

# **IS MAHARASHTRA LAGGING BEHIND IN TOTAL FACTOR PRODUCTIVITY?**

**An Analysis for 1981-1998**

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# Is Maharashtra lagging behind in Total Factor Productivity? An Analysis for 1981-1998

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## *Abstract*

*This paper analyses total factor productivity growth in the manufacturing sectors in Maharashtra, Tamil Nadu, Andhra Pradesh, Gujarat and Karnataka, using a fixed effects panel data technique for estimating manufacturing sector wise production functions. The main argument of the paper is that computation of total factor productivity growth assumes constant returns to scale and competitive factor markets. Given this requirement, it is not theoretically correct to estimate individual sector specific Cobb-Douglas production functions, which will yield, sector specific labour and capital elasticities. Under the assumption of CRS and perfect competition in factor markets, labour and capital elasticities must be identical across sectors. Hence, fixed effects panel data model is used to estimate TFPG. We estimate models for Maharashtra, Gujarat, Andhra Pradesh, Karnataka, Tamil Nadu and rest of India.*

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### **Introduction:**

The aims of this paper are two-fold. First, it makes a methodological point regarding the estimation of total factor productivity in the context of econometric estimation of production functions. This approach has several limitations like assuming perfect competition, the existence of an economy-wide production function and several studies have recently moved away from this approach by using disaggregated firm level data. (Das (2003), Goldar, Ranganathan and Banga (2003), Siddhartha and Lal (2003)). Assuming a homothetic aggregate production function, this paper argues, in section 1, that estimating Total Factor Productivity Growth (TFPG) by estimating a separate production function for each sub-sector is theoretically invalid. It then uses a fixed effects panel data method to estimate TFPG in the manufacturing sector. In the second section, we estimate and compare TFPG rates for Maharashtra, Karnataka, Tamil Nadu, Andhra Pradesh and Rest of India for the period 1981-1998. It then attempts to evaluate the performance of TFPG in Maharashtra vis-à-vis these other states and rest of India.

## **Section 1:**

Assume that the economy wide production function is given as follows:

$$Y(t) = A(t)K(t)^\alpha L(t)^{1-\alpha} \quad \text{-----(1)}$$

Total factor productivity growth is given as:

$$TFPG(t) = DY(t) - \alpha RKT(t) - (1-\alpha)RLT(t) \quad \text{-----(2)}$$

Where  $DY(t)$  is the percentage rate of growth of output,  $RKT(t)$  is the percentage rate of growth of capital stock whereas  $RLT(t)$  is the percentage rate of growth of labour supply. Under the assumption of perfect competition,  $\alpha$  equals the share of capital in output whereas  $(1-\alpha)$  equals the share of labour in output.

Thus,  $\alpha = rK/Y$  and  $(1-\alpha) = wL/Y$  where,  $r$  is the interest rate and  $w$  is the wage rate.

This relationship in turn comes about by setting the marginal product of labour equal to the wage rate and the marginal product of capital equal to the rate of interest. This is justified by the assumption of perfect competition in the factor markets. A Cobb-Douglas production function is then estimated for each sub-sector, sector specific  $\alpha$  and  $(1-\alpha)$  are estimated and sector specific total factor productivity growth rates are then estimated.

The most commonly used data source used to estimate the sectoral TFPGs is the Annual Survey of Industries and the sectoral classification that is used is the 2 – digit level classification.

We make the following assumptions:

- 1) Each firm in each sub sector is identical and cost minimizing.
- 2) Firms differ across sub-sectors only in the scale of output.

- 3) The aggregate, region wise industrial sector is divided into  $i$  sub-sectors, say, the Annual Survey of Industries 2-digit classification.

