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Measuring Productivity for Firms: A Study of Indian Pharmaceutical Industry

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Abstract: This paper analyses productivity in Indian Pharmaceutical Industry by size of firms and covers the period 1994-95 to 2016-17. More specifically, it examines the trends in different types of productivities in the pharma-industry based on the size of the firms and comparison is drawn in the productivity measurement in prerecession and post-recession period. The paper finds that the Indian Pharmaceuticals industry as a whole has experienced increased total productivity along with increase in labour and capital productivities. Increase in labour productivity appears to be universal across firms. However, with capital productivity varies across firm sizes. Smaller sized firms have experienced both- increased labour as well as capital productivities, and capital deepening here has not resulted in excess capacity. Mid sized firms exhibit increased labour productivity but a near constant capital productivity. These firms have experienced capital deepening and this has not been translated in to higher capital productivity thus resulting in excess capacity.

I. Introduction

The drugs and pharmaceutical industry in India is almost a century old. It has undergone a drastic change particularly in the post- independence period. Before 1947, pharma-industry was dominated by the multinationals. In the global context, Indian pharmaceutical industry is one of the largest in terms of the number of companies, third largest in terms of volume and ranks among the top thirteenth in terms of value. The industry accounts for 20 per cent in terms of volume and 1.4 per cent in terms of value of the Global Pharmaceutical industry (Equity Master, 2016).

Notwithstanding this healthy scenario, the pharma-industry has some major challenges to address. The industry needs to remain globally competitive at a time when the technological changes in the pharmaceutical industry – from powerful new drug discoveries to innovative R&D partnership and marketing plans – are reshaping the business strategies of many pharmaceutical companies at the global level. This has again assumed increased importance, albeit for other reasons. Following the WTO norms, product patent regime has been replaced by the process patent regime in 2005.

One of the important ways of ensuring global competitiveness of this industry is to increase its resource use efficiency or otherwise called productivity. However, a blanket study on productivity of this industry may not bring out clear-cut picture of its competitiveness and therefore may not be very useful from the point of view policy formulations and influence.

This paper is an attempt to study the productivity of the Indian pharmaceutical industry by the size of the firms. Analyzing productivity on the basis of size makes the analysis poignant and effective. We report the results from our analysis which focuses mainly on productivity changes in terms of labour, capital and technology utilization.

II. Concept of Size and Productivity

Size

The determination of size of the firms is a contentious issue. There are various indicators that can be used to classify the firms into different sizes. In India, the most important consideration of size of firm has been the number of workers used in the production process. In fact, the division of entire manufacturing sector into small scale and large scale sector is done using the number of workers and thus we have used this criterion to classify the pharmaceutical sector in our study, into seven mutually exclusive size groups or categories as given in Table 1.

Table 1: Size of Firms and Workers

Number of Workers	Size Group
< 25	I
26 - 50	II
51 - 100	III
101 - 250	IV
251 - 500	V

501 - 1000	VI
> 1000	VII

Source: Authors' grouping based on unit record data from ASI.

Productivity

Productivity is a measure of how well labour, capital and other inputs are utilized to produce output. In the broader sense, productivity may be defined as the ratio of available goods and services to the potential resources of the community or the country. In a narrow sense, productivity is the ratio between the output of wealth produced and the input of resources used up in the process of production. In this study, we define productivity as the relationship between output of goods and services (O) and input (I) of resources used in the production process.

Productivity has become almost synonymous for progress. The standard of living in a society depends upon the degree to which the minimum needs of the people are satisfied. Higher productivity requires elimination of wastes in all forms. Studies on total factor productivity acquire great significance in the context of growth in developing economies. The generation of surplus, which plays pivotal role in their growth, depends crucially on the efficiency with which resources are used (Goldar, 1986). Estimation of total factor productivity in so far as they reflect advances in knowledge bring out how effective technological progress has been in circumventing the problem of resource scarcity and in bringing about efficient use of resources.

