AN APPROPRIATE SYSTEM FOR DEFLATION OF SECTORAL INCOME IN A DEVELOPING ECONOMY ILLUSTRATED BY THE INDUSTRIAL SECTOR OF THE INDIAN ECONOMY FROM 1951 to 1965*

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The technique of national income accounting is a part of what Hicks has termed "The Fixprice Method". Deflation is an attempt to approximate a real economy to a fixprice economy. It is shown that if the propositions of macro-dynamics are to hold, this deflation cannot be done in accordance with the price structure prevailing at any particular historical time, but must use that given by the capital theory of value, viz., when returns to labour are equal to zero. For a labour-abundant developing economy this will correspond to prices based on opportunity cost principles.

As an illustration, sectoral incomes on this basis have been calculated for the industrial sector of the Indian economy for the years 1951 to 1965.

1. *Introduction*

The technique of national income accounting is primarily a part of what Hicks has termed as "The Fixprice Method".[1] "When prices are constant," writes Sir John, "quantities of goods and services can be added by adding their money values; money values become volume indexes. By its own inner logic, and without any deliberate decision having been taken to slew it in that direction, the model becomes a macro model. The fixprice method has an inherent tendency to go macro."[2]

Deflation is an attempt to approximate a real economy to a fixprice economy so that the techniques developed for analysing a fixprice system can be used. But, what price structure should be chosen to convert an economic series from actual changing prices to the one approximating a system having fixprices? The usual method is to deflate the whole series to a historically given price structure. The point to consider is whether that historically given price structure of the base period reflects the scarcity or constraints of a growing economy. For, then and only then the fixprice system will prove to be analytically useful. (See appendix.)

2. *Fixprice Structure with Stable Technology*

If in the base period, the economy had been in a state of stationary equilibrium (or in a steady state of growth) the base period price structure would

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1. J. R. Hicks, *Capital and Growth*, Oxford University Press, 1965.
2. Hicks, *ibid.*, p. 78.

have reflected the technological complex corresponding to the then prevalent stationary state. It is ideal to deflate an economic series from the actual market prices of an economy to the price structure corresponding to the above base if the basic technological complex remains the same over the relevant period. This will iron out all the price variations due to transient market forces delineating the progress of an economy in the terms of its basic structure.

If there is no such historical period in which the economy has been in a stationary state, the corresponding price system will not be available as a historical datum. In that case, the best thing to do would be to construct one with the help of a set of given technological relations. To take any year as a base period and take the price relations prevailing in that year as the norm to deflate the national income would be arbitrary. For as pointed out above, the prevailing price system in any year which is not in a stationary equilibrium will be affected by transient market conditions, distortions due to monopoly practices, etc., and will thus not reflect the basic economic conditions.

But, as is well known, the technological relations by themselves are not able to determine the price-structure uniquely.[3] There remains what R. Frisch has aptly termed one degree of freedom; that is, to determine the price structure uniquely, it is necessary to fix either the wage rate or the profit rate for the economy. Empirically this may not pose an insuperable difficulty provided the profit rate has been stable in the economy. If not, analytical tools depending on fixprice methods are suspect.

3. *Fixprice for a Developing Economy*

In a developing economy the problem seems to be more intractable for not only is the profit rate likely to be much more unstable in a developing economy, but the underlying technological base of the economy will also change significantly. In fact the development of an economy is primarily a process of changing the economy from one technological complex to another, more efficient, one. The process of development consists mainly in accumulating the capital equipment necessary for the working of a modern technological complex. In a developing economy two types of techniques of production—traditional and modern—exist side by side. In the process of development the share of the modern technological complex increases.

Thus it is clear that the technological complex underlying production in the developing economy will be constantly changing, until and unless the whole of the labour force is employed using capital of modern vintage. The point to consider is whether in such circumstances any analytical tool based on fixprice method can be useful at all. And if the answer is in the affirmative, what then is the price structure which should be used in the evaluation of the national product or the components thereof? According to Hicks, "When the price ratios that are appropriate to the new equilibrium and the old are not the same, a corresponding

3. For fuller discussion see author's "A Modified Leontief Dynamic Model and Related Price System", *Econometric Annual* of the *Indian Economic Journal*, 1965.

