



Title	An Essay on the Theory of the Firm
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Citation	農業経営研究, 2, 133-153
Issue Date	1975-02
Doc URL	https://hdl.handle.net/2115/36353
Type	departmental bulletin paper
File Information	2_133-153.pdf



AN ESSAY ON THE THEORY OF THE FIRM.

Lee, Jung Hwan

Prologue.

1. The theory of the firm in Neoclassical Microeconomics.
2. The theory of the firm in Mathematical Programming.
3. Theories of the firm under imperfect knowledge.
4. Dynamic theory of the firm.
5. Organization theory of the firm.
6. Environment theory of the firm.

Summary

Prologue

I shall be concerned with the theory of the firm. I will allow "the theory of the firm" to envelop all theories intended to explain, predict and instruct the behavior of the firm, whatever the term has been used for.

Various theories have been developed in relation to the firm with their own purposes and with their own cognitions for the firm. In order to apply their establishments to our purpose without any confusion and misuse it is necessary and worth while to investigate and make clear with what purpose and cognition for the firm they were evolved and have been developed respectively. We can not find how to improve and admit those theories into the study of the firm until their intentions and purposes are made clear.

Three kinds of theories are presented under the domain of the theory of the firm in this paper; economic theory, organization theory, and environment theory. Under the economic theory I will place neoclassical microeconomics, mathematical programming theory, imperfect knowledge theory, and dynamic theory.

1. The theory of the firm in neoclassical microeconomics.

* A short glance at its history.

The first firm described by the economist was the Smith's firm. But the grandfathers of the theory of the firm were Cournot and Tünen who explicitly defined the equality of marginal productivity among resources as the profit maximization condition. Extended by Marshall and others, this theory was fully established as the marginal principle of the firm with

advent of the Hicks' firm model.

* The framework of the theory.

The firm is thought of as an input-output structure which certain input of factors of production flow into and output of products flow out of. The single motive of this flowing is the desire of profit maximization. The position of the firm is specified by two kinds of constraint which its nature and environment place on the firm; production and market functions.

Production function is a mathematical or numerical function which shows the maximum output attainable from any specified set of input. This function is assumed to be continuous, concave and predetermined by the firm's technicians with a set of technical experiment.

Product's price is determined in the market of the product at the level of equilibrium between consumer's demand originated from their utility function and the industry's supply derived from the industry's marginal cost function. On the other hand, factors' prices are determined in a similar way in the market of each factor.

These two external market functions and internal production function determine the optimum position of the firm at which its profit is to be maximized, and then the firm moves to the position with rationality. The optimum position is calculated with the Lagrangian calculus technique, and the well-known three decision rules of marginalism are obtained.

* Criticisms against neoclassical microeconomics.^{1,4,5,17}

Very hot controversies over the validity of the marginal theory of the firm were broken out in the United States around 1946. First, many economists have criticized the assumption of profit maximization goal. They claim that the firm has its own multiple goals which may be conflicting, cooperative, or

independent one another, and that these goals are to change in themselves or in relative importance over the course of time as the contemporary situation and the thought of the firm are changed and the experiences of the firm are accumulated. The objective of the firm is not to maximize one of the multiple goals at the cost of all others but to attain a satisfactory level for all goals.

Second, there has been another debate with respect to the assumption of perfect knowledge. Microeconomics assumes the firm has perfect knowledge about its given production function and market functions and therefore what will come out of his action is known to the firm with certainty. As long as we assume that the technological and the market situation are given exogeneously and the knowledge about them is perfect, the only work of decision maker of the firm is to find the position of optimum and move to the new position whenever technological or and market situation change. Accordingly there are no needs for information, anticipation and decision making.

Third, neoclassical theory assumes that the optimum technical production process has somewhat already been determined so as to realize the maximum product obtainable from a set of input before the decision maker go to work on the problem. And the remained work is only to combine inputs and outputs mechanically. However, the choice of production process and organization to exploit more and better services from the given productive resources is the very critical work of management.

* In defence of Neoclassical Microeconomics. 2,4,17,18,20

Friedman argues in his "Positive Economics" that validity of a theory is to be tested with its power of prediction and not with the reality of its assumptions. This claim seems very acceptable when we consider that the Neoclassical theory has been very powerful in predicting in spite of all contro-

versies over it.

Another plausible defence is "Evolution Analysis". Alchian concedes that firms do not pursue the marginal calculation and that firms may many differtial goals. However, since in the long run firms will survive only if they make dicisions dictat ed by marginal theory, the theory will predict the behavior of viaole firms. We need only a theory of fit and are not asked to describe how firms solve their problems.

