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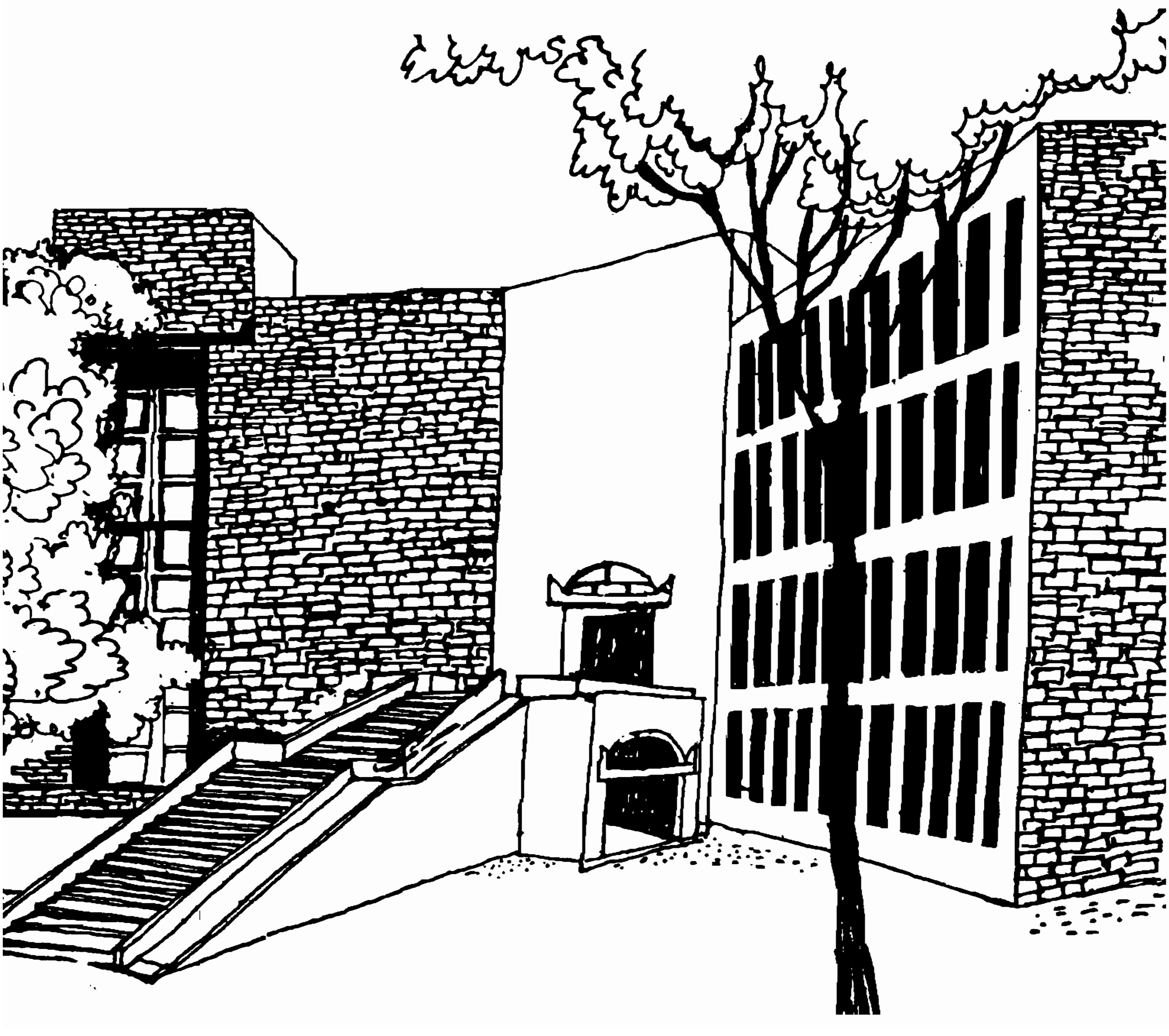

APPROPRIATE MEASURE OF REAL VALUE ADDED AND TOTAL FACTOR PRODUCTIVITY GROWTH IN INDIAN MANUFACTURING

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Abstract

It is a widely held hypothesis that the Indian industry experienced a significant turnaround in its Total Factor Productivity Growth (TFPG) during the decade of the eighties as compared to the seventies. Recently it is argued that if the real value added is estimated by using the double deflation method instead of the usual single deflation method, this hypothesis does not hold. It is also suggested that the double deflation method provides a more appropriate measure of the real value added. In the present paper, it is shown that the hypothesis of a significant increase in TFPG during the eighties in the Indian industries is clearly corroborated if sufficient care is taken about applying the double deflation method. Moreover, it is also argued that the double deflation method per se is not necessarily superior to the single deflation method for measuring the real value added.

