Chapter 3

RESOURCE ALLOCATION IN POSTWAR JAPAN AND PROPERTIES OF THE SUPPLY STRUCTURE

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INTRODUCTION

The purpose of this paper is to propose an analytical framework in which we can depict the supply structure of economy. We will try to explain the time-series movements of the supply structure of the Japanese economy by implementing our approach to industry data during the period 1960–1974. When comparing time-series fluctuations of nominal and real GNP growth rates since 1960, we can confirm the fact that the nominal growth rate has changed in parallel with the real growth rate in the Japanese economy at least until 1970 although the norminal rate has been higher than the real rate. This implies that aggregate demand and supply in the Japanese economy have been in balance while accompanied by a slight increase in prices. However, the growth rates of individual industries differ considerably and nominal and real growth rates of output did not necessarily move in parallel during this period for all industries. In heavy industries where a large amount of resources was allocated in the process of postwar development the discrepancy between the real and nominal growth rates has been small enough that it could be ignored. By contrast, the nominal growth rate of light manufacturing and service industries has been always higher than the real growth rate.

If we regard the difference between the nominal and real growth rates as the rate of increase in prices[1], it conforms with the fact that retail prices including service prices increased rapidly, while wholesale prices which consist mainly of prices of manufactured goods were relatively stable during the period. This implies that the supply and demand in each industry were not always balanced while a seeming balance is attained at the aggregated level since imbalances for different industries are offset.

The allocation of resources has been centralized into the sector of heavy manufacturing industries during the process of postwar economic growth.[2] The

[1] The rate of nominal output is differentiated with time as follows;

$$\dot{\widehat{px}}/px=\dot{p}/p+\dot{x}/x+\dot{p}\dot{x}/px$$

where $\dot{\widehat{px}}$, $\dot{p}$, $\dot{x}$ and $\dot{p}\dot{x}$ represent the time derivertives respectively. If $\dot{p}\dot{x}$ is small enough as it can be ignored, the difference between both nominal and real growth rate is regarded as the rate of price increasing.

[2] See Table 1-1 mentioned below.

fact that various industries grew at different rates seems to be closely related to this type of uneven allocation of resources during the period. A major objective of our paper is to analyze the properties of the supply structure in the Japanese economy which was created through this selective allocation of resources among industries using our theoretical framework, and to investigate the determinants of the above mentioned differential movements in prices from the viewpoint of the supply structure of the economy. The Japanese economy has experienced a rapid inflation since 1970 and a "stagflation" in which prices increase remarkably in a recession, especially in 1974 after the world oil crisis. Many reports have been published which discuss causes of such inflationary movements in the Japanese economy from various view points: (1) an increase in the money supply which was an inevitable consequence of the fixed exchange rate policy,[3] (2) an increase in the wage rate to keep up with increased consumers' prices which surpass increases in labor productivity, (3) an "acute poly-poly" type behavior of firms and the resultant distortion of the market mechanism[4] and (4) the deficient growth of supply relative to demand resulting from the constraints on the supply capacity of the economy due to the limited supplies of natural resources and the social pressure for environmental protection. It has often been maintained that these independent factors emerged simultaneously and disturbed the mechanism of price adjustment in the market. The causal relationships among such various factors, however, can be analyzed appropriately only by using an empirical general equilibrium model. In terms of time-series changes, the gains in efficiency obtained through increases in productivity have been gradually declining for each individual industry. And from the viewpoint of our general equilibrium analysis, we can point out that the diminishing gains in efficiency have already prepared the ground for stagflation in the market by shifting the supply schedule to upward for several industries well before the oil crisis.