Closing my sketch on Neoclassical microeconomics, I like to make one point clear. The distinction feature of any science lies in the subject matter with which it deals and on which its theories are to function. Is the firm the subject matter of microeconomics ? we have to say firms are not the subject matter of microeconomics but only a medium in order to reach the market. Theory of the firm in microeconomics was not intended to serve as managerial decision theory but constructed for the purpose of the central problem of economic analysis, the way in which prices and allocatin of resources among different uses are determined.

I believe we don't have to complain about microeconomics only because it is not appropriate for our purpose of the study of management. because it has its own job and duty on its own subject of market. This statement never means that behavior of market and price may be neglected in study of management . We always notethat market and price are great dictators on the firm and we should consider theories of microeconomics for our study of management.

2. The theory of the firm in Mathematical programming.

* The framework of the theory.

Although the basic principle of marginalism behind the mathematical programming is essentially the same with microeconomics, it was evolved by paying special attention to the fixed

factors of production in multi-factor multi-product firm. Microeconomics focuses its attention on the flow of variable factors and product because these variables tell how much quantity of goods will be demanded or supplied in the market, which is the main concern of the theory as pointed out already. Fixed factors are regarded as being aside from the problem just because their quantities are possessed by the firm and do not create any new demand for the market.

In the mathematical programming theory, on the other hand, fixed productive factors are central problem, because they determine the range of the firm's activity and then they have internal opportunity cost in case of multi-product firm. They can be used in different line of production and have possibility of being transferred from one line of production to another, and affect the combination of product in short-run.

Equation system including inequality constraints can not be solved by the Lagrangian method but only by the theorem of Kuhn-Tucker and iteration, that is, the technique of mathematical programming. Kuhn-Tucker theorem produces the well-known four decision rules of mathematical programming.

Specially when the objective and constraint functions are all linear, this model is defined as linear programming model. When the objective functions are non-linear, it is called non-linear programming model whichever the constraints are.

* linear programming model.^{5,11,17}

Neoclassical marginalism supposes continuous proportion concave production function which means one factor is substitutable with another continuously. In practical world, however, there usually exists a very inflexible or fixed combination ratio between factors under a given technology. This characteristics might be emphasized in accordance with high mechanization. And therefore required decision is to choose

the technology and/or their combination rather than proper combination of factor under a decided technology. And at the same time there usually operates constant marginal cost in practical firms at least in reference with production.

On the consideration like above, linear programming model was established in order to handle both technological decision and production quantity simultaneously. However, it stands on assumptions; constant input-output ratio in all relevant activities, no interaction among activities, complete transferrability of all fixed factors between two activities, and perfect knowledge about them.

* Non-linear programming.¹⁰

When the firm supplies a imperfect market with its product, the objective function is no more linear because its marginal revenue is diminishing. This consideration for a imperfect market made the model of non-linear programming required. Another requirement of non-linear programming is found when the problem of uncertainty is incorporated as will be seen in the next section.