Appropriate Measure of Real Value Added and Total Factor Productivity Growth in Indian Manufacturing

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In a recent study on "Total Factor Productivity Growth in the Manufacturing Industry in India", Balakrishnan and Pushpangadan (in *EPW* July 30, 1994, henceforth referred to as B-P, 1994) have attempted a very interesting exercise. They argue that the estimate of Total Factor Productivity Growth (TFPG) is highly sensitive to the way the real value added is measured. With the help of the example of the growth experience of the manufacturing industry in India, B-P (1994) have tried to show that measurement of real value added by the double deflation method, instead of single deflation method which is more widely used by the researchers, not only alters quantitatively the estimate of TFPG, but also affects qualitative conclusions about the behaviour of TFPG over time. Thus, they argue that if double deflation method is used, during the decade of the eighties TFPG does not show any acceleration over the previous period. Rather TFPG during the seventies turns out to be higher than during the eighties. In the present note we would like to show that (1) the qualitative conclusion about the behaviour of TFPG in the Indian manufacturing industry over time - particularly during the eighties as compared to the seventies does not change if sufficient care is taken about applying the double deflation method; and (2) the double deflation method *per se* is not necessarily superior to the single deflation method.

1. TFPG with Double Deflation Method

It is possible to find faults on a number of points in the empirical exercise reported by B-P (1994), e.g., (1) The study is based on the ASI data, but remains silent on the adjustments for the non-reporting units; (2) Presence of aggregation bias in using weights from input-output transaction table which is further aggregated to form 19 input groups may distort the results; (3) While the B-P (1994) study considers at best a large part of the registered manufacturing sector only, the I-O table is based on the inputs and outputs of the entire manufacturing sector which can introduce significant biases and distort the deflators used; etc. It should be noted here that the CSO (1980, p.26; and 1989, p.84) has repeatedly regretted its inability to follow the double deflation method to obtain the real value added with the required degree of rigour on account of data constraints and non-feasibility of the method particularly for multi-product industry groups. On the other hand, when one is making a bold effort to follow the double deflation method ignoring all these limitations, one has to be extremely careful in using all possible information to approximate the reality as closely as possible. This is where the B-P study (1994) seems to be lacking.

Basic problem in estimating real value added by double deflation method is the estimation of an appropriate price index for material inputs. Even after the input groups are properly identified and the respective price indexes for each input group are obtained, the weights attached to each input group would play a significant role in the determination of overall input price index. B-P (1994) have identified 19 input groups as the components of the overall material input for the organized manufacturing sector and they have obtained their respective weights from the input-output transactions matrix prepared by the CSO for the reference year 1973-74 by reclassifying various categories into these 19 groups. It was possible for them to use the weights as implicit in the wholesale price indices since they represent the weights of the inputs as used in the economy. If, however, these weights from the WPI are not considered because they cover a wider segment of the economy than the organized manufacturing industry, the weights used by B-P (1994) also need not be used on the same ground. It is evident that the CSO transactions matrix incorporates inter-industry transactions that cover not only the organized or registered manufacturing sector but also the unregistered manufacturing sector. Since the output mix of registered manufacturing sector differs significantly from that of the unregistered manufacturing sector and since the input mix depends essentially on the output mix, one should expect significant differences in the weightages to be attached to the various input groups between registered and unregistered manufacturing sectors. We have estimated the break-up of the total input use as given in the CSO transactions matrix for 1973-74 between registered and unregistered manufacturing sectors by using the available information on the corresponding product mix for 1973-74 from the *National Accounts Statistics*. *Table 1* provides data on wholesale price index and alternative weights for the 19 input groups.