III. Studies on Size and Productivity

There are many studies throwing valuable light on the nature and degree of relationship between size and productivity. Among the notable contributions on size-productivity relationship are TNEC's Monograph on "The Relative Efficiency of Large, Medium-Sized and small Business" and "Productivity, Prices and Distribution in Selected Industries" by Rostas (1943). "The relationship between size and Efficiency" by Blair's (1942) and "A study of the Relation between Size and Efficiency of Industries, with special reference to the history of selected British and American Industries (1850-1910)" by Jones (1950) are other pioneering studies. There are also number of studies that have tested the size-profitability relationship across industries, like Stekler (1963), Hall and Weiss (1967), Singh and Whittington (1968), Sephered (1972), Whittington (1980), Pomfret and Shapiro (1980) and Amato and Wilder (1985). These studies arrived at some contradictory results because they have used different hypotheses. The tendency to study the relationship across industries has been criticized because the size-profitability relationship can differ across industries and also because all inter-industry differences cannot be controlled for in estimating the relationship (Nagrajan and Barthwal, 1988).

There are number of studies that have investigated productivity in Indian industries and its impact on the economy and industries in particular. Banerji (1975) using Solow, Kenderick and CES index observed significant falling trend in TFP. Gupta (1975) analyzed TFP as well as factor productivity in the fertilizer industry in India and found that over the years, TFP as well as the productivity of labour and capital has tended to decline in both the public and private sectors, when the performance of all the units was considered. Goldar (1986) has attempted to analyze productivity trend in Indian Manufacturing industry for the period 1951-79 and found that the growth rate of total factor productivity for aggregate industry had been positive but quite low and the performance of some modern industries like metals, chemicals etc., contrary to expectations, had been relatively low as compared to the traditional industries.

Ahluwalia (1991) observed a decline in total factor productivity during 1960s and 1970s and a turnaround in the first half of the 1980s. Ahluwalia (1991) attributed the improvement in total factor productivity to increase in labour productivity while the capital productivity was more or less constant. Dholakia and Dholakia (1994) find that the performance of public enterprises in the manufacturing sector during 1960-61 to 1975-76 was remarkable as compared to private enterprises. Pradhan and Barik (1999) observed a declining trend of TFPG in the aggregate manufacturing sector supported by most of the individual industries. Unel (2003) has concluded that the total factor productivity growth in aggregate manufacturing and many sub-sectors accelerated after the 1991. Das (2004) claimed that the productivity performance seemed to worsen as the pace of trade reforms gathered momentum. He observed that that there was a marked fall in the growth of total factor productivity in Indian manufacturing in the 1990s from that in the 1980s.

The review of the literature suggests that the size has got an important implication on the performance of a firm. It also appears from the brief review that either size of the firms is not taken into account in most of the studies on Indian industry or size and performance of firms are not conclusively established on the productivity variation in Indian pharmaceutical industry. Thus it is worthwhile to undertake a study on the productivity variation in the Indian pharmaceutical industry by size of the firms.

IV. Methodology and Data

Productivity Measurement

Productivity may be measured either on aggregate or on individual basis. In the first case output is compared with all the input factors taken together. This is known as total factor productivity. In the second case output is compared with any one of the input factors and this is called partial productivity or factor productivity.

$$\text{Total Productivity Index} = \frac{\text{Total Output}}{\text{Total Input}} = \frac{\text{Total Production of Goods and Services}}{\text{Labour + Materials + Capital + Energy}} \quad (1)$$

This index measures the efficiency of the entire organization in the use of all the resources. It is a strategic yardstick for evaluating the operating efficiency of the entire plants or firms. Sangha (1964) has shown the ways of constructing the productivity indices, which can be done mainly in two ways. First, it is possible to compare base period with the current period, and secondly, it is possible to compare current period with the base period. If calculations are performed on the base period production composites, the unit labour requirement index will measure the ratio of labour that would have been spent in the current period to produce the base period complex of goods to total labour actually expended in the base period.