'fixprice' policy would presumably imply that prices are adapted at once (or sought to be adapted at once) to the new equilibrium."[4] He further says, "The stationary equilibrium could only be stationary because its continuance was expected; the change in technology was not expected. The new values that were set (or should have been set) were based on an expectation of permanence of the new technology."[5] Thus we see that Hick's answer to our question is that the fixprice methods may be useful in a developing economy, and the price structure adopted should be that corresponding to the new technology. We may consider Hicks to be overoptimistic insofar as he thinks that the new price system will be "adapted at once" or even "will be sought to be adapted at once". His important contention may be taken that prices "should have been set" corresponding to the new technological complex.

The primary use of a price system is to give guidance for resource allocation. This is accomplished by putting a valuation on scarce resources and their products denoting the intensities of scarcity. When a new technological complex appears on the horizon, the problem of resource allocation is important mainly in relation to it. After its appearance there remains no question about investment in the old technology. The new price system based on the new technological complex should be the guiding star.[6,7]

Even after deciding that the price system should be one relating to the new technological relations, to determine the price structure uniquely it is necessary to find the relevant profit rate, or the wage rate. As the price system should reflect the implications of factor scarcities, the problem boils down—to put it in familiar terminology—to finding the opportunity cost of different factors during the process of development. As we have already seen, the process of development consists mainly in accumulating capital equipment of modern vintage, for labour is not a limiting factor until the whole labour force is working with the new technology. The labour required for the new capital equipment can always be transferred from that working with capital of the older vintage now becoming obsolete, and/or that which has been unemployed or under-employed previously. Thus, as far as the growth of the modern technological complex within the economy is concerned, the opportunity cost of labour should be put as equivalent to zero. Thus it will be the prices derived from a capital theory of value for the new technology that will be most appropriate. By the capital theory of value we may understand that the price system is such as would be prevalent if all the other factors except capital are available at zero price. Only shadow prices determined on this hypothesis are relevant for taking decisions for the growth of the modern sector of the economy, which is in the process of

4. Hicks, *ibid.*, p. 196.
5. Hicks, *ibid.*, p. 305.
6. This should automatically lead to the revaluation of existing fixed capital goods also, as the relative unsuitability of the old equipment to the new technology should lead to a fall in its value.
7. This should be the guideline even for the continuance of firms having capital of the older vintage. However, how long an old firm should continue will depend not on relative price structure, but on the rate of interest.

transformation from the traditional economic system to the modern one.[8] This is the price system which is appropriate if the fixprice method of analysis is to be used. In other words, a constant price national income series in a developing economy should be expressed in a price system derived by this method rather than in any historically given one.

4. *Calculation Procedure of the Appropriate Fixprice Structure*

From the criteria discussed in the preceding section the fixprice structure for a developing economy can be derived as follows. Let A be the input-output flow matrix corresponding to the modern sector (new technological complex) of the economy. And let B be the corresponding capital coefficient matrix, of which the element b_{ij} will represent the amount of commodity i required for creating a unit capacity for the production of commodity j. Then if P is the price vector then PB will give a vector of capital costs for the individual sectors of the economy. The value added in individual sectors is given by $P(1-A)$. From the viewpoint of the capital theory of value, this should be proportionate to PB. As pointed out earlier, it is only the capital theory of value that is relevant for deriving the appropriate fixprice structure for a developing economy. Let r be this proportionality factor. Then we get

$$P(1-A) = rPB \text{ or } P((1-A) - rB) = 0$$

or,

$$P(1-A)\,[\mathrm{v} - (1-A)^{-1}rB] = 0 \tag{1}$$

This shows that $Z = P(1-A)$ is an Eigen row vector of the matrix $(1-A)^{-1}B$. As Z denotes the value added, it must be non-negative in all its elements. By Frobenious Theorem, it will be true for the Eigen row vector corresponding to the greatest Eigen value only. Thus the vector Z is uniquely determined, determining P, the price vector, in its turn. The corresponding r will give the common value added/capital ratio.