It can be seen from Table 1 that change in prices varies considerably across the input groups not only during the seventies but also during the eighties. Moreover, the input groups identified by B-P (1994) experiencing higher inflation rates during the two decades also differ considerably. In view of such a significant variation in the inflation rates across the input groups, the weights attached to these input groups to arrive at an overall price index for the material input would assume great importance. They cannot be taken lightly for making any serious attempt to measure real value added in the Indian manufacturing sector by the double deflation method. This is all the more important because the weights do differ significantly depending on the segment of the economy considered for the purpose as is evident from Table 1. The three alternative series of weights reported in Table 1 differ significantly from one another. In our opinion, the set of weights estimated by us using the CSO 1973-74 I-O matrix adjusted for only registered manufacturing sector is the most appropriate one for estimating TFPG in the registered manufacturing sector in India. However, in order to show the sensitivity of the estimate of TFPG to the weights used for input groups in the double deflation method, we have estimated real value added in manufacturing sector and the implied growth rates by using the three alternative sets of weights reported in Table 1. These alternative estimates of the growth rates of real value added in the Indian registered manufacturing sector are reported in *Table 2*.

It can be seen from Table 2 that the annual growth of real value added in the Indian registered manufacturing sector when measured through single deflation method shows remarkable acceleration during the eighties as compared to the seventies (from 3% to 8%). If, however, the same is measured through double deflation method, the acceleration in the growth rate is found to be : (i) much higher during the eighties as compared to the seventies (3.5% to 11.2%) when the weights for the 19 input groups based on WPI (1970-71) are used; (ii) negligible during the eighties as compared to the seventies (7.5% to 8.1%) when weights for the whole manufacturing sector as considered by B-P (1994) are used; and (iii) lower in magnitude but significant during the eighties with 9.8% growth as compared to 5.9% growth during the seventies, when weights for only the registered manufacturing sector as estimated by us are used. Thus, it can be seen that the growth of real value added by using the double deflation method is highly sensitive to the set of weights used to derive the input price index. Hence it is expected that the estimate of TFPG by using the double deflation method would also be highly sensitive to the same set of weights. *Table 3* provides the estimates of TFPG for the Indian registered manufacturing sector during the seventies and the eighties based on alternative ways of measuring the real value added.

Table 3 clearly reveals that the estimate of TFPG for the decade of the seventies is negative around (-)1.5 to (-)1.7 per cent when the traditional single deflation method is used to measure the real value added in the Indian registered manufacturing sector. During the eighties, however, the estimate of TFPG through single deflation method turns out to be positive around 1.9 to 2 per cent. Thus, when single deflation method is used the TFPG shows a remarkable acceleration of about 3.5 to 3.6 percentage points during the eighties as compared to the seventies. On the other hand, when we use the double deflation method to measure the real value added in the Indian registered manufacturing sector the quantitative estimate of TFPG as well as the qualitative behaviour of TFPG over time turn out to be totally different depending on the set of weights used for deriving the input price index. Thus, when WPI (1970-71) weights are used, we get a significantly higher acceleration in TFPG of about 5.8 percentage points from the seventies to the eighties, but when the weights for the whole manufacturing sector are used (as is done by B-P, 1994) we actually get a deceleration of 0.8 percentage points in TFPG from the seventies to the eighties. However, when the weights for the registered manufacturing sector are used (as estimated by us), we obtain a clear but much subdued acceleration of about 2.3 percentage points in TFPG from the seventies to the eighties. Thus, the B-P study (1994) questioned the hypothesis of significant turn-around in the Total Factor Productivity Growth (TFPG) since 1980 in the Indian registered manufacturing sector by following what they considered "a more appropriate measure of real value added". However, a further refinement within their own double deflation based measure of the real value added confirms the hypothesis of a clear and significant turn-around in TFPG in the Indian registered manufacturing sector since 1980.

2. Double Deflation v/s. Single Deflation

The above discussion clearly suggests that use of double deflation method to estimate real value added has to be made very cautiously and carefully particularly when there are serious data constraints and even feasibility questions involved in following the method as repeatedly pointed out by the CSO (1980 and 1989). The B-P study (1994) may be considered to raise a methodological point about the appropriate measurement of the real value added and the empirical exercise reported in the paper can only be seen as an illustration of the argument. However, from their conclusion, one gets an impression that but for the correction required for the capacity utilization and the existence of a mark-up over marginal cost, the authors consider the measure of total factor productivity growth in the Indian industry adopted in their study as ideal (B-P, 1994; p.2032). This is precisely what happens when the illustrative exercise to make an essentially methodological point is selected from the real life situation. In the process, the methodological issue may be lost in the complexities of the illustration.