Analysis of sources of growth may also be related in individual classes of inputs – such as labor hour, man-made capital and land – or to sub categories of these classes. As a result, we get a measure of average productivity of land, labor or capital, which is known as single factor productivity (SFP) measure (Ahluwalia, 1991). However, the most commonly used measurement of productivity changes is the total factor productivity (TFP) measure (Goldar, 1986).

Following (Goldar, 1986), using four quantities like rate of growth of output (Y), rate of growth of labour input (L), the rate of growth of capital (K) and the rate of growth of intermediate goods (I) a standard formula for TFP measurement is developed for measuring changes in inputs and outputs as

$$\dot{A} = \dot{Y} - [\alpha (\dot{L})] - [\beta (\dot{K})] - [(1-\alpha-\beta)(\dot{I})] \quad (2)$$

where, $\dot{A}$ is TFP change, $\dot{Y}$ is the total value added, α is the weight attached to contribution of labour to the output and β is the weight attached to the contribution of capital to the output.

TFP which attempts to measure the change in output net of the changes in all inputs has been considered a better approach. The TFP is often referred to as index of technical progress (Solow, 1957). The analytical framework for TFP is based on the economic theory of production. For this purpose, the theory consists of a production function with constant returns to scale together with the necessary conditions for producer equilibrium. In many of the empirical studies, the Solow index has been used. Following this, we have also used in our study this index. Solow's (1957) measure is based on the assumptions of aggregate production function, with constant returns to scale and autonomous neutral technical change. With these assumptions, the production function becomes, $V = A(t) f(K, L)$, where, A(t) is a time verifying efficiency parameter that allows the neutral shifts in the production, and K and L are capital and labour respectively. It is to be noted that if the quantities of the inputs are held constant, the rate of change of output is precisely equal to the rate of change of A(t). Thus A(t) may be identified as a measure of the level of total factor productivity. An index of total factor productivity for each year can be derived from the identity:

$$A_{(t+1)} = A_{(t)} \left[1 + \frac{\Delta A(t)}{A(t)} \right] \quad (3)$$

Thus, A(t) series can be constructed by A(t) = 1 for the base year.

Data Sources and Period of Study

For measuring Total factor productivity at the firm level, there is a need for firm level data on output, capital stock and employment. As theses data are readily available in standardized form in National Accounts statistics (NAS) and Central Statistical Organizations (CSO), they are not comparable.

We have used the firm level data obtained from Annual Survey of Industries from 1994-95 to 2016-17 to estimate the measures of productivity.

V. Results and Discussions

Partial Productivity Analysis

Table 2 indicates the index of labour productivity in the pharmaceutical firms. It exhibits a mixed trend over the years. The labour productivity has shown an increasing trend from 1994-95 to 2016-17 with mild fluctuations. However if we look at the firms employing less than 50 workers, the labour productivity has declined considerably over the years though there has been some upward trend in some years. The index of labour productivity for the firms employing more than 1000 workers has shown a declining trend though there has been some upward trend in some years. The index in labour productivity for the firms employing more than 50 workers and less than 1000 workers has shown an upward trend.

