Estimation of Total Five-Year Plan Investment
An Alternative to the Sixth Plan Model

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This paper presents a method for estimating plan investment, sectoral as well as aggregate, along with its different components, viz, pipeline committed investment, plan investment for capacity creation during plan and post-plan periods, using a distributive lag model of investment. The model considers adequate time structure behind the accelerator type relation between investment and capacity output and expresses the total plan investment as a function of pre- as well as post-terminal rates of growth of capacity output. These rates of growth, on the other hand, can be treated as unknown solution variables in a plan model and the total plan investment can be estimated consistently with plan objectives.

The paper describes the model and uses it for estimating the total plan investment during the Sixth Plan period. The results obtained are then compared and discussed in relation to those reported in the Technical Note on the Sixth Plan.

ESTIMATION of total Five-Year Plan investment, aggregate as well as sectoral, raises a number of problems particularly in a static input-output framework. Although in a dynamic framework these problems can be greatly met, the development of an operational dynamic model poses various other issues and assumptions with regard to short-run behaviour of the economy. In Indian plan exercises from First Plan to the Sixth Plan the aggregate total plan investment was based mainly on a global incremental capital output ratio (ICOR) and growth in net or gross domestic product, while its sectoral allocations were mostly decided on best judgments except in Fifth Plan[1] where sectoral ICOR were used externally to meet consistency with the aggregate. In Sixth Plan exercises,[2] though sectoral terminal year investments were estimated endogenously by using investment functions and post-terminal year growth rates, investment requirement during the first four years of the plan period were estimated by suitably adjusting the sectoral investment growth paths obviously to meet some pre-assigned level. In these exercises no consideration of possible growth path of sectoral capacity/output or of the committed pipeline investment and its impact on pre-terminal growth were taken into account in calculating the total five year plan investment. As a result the total five year plan investment is inconsistent with the average annual growth of capacity during the plan period as implied by the plan model. Moreover, in such an exercise one does not have any information regarding the magnitude of pipeline investment the share of which in total plan investment is gradually increasing over years.

In this paper we present a methd for estimating the plan investment, sectoral as well as aggregate, along with its different components, *viz*, pipeline committed investment, plan investment for capacity creation during plan and post-plan periods, using a distributive lag model of investment. This model, which is similar to those considered by Chakravarty (1959), Eckans and Parikh (1968), Lahiri (1976), etc, considers adequate time structure behind the accelerator type relation between investment and capacity output and expresses the total plan investment as a function of pre- as well as post-terminal rates of growth of capacity output. These rates of growth, on the other hand, can be treated as unknown solution variables in a plan model and the total plan investment can be estimated consistently with plan objectives.

In what follows we describe the model and use it for estimating the total plan investment during the Sixth Plan period. The results obtained by our method are then compared and discussed in relation to those reported in the Technical Note on the Sixth Plan of India (1981).

Methodology

Investment project in a particular year may be seen as an action once initiated is completed with a definite time lag between its initiation and completion. During this period different commodities are used up and at the end a definite capacity is created. Total investment in a sector at a particular year is made partly to meet requirements of old projects started earlier and partly for new projects to be initiated during the plan period.

Consider a particular project with gestation period of w years and let a_k (k = 1, 2, ... w) be the proportion of investment to be made in the k th year of the gestation period. If such a project is undertaken in a sector with incremental capital-output ratio 'b' then the total investment at a particular year 't' is given by

$$u_t = d_t + b.\sum_{k=1}^{w} (V_{t+k} - V_{t+k-1}) \, a_{w-k+1} \quad \ldots (1)$$

TABLE 1: TOTAL FIVE-YEAR PLAN INVESTMENT AT 1979-80 PRICES

(Rs million)

