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An Optimal Investment Planning

—An Analysis of Flow Process in a Firm—

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In this thesis which is composed of three independent chapters, some investment problems in a firm are considered.

There is a number of methods for solving investment problems, e. g., present value method, rate of return method and so on. But all of these have some shortcomings such as that the uncertainty of return or expenditure in future is not considered, or that the dynamic decision process on time sequence is not included. "Chapt. 1 Investment Programs by D. P. or Q. P." presents some investment programs in which the uncertainty or the dynamic decision process is considered. Capital investment program and funds allocation program by dynamic programming and portfolio selection by quadratic programming are centered in this chapter.

All the activities and their programs in a firm are mutually connected. Therefore we need to predict quantitatively how one investment decision affects the others. For the purpose of achieving this, we need to know the csusal relationship of all these activities, and make a model out of the relationship. One step in progress, "Chapt. 2 Capital Investment Program and its Simulation" a macro model, named Balance Sheet Generater of *S* company is made and the practicality is discussed. This makes an estimated balance sheet and income statement each period when the future sales amount and investment amount are given as input.

Generally speaking, firm s return or expenditure varies with the scale of an equipment and the percentage of its operation. For instance, when the production of 100 pieces of some article are required per day, it is more economical to use the equipment which produces 100 pieces per day instead of using the equipment which produces 200 pieces per day. On the other hand, when 200 pieces are required per day, it is more economical to use one equipment only which produces 200 pieces per day, instead of using two equipment which produces 100 pieces each per day.

In "Chapt. 3 Equipment Expansion Programs Against Increasing Demand," under some assumptions and given an increasing demand pattern, some methods to decide the optimal expansion time and its scale of the equipment are developed. Here they are assumed that the firm's expenditure consists of two parts, a variable part proportional to the percentage of an equipment operation and a fixed part, and that each is expressed as a function of an equipment capacity expanded. Some models

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are formulated by dynamic programming and these numerical examples are shown.

For instance, the functional equations of a typical model are

$$F_1(T)=\sum_{\tau=1}^{r}\left\{f(g(r))+v(g(r))\cdot g(\tau)\right\}a^{\tau}+\frac{a^{r+1}}{1-a}\left\{f(g(r))+v(g(r))\cdot g(\tau)\right\},$$

$$1\leqq T\leqq T_M$$

$$F_n(T)=\min_{n-1\leqq t_n<T}\left[\sum_{\tau=t_n+1}^{r}\left\{f(g(r)-g(t_n))+v(g(r)-g(t_n))(g(\tau)-g(t_n))\right\}a^{\tau}\right.$$

$$\left.+\frac{a^{r+1}}{1-a}\left\{f(g(r)-g(t_n))+v(g(r)-g(t_n))(g(r)-g(t_n))\right\}+F_{n-1}(t_n)\right],$$

$$n\leqq T\leqq T_M$$

where, $F_n(T)$ represents the minimum production cost, n optimal expansions are made by time T and these equipments are used infitely, t_n represents the n-th expansion time, f is the fixed cost and v is the variable cost which are expressed as a function of the production capacity of an equipment expanded, $g(\tau)$ is the demand or production quantity from time $(\tau-1)$ till time τ and $a=1/(1+r)$ where r is a discount factor.

More detailed explanation of this formulation is shown in "§ 1 model 1."

The examples in Chapt. 2 and Chapt. 3 are computed by IBM 7090 and UNIVAC 1107 computor and these outputs are affixed in the last of this thesis.