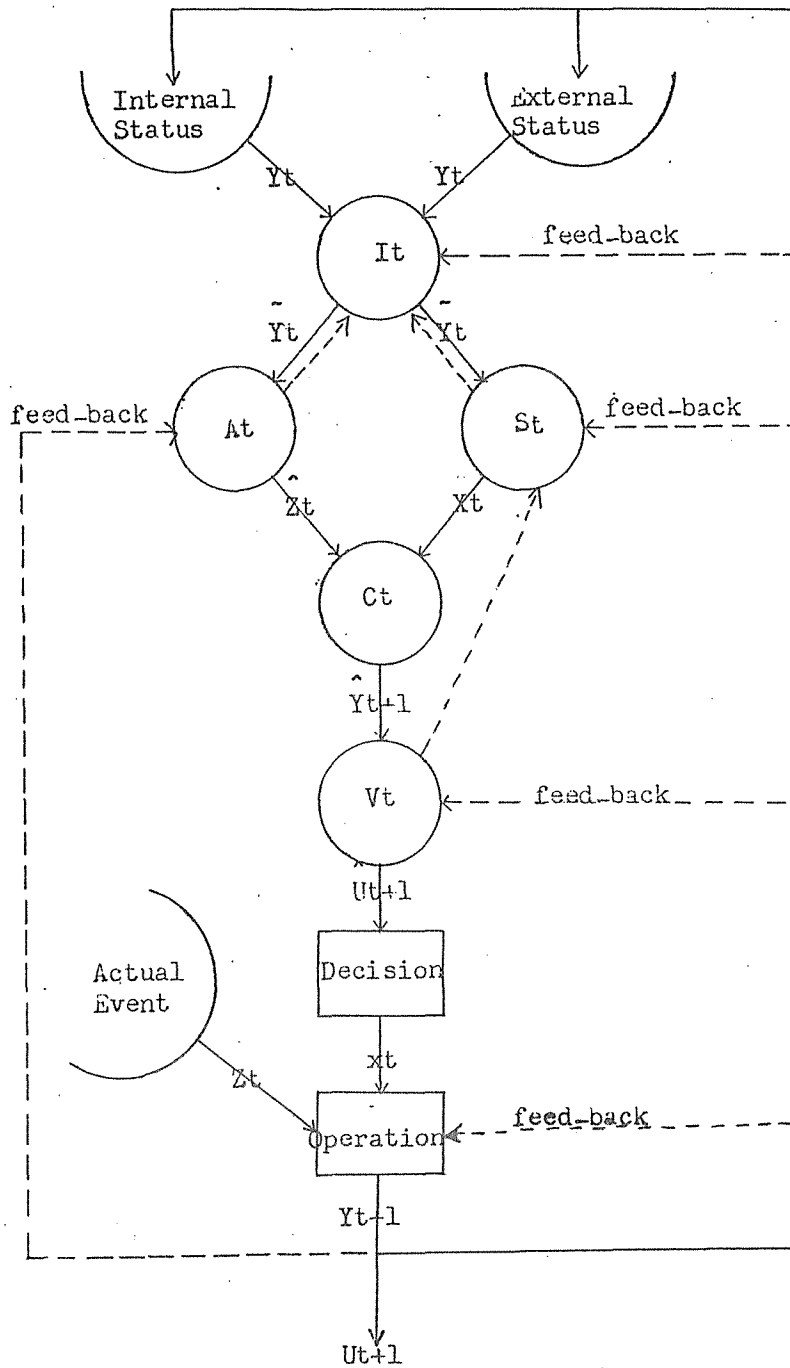
Non-linear programming model, however, solvable with present mathematical technique is restricted to a few special cases; approximating technique which is available when constraints are linear and objective functions can be separated into n-linear functions, and quadratic programming technique which is used in the problem of quadratic polynomial objective and linear constraint functions.

3. Theories of the firm under imperfect knowledge.

* Rationale and decision making.^{2,6,10,14,24}

When perfect knowledge is assumed, there is no special role of decision maker except finding the objectively optimum input output combination as mentioned already. On the account

Fig.1 Genreal Decision Model



- * All capital lettered variables denote a matrix
- * Tailed letters denote an imaged value.
- * Capped letters denote an anticipated value.

of it, it is taken for granted that the conventional marginalism could not find any necessity to look into the decision problem in the firm. As we take notice of imperfect knowledge of the firm, the central issue of management would move to the problem of information and decision.

As I like to be given an opportunity to discuss about decision and its modelling in another paper, I am going to avoid detail explanation but a brief description required for the objective of this paper. I will present a decision model which I hope describes decision process very efficiently and generally.

Decision making may be defined as choice of a course of action out of a set of courses available to the firm. Decision model usually consists of statement of variables and specification of relationship among them. Relevant variables are actual, imaged and anticipated state variable ($Y, \bar{Y}, \hat{Y}$), decision variable (X), actual and anticipated pay-off ($U, \hat{U}$). These variables are connected and interrelated through following functions and processes; information-imagination function (I), anticipation function (A), strategy function (S), consequence function (C), criteria function (V), and decision process, operation process, feed-back process.

The firm --- I will implicate the appropriate part of the firm with the word of "firm" --- makes an image about both the firm itself and the environment, and there turns up in the model the imagined status ($\bar{Y}$). The firm makes necessary expectation for the future ($\hat{Z}$) and at the same time thinks out some alternative strategies basing on the imagined status. What consequence ($\hat{Y}_{t+1}$) will come out of each strategy is estimated and the anticipated consequence is evaluated in terms of the firm's criteria of values ($\hat{U}_{t+1}$). The best strategy is selected and put into operation, which is to come

across with the actual event(Z) and results in the real consequence (Y_{t+1}). These consequence satisfies the values of the firm and composes the new status of the firm. Thought and character of the firm are somewhat affected by this experience and therefore some or all functions of the model are revised or transformed.