Sector	By the Present Model			As Per Sixth TN		
	For Capacity Increase		Total	For Capacity Increase		Total
	During Sixth Plan Period	During Seventh and Eighth Plan		During Sixth Plan Period	During Seventh and Eighth Plan	
1 Agriculture and allied	109033	70746	179779	294963	39717	334680
	(60.65)**	(39.35)**	(1.0)*	(88.13)	(11.87)	
2 Mining	76019	21344	97363	0	65750	65750
	(78.08)	(21.92)	(5.1)	(0.0)	(100.00)	
3 Manufacturing	169962	135214	305176	171178	283971	455149
	(55.70)	(44.30)	(19.0)	(37.61)	(62.40)	
4 Construction	23526	1898	25424	7458	10142	17600
	(92.53)	(7.47)	(1.7)	(42.37)	(57.62)	
5 Electricity, etc	54523	151167	205690	0	235541	235541
	(26.50)	(73.50)	(41.3)	(0.0)	(100.00)	
6 Railways and other transport	85606	48286	133892	51744	108806	160550
	(63.94)	(36.06)	(7.5)	(32.23)	(67.77)	
7 Service	248230	174824	423054	193777	123863	317640
	(58.68)	(41.42)	(2.0)	(61.61)	(38.94)	
Total	766899	603479	1370378	719120	867790	1586910

Notes: * Figures in the bracket of this column indicate percentage share of pipeline investment
** Figures in the bracket of this column indicate percentage share in the sectoral total investment.

where V_t is capacity value added or output at the year 't' and d_t is that part of investment which does not go for new capacity creation such as investment for repair and maintenance etc. If we assume uniform distribution of investment cost over the gestation period, that is if, $a_k = 1/w$ for $k = 1, 2, \ldots w$, as assumed in Sixth Plan Technical Note (here after referred as Sixth TN then (1) will reduce to

$$u_t = d_t + b.(V_{t+w} - V_t)/w \quad \ldots (2)$$

which is same as considered in Sixth TN. Total investment for a plan period of T years (U_T) is then given by the sum total of u_t over this period, that is

$$U_T = \sum_{t=1}^{T} u_t \quad \ldots (3)$$

Now the total plan investment U_T can be notionally split into three distinct components : (i) the committed investment to be made during plan period for the projects started during the pre-plan period but to be completed during plan or post-plan period (U_T^c). This type of investment is termed as pipeline investment, (ii) the new investment in the plan period for creating additional capacity in the plan period (U_T^p), and (iii) the new investment made in the plan period for creating new capacity in the post-plan period (U_T^Q). For estimating these individual components let us demarcate the plan period by the terminal year (T) and the base year (0). The intervening years, including the terminal year, will be referred as plan period while the periods earlier to base year and beyond the terminal year will be referred as pre- and post-plan periods respectively. Investment requirement for any particular year 't' can also be split into corresponding components and estimates of U_T^c, U_T^p and U_T^Q can be built up from the corresponding estimates of the individual year 't' denoted by u_t^c, u_t^p and u_t^Q respectively.

For estimating U_T^c it is sufficient to note that for any year 't' during the plan period the pipeline investment is the committed investment required for the stream of projects started in the years $(t - w + 1)$, $(t - w + 2) \ldots (0)$, to create capacities in the years $(t + 1)$, $(t + 2)$, $\ldots$ w respectively. Thus capacities upto the year w is created by pipeline investment and the years beyond the year 'w' has no pipeline component of investment. Thus omitting d_t for simplicity,

$$u_t^c = b \sum_{k=1}^{w-t} (V_{t+k} - V_{t+k-1}).\ a_{w-k+1},\ t = 1, 2, \ldots (w-1)$$
$$= 0, \text{otherwise} \quad \ldots (4)$$

TABLE 2: STRUCTURE OF INVESTMENT
(Percentage Share of Sectoral Investment in Total Plan Investment)

Sector	By the Present Model			As Per Sixth Plan TN		
	For Capacity Expansion		Total	For Capacity Expansion		Total
	During Sixth Plan Period	During Seventh and Eighth Plan		During Sixth Plan Period	During Seventh and Eighth Plan	
1 Agriculture and allied	14.22	12.38	13.12	41.02	4.58	21.09
2 Mining	9.91	3.54	7.10	0	7.58	4.14
3 Manufacturing	22.16	22.40	22.27	23.80	32.72	28.68
4 Construction	3.07	.31	1.86	1.04	1.17	1.11
5 Electricity, etc	7.11	25.04	15.01	0	27.14	14.84
6 Railways and other transport	11.16	8.00	9.78	7.20	12.53	10.12
7 Service	32.37	30.52	30.86	26.94	14.28	20.02