The basic premise of B-P (1994) is that double deflation measure of the real value added is superior to the single deflation measure. Goldar (1992) and Lahiri (1992) also recognize this point almost accepting it uncritically. We feel, however, that the two alternative measures of the real value added require a closer examination. Since the discussion is at a conceptual plane, a simple numerical example should serve the same purpose. We consider a hypothetical example as given in *Table 4* where we consider gross output (Q) as a function of two basic factors (L and K) and three material inputs (N_1, N_2 and N_3) with their respective prices and quantities in two time periods, t=0 and t=1; i.e.,

(1) $Q = Q(L, K, N_1, N_2 \text{ and } N_3)$.

We may now consider the two alternative measures of the real value added. By definition, the concept of real value added requires prices to be held constant at some point of time. We may consider both the points as base period for holding prices constant one by one. The single deflation method uses the output prices (P) to deflate the nominal value added. The double deflation method uses output prices to deflate the output and input prices to deflate the inputs. Using the same notation as B-P (1994), we call these measures as VASD and VADD respectively. From Table 4 we can easily calculate both these measures of real value added when prices are held constant at t=0 and at t=1. *Table 5* gives these numbers for the value added. Moreover, it may be noted that we have kept the quantities of the two basic inputs (L and K) the same over time in order to avoid complications not relevant to the main argument and to focus on the basic issues involved in the measurement of real value added in manufacturing. As a result, in our example, the growth of real value added in effect reflects the growth of total factor productivity over the period t=0 to t=1.

From Table 5 it can be seen that value added at current prices is positive in both the period and has grown by 330%. If we use single deflation method, we again get positive value added in both the periods. We also get the identical growth of real value added (VASD) of 115% when we use the constant base period prices at t=0 or t=1. But when we use the double deflation method, we get very different and uncomfortable (or uninterpretable!) results. Using constant base period prices at t=0, the 'real' value added in period t=1 turns out to be negative. It is indeed very strange. With the quantities of both the basic factors (L & K) remaining the same and their prices having increased, it is impossible to reconcile with the negative 'real' value added in period t=1. How do we deflate the two factor rewards to get a negative 'real' value added as the summation of the 'real' factor rewards? What economic interpretation, if at all any,is to be given to such a negative 'real' value added? If we believe in this method, we get a negative growth of (-)105% in the real value added over the period t=0 to t=1. However, even this is not unique. If we consider the same double deflation method but now with constant base period prices at t=1, we get positive value added in both the years! And the growth of 'real' value added during the same period turns out to be (+)37.6%! How do we now reconcile with the real value added as summation of the real factor rewards? Moreover, what is happening to the growth of the total factor productivity? Is it positive or negative during the period t=0 and t=1? Double deflation method would provide different answers for different base years for constant prices, whereas the single deflation method gives a unique answer. Thus, the method of double deflation is also subject to the index number problem which is largely avoided in the single deflation method. Technically, the method of double deflation requires dealing at the most disaggregated level which is often not feasible (see, CSO 1980 p.26; and CSO 1989, p.84). Any grouping or partial aggregation can lead to serious errors and one is not sure whether it is better or worse than total aggregation unless one can support such a stand with convincing evidence. As we have already seen, the estimates of the real value added as well as of Total Factor Productivity Growth (TFPG) are highly sensitive to the set of weights used to arrive at the overall input price index. The hypothetical example considered here also brings out the possibility of non-unique and sometimes extremely divergent estimates of crucial aggregates if the base year of the weights also changes.

Even when we consider the case where the double deflation method is feasible with complete disaggregation available, the possibility of negative 'real' value added with positive nominal value added still remains. This is, in fact, valid for all aggregates which are obtained as the difference of two other aggregates, e.g., budget deficit, trade balance, etc. While it may be interesting for somebody to use double deflation method to show that Country A has budget surplus in 'real' terms but budget deficit in nominal terms, not much of a useful purpose may be served by such findings. It is perhaps to avoid such inconsistencies in the basic concepts that we should prefer to use single deflation method as is commonly done to get the real value of an aggregate defined in terms of the difference between two other aggregates.