In Section 1 we will explain our theoretical framework of analysis and summarize the technological properties of the Japanese industries found by our analysis. In Section 2, we will develop analytical tools by which we analyze the simultaneous determination mechanism of prices and wages of various sectors. We will describe simulated results of time-series gains in efficiency obtained through improvements in labor productivity for each industry using simultaneous equations. Finally in Section 3 we will measure the degree to which firms take the "acute poly-poly" type behavior by using our simultaneous equation system. Even in competitive markets we often observe that producers limit their supplies in order to raise prices when ample excess demand exists in the market. Although such behavior was observed in markets of certain products in 1973 and 1974, they have to be distinguished from the oligopolistic behavior of the firm. This

[3] See Nishiyama (1976).

[4] See Tsujimura and Tsuzuki (1974.)

is because we can observe such phenomena even in a competitive market where there is a large number of competitors. Let us call it "acute poly-polistic" behavior of the firm following the conceptualization of Ragner Frisch.[5,6] We will show that such behavior of firms will raise their profit rates, which are also raised by an increased capital-labor ratio.

SECTION 1. TECHNOLOGICAL STRUCTURE OF JAPANESE MANUFACTURING INDUSTRIES DURING THE POSTWAR PERIOD

Table 1-1 shows proportions of gross output, labor input and capital input of selected industries to those of national totals for five year intervals since 1955. Gross output is measured at constant prices in 1965. Labor input is measured in terms of the number of workers. Capital input is measured in terms of capital stock at 1965 constant price. In Table 1-1 we clssified 18 two-digit industries into 7 categories (A through G) according to their technological similarity, as we will mention below.

In chemical and related products, iron and steel, petroleum and coal products industries, which are classified as Type D, the proportion of gross output increased from 8.68 percent to 16.09 percent during the period 1955–1970, while the proportion of the labor input of these industries increased only by one percent. On the other hand, the proportion of capital input increased twice as much from 8.72 to 15.16 percent. This means that the technology for Type D may be characterized as "labor saving and capital intensive."

Accompanying the expansion of the supply capacity in above primary manufacturing industries, the capacity of the machinery industry also increased remarkably. The proportion of output of precision instruments, transportation equipment and electrical machinery increased by three times since 1955. Simultaneously the proportion of the labor input also expanded together with the output. These trends are quite different from the trends of Type D. On the contrary the proportions of output and capital input in A and E type industries decreased remarkably during the period. In construction, food and kindred products and textile industries, the proportion of output decreased from 21 percent in 1955 to 17 percent in 1970, the proportion of capital stock remained more or less constant during these period, and the proportion of labor input increased remarkably. This means that industries in Type A and E have so-called "labor intensive" technology. In utility, finance and insurance industries, the proportion of output remained more or less constant while the proportions of labor and capital inputs increased slightly. In agriculture, forestry and fisheries and mining classified as type G, the proportions of output, labor and capital inputs all decreased remarkably.

[5] See Frisch (1933).

[6] See Tsujimura and Tsuzuki (1974).

TABLE 1-1. TIME-SERIES MOVEMENT OF RESOURCE ALLOCATION IN THE JAPANESE ECONOMY

Type and Industry	Ratio of output				Ratio of labor input				Ratio of capital input			
	1955 %	1960 %	1965 %	1970 %	1955 %	1960 %	1965 %	1970 %	1955 %	1960 %	1965 %	1970 %
(A) Construction, Food and kindred products and Textile products	21.3	23.4	21.0	17.2	9.7	11.3	12.3	12.3	9.5	9.5	9.5	9.5
(B) Precision instruments, Transportation equipment Machinery and Electric machinery and equipments	5.2	10.3	12.6	18.1	3.1	5.0	6.0	7.4	3.9	4.9	8.1	8.2
(C) Pulp, paper and paper products, Stone, clay and glass products, Fablicated metal products and Other manufacturing products	9.5	10.5	12.5	12.8	7.2	9.0	12.4	13.0	5.2	6.2	7.9	9.0
(D) Chemical and related products, Iron and steel, Petrolium and other related products	8.7	11.5	13.1	16.1	2.1	2.6	2.8	2.8	8.7	10.0	14.0	15.2
(E) Whole-sale and retail trade and Service industries	26.4	19.2	18.6	18.0	25.2	27.7	31.3	34.0	27.4	24.0	20.1	19.3
(F) Utility, Finance and Insurance and Real estate	11.7	11.8	12.8	11.8	6.8	7.4	7.5	9.3	16.4	19.7	20.6	20.6
(G) Agricultural products, Forestry and hunting, Fisheries and Mining	17.2	13.3	9.4	6.0	45.9	37.0	27.7	21.2	28.9	25.7	19.8	18.2

Note: Each value in the table stands for the proportion of output, labor input and capital input of each industry to the nation-wide aggregates.