Table 2: Index of Labour Productivity by Size

	Size							
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Total**
1994-95	100	100	100	100	100	100	100	100
1996-97	101.2	111.4	94.7	101.0	116.6	114.4	98.9	102.8
1997-98	122.5	94.5	113.5	118.9	96.5	124.7	113.5	123.4
1998-99	125.6	147.5	113.9	98.2	122.0	98.5	108.8	115.3
1999-00	110.2	90.3	130.2	108.5	97.0	93.7	105.0	114.0
2000-01	98.8	127.5	101.0	105.7	118.7	108.1	80.8	103.3
2001-02	115.2	87.3	80.9	105.4	77.1	108.7	76.9	75.3
2002-03	99.3	100.9	95.9	105.1	117.9	84.5	128.9	119.1
2003-04	100.6	105.1	126.6	87.7	95.7	114.3	92.0	119.1
2004-05	115.9	101.8	93.0	126.3	110.3	108.7	124.7	94.4
2005-06	78.4	101.7	114.2	117.8	133.1	123.3	87.9	109.4
2006-07	113.0	101.7	94.9	90.4	105.1	96.9	108.6	105.1
2007-08	82.7	107.8	101.1	82.9	69.6	76.9	76.9	79.2
2008-09	95.8	98.8	131.4	114.0	136.6	109.7	109.4	122.4
2009-10	100.2	115.7	104.5	93.8	93.0	95.4	100.6	102.7
2010-11	131.5	97.8	92.9	116.7	108.0	116.8	98.7	105.3
2011-12	125.6	135.2	115.5	99.0	88.9	107.9	110.5	113.9
2012-13	123.6	81.2	104.9	103.9	101.6	96.7	95.0	109.2
2013-14	127.5	160.9	105.1	102.4	111.7	102.4	98.3	118.0
2014-15	126.3	84.8	88.2	102.6	102.7	105.9	95.3	97.7
2015-16	129.4	121.1	125.5	102.5	104.9	107.9	155.3	90.5
2016-17	131.2	93.4	104.9	102.5	93.2	124.5	104.6	107.4

Note: Firm sizes as reported in Table 1

Source: Calculated by the author using unit record data from ASI.

Like labour productivity, compared to the pre-recession period of 1994-95 to 2008-09, it has consistently been higher in the post-recession period of 2009-10 to 2016-17. Within the post-recession period, it has again been comparatively higher in the latter phase of post-recession (1996-97 to 2002-03) vis-à-vis the early phase (2000-01 to 2007-08). This shows that as in the case of labour productivity, the government policies have helped average capital productivity to increase in the pharmaceutical sector as a whole.

The average capital productivity for the small sized firms (firms I, II, III) particularly in the post-recession period has been higher than the middle sized firms (IV, V). For firms employing workers in between 500 to 1000 (Firms VI), the average productivity of capital has been very low and even shows a declining trend for the whole period of 1994-95 to 2007-08. However, average capital productivity, has significantly increased for firms size VII during the latter period of recession i.e. 2009-10 to 2016-17. This shows that post-recession policies have helped capital productivity to increase for smaller sized firms as well as very large-sized firms. Medium sized firms have not been able increase their capital productivity much during this period of economic recession.

Table 3 reports the index of capital productivity in the pharmaceutical industry. The index of capital productivity has increased over the years with much fluctuation. The index was only 45.48 in 1995-96, increased to high at 154.78 in 2007-08 and then it declined to 103.10 in 2003. The index of capital productivity for the firms employing less than 25 workers has shown a declining trend with much fluctuation has been noticed. The index was 150.1 in 1994-95 and then it declined to 88.05 in 2016-17. The index in capital

productivity for the firms employing more than 1000 workers has increased from 105.1 in 1995-96 to 202.7 in 2004-05 and then it declined to 106.20 in 2016-17. The same trend has also been seen for other size of firms.

If both labour productivity and capital productivity index were moving in same positive direction, it means that the overall productivity of the firm/industry is increasing and vice-versa. If increased productivity indices are accompanied with a fall in capital intensity, the implication might be that there is better utilization of capital and capacity. Such a situation arises for the mid sized firms. In contrast, when the capital intensity is increasing with a declining trend in the partial productivity indices (as in the case of large sized firms), it shows that there is excess capacity and over capitalization. If, in addition to increase in labour productivity, we also find that capital intensity is also increasing, then increase in labour productivity may be due to capital deepening. Such a tendency is noticed in small sized firms that is, the firms generally employing less than 100 labourers in the Indian pharmaceutical industry. However, capital productivity at the same time was very marginal and labour productivity was increasing during the same period. Thus, the factor, which seems to explain labour productivity in the pharmaceutical firms, is capital intensity. However, the above results confirm that the small sized firms have performed better in terms of higher productivity of factors with low capital intensity as compared to large sized firms in the Indian pharmaceutical industry.

