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PROCESSES OF ECONOMIC GROWTH AND FORMS OF PLANNING

by

Dr. A. Qayum

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Processes of Economic Growth
And Forms of Planning

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A. Qayum

Aligarh, India

Since Prof. Harrod first set the ball rolling in the late thirties, there has appeared a plethora of literature on growth economics. Mostly, efforts have been made to explain the process of growth in a balanced competitive economy by establishing a relationship between the proportion of income invested and the resultant increase of income on the basis of capital coefficient of production. If a is the proportion saved and invested of income Y and B is the capital coefficient, the increase of income in the next period is $Y \frac{a}{B}$. The purpose of this article is to compare the process of balanced growth with alternative processes of growth.

In a perfectly competitive economy, capital as well as consumption goods are produced in anticipation of demand. In the absence of disequilibrating forces, producers of consumption goods (henceforth called C goods) try to produce C goods equal to anticipated demand; and producers of capital goods (henceforth called I goods) endeavour to produce only as much of I goods as are required to produce the additional amount of C goods. Hence if the pattern of consumption does not change and the techniques of production remain the same, the ratio of additional I goods to additional C goods will remain constant and equal to the ratio of total capital stock existing in the economy and the total C goods produced in successive periods.

This can be easily seen. If Y, C, I denote national income, C goods, I goods of a community in a certain period, and suffixes r, r+I,... etc. denote the order of periods, then,

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(1) Published in Weltwirtschaftliches Archive Vol. 85 1960 PP. 270-76.

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$$Y_r = C_r + I_r$$

Total capital stock in period r is $B. Y_r$.

The ratio of total capital stock to total C goods produced

$$= \frac{B \cdot Y_r}{C_r} = \frac{B \cdot Y_{r+1}}{C_{r+1}}$$

$$= \frac{B\,(Y_{r+1} - Y_r)}{C_{r+1} - C_r}$$

$$= \frac{\text{Increase in I goods}}{\text{Increase in C goods}} \quad \ldots\ldots\ldots\ldots \quad (1)$$

Splitting B in two components B_c and B_i, the capital coefficients in C goods and I goods industries respectively,.

$$Y\,B = C\,B_c + I\,B_i$$

$$\frac{Y\,B}{C} = \frac{C.\,B_c + I \cdot B_i}{C} = K \text{ (some constant)}$$

So,

$$\frac{I}{C} = \frac{K - B_c}{B_i} = K' \text{ (a constant)} \quad \ldots\ldots\ldots\ldots \quad (II)$$

As B_i and B_c are assumed to be constant, the ratio of I and C goods produced in each period remains constant.

In a balanced economy,

$$\frac{I_r}{C_r} = \frac{I_{r+1}}{C_{r+1}} = \frac{I_{r+1} - I_r}{C_{r+1} - C_r}$$

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$$= \frac{I_{ir} / B_i}{I_{cr} / B_c}$$

(I_i and I_c denote the parts of I going to I and C goods sectors respectively).

$$\therefore \frac{I_{ir}}{I_{cr}} = \frac{I_r \cdot B_i}{C_r \cdot B_c} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad \text{(III)}$$

To sum up, in the absence of technical changes, the growth of a perfectly balanced economy is subject to the following conditions:

(1) Ratio of total capital stock to total C goods produced remains constant (I)

(2) Ratio of I goods to C goods produced in each period remains constant (II)

(3) Investment is divided between I and C goods industries in the I goods industries to C goods multiplied by capital coefficient in C goods industries (III)

To illustrate arithmetically,

let $Y_o = 100$, $C_o = 80$, $I_o = 20$;

$B_c = 2$, $B_i = 4$

From (III),

$$\frac{I_{ir}}{I_{cr}} = \frac{I_r B_i}{C_r B_c} = \frac{I_o \left(I + \frac{a}{B} \right)^r \cdot B_i}{C_o \left(I + \frac{a}{B} \right)^r \cdot B_c}$$

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$$= \frac{I_o B_i}{C_o B_c}$$

$$= \frac{20 \times 4}{80 \times 2}$$

$$= \frac{I}{2}$$

Under the present assumptions, investment in each period is divided between the I and C goods sectors in the ratio I : 2.