If we have assumed perfect competition in the factor markets, then the wage rate and the interest rate must be identical across the  $i$  sub-sectors. Even if the labour markets are differentiated by some characteristics, there is no reason to assume that the labour market differentiation exactly overlaps with the Annual Survey of Industries Classification. In fact, in many cases, and at least for some categories of labour, industries belonging to different sub-sectors may be simultaneously competing for all the same labour pool. Hence, we assume that firms in all the sub-sectors face the same wage and interest rate.

These assumptions have an important implication when viewed in conjunction with the assumption of perfect competition. We know that if the production function is homothetic, the factor proportions are independent of scale and depend only on factor prices. This implies that factor shares must be constant. In the case of a Cobb-Douglas, this means that all firms in a regional industrial sector will have the same factor shares and consequently will have identical values of  $\alpha$  and  $(1-\alpha)$ .

This implies that we cannot estimate sub-sector specific Cob-Douglas production functions because there is no guarantee that the estimated sub sector specific elasticities (i.e.  $\alpha$ 's in the Cobb-Douglas case) will be identical for all sub sectors which the theory requires under the assumptions that are made above.

The appropriate method of estimation will be a panel data model with fixed effects where the cross section units are the sub-sectors and the time series units are time series on K, L and Y. The specification of the model to be estimated for region  $i$  is (see Greene (1998)):

$$l_n(Y_i(t)) = \alpha * l_n(K_i(t)) + (1-\alpha) * l_n(L_i(t)) + \sum_{j=1}^{16} d_{ij} e_i(t) \quad \text{-----}(3)$$

With  $Y_i(t) = 1 \times 288$  matrix where the first 18 observations are from sector 20-21, the next 18 are from the next sector and so on. The vectors  $K_i(t)$  and  $L_i(t)$  are also stacked similarly. The  $d_i$ 's are dummy variables which take a value of one for the  $j$ th sector and zero otherwise.

This specification implies that only the scale parameters differ across sub-sectors. The coefficients of  $l_n(K_i(t))$  and  $l_n(L_i(t))$  give us the estimated elasticities, which are constant across the whole regional industrial sector and the  $d_i$ 's are the sub-sector specific scale parameters.

## **Section 2:**

We estimated TFPG using a fixed effects panel data model using the Annual Survey of Industries data for the period 1973-1998. We have used the two-digit classification. A series of real capital stock is calculated, the methodology for which is available from the authors. We have used the single deflation method using all India WPI since the state-wise WPI are not available. It is well known that the single deflation method creates a systematic bias in TFPG estimates across time (Balkrishnan and Pushpangadan (1994)). However, we are interested in comparing the TFPG's across regions at a specific point in time. Because the bias is related to the use of all India price statistics, all our estimates have exactly the same bias at any given point in time. Hence, as we are not interested in absolute TFPG numbers but their across region comparisons, the bias does not matter in our case.

We estimated separate panel data models for Maharashtra, Andhra Pradesh, Karnataka, Tamil Nadu, Gujarat and rest of India (which does not include Maharashtra but includes other states) included in the analysis. The models were estimated with the restriction that capital and labour elasticities sum to 1 as well as without the restriction. In the tables below, we present estimates of labour and capital elasticities for each of the regions mentioned above with and without restrictions as well as F tests of the restrictions.

**Table 1:**

Estimated Elasticities with Constant Return to Scale Restriction

	$\alpha$	$1-\alpha$
Maharashtra	0.55191	0.44809
Gujarat	0.49385	0.50615
Karnataka	0.54298	0.45702
Tamil Nadu	0.49790	0.50210
Andhra Pradesh	0.56834	0.43166
Rest of India	0.58847	0.41153

**Table 2:**

Estimated Elasticities without the Constant Returns to Scale Restriction

	$\alpha$	$1-\alpha$
Maharashtra	0.54740	0.56118
Gujarat	0.46209	0.92861
Karnataka	0.50737	0.64412
Tamil Nadu	0.46466	0.68862
Andhra Pradesh	0.49567	0.82227
Rest of India	0.54160	0.63606