Table 3: Index of Capital Productivity

Year	Size							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**Total**
1994-95	100	100	100	100	100	100	100	100
1996-97	150.1	104.6	94.3	144.4	109.0	109.2	105.1	45.5
1997-98	136.3	107.1	103.0	102.4	104.7	99.1	145.8	141.4
1998-99	115.1	114.3	127.0	121.2	102.6	79.7	105.8	98.8
1999-00	126.5	119.7	98.8	113.4	126.0	95.4	80.7	131.1
2000-01	103.3	93.2	106.0	83.6	100.4	100.7	102.1	95.7
2001-02	69.1	86.3	79.0	74.6	127.5	150.5	140.9	92.7
2002-03	112.9	121.8	104.2	128.0	88.5	78.9	94.5	51.4
2003-04	104.2	104.5	129.7	113.9	113.8	84.6	107.6	110.9
2004-05	109.5	120.1	142.7	77.1	96.0	88.9	202.7	187.0
2005-06	97.9	127.5	128.6	129.4	89.1	139.5	114.6	124.7
2006-07	94.3	73.6	69.5	88.7	83.1	77.5	114.8	75.8
2007-08	80.5	99.5	106.7	77.1	135.9	72.8	112.7	154.8
2008-09	150.1	97.7	94.5	86.7	109.6	120.3	110.6	73.7
2009-10	87.0	111.8	94.1	89.2	134.6	74.6	109.9	101.9
2010-11	111.4	109.3	124.2	139.9	83.6	121.6	94.3	101.9
2011-12	90.4	76.0	142.7	117.8	121.9	144.3	115.6	103.4
2012-13	100.7	84.6	79.4	105.5	79.3	166.2	108.2	110.1
2013-14	100.7	143.6	105.0	95.4	114.1	36.8	107.6	97.4
2014-15	100.7	102.3	121.7	83.9	103.5	160.4	107.1	101.5
2015-16	100.7	99.8	91.7	98.2	103.4	63.7	106.6	105.6
2016-17	88.1	104.2	103.8	99.4	103.3	76.9	106.2	103.1

Note: Firm sizes as reported in Table 1
Source: Calculated by the author using unit record data from ASI.

For the pharmaceuticals industry as a whole, when both labour and capital productivity have increased over the period 1994-95 to 2016-17, suggesting that overall productivity has increased in the industry. This inference is robust for the smaller sized firms. For the mid-sized firms (firms IV, V and VI), increase in labour productivity and the trend of near-constancy in capital productivity, apparently suggests increase in labour productivity because of capital deepening. It also indicates presence of excess capacity in these firms. Finally, the above results confirm that the small sized firms have performed better in terms of higher productivity of factors with low capital intensity as compared to the large sized firms in the Indian pharmaceutical industry.

The relatively high rate of growth in labour productivity in most of the firms may be largely due to high capital intensity of their operations. While capital deepening may have contributed to a growth in labour productivity of some of these firms, it does not seem to have had much impact on overall efficiency in the mid-sized firms. It appears that this increase in labour productivity because of capital deepening has been offset by a

decline in capital productivity, more so in the post-recession period. This declining trend in the capital productivity may be due to under-utilization of capital and capacity in the mid-sized firms.

Total Factor Productivity (Solow Index) Analysis

We then analyze the trends in the TFP in search of more conclusive evidence on overall efficiency of the pharmaceutical industry. As mentioned earlier, we have adopted Solow index of measuring the TFP because of its wide acceptance and application. TFP index of pharmaceutical firms according to size, based on the methods of Solow, has been analyzed and the results are reported in Table 4.