TABLE 3: COMPARISON OF TOTAL PLAN INVESTMENT BY PRESENT MODEL WITH THAT OF SIXTH TN

Sector	Capacity Increase during Sixth Plan Period (Present Model/Sixth TN)	Capacity Increase during Seventh and Eigth Plan Period Present Model/ Sixth TN)	Total (Present Model/ Sixth TN)
1 Agriculture and allied	.3696	1.7813	.5372
2 Mining	—	.325	1.481
3 Manufacturing	.993	.476	.670
4 Construction	3.154	.187	1.444
5 Electricity, etc	—	.642	.873
6 Railways and other transport	1.6544	.4438	.8340
7 Services	1.2810	1.4114	1.3319
Total	1.109	.660	.864

For estimating u_t^p it may be noted that for $w < T$ any investment started in the year $(t - w)$ or beyond does not create new capacities in the plan period. For the remaining years in the plan period u_t^p consists of investments required for projects started in the years $(t - w + 1)$ (≥ 1), $\ldots$ t and creating capacities in the years $(t + 1)$, $\ldots$ $(t + w)$ $(\leq T)$. Thus,

$$u_t^p = b. \sum_{k=x_1}^{x_2} (V_{t+k} - V_{t+k-1})\ a_{w-k+1},\ 1 \leq t \leq T-1,\ w < T$$
$$t + k \leq T \quad \ldots (5)$$
$$= 0, \text{otherwise}$$

where, $x_1 = \max(1, w - t + 1)$ and $x_2 = \max(x_1, w)$

Similarly for estimating u_t^Q let us note that for $w \leq T$ any investment started in the year $(T - w)$ or before will be completed during the plan period and hence will not make a part of u_t^Q for all t. Only those investment projects which are to start at the year $(T - w + 1)$ and after will be completed during the post-plan period and will contribute to u_t^Q. However, for $w > T$, all the years during the plan period will have a positive contribution to u_t^Q. Thus, for $t = T - w + 1$ to T when $w < T$, and $t = 1, 2, \ldots w$ when $w \geq T$, u_t^Q will consist of investment required for projects started in the years $\max(1, T - w + 1), \ldots t$ creating capacities in the years $(T + 1), \ldots (t + w)$ $(> T)$. Thus

$$u_t^Q = b. \sum_{k=T-t+1}^{w} (V_{t+k} - V_{t+k-1})\ a_{w-k+1} \text{ for } w < T$$
$$= b. \sum_{k=w-t+1}^{w} (V_{t+k} - V_{t+k-1}).\ a_{w-k+1}, \text{for } w \geq T \quad \ldots (6)$$

where, $t = \max(1, T - w + 1), \ldots \max(T, w)$.

The total investment during the plan period, U_T, is then, given by

$$U_T = U_T^c + U_T^p + U_T^Q$$

where $U_T^c = \sum_{t=1}^{T} u_t^c = b \sum_{k=1}^{w-1}$

$$a_{w-k+1}(V_w - V_k),\ 1 < w < T+1$$
$$= b \sum_{k=w-T}^{w-1} a_{w-k+1}(V_w - V_k) +$$
$$b \sum_{K=1}^{W-T-1} a_{w-k+1}(V_{w-k} - V_k),\ W > T+1$$
$$= 0, \text{ if } w = 1 \quad \ldots (7)$$

$$U_T^P = \sum_{t=1}^{T} u_t^P = b\,(V_T - V_w),\ w < T$$
$$= 0,\ w \geq T \qquad \ldots (8)$$

$$\text{and } U_T^Q = \sum_{t=1}^{T} u_t^Q = b \sum_{k=T-w+1}^{T} a_{T-k+1}\,(V_{w+k} - V_T),\quad w \leq T$$
$$= b \sum_{k=1}^{T} a_{T-k+1}\,(V_{w+k} - V_w),\ w > T \ldots (9)$$