Series of output are obtained from our estimated time-series Input–Output tables. Series of labor input which is indicated in terms of the number of workers are available in *the Labor Force Survey*. Series of capital stock at constant prices are available the unpublished data of Economic Planning Agency (EPA). These data were estimated by using the perpetual inventory method when EPA constructed *the National Economic Plan for the Second Half of the 1970's* in the Committee for the Economic Model Analysis.

Type A through G is the industry group which is categorized by the properties of the technology mentioned in this paper.

These time-series movements of resource allocation shown in Table 1-1 reflect various elements of structural changes such as technological progress, changes in tastes and factor costs. Especially in this section we would like to focus our attention upon technological properties of industries and thereby construct appropriate tools to analyze the supply structure of the economy.

Jorgenson and Nishimizu (1978)[7] have employed the approach of total factor productivity measurement, which was developed by Christensen and Jorgenson (1969, 1973a),[8] for their analysis of the Japanese economy for the period 1955–1973. Based on the assumption of constant returns to scale and the hypothesis of market equilibrium, they deduced some interesting results about the properties of Japanese factor productivity; they found, for instance, that the growth of capital and intermediate inputs played a far more important role than technological change in the growth of all industries, and that recently the role of capital input has become increasingly more important for the economy as a whole. We have also deduced similar results in the measurement of the CES production function in an attempt to examine the internal consistency of the estimated parameters using time-series data of the Japanese economy. One of the notable findings obtained from the analysis of the Japanese data was that in industries where output increased rapidly, such as the automobile and electrical machinery industries, the elasticity of substitution was greater than unity, while in industries where output increased sluggishly and labor's relative share remained stable, such as the textile industry, it was less than unity. This finding associated with the former type industries may be interpreted as showing that since the elasticity of substitution is greater than unity, the capital labor ratio increased rapidly by rapid substitution of capital for labor in response to increases in wages relative to capital cost. The explanation that the capital-labor ratio increased rapidly due to high capital labor substitutability in the leading industrial sector seems to correspond to the Jorgenson and Nishimizu's suggestion in which capital input has played an important role in the postwar economic growth. These explanations proposed on the assumption of constant returns to scale may be one plausible interpretation of the rapid industrial growth of the Japanese economy [see Kuroda (1973)[9] and Tsujimura and Kuroda (1975)[10]].

However the same phenomenon can be explained alternatively by a factor limitational type production function. Ozaki showed on the basis of the estimation of input functions using cross-section manufacturing data that there are constant returns to scale with respect to raw material input, economies of scale with respect to labor input and diseconomies of scale with respect to capital input [see

[7] See Jorgenson and Nishimizu (1978).
[8] See Jorgenson and Christensen (1969) and (1973).
[9] See Kuroda (1974).
[10] See Tsujimura and Kuroda (1975).

Ozaki (1966)[11]]. Taking the findings on economies of scale reported by Ozaki and others into account, we tried to formulate a production function model which has the virtues of both a factor substitutable function, such as the CES production function, and a factor limitational function. We call this production function the Semi-Factor Substitution Production Function [see Kuroda (1973)[12] and Tsujimura, Kuroda and Shimada[13]].

Given the level of capital stock at the beginning of the year we can deduce the supply schedule according to the relevant market condition and production technology on the assumption of the profit maximizing behavior of the firm. We introduce an analytical tool by which we can deal with various technological conditions including the case of increasing returns to scale appropriately without being constrained by the assumption of perfect competition in the market. We call it the short-run anticipated demand function [see Tsujimura, Kuroda and Shimada].