**Table 3:**

Tests of the Constant Returns to Scale Restriction

	<b>F-Statistic</b>	<b>P-Value</b>
Maharashtra	2.22277	0.13716
Gujarat	44.86105	0.00000
Karnataka	14.86789	0.00014
Tamil Nadu	10.43622	0.00139
Andhra Pradesh	38.76162	0.00000
Rest of India	7.48600	0.00663

As we can see from the above table no. 3, the restriction of constant returns to scale was accepted in the case of Maharashtra and rejected for all other regions. Hence, the correct



way of comparing TFPG's would be to compare the TFPG for Maharashtra under the constant returns to scale restriction with those of other regions without the constant returns to scale assumption. Therefore in the following table we consider the average TFPG for Maharashtra with constant returns to scale and the TFPG for other states and rest of India with no constant returns to scale.

**Table 4:**

The Ranking Position of Maharashtra in Comparison with Rest of India and other states.

		Average TFP Growth with						Ranking	
		CRS	NCRS	NCRS	NCRS	NCRS	NCRS	Compared to	
Sectors		Maharashtra	Andhra Pradesh	Gujarat	Karnataka	Tamil Nadu	Rest of India	Other States	Rest of India
<b>20-21</b>	Pre. Re.	0.06893	-0.10534	-0.01710	0.07718	0.01680	0.04192	2	1
	Pos. Re.	0.01070	-0.25202	0.13119	0.02785	0.04997	-0.00149	4	1
<b>22</b>	Pre. Re.	-0.09986	-0.12922	0.14366	0.05622	-0.03897	-0.05106	4	2
	Pos. Re.	-0.05306	-0.04669	0.26422	-0.01407	0.04218	-0.02730	5	2
<b>23</b>	Pre. Re.	0.00337	-0.08236	0.04955	0.01137	-0.01360	-0.00266	3	1
	Pos. Re.	-0.02692	-0.17282	0.31023	-0.00770	-0.00619	-0.05084	4	1
<b>24</b>	Pre. Re.	0.03792	-0.23776	0.10120	-0.12824	0.01311	0.01421	2	1
	Pos. Re.	-0.02206	-0.67909	0.06633	-0.01879	-0.06574	0.01737	3	2
<b>26</b>	Pre. Re.	-0.01553	-0.34549	-0.04283	-0.01974	0.00424	0.01182	2	2
	Pos. Re.	-0.05792	-0.49266	0.43297	-0.07463	-0.05232	-0.07003	3	1
<b>27</b>	Pre. Re.	0.05237	0.15291	0.35215	0.06176	0.08964	0.04345	5	1
	Pos. Re.	-0.13283	-0.50464	0.13637	-0.03593	-0.11242	-0.13841	4	1

(contd.)