It can be noted from (7) that pipeline investment component of total five year plan investment is determined by the gestation period and greater the gestation period higher is its share in the total plan investment. Similarly from (8) and (9) one can see that the remaining components of U_T depend upon both pre- as well as post-terminal rate of capacity expansion. Because if we denote the pre- and post-terminal (annual) rate of growth of capacity by r and R respectively then $(V_T - V_w)$ in (8) can be expressed as $V_w \left\{(1+r)^{T-w} - 1\right\}$, and $(V_{w+k} - V_T)$ in (9) can be expressed as $V_T\left\{(1+R)^{w+k-T} - 1\right\}$ respectively. Now to calculate the total investment for capacity creation in the plan period let us note that *not* the entire part of U_T^c create capacity during the plan period, because there are sectors like 'electricity' for which gestation period is sufficiently long to cover the entire plan horizon. Thus the total plan investment for capacity expansion in the plan period is given by,

$$U_T^* = \sum_{t=1}^{T} u_t^P + \sum_{t=1}^{T}\sum_{k=1}^{w-t} a_{w-k+1}\,(V_{t+k} - V_{t+k-1}) \qquad \ldots (10)$$
$$1 < t + k \leq T$$

The total plan investment for capacity increase in the post-plan period is given by

$$U_t^{**} = \sum_{t=1}^{T} u_t^Q + \sum_{t=1}^{T}\sum_{k=1}^{w-t} a_{w-k+1}\,(V_{t+k} - V_{t+k-1}) \qquad \ldots (11)$$
$$t + k > T$$
$$w - t \geq 1$$

However, if one assumes uniform distribution of investment over the gestation period the above expressions simplify to a great extent. Thus if $a_k = 1/w$ for all k the total plan investment is given by

$$U_T = \frac{b}{w} \sum_{k=1}^{w} (V_{T+k} - V_k) \qquad \ldots (12)$$

Estimate of Investment for Sixth Plan

In this study we have not attempted to estimate the investment distribution parameters a_k, k = 1, 2,... w and as such we shall use expressions (4) through (12) for estimating the Sixth Plan investment and its different components using the same parameters provided in Sixth TN for 14 sectors. In the present method we are required first to estimate the capacity outputs, V_t, for t = 1,2, ... w (sectoral value added in case of Sixth TN investment functions) by solving the expression (1) which simplifies to the following when $a_k = 1/w$ for k = 1,2, ... w,

$$u_{t-w} = d_{t-w} + b \sum_{k=1}^{w} (V_{t-w+k} - V_{t-w+k-1})/w \ldots (13)$$

Putting t = 1,2, ... w in (13) we obtain w equations with $V_1, V_2, \ldots V_w$ as unknowns which can be solved in terms of $u_0, u_{-1} \ldots u_{-(w-1)}$ and $V_0, V_1, \ldots V_{-(w-1)}$ which are known from National Accounts Statistics (CSO, 1983). Post-terminal growth rates are used to estimate V_t for $t \geq T$ (= 5) required in equations (6), (7), (11) and (12). Sixth TN, however, has not provided post-terminal growth rates of any sector, though Sixth Plan document (Planning Commission, 1980) has provided growth rates of sectoral value added for seven aggregated sectors both for Sixth Five-Year Plan period and perspective period—from 1984-85 to 1989-90. We have made use of these growth rates and other informations provided in the Sixth Plan document in respect of perspective of development, to estimate the post-terminal growth rates of 14 sectors for which parameters of the investment functions are provided in Sixth TN.

In Sixth TN total Sixth Plan investment are shown for new capacity creation separately during (i) Sixth Plan period (1980-85) and (ii) perspective period, that is, Seventh and Eighth Plan (1985-95). However, nowhere method of estimating them has been indicated. Expressions (11) and (12) in our method provide estimates of plan investment required for additional capacity creation during plan as well as post-plan periods. Peculiarly enough, Sixth TN has not provided any investment for capacity creation in mining and electricity sectors during the Sixth Plan period, thus ignoring the fact that a number of projects in these sectors, started in Fifth Plan period would not only be completed but even commissioned during Sixth Plan period. Sectoral total plan investment during the Sixth Plan period along with its different components, as estimated by the present method and those provided in Sixth TN for 14 sectors are aggregated to 7 sectors and presented in Table 1. Structure of investment, as given by the share of sectoral investment in the total investment are given in Table 2, while Table 3 compares the estimates by the present method with those provided in Sixth TN. In the folowing section we discuss our estimates in comparison to that of Sixth TN.