* Imperfect knowledge in strategy generating.¹⁶

Imperfect knowledge is related with decision in two kinds of respects; strategy generating and anticipating. Conventional marginalism supposes the decision maker has indefinite and perfect information and imagination horizon and chooses objectively best strategy of all possible strategies available to the firm. However, strategies that are found to be possible and taken into evaluation are limited in number, because human being's imagination and capacity is confined and information gathering is costsome. Therefore its decision selected out of the confined number can not always be consistent with the objectively best even if all other parts of the model are perfect.

* Imperfect knowledge in anticipation-----uncertainty.

The most important parts in reference with uncertainty are $\hat{Z}$ and V , anticipated value of future event or parameter and criteria respectively. According to the probabilistic properties of $\hat{Z}$ the model is classified into certainty, risk, and uncertainty. If $\hat{Z}$ is a single-valued without other possibility, it is a certainty model. Otherwise, noncertainty model.

* Objective risk model^{6,17}

When the probabilistic distribution of $\hat{Z}$ can be acquired statistically with objectivity, the decision is under risk. Strictly speaking, it is a variety of certainty.

Decision criteria suggested for this situation; risk dis-

counting certainty equivalence, expected value, etc. Risk discounting and certainty equivalence criteria are accounting for the difference of risk aversion among decision maker, but expected value not. Expected utility is calculated by the Von Neuman's special utility function.

* Uncertainty model 3,15,16,13

Approaches to decision making under uncertainty may be divided into two classes; probabilistic and game theoretic. Game theoretic model is characterized by the supposition that certain event can be realized as possible but not meaningfully described further with probabilistic concept. In such situation each choice of a course of action is associated with possible consequence respectively and the decision maker has some preference among the possible consequences.

Decision criteria suggested are Laplace's, maximin, maximaxi, Hurwicz's, minimaxi, and Schackle's etc. Minimaxi criterium has been broadly applied.

The probabilistic theory postulates that the decision maker acts as if he has a subjective probabilistic distribution over Z . Criticism against the existence of objective probability for the future made once probability very weak and meaningless concept for decision problem. However, broadening the concept of probability, we stand on the position not worrying whether objective probability might exist or not. We may regard the uncertain situation as risk without much trouble as far as concerned with prediction and explanation of behaviors of the firm. We understand here what a great role the information flowing into A has, however trivial it may be.

Decision criteria of risk decision can be used as such. However, in the situation of ambiguity where some estimates of the probability are not completely reliable, the decision maker will not rely completely on the expected value but prones

to take some additional informations into account. Truncated minimaxi or maximini criteria are suggested on his consideration. That is, the decision maker intends to maximize his subjective expected value subject to the constraints that the probability of the expected value less than a predetermined level is smaller than a certain bigness.

Practical solution for these objective or subjective risk model, subject to the condition that the theory of mathematical programming are accepted, is attained with following technique; stochastic programming in which objective coefficients or restraints are stochastic, two stage fat programming in which both objective and constraints are probabilistic, chance-constrained programming which admits exceeding of constraints by disposing it as cost.

4. Dynamic theory of the firm.^{2,9,12,13,17,24}

* Statics and dynamics.

Neoclassical microeconomics was preoccupied with the optimum condition of equilibrium, and looked into the firm of at the particular moment rather than over time. Taking into account that the firm is a historical consequence and is to be projected into future, many economists have had doubts from early time whether behaviors of the firm could be understood and instructed with only the timeless present and equilibrium status. There have been many efforts to explain the behavior of the firm in terms of dynamic concept, which can be abstracted into four aspects.

* Time-different values.

In a real firm almost all input and putput are not executed simultaneously. There is usually some time interval between input and output, and that one or both of them are executed over time. Meantime two time-differcnt values are not evaluat-

ed equivalent by the firm in spite of the equivalency in their absolute values.

This problem was realized to be solvable with some appropriate discounting rate which would make two time-different values indifferent to the firm. Discounting all relevant variables with the appropriate rate, we return to the static situation of decision of decision making. The matter of difficulty is rather to find the appropriate rate and many discussions have been focused over this problem.

* Time-sequential variable.

As shown on the previous decision model, all variables flowing into at present are accumulated consequences of the past and all variables flowing out of at present compose the future variables. Decision made at present, therefore, will not be fully understood without considering the hitherto and hereafter path of the variables. This kind of problem is built in a model and solved with differential equation and sequential or dynamic programming.