Sectors		Average TFP Growth with						Ranking	
		CRS	NCRS	NCRS	NCRS	NCRS	NCRS	Compared to	
		Maharashtra	Andhra Pradesh	Gujarat	Karnataka	Tamil Nadu	Rest of India	Other States	Rest of India
28	Pre. Re.	0.00188	-0.00547	0.09027	-0.02317	-0.06698	0.00236	2	2
	Pos. Re.	0.00764	-0.10593	0.28753	-0.10605	-0.22734	-0.04085	2	1
29	Pre. Re.	0.28514	-0.06004	0.66383	0.01309	-0.00015	-0.00133	2	1
	Pos. Re.	0.06423	0.05200	0.06778	0.04230	0.07096	0.04171	3	1
30	Pre. Re.	0.05648	0.18889	0.06856	0.12502	0.03469	0.07359	4	2
	Pos. Re.	-0.01501	-0.56137	0.21511	-0.07113	-0.04009	-0.00751	2	2
31	Pre. Re.	0.03027	-1.20107	0.12270	0.04499	-0.02844	-0.01504	3	1
	Pos. Re.	-0.04562	-0.13014	0.02992	-0.23384	0.05179	0.06316	3	2
32	Pre. Re.	0.01400	-0.22202	0.19929	0.03331	0.04198	0.01857	4	2
	Pos. Re.	-0.01031	-0.06100	0.28899	0.02715	0.00049	0.00652	4	2
33	Pre. Re.	0.00495	-2.39087	0.07279	0.05952	-0.04710	0.02699	3	2
	Pos. Re.	0.00665	-0.08731	0.66355	-0.23167	0.01801	0.07320	3	2
34	Pre. Re.	-0.02313	-0.40797	0.09212	-0.01479	-0.06091	-0.00239	3	2
	Pos. Re.	0.02602	-0.70399	0.27694	-0.09634	0.00777	0.00397	2	1
35-36	Pre. Re.	0.03241	-0.03485	0.10318	0.02225	0.01559	0.01893	2	1
	Pos. Re.	-0.01267	0.03275	0.13703	0.02703	-0.00580	0.00351	5	2
37	Pre. Re.	0.04712	-0.03928	0.19423	-0.04451	0.01393	0.05052	2	2
	Pos. Re.	0.01725	0.00184	0.27114	0.06352	0.02710	0.02254	4	2
38	Pre. Re.	0.04151	-0.58767	0.07785	-0.01734	-0.02806	0.02085	2	1
	Pos. Re.	-0.07655	0.00078	0.41074	0.08288	0.00851	0.02594	5	2

Note: Pre. Re. is Pre-Reforms. Pos. Re. is Post-Reforms

In food products (20-21), cotton textile (23), wood and wood products (27) and leather and fur products (29), it was found that for the pre and post reform period the rank of Maharashtra was higher than the rest of India. (*Figures in the parenthesis indicate the 2-digit ASI classification. See table in appendix*). Whereas, in the case of beverages, tobacco and related products (22), rubber, plastic, petroleum and coal products (30), non-metallic mineral products (32), basic metals and alloy products (33) and Transport Equipment and Parts (37) Maharashtra rank was less than that of the rest of India in the pre and post reform period. The decrease in rank in the post reform over the pre reform period was noticeable in jute, hemp and Mesta textiles (24), Chemicals and Chemical Products (31), Machinery, Machine Tools and Parts (including electrical machinery) (35-36) and Other Manufacturing Industries (38) sectors. Only in three manufacturing sectors Textile Products (including wearing apparel) (26), Paper and Paper products inc. publishing (28) and Metal Products and Parts (except machinery and Transport) (34) Maharashtra rank had shown an increase in the post reform period.

With the above comparison of Maharashtra State with the rest of India we can conclude that the overall ranking performance of Maharashtra was almost similar to that of the rest of India.

Comparing Maharashtra State with other four states (Andhra Pradesh, Gujarat, Karnataka and Tamil Nadu) we find that Maharashtra never stood first in ranking. The performance of the State had shown a decline in ranking in many manufacturing sectors in Food Products (20-21) Maharashtra was in the second position as compared to other states then became fourth in the post-reform period. In Nine out of 16 sectors Maharashtra ranking had declined in the post-reform period as compared to others.

Which shows that the performance of Maharashtra in the pre-reform era was better off than in the post reform period, this indicates a loss of technological competitiveness in these sectors for Maharashtra state.

Only in three sectors, Wood and Wood Products (27), Rubber, Plastic, Petroleum and Coal Products (30) and Metal Products and Parts (except machinery and Transport) (34) Maharashtra ranking in the post reform period had changed positively, from the 5<sup>th</sup> to 4<sup>th</sup>, 4<sup>th</sup> to 2<sup>nd</sup> and from 3<sup>rd</sup> to 2<sup>nd</sup> position respectively.

There was no change in the ranking over the pre reform period in the Paper and Paper products inc. publishing (28), Chemicals and Chemical Products (31), Non-Metallic Mineral Products (32) and Basic Metals and Alloy Products (33) sectors. In these sectors, Maharashtra maintained its position as the 2<sup>nd</sup>, 3<sup>rd</sup>, 4<sup>th</sup> and 3<sup>rd</sup> respectively.

