The Fel'dman (菲尔德曼) Model: theoretical justifications for the Stalinist model of forced industrialization for CPEs

(Reference: Hywel G. Jones, An Introduction to the Modern Theories of Economic Growth, McGraw-Hill, 1976).

If we move beyond the short run models and look at long term growth, we find that the former Soviet Union, China, East Europe had all opted for versions of investment first growth model and development strategy. The basic historical reason was they were all trying to do "leap-frogging", **"big push"**, instead of following the "natural order of development" hypothesized by the theory of the "flying geese". Fel'dman was a Russian economist in the 1920s.

Three points to note above the Fel'dman Model:

(a) Following Marxian political economy, all capital goods, ie., all means of production, were included in Category 1. On the other hand, all consumer goods, including the corresponding raw materials, were included in Category 2. Almost all the writers who have discussed the model of G.A. Fel'dman developed in the 1920's have noticed that, although the scheme is theoretically attractive, it is not possible to give it any but the roughest empirical meaning.

(b) The Fel'dman model is one of the few growth models whose construction depended explicitly on the requirements of public policy for development and which can be said to have direct policy implications. It seems clear that the model had little influence on policy formulation in the Soviet Union but the consistency of his results with the content and style of the first two Five-Year Plans is remarkable. The general strategy of Soviet growth policy and the preoccupation with heavy industry can be easily analysed within the framework provided by the model.

(c) Capital is the only factor that limits growth, i.e. there are assumed to be "unlimited supplies of labour" along the lines of Arthur Lewis. Here a "stylised fact" of underdeveloped economies is made a basic assumption of the analysis continuing the emphasis on the strategic role of the capacity to produce capital goods in the domestic economy.

Assumptions:

Assumption 1 (important):
The economy is divided into two sectors or categories: 1 and 2. Category 1 produces capital goods and these capital goods can then be used in either of

the two categories. Once installed, they **cannot be transferred from sector to sector** -- i.e., once a machine is placed in Category 1, it cannot be used in Category 2. In short, capital is not mobile.

Let μ be the output of Category 1 allocated to itself, and 1- μ be the portion allocated to Category 2.

Assumption 2 (important):
Fixed-coefficients technologies are used in both categories, i.e.

$Y_1 = \min(K_1/v_1, L_1/u_1)$ $\quad\quad$ $Y_2 = \min(K_2/v_2, L_2/u_2)$

Where Y, K, L are output, capital and labour respectively, and v_1, u_1, v_2, u_2 are fixed coefficients. Since labour is assumed to be abundant (actually of unlimited supplies), **capital is the only limiting factor**. Hence

$Y_1 = K_1/v_1$
$Y_2 = K_2/v_2$

Assumption 3

No depreciation is considered for simplicity's sake.

Assumption 4

The economy is closed.

Assumption 5 (crucial):

*** **Production in Category 1 is completely independent of production in Category 2!** Even if the output of consumer goods falls to zero, the production of capital goods will continue.

We can now derive the Fel'dman Model:

The investment equation

Given these assumptions,

$$I_1 = Y_1 = \frac{K_1}{v_1} \qquad (1)$$

$$\text{So} \quad \dot{I}_1 = \dot{Y}_1 = \frac{\dot{K}_1}{v_1} \qquad (2)$$

And the change in the capital stock in Category 1, $\dot{K}_1$, is equal to

$$\dot{K}_1 = I_1 = \mu I \qquad (3)$$

Substitute (3) into (2), we have

$$\dot{I} = \frac{\mu I}{v_1}$$

$$\frac{\dot{I}}{I} = \frac{\mu}{v_1} \qquad (4)$$

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$\frac{\dot{I}}{I}$ is the proportionate rate of growth of the capital stock and is equal to $\frac{\mu}{v_1}$ in the Fel'dman model. So a higher portion of Category 1 output to Category 1, i.e. a higher μ, would increase the growth rate of total investment and hence of the capital stock.

The consumption equation

Through similar manipulation, we can arrive at the consumption equation:

$$\frac{\dot{C}}{C} = \frac{(1-\mu)I}{v_2 C} \qquad (5)$$

Central Propositions of the Fel'dman Model:

(1) The long run growth of the economy is given by the rate of growth of investment: $\frac{\mu}{v_1}$. The rate of growth of national output, *Y*, and consumption, *C*, will not be equal to it, but will eventually converge to it (**steady state**).

(2) It is advisable to have **an investment-led development strategy**, as the simulation results in Jones (1976) show (Hywel G. Jones, An Introduction to the Modern Theories of Economic Growth, McGraw-Hill, 1976). If a higher μ is allocated to Category 1, the long run growth of investment (*I*), national output (*Y*) and consumption (*C*) will be higher than if a lower μ is allocated to Category 1.