5. *An Appropriate Fixprice Structure for the Industrial Sector of the Indian Economy*

The above method enables us to calculate the appropriate fixprice structure for different commodity groups that are distinguished in an input-output table. For India an input-output table for the year 1959 has been prepared by the Economics Division of the Planning Commission which distinguishes 21 different industrial commodity groups, including transport. The coefficients in it have been derived from the data obtained by the Annual Survey of Industries for the large scale sector. They can be taken as pertaining to the modern technological com-

8. It will be clear that such a price system will be purely of an accounting character. It can never be actually prevalent in the economy irrespective of the competitive character of the economy. It can only prevail if the whole of the labour force is subsidized by the central planning authority and then free competition prevails in equalizing the rate of return to all the entrepreneurs engaged in production with technology of modern vintage. This highlights vividly the different price systems that should govern the actions of individual entrepreneurs and the planning authority in a country experiencing technological transformation. In such circumstances a pure laissez-faire economy is not likely to deliver goods, nor is a controlled economy unguided by the shadow price system described above.

plex of the industrial sector. Corresponding to this, we at Gokhale Institute have prepared a capital coefficient matrix.[9] With the help of these two tables, we have calculated the appropriate fix-price structure for the Indian economy. This is given in Table I. This table shows the percentage adjustments to 1959 prices necessary to arrive at the appropriate fixprice system. These have been normalised in such a way that the total output for the year 1959, when calculated by using these prices, will be equal to total output calculated by using the prevalent market prices in 1959. The proportion that different commodity groups form of the total output is also given in the same table. Table II gives the total output of various commodity groups in fixprices over the years 1951 to 1965. Output of each group for each year has been estimated by using the relevant index number of sectoral industrial production prepared by the Central Statistical Office, and the output for 1959 is taken from the input-output table.

Table III gives the yearly growth rate of industrial output calculated with these two price systems. It will be seen that the average growth rate during the last five years turns out to be more than that surmised on the basis of the constant price series, though there is not much difference in pre-1958 growth rates. This signifies that it is mainly after 1958 that the structure of industrial production has become significantly growth-oriented, and now we are able to sustain a much higher rate of industrial growth than was possible before 1958.

6. *Deflation of Value Added*

Once the fixprice structure is given the proportion of the value added to the value of total output is fixed if the underlying technological complex remains the same. But as pointed out above, in a developing economy it is this technological complex that will be changing from year to year as the proportion of capital of modern vintage increases over the years. This implies that the proportion of value added to total output under the fixprice system described above must be calculated every year in order to construct a series of value added for each commodity group at fixprices. It will be seen that the total value added thus derived will be equal in each year to the total value of commodities available for use in final demand at fixprices. This is a very important requirement that must be satisfied by all deflation schemes if they are to be analytically useful.

The construction of this requires the availability of average input-output tables for the economy for each year, so that differences in the proportion of value added due to technological change can be estimated. Unfortunately no average input-output table is available for India. In the input-output table prepared by the Economic Division of the Planning Commission for the year 1959, the input coefficients for the manufacturing sector were derived from the data available for the large scale sector only in the census part of the Annual Survey of Industries, and the same coefficients were applied to the total output of the sectors to derive the total inputs. Therefore, this table cannot be taken as an average one for this purpose. Thus at present it is not possible to deflate the value added series in this manner due to the paucity of relevant information.

9. "An Inter-Industry Capital Table for India—First Approximation", by P. N. Mathur, presented at the Input-Output Seminar, Poona, 1965.

