26

Trace test indicates 1 cointegrating equation at the 1% level

*(**) denotes rejection of the hypothesis at the 5%(1%) level

Table 3.3.6: Granger Causality test Results

Null Hypothesis	Lag	Observations	F-Statistics	Probability	Decision
Partial labour productivity does not Granger Cause Real wage rate	1	29	1.1903	0.1781	Accept
	2	28	4.67399	0.0230	Reject
	3	27	4.10934	0.0274	Reject
	4	26	4.57102	0.0238	Reject
Real wage rate does not Granger Cause Partial labour productivity	1	29	0.76091	0.5270	Accept
	2	28	0.28103	0.7941	Accept
	3	26	0.24999	0.8289	Accept
	4	27	1.51890	0.1271	Accept

Source: Authors own estimate.