Discussion and Conclusion

The total plan investment for Sixth Plan period estimated by the present method is Rs 137,000 crore against Rs 158,700 crore as reported in Sixth TN. Thus our estimate is about 80 per cent of the official estimate of the total plan investment. However, our estimate of plan investment for agriculture, manufacturing, electricity and transport sectors are respectively 54 per cent, 67 per cent, 87 per cent and 83 per cent of Sixth TN estimates, while our estimate of mining, construction and service sectors are higher than Sixth TN estimates by 48 per cent, 44 per cent and 32 per cent respectively (see Table 3). On the other hand, investment for capacity creation during plan period estimated by the present method enjoy higher share in total plan investment as compared to Sixth TN estimates. However, for agriculture and electricity sectors this share is less than those provided in Sixth TN. It is also seen that share of pipeline investment in total investment may be as high as 41 per cent for sectors with long gestation period like electricity. When we turn to the structure of investment (see Table 2) we see that share of agriculture and service sectors in the total plan investment as estimated by us are substantially different from the estimates provided in Sixth TN. To explain the discrepancy between our estimate and those provided the Sixth TN we may only point out certain inaccuracies in the Sixth TN method for estimating total plan investment and the inconsistencies in the reported results obtained from such a method. As noted earlier the Sixth TN estimates of total plan investment is based on arbitary adjustment factors (G_i^1, see Sixth TN) for first four years of plan period, obviously to meet the exogenously fixed sectoral and total plan investment. The present method, however, is based on detailed time structure of fixed capital investment which enables one to estimate the plan investment consistently with projected growth of output and capacity. Moreover, in this method the different components of total plan investment, *viz*, pipeline investment, investment for capacity creation during plan and post-plan periods are estimated separately. To mention the consistencies in the results reported in Sixth TN one may refer to investment in agriculture sector. In Sixth TN investment in this sector is estimated at Rs 50510 million in 1979-80, while for 1984-85 it is estimated at Rs 28518 million which is about 56 per cent of base year (1979-80) investment. But when one compares the total five-year plan investment in agriculture sector (Rs 322420 million, see Sixth TN) with the above mentioned figures the inconsistency becomes quiet apparent. Because the annual investment requirement for agriculture (about Rs 73,565 million) corresponding to the estimated total plan invest-

ment in agriculture is much higher than the terminal year investment in agriculture sector. In absence of pipeline investment and under the assumption of uniform use of investment expenditure during gestation period (as done in Sixth TN) these figures appear to be inconsistent to each other. Inconsistency is also reflected when structure of total plan investment is compared to that of the base year (1979-80) and terminal year (1984-85). Because of ad hoc method of using adjustment factors for different sectors in the plan periods the total plan investment is also inconsistent with growth targets in Sixth Plan. As to the pipeline investment Sixth TN shows (see Table 1) that no investment is required for capacity increase in mining and electricity sectors during Sixth Plan period, the whole of plan investment being meant for Seventh and Eighth Plans. This is incomprehensible as there are a number of projects pertaining to these sectors which were started during Fifth Plan period and committed to be finished during Sixth Plan period. By our method, we find that about 73 per cent and 41 per cent of the total plan investment would be required for capacity creation in mining and electricity sectors respectively during Sixth Plan period.

Thus we see that total plan investment has to be estimated consistently with plan targets. For this the model for estimating the total plan investment with a detailed time structure of fixed capital investment, has to be integrated with the core plan model. Moreover, the pipeline investment the share of which in total plan investment is substantial, has a vital role in estimating plan investment and cannot be ignored in such an exercise. In case any desired level of plan investment for a particular sector is required to be exogenously fixed, it is imperative that the core plan model has to be modified to meet such constraints.