TABLE I

APPROPRIATE FIXPRICE STRUCTURE OF INDUSTRIAL SECTOR 1959

I	Commodity II	Appropriate Fixprice Structure III	1959 Production in Market Prices (10 m.rupees) IV	1959 Production in Fixprices (10 m.rupees) V	Percentage of 1959 Production in Market Prices VI	Percentage of 1959 Production in Appropriate Fixprices VII	1959 Gross Value Added in Fixprices (10 m.rupees) VIII
1	Coal	0.55	94.9	52.0	1.7	0.9	29.8
2	Iron Ore and Iron & Steel	1.68	243.3	409.7	4.4	7.4	242.5
3	Other Minerals	0.68	61.7	41.8	1.1	0.8	31.5
4	Other Metals	1.11	18.6	20.6	0.3	0.4	8.7
5	Non-Electrical Equipment	1.05	318.9	334.5	5.7	6.0	192.6
6	Electrical Equipment	1.03	101.8	105.1	1.8	1.9	53.1
7	Transport Equipment	0.97	237.9	230.0	4.3	4.1	123.2
8	Chemicals	0.92	212.0	194.6	3.8	3.5	97.1
9	Petroleum & Crude Oil	1.28	72.0	92.4	1.3	1.7	64.2
10	Fertilizers	3.19	25.6	81.7	0.5	1.5	48.9
11	Cement	1.45	44.4	64.4	0.8	1.2	41.8
12	Glass, Wood, Non-Metallic etc.	1.12	180.9	202.5	3.3	3.6	131.6
13	Food Industry	0.40	1,451.0	587.5	26.1	10.6	412.1
14	Cotton & Other Textiles	0.76	852.6	648.8	15.3	11.9	372.6
15	Jute Textiles	0.54	161.7	87.5	2.9	1.6	54.0
16	Leather & Rubber Products	0.50	153.6	76.9	2.8	1.4	37.5
17	Paper & Products	1.47	130.3	191.9	2.3	3.4	132.4
18	Electricity Generation	2.84	124.6	353.7	2.2	6.4	272.1
19	Other Industry	0.94	100.7	94.9	1.8	1.7	50.4
20	Railway Transport	2.26	426.5	962.2	7.7	17.3	892.7
21	Road Transport	1.33	543.6	724.4	9.8	13.0	572.8
			5,556.6	5,556.6	100.0	100.0	3,861.6

TABLE II

INDUSTRIAL PRODUCTION AT FIXPRICE STRUCTURE

†	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
								(in 10 million rupees)							
1	37.9	39.7	39.5	40.6	42.2	43.6	48.1	50.1	52.0	57.2	61.0	66.9	72.8	69.6	75.1
2	246.5	255.9	241.3	279.0	281.3	292.4	288.9	306.5	409.7	561.8	549.8	692.2	788.1	792.2	821.2
3	29.6	31.3	30.8	31.7	33.1	34.1	37.3	39.5	41.8	46.7	50.2	54.9	59.9	57.6	62.2
4	12.5	12.2	11.6	14.6	15.4	15.6	16.0	17.9	20.6	22.7	24.2	31.3	33.6	34.0	33.9
5	81.4	64.3	67.9	103.5	150.0	180.0	233.1	267.0	334.5	426.1	483.7	527.9	656.2	739.2	884.9
6	34.4	38.9	41.1	46.0	56.6	78.8	93.4	98.2	105.1	138.6	144.3	166.5	187.3	222.3	248.0
7	107.9	92.9	97.3	115.8	171.0	234.0	246.6	223.4	230.0	279.4	306.0	354.2	353.1	450.6	486.0
8	108.2	116.4	124.2	125.4	142.9	148.4	149.2	172.8	194.6	219.2	262.2	285.9	352.1	336.2	354.5
9	4.5	4.2	4.4	11.5	54.2	69.8	79.8	85.6	92.4	103.1	109.2	118.1	137.2	151.6	159.0
10	14.1	36.4	50.7	59.8	64.0	65.0	70.3	74.0	81.7	90.0	115.4	127.6	148.0	163.4	169.4
11	30.1	33.4	35.7	41.5	42.3	46.5	52.8	57.2	64.4	72.9	76.6	79.7	86.9	90.0	97.1
12	89.3	95.8	97.4	111.0	121.4	138.7	158.9	178.5	202.5	233.2	250.8	305.4	283.8	299.2	320.4
13	422.7	444.5	429.6	430.7	491.1	529.8	565.8	572.7	587.5	633.6	695.6	689.2	664.3	738.5	798.9
14	495.9	511.7	558.5	576.1	590.0	631.7	636.2	623.5	648.8	667.8	703.1	720.2	767.6	824.4	1086.6
15	70.1	75.5	70.9	75.5	83.2	89.0	84.3	86.6	87.5	88.4	79.8	98.3	104.3	107.7	112.1
16	50.7	45.4	47.4	55.2	60.4	65.6	67.9	70.5	76.9	93.6	101.8	109.6	121.3	127.7	140.5
17	87.5	91.1	94.9	107.2	126.2	131.6	144.1	167.6	191.4	228.3	239.4	250.9	298.6	313.0	325.4
18	142.3	148.8	161.2	180.8	205.8	233.6	263.5	297.6	353.7	399.5	464.4	521.9	602.5	691.3	750.6
19	59.9	61.7	63.3	67.7	74.9	81.5	84.9	87.3	94.9	106.0	113.4	123.2	133.4	142.3	150.5
20	664.8	617.0	616.7	653.6	721.4	790.3	873.4	885.1	962.2	1042.3	1140.2	1296.2	1427.7	1445.8	1592.3
21	401.8	412.2	448.6	485.3	512.2	584.4	605.5	653.2	724.4	768.8	822.6	912.2	1045.8	N.A.	N.A.
Total	3192.1	3229.3	3333.0	3612.5	4039.6	4484.4	4800.0	5014.8	5556.6	6279.2	6793.7	7532.3	8324.5	7796.6*	8668.6*
Total A	3415.6	3489.9	3562.2	3788.1	4242.0	4681.3	4669.0	5134.5	5556.6	6202.9	6695.2	7238.7	7801.3	7574.0*	8490.0*
Total B	2246.1	2259.4	2326.5	2514.5	2806.4	3111.7	3340.3	3490.4	3861.6	4333.3	4693.1	5207.1	5752.5	5255.1*	5827.2*