* Transformation of functions.

Not only variables but the structure of the decision making of the firm is the consequence of all experiences of the firm and would be changing on. In other words, parameters, relevant variables and equation system constituting each function in the decision model have been and will be transformed over time as the result of the historical series of Y_t , X_t and Z_t as shown by the dotted line of feed-back.

* The theory of growth of the firm.^{8,18}

Dynamic concepts as above have been developed into the theory of growth. Traditional microeconomics postulates the optimum size on the long run cost curve and explains that the movement from one size to another is in search for the optimum size.

There have been a lot of discussions about the advantages and disadvantages of being a particular size in order to mould the long run cost curve. With this long run cost and market functions given, profit maximizing output is determined. This is possible only if the long run cost curve is rising up at some output level, which is due to the limit of managerial ability in the end. And then optimum size, at which the profit maximizing output is produced with the minimum cost, is determined.

However, size is only a result of growth, and the true problem is the process and mechanism of growth. Even though all environmental conditions are fixed constantly, managerial services can not be static or fixed as supposed by the Neoclassicalism due to the called mutual-creating relation between managerial resources and physical resources.

Managerial services drawn out of given managerial resource is believed to be augmented continuously along with the skill, knowledge and informations acquired during common operation. This augmented managerial services now open new productive opportunity to the firm and force the firm to grow. Growth is a kind of nature of the firm and is a necessary condition of existence of the firm. Consequently, it is not very meaningful to argue about the optimum size under the assumption of fixed managerial resource, we have to rather discuss the augmentation speed of managerial services and the harmonized growth rate.

This is not intending to rule out the external effect on growth. However, external forces are usually common forces to all firms in terms of objectivity. How to image them and response to them is the internal process of an individual firm in the end, and same logic holds true.

5. Organization theory of the firm.^{1,2,4,14,19,20,23}

In contrast to that Neoclassical microeconomics and most

its revisionists identify the individual decision maker and the firm as one and same entity, there has developed, rather earlier time than the revisionists, organizational theory which recognizes the firm as an organization and is largely concerned with the intra-firm allocation of human resources that the Microeconomists regarded as solved optimally already.

It might be worth while to pay attention to that organization theory of non-farm management has concerned mostly with the human organization in contrast to farm management mainly dealing with farming system.

* Classical organization theory; Business administration.

The main pillar of this theory, which has been one of the most powerful streams in the United States, is the notion of the benefits derived from division of labor. They believe the most efficient human allocation is attained when division of labor is fabricated along the nature of material system in the plant, and pursue the maximum efficiency through it.

* Neoclassical organization theory; Firm psychology.

As a reaction to the classical theory, Neoclassical organization theory acknowledges that the maximum efficiency can not be attained only with authoritarian approach due to the complicate personal relationship, and insists on considering the internal human relation, communication and friction.

* Modern organization theory; Behavioral theory.

This theory should be distinguished from both traditional organization theories and economic theory of the firm in that it seeks to achieve a more complete understanding of the behavior of the firm, so to speak, descriptive decision theory, by integrating the organizational approaches into the economic theory of the firm.

It refuses to assume in advance the firm as pure economic

entity or pure mechanic system, or pure human organization. Instead it observes the actual decision behavior of the firm empirically, sets up some hypotheses derived from the empirical acknowledgement, and tests them with simulation technique.

6. Environment theory.

With advent of very large firms, behavior of the firm becomes to influence the society and public too much to be discussed in the dimension of internal organization. Responsibility and morality of the firm become to be cognized, and a new thought turns up which is going to attain a more realistic explanation and fair normative instruction from the relation between the firm and 'its larger environment'. Larger environment means 'public' and ethics. Attitudes and opinions on the part of other organization and public related with the firm, and self-image of the decision maker are important factor affecting the behavior of the firm.

Summary.

Neoclassical microeconomics was constructed for the purpose of describing how prices and allocation of resources are determined in the market. On the account of it their assumption on the firm are too unrealistic to do the job of predicting, explaining and instructing the behavior of the firm.

With the aim of giving the microeconomics reality to be possibly used in practical business administration, there have been three orientation of progress; programming theory with respect to fixed resources allocation, uncertainty theory concerning with imperfect knowledge and dynamic theory related with time. Three revisionisms can be embraced under the name of Managerial Economics and Management Science.