Table 1: Simulation results of the Fel'dman Model under different investment coefficients (μ)

Initial conditions: $Y_0 = 10$; $C_0 = 9$; $v_1 = v_2 = 3$

Growth Rates of National Product (Y) and Consumption Goods (C): %

	μ = 0.3		μ = 0.6		μ = 0.9	
Year	Y	C	Y	C	Y	C
1	3.56	2.79	3.93	1.78	4.40	0.25
2	3.79	2.99	4.60	2.13	5.75	0.35
3	4.03	3.21	5.34	2.54	7.39	0.47
4	4.27	3.43	6.16	3.02	9.33	0.65
5	4.52	3.66	7.04	3.57	11.54	0.88
6	4.77	3.89	7.98	4.20	13.94	1.20
7	5.02	4.13	8.96	4.90	16.44	1.62
8	5.27	4.38	9.95	5.68	18.91	2.18
9	5.52	4.63	10.95	6.52	21.23	2.92
10	5.76	4.88	11.93	7.43	23.31	3.88
15	6.91	6.11	16.61	12.33	29.50	12.82
20	7.87	7.21	18.32	16.27	31.20	24.32
25	8.59	8.10	19.35	18.45	31.57	29.82
30	9.09	8.75	19.76	19.40	31.65	31.27
35	9.43	9.21	19.91	19.77	31.66	31.58
40	9.65	9.50	20.00	19.92	31.67	31.65
45	9.78	9.69	20.00	19.97	31.67	31.66
50	9.87	9.81	20.00	19.99	31.67	31.67
55	9.92	9.88	20.00	20.00	31.67	31.67
60	9.95	9.93	20.00	20.00	31.67	31.67
65	9.97	9.96	20.00	20.00	31.67	31.67
70	9.98	9.97	20.00	20.00	31.67	31.67

Criticisms of the Fel'dman Model: the Kalecki Model of Economic Reforms

The Fel'dman model could be criticized as it neglects the consequences of low consumption on workers' morale, hence labour productivity and eventually output in both Category 1 and Category 2. That is the essence of the model of Michael Kalecki (米哈爾·卡萊斯基, 1899-1970). It forms the theoretical foundation for the liberalization process in the era of **economic reforms**.