†Serial nos. of commodities are same as Table I.
Total A = Total Industrial Production in 1959 Constant Prices.
Total B = Total Gross Value Added in Fixprice in Industrial Sector.
N.A. Not available.
*Sum of first twenty sectors.

TABLE III

YEARLY PERCENTAGE GROWTH RATE FROM 1951 TO 1963

From To	1951 1952	1952 1953	1953 1954	1954 1955	1955 1956	1956 1957	1957 1958	Average yearly rate	1958 1959	1959 1960	1960 1961	1961 1962	1962 1963	Average yearly rate
A. Total Industrial Output														
At Fixprices	3.54	3.20	8.25	11.41	10.84	6.80	4.69	6.96	11.32	15.44	9.09	10.27	9.82	11.91
At Constant 1959 Prices	3.14	1.74	5.93	12.32	10.60	6.04	3.03	6.11	7.87	12.57	7.06	8.20	6.75	8.49
B. Value Added														
At Fixprices	0.59	2.97	8.10	11.61	10.88	7.35	4.49	6.59	10.63	12.22	8.30	10.95	10.47	10.51

However, for the present paper, we have constructed a series of value added according to industrial origin in fixprices,[10] on the assumption that the input-output table prepared by the Planning Commission is an average table and the average structure has remained the same. This series is given in Table III. As pointed out above, both these assumptions are very tenuous in our circumstances, so that the series should be considered more as an illustrative exercise rather than a substantive piece. It can be considered only a counterpart in fixprice system of the usual constant price series, where the net value added is carried forward by an index of industrial production. Both involve the assumption of a constant ratio of value added to total production during the relevant period, which is unlikely to be satisfied in the context of a developing economy.

MATHEMATICAL APPENDIX

The Suitability of the Appropriate Fixprice System for Macro-Analysis of a Developing Economy

Let A and B denote input and capital coefficient matrices respectively. And let $\bar{P}$ denote the fixprice system appropriate for developing economies developed in the text. Then irrespective of the composition of the output vector X,

$$\bar{P}(1-A-\rho B)X = 0 \tag{1}$$

where ρ is the value-added capital ratio which is same in each activity (industry) with $\bar{P}$ price-structure. Let π_j be the rate of profit in j-th industry and π be the diagonal matrix having π_j as an element in its j-th row and j-th column. Further, let r_j be the rate of growth of the output of j-th industry and R be the diagonal matrix having r_j as an element in its j-th row and j-th column. Further, let S_c be the rate of savings of the profit earners and S_w that of wage earners.

The total profits earned will be $\bar{P}B\pi X$ while the wages will be equal to the remaining value added, viz. $\bar{P}(1-A-B\pi)X$.