Model I traces the process of growth of national income in a perfectly balanced economy.

Model I[a]

Period	National income	C goods	I goods	Invest-ment.	Increase	Invest-ment.	Increase.
				in C goods		in I goods	
0	100,00	80,00	20,00	13,33	6,67	6,67	1,67
I	108,33	86,66	21,66	14,04	7,02	7,02	1,75
2	117,36	93,89	23.47	15,65	7,82	7,82	1,96
3	127,14	101,71	25,43	16,95	8,48	8,48	2,12
4	137,74	110,19	27,55	18,37	9,18	9,18	2,30
5	149,25	119,40	29,85	19,90	9,95	9,95	2,49
6	161,65	129,32	32,33	21,55	10,78	10,78	2,69
7	175,22	140,18	35,04	23,36	11,69	11,69	2,97
8	189,71	151,77	37,97	25,30	12,65	12,65	3,16
9	205,52	164,42	41,10	27,40	13,70	13,70	3,43
10	221,65	177,12	44,53	29,69	14,85	18,84	3,71
11	240,21	191,97	48,24	32,16	16,08	16,08	4,02
12	260,31	208,05	52,26	34,84	17,42	17,42	4,36
13	282,09	225,47	56,62	37,74	18,87	18,87	4,72

a In constructing the model, the elements in column "I goods" should be divided in the ratio I:2 for investment in I and C goods sectors.

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Harrod-Domar[1] type of models use an over-all capital cofficient; under the present assumptions, it will equal 2.4, the weighted average of the two coefficients, B_c and B_i. So long as the analysis is confined to balanced growth, there is no need of having more than one coefficient, for all the components move at the same rate and in the same direction. The income in period 9 can be easily calculated by compounding the rate of annual growth. It is

$$100\left(1+\frac{20}{100}\cdot\frac{1}{2.4}\right)^9 = 100\left(1+\frac{1}{12}\right)^9 = 205.52$$

Recently Prof. Mahalanobis[2] has made a significant departure from the balanced economic growth. The rationale of his approach lies in the emphasis on the production of I goods. Permitting a marked difference in capital coefficients in the two sectors, he shows how a community's income can be raised to a higher level by devoting a larger proportion of investible fund to I goods industry. In order to illustrate this approach let a higher proportion of I goods, say, 2:3, instead of 1:2 in Model I, be directed to I goods production. Other assumptions remaining the same, Model II traces the growth of national income and its components with a higher proportion of I goods industries.

Model II[a]

Period	National income	Consumption goods	Investment. goods	Investment. in C goods	Increase in C goods	Investment. in I goods	Increase in I goods
0	100.00	80.00	20.00	12,00	6.00	8.00	2.00
1	108.00	86.00	22.00	13.20	6.60	8.80	2.20
2	116.80	92.60	24.20	14.52	7.26	9.68	2.42

(Con't Page 6)..

1) R. F. Harrod, Towards a Dynamic Economics, Some Recent Development of economic Theory and Their Application to Policy, London, 1948.-Evsey D. Domar, "Expansion and Employment", The American Economic Review, Vol.XXXVII, Evanston, Ill., 1947, PP.34sqq.-I dem, "Capital Expansion, Rate of Growth, and Emplyment", Econometrica, Vol. XIV, Menasha, Wisc., 1946, PP. 137 sqq.

2) P.C. Mahalanobis, "Some Observations on the Process of Growth of National Income", Sankhya, Vol, XII, Calcutta, 1952/53, PP. 307sqq.

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(Con't Page 5)..