In item 2 below we will summarize briefly the formulation and implications of the SFS production function and the short-run anticipated demand function. In item 3, the results of the estimation of the structural parameters will be presented together with an explanation of the method of estimation itself. Finally in item 4 we will point out some findings about the supply structure of the Japanese economy by using the estimated parameters and give some interpretations on changes in resource allocation as shown in Table 1-1.

1. *Analytical Framework*

We deduce the supply equation from the scheme of the producer's equilibrium subject to the production technology and the relevant market condition.

(1) The production technology is specified by the Semi-Factor Substitution Production Function. The input of raw materials is proportional to the level of output. Therefore we imply here that a fixed input coefficient is assumed with respect to input of raw materials according to the assertion of Ozaki and others. In the following formulation we divided raw materials into domestic and imported goods, and assumed fixed input coefficients given exogenously for each domestic and imported intermediate goods.

On the other hand the relationships of labor and capital input with output will be specified as follows:

$$(1\text{-}1) \qquad Q_j = a_j K_j^{b_j},$$

where K_j and Q_j stand for the capital equipment measured by capital stock at constant prices in 1970 and capacity output per unit period, a_j and b_j represent unknown parameters. The subscript j denotes the j-th industry.

[11] See Ozaki (1966) (1972).

[12] See Kuroda (1973) and Tsujimura, Kuroda and Shimada (1978).

[13] See Tsujimura, Kuroda and Shimada (1978).

The capital equipment K_j and the number of workers attached to it, L_j, are assumed to be related as

$$(1\text{-}2) \qquad L_j = c_j K_j^{d_j}.$$

Note that in formulating our SFS production function we distinguish clearly between the number of workers and hours worked in the concept of labor input. We do so because we try to demonstrate explicitly the existence of economies of scale which govern the relationship between the number of workers allocated and capital equipment. Denoting the level of output during a year by x_j, we assume that the following relationship holds:

$$(1\text{-}3) \qquad x_j = Qh^*(h/h^*)^{\alpha},$$

where h is actual hours of operation for a year, Q is the capacity of hourly output, and h^* is normal operating hours planned at the stage of designing the equipment. Equation (1-3) indicates that even though the capacity of output is fixed in the short-run, the amount of output does not necessarily vary proportionately with hours of operation if actual hours of operation h deviates from the normal hours of operation h^*.

Thus far, we have formulated a production function by explicitly incorporating the observed fact of the economies of scale. In contrast to the approach of introducing the element of technological change into the linear homogeneous production function, our approach is to represent technological conditions by the SFS production function focusing on the fact that technological innovation itself has been achieved solely in the process of pursuing economies of scale, at least in the course of the postwar development of the Japanese economy.

(2) The firm should determine how much to produce considering how the conditions of demand for its products and how the competing firms are likely to react to its actions. The assumption itself that the market price is given to the firm may be interpreted as meaning that the firm operates under a specific presumption concerning the demand conditions in the market and reactions of competitors. It is not sound analytically to assume a priori that the market is either "monopolistic" or "atomistically competitive". This analytical pitfall can be avoided by introducing a general anticipated demand function into the model of producer's equilibrium.

The j-th firm assesses prospective sales before deciding the amount of supply x_j. Let us postulate that this firm will presuppose the demand function with which it will be faced during the forthcoming period as

$$(1\text{-}4) \qquad p_j^d = g(x_j \mid Y, P).$$

The demand function (1-4) should be distinguished from the market demand function. Equation (1-4) expresses anticipated reactions in the market in response to the supply x_j of the j-th firm perceived by the j-th firm. Let us call this "the anticipated demand function" and distinguish it from the market demand function.