參考： 符綱戰、史正富、金重仁，《社會主義宏觀經濟分析》，上海學林出版社，一九八六年。

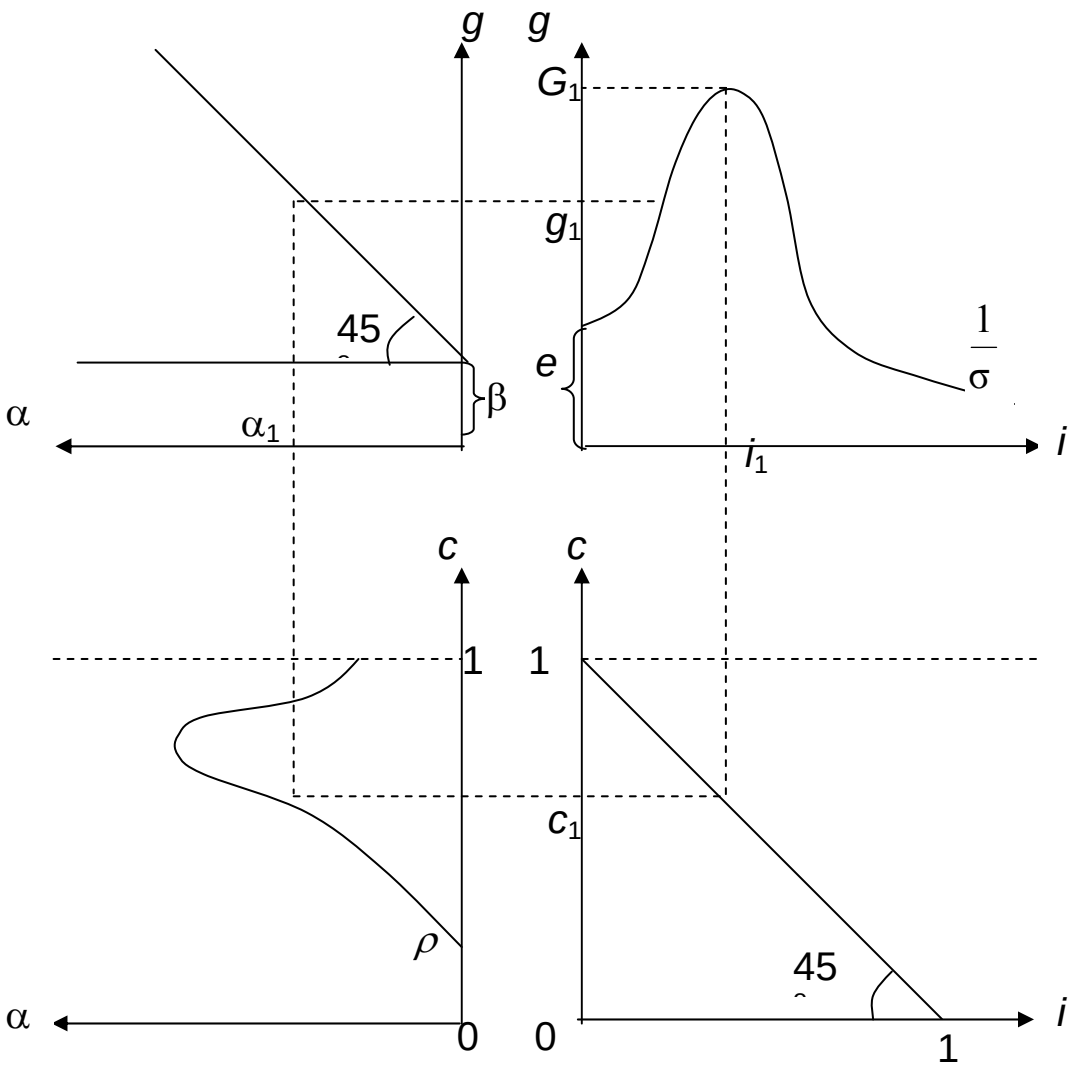


Figure 10-3 (modified)

Let us denote the growth rate $\frac{\Delta Y}{Y}$ as g and investigate its determination. A first approximation is that

$$g \equiv \alpha + \beta \equiv p + q \qquad \text{---------- (1)}$$

where α is the growth rate of labour productivity, β is the growth rate of the labour force, p is the growth rate of (net) capital stock, q is the growth rate of capital productivity (see Fu et al., pp.219-223 for the derivation and the assumption). But this model only deals with potential/latent supply (潛在供給).

To deal with effective growth in CPEs, we need a more realistic model.

First define $\sigma = \frac{I}{\Delta Y}$ ---------- (2)

where I stands for investment, ΔY change in national output. σ is therefore the "investment coefficient" and $\frac{1}{\sigma}$ represents "investment efficiency" as

$\frac{1}{\sigma} = \frac{\Delta Y}{I}$ (單位投資帶來的國民收入增量)

To simplify the analysis, we neglect depreciation and postulate another source of growth from skill improvement and institutional reform, e, thus

$$\Delta Y = I.\frac{1}{\sigma} + eY \qquad \text{---------- (3)}$$

Dividing both side by Y, we have

$$\frac{\Delta Y}{Y} = g = \frac{I}{Y} \bullet \frac{1}{\sigma} + e$$

$$\therefore\ g = \frac{i}{\sigma} + e \qquad \text{--------- (4)}$$

where i stands for $\frac{I}{Y}$, the investment ratio (or accumulation ratio).

In optimal equilibrium:

$$g = \alpha + \beta = \frac{i}{\sigma} + e \qquad \text{--------- (5)}$$

(This is in effect a simplified version of the Kalecki model of growth.) For details, see M. Kalecki, Selected Essays on the Economic Growth of the Socialist and the Mixed Economy, Cambridge University Press, 1972).

From (5), it is possible to derive the simplistic conclusion that since $\frac{dg}{di} > 0$. Thus, an "investment-priority strategy" is optimal (The Fel'dman model or the Harrod-Domar model).

The trouble with eq.(5) is that it is derived only from identities and is static in nature. We have to investigate the dynamics of investment and growth to gain a more realistic picture.

In the S-R, the rise in i ($=\frac{I}{Y}$) would mean a fell in c ($=\frac{C}{Y}$, where C represents consumption). So eq.(4) can be rewritten as

$$g = \frac{1 - c}{\sigma} + e = \frac{i}{\sigma} + e \qquad \text{---------- (6)}$$

Even for (6), the Fel'dman model can be proved to be correct as long as α – labour productivity is not affected by variations in distribution between C and I, i.e. variations in the sizes of $c + i$ (=1). The "Stalinist" model of giving priority to accumulation can still be justified.