3	126.48	99.86	26.62	15.97	7.99	10.65	2.66
4	137.13	107.85	29.28	17.57	8.78	11.71	2.03
5	148.84	116.63	32.21	19.33	9.66	12.88	3.22
6	161.72	126.29	35.43	21.26	10.63	14.17	3.54
7	175.89	136.97	38.97	23,38	11.69	15.59	3.90
8	191.48	148.61	42.87	25.72	12.86	17.15	4.29
9	208.64	161.48	47.16	28.30	14.15	18.86	4.72
10	227.51	175.63	51.88	31.13	15.57	20.75	5.19
11	248.27	191.20	57.07	34.24	17.12	22.83	5.71
12	271.10	208.32	62.78	37.67	18.81	25.11	6.28
13	297.19	227.13	69.06	41.44	20.72	27.62	6.91

a In constructing the Model II, the elements in the column "I goods" have been divided in the proportion 2:3 for investment in the two broad sectors.

In Modell II income rises at a lower rate in the intial stages, but by period 6, it catches up with that in Model I and increases at a faster rate in the following periods. Increase in C goods in Modell also is lower in the beginning, but in period 7 it equals that in Model I; thereafter, consumption also rises at a faster rate. In period 12, total C goods produced in Model II is also greater than that in Model I. The critical period after which income and consumption in Model II exceed those in Model I will be longer, the larger the difference in capital coefficients in the two sectors and higher the proportion of I goods that is diverted to I goods sector.

Model II depicts the situation which is a compromise between a free competitive balanced economy and a perfectly planned economy. Here, the principle of maintaining a balance in the increments of I and C goods is given up for a more rapid growth of national income by directing a

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larger proportion of investment in I goods industries. But the proportion of investment going to the two broad sectors is kept constant.

Once a stage has been reached where consumption can be suppressed for building up capital stock, steps may be taken towards fuller planning by doing away with the necessity of maintaining a constant ratio between investments in the two sectors. In the early stages most of the investible resources may be channelled in I goods industries for achieving an adequate base of capital stock. After a satisfactory level has been achieved in this direction, the resources may be diverted to the production of C goods which is the ultimate goal of all economic development. The following model illustrates the growth in an economy where the planning authority has perfect freedom of resource-allocation.

Model III

Period	National income	C goods	I goods	Investment. in C goods	Increase in C goods	Investment. in I goods	Increase in I goods
0	100	80	20	4	2	16	4
1	106	82	24	0	0	24	6
2	112	82	30	2	I	28	7
3	120	83	37	I	.5	36	9
4	129.5	83.5	46	2	I	44	II
5	I4I.5	84.5	57	2I	II.5	36	9
6	162	96	66	50	25	16	4
7	191	121	70	62	3I	8	2
8	224	I52	72	68	34	4	I
9	259	I86	73	--	--	--	--

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Model III depicts the situation in a perfectly planned economy. Income remains lower till period 5 and production of C goods till period 7. Thereafter, both exceed the levels achieved in the corresponding periods in the first two models. In period 9, income in Model III exceeds by 53 and 50 those in Models I and II, respectively, and consumption exceeds by more than 24 and 21.

The three models discussed here illustrate the process of economic growth in a free competitive balanced economy, in a partially planned or mixed economy and in a perfectly planned economy. In the first the state has more or less to act as an umpire to ensure that the rules of the game are followed; in the second, the state, besides acting as an umpire, participates in the game, and posts itself at strategic points; in the third, the game is mainly played by the state itself. The first involves minimum of state intervention in productive activity, the second, control of finance, money and banking and key industries, the third an all over control of prices and production.

The ultimate objective of all economic growth is the maximisation of consumption goods. A growth rate may lead to a higher level of national income by the end of a certain period than any other but the latter may enable the production of C goods to rise to a higher level. It is true that in the former case, if the level of national income is higher, this would enable the economy to raise the production of C goods to a higher level after another quinquennium or decade. But in reality it may not be possible to suppress consumption for longer periods than the community can bear. Hence it is profitable to see, that given the period by the end of which production of C goods has to be maximised, and the capital coefficients in C and I goods industries, whether it is possible to allocate I resources between the I and C goods sectors in such a way that the production of

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C goods is maximised by the end of the period.