Let us represent the j-th firm revenue as follows:

$$R_j = p_j^d x_j. \tag{1-5}$$

Then marginal revenue may be written in the following form:

$$\begin{aligned} \frac{\partial p_j^d x_j}{\partial x_j} &= p_j^d\left(1+\frac{\partial P_j^d}{\partial x_j}\cdot\frac{x_j}{p_j^d}\right) \\ &= p_j^d\left(1+\frac{\partial p_j^d}{\partial X}\cdot\frac{\partial X}{\partial x_j}\cdot\frac{x_j}{X}\cdot\frac{X}{p_j^d}\right) \\ &= p_j^p\left(1+\frac{\partial X/\partial x_j\cdot x_j/X}{\partial X/\partial p_j^d\cdot p_j^d/X}\right) = p_j^d\left(1+\frac{\lambda_j}{\eta_j}\right), \end{aligned} \tag{1-6}$$

where x_j stands for the demand faced by the j-th firm and X represents aggregate demand in the market which includes x_j. Parameters η_j and λ_j represent the price elasticity measured on the market demand function and the market sensitivity.

If we specify the anticipated demand function (1-4) of the j-th firm for the j-th commodity as

$$\frac{p_j^d x_j}{P} = \alpha_{sj} Y + \beta_{sj} W + \gamma_{js}\frac{p_j^d}{P} + \eta_{sj}, \tag{1-7}$$

or

$$p_j^d = \frac{P(\alpha_{sj} Y + \beta_{sj} W + \eta_{sj})}{(x_j - \gamma_{sj})},$$

where Y is real GDP, and W is real amount of the world trade, we can approximate the value (λ_j/η_j) in equation (1-6) by the equation

$$\lambda_j/\eta_j = -x_j/(x_j - \gamma_{sj}). \tag{1-8}$$

This specific form is called a linear expenditure system. Further we infer from the equation

$$\lim_{x_j\to\infty} p_j^d x_j = P(\alpha_{sj} Y + \beta_{sj} W + \eta_{sj}), \tag{1-9}$$

that the sales will converge to $P(\alpha_{sj}Y+\beta_{sj}W+\eta_{sj})$ as x_j increases, and will shift upward as Y, W and P increase.

(3) We assume that $\partial p_i^d/\partial x_j = 0$ for prices of other goods $(i \neq j)$. We treat prices of other goods in this way for the sake of simplicity and also for the reason that we do not think it is necessary to incorporate into our model an unrealistic assumption that the firm changes the level of its production according to changes in prices of commodities of other sectors deduced by changes in its own production.

(4) Let us now define the cost of production

$$C_j = L_j h_j w_j + K_j p_k(r_j + d_{ej}) + \sum p_i^d a_{ij}^d x_j + \sum p_i^m a_{ij}^m x_j + t_{Ij} p_j^d x_j, \tag{1-10}$$

where C_j is production cost of the j-th sector, $L_j h_j w_j$ is labor cost, $K_j p_k(r_j + d_{ej})$

is capital cost, $\sum p_i{}^d a_{ij}^d x_j$ and $\sum p_i{}^m a_{ij}^m x_j$ respectively are domestic and imported raw material costs, p_k is the investment good deflator, r_j is the unit capital cost and d_{ej} is the rate of depreciation. The last term t_{Ij} is the rate of indirect tax for the j-th sector.

Specifiing the cost of production as (1-10), the profit will be defined as

$$\Pi_j = p_j{}^d x_j - C_j. \tag{1-11}$$

The necessary condition for equilibrium in this formulation with the capital stock fixed in the short-run is equality between marginal revenue and marginal cost.

Deriving the equation of the equilibrium condition $MR=MC$ from the specification of production function and the anticipated demand function and rearranging it with respect to $p_j{}^d$, we get

$$p_j{}^d = \frac{(x_j - \gamma_{sj})}{\gamma_{sj}(a_{jj}^d + t_{Ij} - 1)} \left[\left(\frac{1}{\alpha_j}\right) \frac{L_j h_j w_j}{x_j} + \sum_{(i \neq j)} p_i{}^d a_{ij}^d + \sum p_i{}^m a_{ij}^m \right] \tag{1-12}$$

which is the short-run supply equation of the j-th sector with fixed capital equipment.