Notes

1 See Approach to Fifth Five-Year Plan of India, Tables 3 and 4 (pp 48-49).
2 See Sixth Plan Technical Note.

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DISCUSSION

Theory of Pricing in Socialist Countries

Ramnath Narayanswamy

THIS has reference to Jaya Mehta's paper on the 'Theory of Pricing in Socialist Countires: Pricing of Industrial Producer Goods' (February 23). Unfortunately, the manner in which the paper has been written vitiates whatever positive aspects it might have contained. Ideally, I would have liked to outline some of the problems connected with this area in the study of Soviet-type systems but this would require an extended comprehensive historical review of the many developments that have occurred in this domain in the various countries (not the least of them all, the Soviet Union and the great debates of the twenties) before we can pause to meaningfully consider the kind of questions that have come to dominate contemporary discussions among East European economists (Janos Kornai, Wlodzimierz Brus or Bauer)[1] or Western specialists (Nove or Bettelheim).[2] Such an examination will clearly go beyond the purview of our present concerns. Instead, I shall restrict myself in this note to pointing out the deficiences stemming from the approach adopted by the author and the wrong conclusions derived as a result of the above.

The title of the paper is clearly misleading—it implies a discussion of pricing theories in the socialist countries, but the only countries mentioned are the USSR and Hungary with a single reference to the GDR, Romania and Bulgaria. The treatment of the latter is moreover extremely inadequate. In the introduction, the author states that in the "Critique of the Gotha Programme" Marx distinguished between socialism and communism by identifying the former as an "intermediate state". This is simply not true. Marx's terms of reference in the "Gotha Programme" relate exclusively to capitalism and communism: the words "socialism" or "intermediate state" will be sought in vain. It is true that Marx talks of a lower and higher stage of communism but these cannot be equated to socialism in whatever sense one might choose to use the term. What Marx did speak of was a period of revolutionary transformation between capitalism and communism in which the state would be nothing but the "revolutionary dictatorship of the proletariat"[3] which in his finalist conception of history constituted "the transition to the abolition of all classes and to a classless society . . .".[4] It is permissible to argue, as Nove does, that Marx had little to say that was practically relevant on the economics of his utopia but it is quite another to label his utopia as "socialist" as Mehta, following Nove, does.[5] The terms "socialism" (identified as a transitory stage in Lenin's Marxism) and "communism" (as a classless non-commodity utopia) were not interchangeable in Marx's vocabulary and the fact that they later became so cannot be attributed to Marx.

This lack of theoretical rigour coupled with a complete indifference to the historical or time dimension in the presentation of the problem can be encountered frequently in the text. The last passage of the Introduction may serve as a typical illustration: "The socialist scientists[this curious appellation to the Bolsheviks is misleading] in the socialist state were thus faced with the complex and unprecedented task of building up the infrastructure of the system of analysis. That is, they had to build up the political-economy of socialism from scratch. Inevitably theoretical discussions were closely related to the situations encountered in practice." Presumably, this refers to the early years following the Bolshevik seizure of power. If so, it is entirely unfounded. It does not require a specialist to confirm that during "war-communsim" the dictates of doctrine and the harsh exigencies of economic reality stood literally poles apart. Bukharin's "Politics and Economics of the Transition Period"[6] and "ABC of Communism"[7] written in collaboration with Preobrazhensky, which were the theoretical bibles of the period, were a far cry from the economic conditions obtaining at that time. On the contrary, they were apologies for the harsh measures being applied systematically against both the working class and the peasantry by the new Soviet state. One of the tragedies of "war-communism" lay precisely in the fact that theoretical discussions of the period had little to do with either prevailing economic conditions or economic or social rationality. Even Lenin, uneasy though he was with Bukharin's unilateral formulations (referred to by the author) was no exception: the partyless utopia sketched in the "State and Revolution" stood in sharp contrast to the socio-economic realities they pointed to.[8] This situation was to continue with essential modifications undertaken throughout the existence of the NEP until the late twenties giving rise to two divergent views on the continuation of the NEP which were ironically to later converge, but by that time it was