Therefore, the total savings of the economy will be $P(B\pi S_c X + (1-A-B\pi)S_w X)$.

Further, the investment requirement for the output of j-th good to grow at the rate $r_j (j = 1, 2 \ldots n)$ is $PBRX$.

For this to be equal to the savings of the economy

$$P[BR - B\pi(S_c - S_w) - (1 - A)S_w]X = 0 \tag{2}$$

or,

$$P[BR - B\pi(S_c - S_w) - \rho BS_w - (1-A-\rho B)S_w]X = 0 \tag{3}$$

But by (1) $P(1-A-\rho B)X = 0$.

Therefore (3) gives

$$\bar{P}BRX = \rho\bar{P}BS_w X + \bar{P}B\pi(S_c - S_w)X \tag{4}$$

10. The fixprice system has been only derived for the industrial sector. The shadow prices of other sectors have been taken as zero.

Dividing both sides by PBX, the value of the total capital in the economy, we get

$$\bar{r} = \rho S_w + \bar{\pi}(S_c - S_w) \tag{5}$$

where r is the rate of growth of capital and $\bar{\pi}$ is the rate of profit in the economy.

We know from (1), that

$$PB - 1/\rho[P(1-A)] \tag{6}$$

Substituting this in (4), we get,

$$\bar{P}(1-A)RX = \rho\bar{P}(1-A)S_wX + \bar{P}(1-A)\ \pi\ (S_c-S_w)X \tag{7}$$

Dividing both sides by $P(1-A)X$, the amount of value added in the economy, we again get eq. (5)

$$\bar{r} = \rho S_w + \bar{\pi}(S_c - S_w) \tag{5}$$

This means that $\bar{r}$ and $\bar{\pi}$ may as well be considered as average rate of growth of value added and average profit rate.

Equation (5) is the *classical macro-economic equation* of growth theory. If there is a common rate of savings in the economy, viz. $S_c = S_w = S$, this becomes

$$\bar{r} = \rho S, \tag{6}$$

the Harrod-Domar equation for growth rate.

Further, if the rates of growth and rates of profits are the same in all the sectors of the economy, equation (4) becomes

$$r\bar{P}BX = \rho\bar{P}BS_wX + \pi\bar{P}B(S_c - S_w)X \tag{8}$$

Dividing both sides by PBX, we get

$$\bar{r} = \rho S_w + (S_c - S_w)\bar{\pi}. \tag{9}$$

While equation (5) refers to the rate of growth of capital or of value added, equation (9) gives the same relationships for the rate of growth of output.

The point to note is that the above simple relationships are based on equation (1) above, which is true *if and only if the price of structure used for valuation is that derived from capital theory of value.*[1]

Further, it may be noted that if rates of growth and/or rates of profit are different for different industries the macro growth relation will hold good for capital goods or for value added but not for total output.[2]

1. This equation also holds if the output structure is proportional in the Eigen column vector. But that condition will be rarely satisfied in practice. See author's *op. cit.*, p. 334.

2. It may be noted that in the above demonstration not only rate of growth and profit rate can be taken to be different for different industries, but even rates of savings—both from profits and wages—can be taken as differing from industry to industry. In that case, S_c and S_w will have to be conceived as corresponding diagonal matrices. Further, matrices R, π, S_c, and S_w may be taken as full rather than only diagonal, introducing interrelatedness between growth rates, profit rates and saving rates in different industries. None of these complications will detract from the main result.

La technique de la comptabilité nationale est une partie de ce que Hicks a appellé la méthode "fixprice". L'usage du déflateur vise à rapprocher une économie réelle d'une économie "fixprice". On montre que pour respecter les propositions de la macrodynamique cette déflation ne peut être calculée sur la base de la structure des prix prévalant à une période déterminée, mais doit utiliser la structure des prix dégagée par la théorie de la valeur et du capital, c'est-à-dire lorsque les revenus du facteur travail égalent zéro. Pour une économie en voie de développement disposant d'un facteur travail abondant ceci correspondra à des prix basés sur le principe du coût alternatif.

Cette analyse sectorielle des revenus est illustrée par l'étude du secteur industriel de l'économie indienne de 1951 à 1965.