2. *Measurement*

We have nine unknown parameters which are contained in our formulation of the short-run supply behavior of the j-th firm. We are especially interested in the estimation of the parameters a_j, b_j, c_j, d_j and α_j in the SFS production function and γ_j in the anticipated demand function in order to know the properties of the technology in each sector and deduce the time series shift of the supply schedule.

Available data sources are summarized as follows:

1) Prior to estimating the unknown parameters we compiled the time-series input-output tables since 1960. In Japan basic input-output tables are available for years 1960, 1965 and 1970. We made estimates for years from 1960 through 1974 other than those years in which the official I–O Tables are available by the Lagrangean interpolation method, which was developed by Kuroda and Yoshioka (1973)[14], using the three official tables as bench marks. The form of the estimated table is of a non-competitive type with 28 industrial sectors shown in Table 1-2. We estimated also the time series data of the output deflator (1970=1.0) based upon the Bank of Japan *Price Indexes Annual* and Office of the Prime Minister *Annual Report on the Consumer Price Indexes*. In this way, complete tables for both current prices and constant 1970 prices became available.

2) Data on capital stock in each sector at constant prices are available in the unpublished data of Economic Planning Agency. These data were estimated by using the perpetual inventory method when they constructed the National Economic Plan for the Second Half of the 1970's described in *The Committee for*

[14] See Kuroda and Yoshioka (1973) and Tsujimura, Kuroda and Shimada (1978).

TABLE 1-2. INDUSTRY CLASSIFICATION

1) Agricultural products	15) Electrical machinery and equipments
2) Forestry and hunting	16) Transportation equipments
3) Fisheries	17) Precision instruments
4) Mining	18) Other manufacturing industries
5) Food and kindred products	19) Electric Utility
6) Textile products	20) Gas Utility
7) Pulp, paper and paper products	21) Water supply and sanitary services
8) Chemical and related products	22) Transportation and warehousing
9) Petroleum and coal products	23) Communication
10) Stone, clay and glass products	24) Construction
11) Iron and steel	25) Whole-sale and retail trade
12) Non-ferrous metal products	26) Finance, insurance and real estate
13) Fablicated metal products	27) Services
14) Machinery	28) Official services

Econometric Model Analysis. Capital stock data for Forestry, Fisheries, Mining, Electricity, Gas, Water supply, Transportation, Communication and Official Services were not available from this source. We decided to exclude these nine industries from our analysis mentioned below.

3) The data of actual operating hours and normal operating hours were substituted for by the data of the actual monthly working hours included over-time hours worked and the monthly working hours excluded over-time respectively, which are obtained from *The Monthly Labor Survey* of the Ministry of Labor.

4) The number of workers, including both employees and non-paid family workers, is available for nine aggregated industries based on *The Labor Force Survey* of Office of the Prime Minister. On the other hand we can obtain the number of workers for 36 industries based upon *The Population Census* of Office of the Prime Minister for every five years since 1960. After the construction of the corresponding table between both classifications, we estimated the time-series data of the number of workers by 28 order classifications using the census data as a bench mark and the data of the Labor Survey as a controlled total for non-census years.

5) The data of wages in each sector are obtained from the compensation of Employees in Input–Output tables and the estimated number of workers.

We estimated parameters by the 13 samples from 1960 to 1972 and used the samples during the period 1973–1974 in order to test the validity of the specification by extrapolation.