The following table shows the change in ranking over the pre-reform period of Maharashtra with rest of India and other states

**Table 5:** Change in Maharashtra’s ranking in comparison with Rest of India and other States:

<b>Maharashtra</b>	<b>Rest of India</b>	<b>Other States</b>
<b>Gained ranking</b>	26, 28 & 34	27, 30 & 34
<b>Lost ranking</b>	24, 31, 35-36 & 38	20-21, 22, 23, 24, 26, 29, 35-36, 37 & 38
<b>No change in ranking</b>	20-21, 22, 23, 27, 29, 30, 32, 33 & 37	28, 31, 32 & 33

As noticed from the above table Maharashtra has enhanced its ranking in Metal Products and Parts (except machinery and Transport) (34) over the pre-reform period and was

leading rest of India but held the 2<sup>nd</sup> position in comparison with other states. While in sectors 26 and 28, Maharashtra was leading rest of India but not other states, whereas, in case of sectors 27 and 30 Maharashtra's rank was higher in the post reform period as compared to other states.

Considering the lost ranking, we can see that Maharashtra had lost its ranking over that of the pre-reform period in the 24, 31, 35-36 & 38 sectors in comparison with rest of India, while with other states the ranking of the following sectors declined (i.e. 20-21, 22, 23, 24, 26, 29, 35-36, 37 & 38).

Maharashtra has recorded no change in ranking in 11 manufacturing sectors and maintained its position in these sectors despite the fluctuation in ranking for other states in the same sectors.

### **Conclusion:**

This paper attempted to examine the total factor productivity growth in Maharashtra vis-à-vis total factor productivity growth in some states of India as well as versus rest of India. A methodology for estimating and comparing total factor productivity was developed. It was found that vis-à-vis rest of India, Maharashtra has lost rank in four sectors, viz. Jute, hemp, and mesta textiles, chemicals and chemical products, machinery, machine tools and parts as well as other manufacturing industries. The first of those was never an important industry in Maharashtra. However, the others are important in Maharashtra vis-à-vis Gujarat, Karnataka, Andhra Pradesh, and Tamil Nadu as a group. Maharashtra has lost its rank in food products, beverages, tobacco and related products, cotton textiles, jute, hemp and mesta textiles, textile products, leather and leather

products, machinery, machine tools and parts, transport equipment and parts, and finally, other manufacturing industries.

With regards to the gain in ranking, it was found that vis-à-vis rest of India, Maharashtra has gained rank in three sectors, i.e. Textile Products, Paper and Paper products and Metal Products and Parts. Of all these sectors, textile products was one of the sectors in which Maharashtra was always a dominant player. The others are important in Maharashtra vis-à-vis Gujarat, Karnataka, Andhra Pradesh, and Tamil Nadu as a group. Maharashtra has gained its rank in Wood and Wood Products, Rubber, Plastic, Petroleum and Coal Products and Metal Products and Parts. Thus, we can say that the study can be broadened into a major research area.

*Appendix:*

<b>ASI classification</b>	<b>Sectors</b>
20-21	Food Products
22	Beverages, Tobacco and Related Products
23	Cotton Textiles
24	Jute, Hemp and Mesta Textiles
26	Textile Products (including wearing apparel)
27	Wood and Wood Products
28	Paper and Paper products inc. publishing
29	Leather, Leather and Fur Products
30	Rubber, Plastic, Petroleum and Coal Products
31	Chemicals and Chemical Products
32	Non-Metallic Mineral Products
33	Basic Metals and Alloy Products
34	Metal Products and Parts (except machinery and Transport)
35-36	Machinery, Machine Tools and Parts (including electrical machinery)
37	Transport Equipment and Parts
38	Other Manufacturing Industries

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