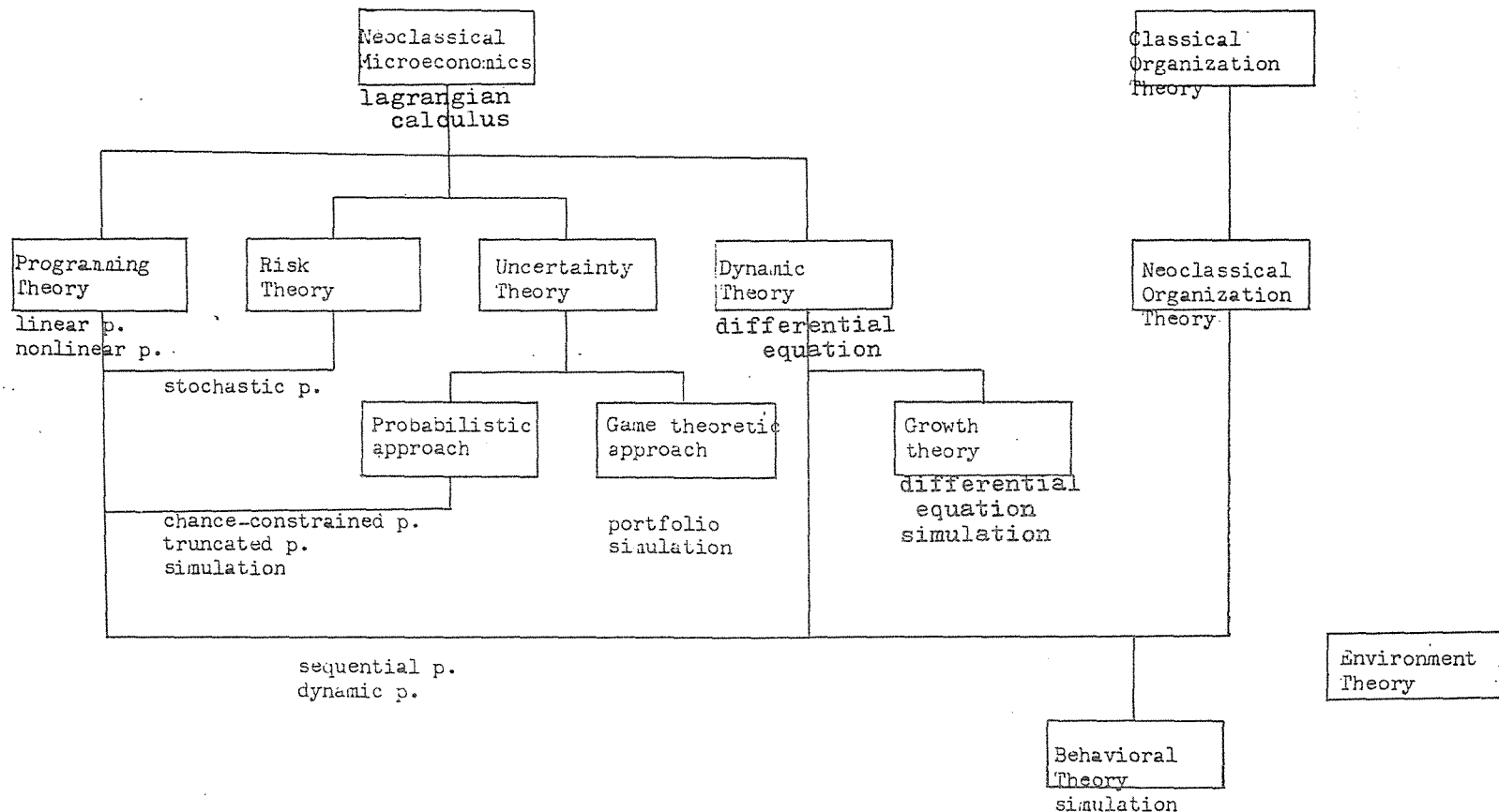


Fig 2. Bird's-eye view of theories of the firm.

* This is not a chronicle chart but only shows relation between theories.

* What is written under squares is a technique to solve the model of the theory in the square, which have been usually developed under domain of Management Science or operation research.

Aside from the economic theories, there have developed Organization theory and Environment theory that focus their purpose on the intra-firm organization and the relation with the public. Behavioral theory turns up as a hybrid between economic and organization theory.

So far they have usually relied on prose or mathematical model and calculus or programming technique to solve the model. However, as we are going to incorporate more and more factors in our model, and as we are going to make our model more realistic and applicable to our purpose, we are likely to rely on computer model and computer simulation technique to solve the model.

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