1) Let us start the estimation of α_j and γ_{sj} in the supply schedule. Reforming the supply function (1-12), we obtain

$$(1\text{-}13)\qquad p_j{}^d+\frac{\sum p_i{}^d a^d_{ij}+\sum p_i{}^m a^m_{ij}}{(a^d_{jj}+t_{Ij}-1)}=\frac{1}{\gamma_{sj}\alpha_j}\Big(\frac{L_jh_jw_j}{a^d_{jj}+t_{Ij}-1}\Big)$$
$$+\frac{1}{\gamma_{sj}}\Big(\frac{x_j(\sum p_i{}^d a^d_{ij}+\sum p_i{}^m a^m_{ij})}{a^d_{jj}+t_{Ij}-1}\Big)-\Big(\frac{1}{\alpha_j}\Big)\Big(\frac{L_jh_jw_j}{(a^d_{jj}+t_{Ij}-1)x_j}\Big)$$

where a^d_{ij} and a^m_{ij} are the vectors of intermediate input coefficients of domestic and of imported goods respectively in the j-th sector which will be estimated using the time-series input-output data mentioned above. The notation t_{Ij} is the rate of indirect taxes for the j-th sector, which is calculated as the average rate of indirect taxes for each sector on the assumption that all indirect taxes are levied according to the values of commodities. The average rate thus obtained is given exogenously each year for each sector. Supplying in addition to them the data for $p_j{}^d$, x_j, $p_j{}^m$, h_j, L_j and w_j during the period 1960–1972, we can estimate parameters γ_{sj} and α_j.

Rewriting equation (1-13) we get a linear regression equation on three independent variables although it has one non-linear constraint imposed on as its parameters.

$$(1\text{-}14)\qquad y_j{}^t=A_{1j}x^t_{1j}+A_{2j}x^t_{2j}+A_{3j}x^t_{3j}+u_j{}^t,$$

where

$$y_j{}^t=p_j{}^d+\frac{\overset{(i\neq j)}{\sum} p_i{}^d a^d_{ij}+\sum p_i{}^m a^m_{ij}}{(a^d_{jj}+t_{Ij}-1)},$$
$$x^t_{1j}=\frac{L_jh_jw_j}{(a^d_{jj}+t_{Ij}-1)},$$
$$x^t_{2j}=\frac{x_j(\overset{(i\neq j)}{\sum} p_i{}^d a^d_{ij}+\sum p_i{}^m a^m_{ij})}{(a^d_{jj}+t_{Ij}-1)},$$
$$x^t_{3j}=\frac{L_jh_jw_j}{(a^d_{jj}+t_{Ij}-1)x_j},$$
$$A_{1j}=1/\gamma_{sj}\alpha_j,\quad A_{2j}=1/\gamma_{sj}\quad\text{and}\quad A_{3j}=-1/\alpha_j.$$

If we take the disturbance term $u_j{}^t$ into account, equation (1-14) can be regarded as the linear regression equation of y_j on independent variables x_{1j}, x_{2j} and x_{3j}. The parameters A_{1j}, A_{2j} and A_{3j} have to satisfy theoretically the following constraint:

$$(1\text{-}15)\qquad A_{1j}=-A_{2j}A_{3j}.$$

We have to find values of parameters A_{1j}, A_{2j} and A_{3j} such that the sum of squares of residuals may be minimized under the constraints of equation (1-15). Because it is non-linear it has been necessary to rely on the convergence computation method. We used the Newton method here. Convergence was achieved quickly. We attempted another convergence computation based upon the values of convergence obtained by the Newton method by altering the direction of errors to the direction of p_j^d using the Pattern method. The final results are shown in Table 1-3. The values of parameters α_j are theoretically expected to fall in the range $0<\alpha_j<1$, and the value of parameter γ_{sj} is expected to be negative. The results in Table 1-3 satisfy these sign conditions. The Theil's U listed in the table as an indicator of the goodness of fit is significantly small during the period of observation.