For the industry as a whole, the index has increased from 101.04 in 1994-95 to 322.07 in 2016-17 with mild fluctuation between the years. This index also shows an annual growth rate of 6.8 per cent for the pharma-industry as a whole during this period. Compared to the pre-recession period, in the post-recession period, the index value has been consistently above 200. However, although the overall trend shows an increase in the total productivity, there exists inter -year fluctuations in this productivity for all the firm sizes. These findings of the TFP analysis vindicate, more or less, the partial productivity analysis trends analyzed in the earlier section.

Table 4: Solow Index of Total Factor Productivity and its Growth

Year	Size							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**Total**
1994-95	100	100	100	100	100	100	100	100
1996-97	97.5	109.4	93.4	98.7	116.9	114.8	97.7	101.0
1997-98	44.1	103.9	124.1	120.1	113.6	144.7	112.8	125.0
1998-99	77.1	160.5	121.6	117.3	147.2	143.2	129.4	147.4
1999-00	215.1	136.4	156.0	151.8	139.3	132.3	142.3	165.9
2000-01	196.4	174.7	156.9	162.3	167.0	144.0	100.8	169.5
2001-02	141.9	158.3	131.8	123.9	137.1	125.3	80.9	134.4
2002-03	243.7	161.5	122.3	104.4	154.5	132.9	106.1	155.9
2003-04	249.3	220.6	158.7	135.4	148.0	161.3	99.1	187.3
2004-05	159.0	218.3	198.8	170.5	163.8	167.3	124.5	177.9
2005-06	221.0	273.8	288.8	197.1	204.0	205.0	192.8	232.0
2006-07	278.7	257.6	236.1	175.4	221.4	194.6	154.3	237.0
2007-08	158.8	197.3	171.5	153.8	164.8	162.5	123.4	168.6
2008-09	212.5	194.2	253.2	176.9	216.8	181.5	128.4	206.4
2009-10	207.9	228.9	274.7	165.9	202.9	161.7	137.9	209.5
2010-11	258.1	273.8	253.5	187.8	203.9	222.8	166.4	248.2
2011-12	335.8	252.0	313.4	199.2	191.3	274.9	142.5	280.3
2012-13	229.9	427.7	333.6	282.9	313.0	322.0	124.6	322.4
2013-14	343.6	358.5	245.9	297.1	343.9	216.5	127.6	330.4
2014-15	191.8	407.1	310.6	251.1	234.7	226.5	184.8	288.6
2015-16	270.8	413.5	343.1	263.8	220.7	312.2	205.4	321.0
2016-17	237.3	375.0	337.7	261.9	288.3	276.6	261.6	322.1
Growth in TFP 1994-17	14.7	8.7	8.2	6.0	7.3	6.5	13.5	6.8

Note: Firm sizes as reported in Table 1

Source: Calculated by the author using unit record data from ASI.

VI. Summary and Conclusion

The performance of the Indian pharmaceutical industry has been a mixed one. There has been a general upward trend in the production has increased impressively over the years. Indian Pharmaceuticals industry as a whole has experienced increased total productivity as well as increase in the labour and capital productivities during the period 1994-95 to 2016-17. This increasing trend is more pronounced in the post-recession period (2008-09 to 2016-17) compared with the pre-recession period (1994-95 to 2007-08).

Simultaneous increase in both labour and capital productivity implies that the industry has made efficient use of both capital and labour. However, analysis of productivity by firm size shows some evidence of differences across firm sizes, with respect to the magnitude and direction of trend in productivities. Smaller sized firms have recorded increased TFP growth during the whole period implying increased returns to scale. Mid sized firms employing more that 100 and less than 1000 workers, show increased labour productivity and a near constant or declining capital productivity, have experienced capital deepening. This capital deepening has not been translated in to higher capital productivity resulting in excess capacity. Value added in almost all the firms have been responsive to labour and capital and the Indian pharmaceutical industry as a whole has experienced considerable technical progress during the period 1994-95 to 2016-17.

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