The first process of economic growth is an automatic process where a perfect balance is maintained between the various components of national income and the volumes of C and I goods produced increase at the same rate. Hence this model is not amenable to any conscious planning.

The second model presented first by Prof. Mahalanobis offers theoretical and practical possibilities for decision making. If the community decides that the volume of C goods production should be maximised by the nth period and B_c and B_i are the capital coefficients in C and I goods respectively, then Prof. Mahalanobis's model can tell what proportion of I be diverted to I goods sector and what to C goods, that is, it can give the value of h_i, where h_c is the proportion of investment going to the I goods sector, so that $I = Ih_i + I\,h_c$, or $h_c + h_i = 1$.

This can be demonstrated as follows:

$$Y_o = C_o + I_o$$

$$Y_1 = C_o + I_o \frac{h_c}{B_c} + I_o + I_o \frac{h_i}{B_i}$$

$$Y_2 = C_o + I_o \frac{h_c}{B_c} + \left(I_o + I_o \frac{h_i}{B_i}\right) \frac{h_c}{B_c} + I_o + I_o \frac{h_i}{B_i} + \left(I_o + I_o \frac{h_i}{B_i}\right) \frac{h_i}{B_i}$$

$$= C_o + I_o \frac{h_c}{B_c}\left\{ I + \left(I + \frac{h_i}{B_i} \right) \right\} + I_o \left(1 + \frac{h_i}{B_i} \right)^2$$

$$Y_3 = C_o + I_o \frac{h_c}{B_c}\left\{ 1 + \left(1 + \frac{h_i}{B_i}\right) + \left(1 + \frac{h_i}{B_i}\right)^2 \right\} + I_o \left(1 + \frac{h_i}{B_i} \right)^3$$

$$Y_n = C_o + I_o \frac{h_c}{B_c}\left\{ \frac{\left(1 + \frac{h_i}{B_i}\right)^n - 1}{\left(1 + \frac{h_i}{B_i}\right) - 1} \right\} + I_o \left(1 + \frac{h_i}{B_i} \right)^n$$

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$$C_n = C_o + 1_o \frac{h_c}{B_c} \left\{ \frac{\left(1 + \frac{h_i}{B_i}\right)^n - 1}{\left(1 + \frac{h_i}{B_i}\right) - 1} \right\}$$

C_n will be maximised when

$$\left\{ \left(1+\frac{h_i}{B_i} \right)^n - 1 \right\} - \frac{n}{B_i} \left(h_c - h_i^2 \right) \left(1+ \frac{h_i}{B_i} \right)^{n-1} = 0$$

The above equation does not give a unique value of h_i. But by giving different values of h_i for a fiven value of n, we can determine the approximate value of h_i and h_c. This is what, in actual practice, is needed. If the community wants to maximise its consumption in 10 periods, h_i should be about. 15, if in 15 periods, it should be between .375 and .5, if in 20 periods it should be between .5 and .625.

The Model III is not amenable to any exact formulation. But it is possible to adopt such courses of division of I goods into I and C goods sectors as may maximise consumption in 10, 15 or 20 periods.

As a postseript it has to be stated, as Hans-Jurglu Vosgerau[3] has shown, that Model II implies an increasing rate of savings whereas Model I rests on the same rate of savings as in the original period. If the savings rate is allowed to increase at the same rate in Model I as in Model II, the income may rise at a higher rate in the farmer case as shown by Vosgerau or perhaps the rates of growth in the two cases approach each other in the long run.

Another point which can be mentioned is that the mxnimisation of consumption goods which has been attempted towards the end of this note

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3) ef. Weltwirtschaftliches Archiv Vol. 90 (1963) , PP. 79-92.

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is a more direct method of maximisation of welfare or social utility. For it can be easily seen that so long as social utility or welfare is a monotomic increasing function of consumption, the rate of saving required with respect to a given time horison will be the same irrespective of the form of the utility function.

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