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Table 1 : Wholesale Price Index and Alternative Weights for Various Input Groups						
	Wholesale Price Index			CSO 1973-74 (B-P, 1994)	WPI 1970-71	CSO 1973-74 Regd. Mfg.
Input Group	1970-71	1980-81	1988-89			
Food Articles (01)	100.00	207.90	416.36	1.16	31.23	0.84
Non-Food Articles (02-04)	100.00	217.70	385.28	32.45	11.13	40.45
Egg, Fish & Meat (05 & 07)	100.00	265.50	528.32	3.47	1.99	2.49
Logs and Timber (06)	100.00	266.40	469.49	1.48	0.18	0.21
Coal Mining (08)	100.00	340.60	901.00	0.93	1.20	0.66
Minerals (09-11)	100.00	1110.20	1152.24	5.78	1.31	4.09
Food Products (12-13)	100.00	308.70	441.77	4.19	13.97	2.98
Beverages & Tobacco (14-15)	100.00	210.70	392.84	0.55	2.84	0.34
Textiles (16-18)	100.00	212.70	312.56	7.78	11.56	6.26
Wood & Wood Products (20)	100.00	266.40	469.49	1.58	0.18	0.23
Paper & Paper Products (22)	100.00	262.20	510.50	2.65	0.89	2.64
Leather & Leather Products (24)	100.00	380.10	619.71	0.85	0.40	0.21
Rubber & Rubber Products (25)	100.00	248.80	441.21	1.53	1.27	1.72
Mineral Oils (26)	100.00	413.60	650.15	1.14	5.15	0.80
Chemicals & Chemical Products (28-32)	100.00	241.30	353.35	9.59	5.82	11.37
Non-metallic Mineral Products (33-34)	100.00	278.70	475.03	0.96	1.48	0.68
Basic Metals, Alloys and Metal Products (35-37)	100.00	272.10	559.36	20.60	6.26	21.37
Other Miscellaneous Manufacturing Industries (44)	100.00	222.10	249.05	0.27	0.62	0.20
Electricity (46)	100.00	239.70	493.77	3.03	2.52	2.46

Table 2 : Alternative Estimates of Real Value Added in the Indian Registered Manufacturing Sector			
	Value at Current Prices (Rs. Crores)		
	1970-71	1980-81	1988-89
Output	13026	56163	166667
Material Input	9688	44236	131082
Value Added	3338	11927	35585
	Price Index		
	1970-71	1980-81	1988-89
Output			
i) WPI for Mfg. articles	100.00	257.30	409.96
ii) As given in B-P (1994)	100.00	262.55	422.86
Material Input			
i) Based on CSO 1973-74 Weights (B-P, 1994)	100.00	304.70	492.80
ii) Based on WPI 1970-71 Weights	100.00	258.66	442.73
iii) Based on CSO 1973-74 Weights for Registered Manufacturing	100.00	277.60	464.86
	Annual Growth Rates of Real Value Added (in %)		
	1970-71 to 1980-81	1980-81 to 1988-89	1970-71 to 1988-89
Double Deflation Method			
i) Based on WPI 1970-71 Weights	3.54	11.20	6.87
ii) Based on CSO 1973-74 Weights (B-P, 1994)	7.49	8.10	7.76
iii) Based on CSO 1973-74 Weights for Registered Manufacturing	5.85	9.81	7.59
Single Deflation Method			
i) Based on WPI	3.34	8.16	5.45
ii) Derived by B-P (1994)	3.13	8.01	5.27

Table 3 : Alternative Estimates of Total Factor Productivity Growth (TFPG) in the Indian Registered Manufacturing Sector

		Annual Growth Rates of TFP (in %)		
		1970-71 to 1980-81	1980-81 to 1988-89	1970-71 to 1988-89
Double Deflation Method				
i)	Based on WPI 1970-71 Weights	-1.63	4.16	0.90
ii)	Based on CSO 1973-74 Weights (B-P, 1994)	2.12	1.26	1.74
iii)	Based on CSO 1973-74 Weights for Registered Manufacturing	0.56	2.86	1.58
Single Deflation Method				
i)	Based on WPI	-1.49	2.03	0.06
ii)	Derived by B-P (1994)	-1.69	1.89	-0.11

Source : Table 2.

Table 4 : A Hypothetical Example		
Item	t=0	t=1
Q	100	180
P	1	2
M_1	10	10
P_1	3	2
M_2	10	15
P_2	2	4
M_3	10	32
P_3	1	1.5
L	10	10
W	2	10
K	10	10
r	2	7.2

Table 5 : Value Added & Growth					
	At current prices	At t=0 const. prices		At t=1 Const. Prices	
		VASD	VADD	VASD	VADD
t=0	40	40	40	80	125
t=1	172	86	-2	172	172
V_1/V_0	4.30	2.15	-0.05	2.15	1.37
Growth of Value Added	330%	115%	-105%	115%	37.6%

Source : Table 4.