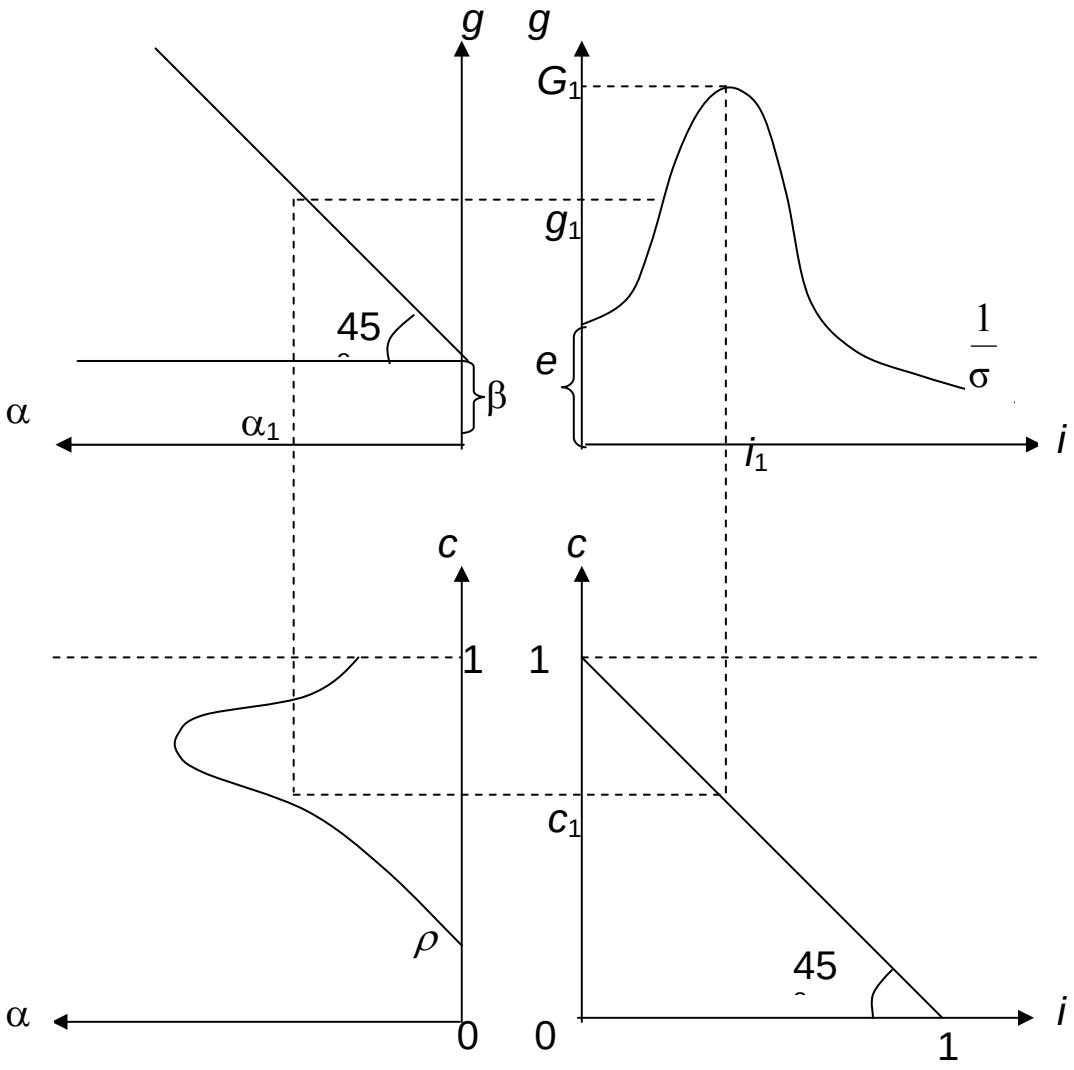
Unfortunately, unless there is such strong social morality that this assumption of non-dependence of labour productivity on consumption holds, the relative distribution between C and I may affect productivity and therefore influence growth. ("良心作用" versus "按酬付勞")

Fu et al. postulate a "labour effort coefficient" ("按酬付勞"系數) ρ (rho) such that

$$\rho = \lambda / \varphi \qquad \text{---------- (7)}$$

where λ is average labour productivity and φ is per capita consumption ($\varphi = \frac{C}{N}$ where N is population).

Overall, Fu et al. propose the following diagram:



Similarly, **the Fel'dman model can be criticized for neglecting the morale of any human factors, not just that of the workers, but also that of the managers, the enterpreneurs, the scientists, the researchers etc.** So on the whole, the Stalinist model would adversely affect any form of efficiency/productivity enhancing, innovative and risk-taking behaviour. Many regard this as the crux of the problems in a socialist economy, and the key reason why **economic reforms and liberalization** have to be carried out.