TABLE 1-3. ESTIMATED PARAMETERS OF SUPPLY SCHEDULE

	Parameters of Supply Schedule			$(d_j-b_j)/\alpha_j$	$1/\alpha_j-1$
	α_j	γ_j	Theil's U		
5. Food and kindred products	0.99991300	−77193.108	0.0128	−.5332	.0009
6. Textile products	0.94985800	−55568.074	0.0219	−.8229	.0528
7. Pulp, paper and paper products	0.52937500	−68296.673	0.0088	−1.9451	.8890
8. Chemical and related products	0.35819680	−67328.203	0.0193	−3.0144	1.7917
9. Petroleum and coal products	0.16426220	−86443.251	0.0139	−5.4457	5.0878
10. Stone, clay and glass products	0.50993164	−64286.133	0.2889	−2.0134	.9610
11. Iron and steel	0.38664960	−186597.890	0.0109	−2.4015	1.5863
12. Non-ferrous metal products	0.49964063	−37512.223	0.0104	−1.4140	1.0014
13. Fablicated metal products	0.65461821	−154557.110	0.0102	−.8444	.5276
14. Machinery	0.53620860	−126406.060	0.0146	−1.2683	.8649
15. Electric machinery and equipment	0.53400420	−56750.822	0.0142	−1.6300	.8726
16. Transportation equipment	0.66320530	−36194.022	0.0233	−1.2028	.5087
17. Precision instruments	0.64066400	−21292.087	0.0228	−1.5419	.5609
18. Other manufacturing products	0.73976560	−212378.200	0.0124	−1.0139	.3518
24. Construction	0.87753940	−97793.581	0.0142	−.5174	.1396
25. Whole-sale and retail trade	0.81248050	−209487.630	0.0329	−1.8870	.2308
26. Finance and insurance	0.25746710	−139591.000	0.0071	−3.1580	2.8840
27. Service	0.73531000	−151252.400	0.0147	−1.1223	.3599

Note: The values of each industry in column α_j and γ_j represent the estimated parameters of the supply equation (1-12). They are converged values by a non-linear estimation method. Theil's U stands for the measurement of the goodness of fit formulated by Henri Theil. Last two columns repesent values of the parameters by which the degree of the investment efficiency and the degree of the demand pull effect are measured, respectively, as explained in Section 1 Item 4.

2) We can generate time-series movement of Q_j in each sector by using the estimated parameter α_j in equation (1-3) with the data of x_j, h_j and h_j^*. We can estimate the parameter a_j and b_j in equation (1-1) by using the ordinary least squares method with the data of Q_j obtained above and K_j. Moreover we can also estimate parameters c_j and d_j in equation (1-2) with the data of L_j and K_j. These results are shown in Table 1-4 with the correlation coefficient.

TABLE 1-4. ESTIMATED PARAMETERS OF PRODUCTION FUNCTION

	$Q_j = a_j K_j^{b_j}$			$L_j = c_j K_j^{d_j}$		
	a_j	b_j	r^*	c_j	d_j	r^*
5. Food & kindred pro.	0.31538	0.64986	0.9948	442.05966	0.116734	0.8489
6. Textile products	0.01443	0.95948	0.9930	505.99151	0.187232	0.8412
7. Pulp, paper & paper pro.	0.00489	1.09144	0.9976	163.63503	0.116659	0.8335
8. Chemical & related pro.	0.00282	1.11927	0.9944	246.23354	0.110312	0.9308
9. Petroleum & coal pro.	0.02332	0.92823	0.9897	12.18586	0.205195	0.9158
10. Stone, clay & glass pro.	0.00282	1.13351	0.9902	128.81009	0.209383	0.9685
11. Iron & steel	0.01438	0.97743	0.9771	195.81154	0.126433	0.9505
12. Non-ferrous metal pro.	0.02420	0.84799	0.9817	29.26648	0.283178	0.9856
13. Fablicated metal pro.	0.09997	0.72731	0.9956	183.62808	0.266689	0.9881
14. Machinery	0.07682	0.78895	0.9606	230.29823	0.203063	0.9851
15. Electric machinery	0.00829	1.09526	0.9586	49.91403	0.429978	0.9914
16. Transportation equip.	0.01421	0.99242	0.9919	90.42131	0.293596	0.9914
17. Precision instruments	0.00668	1.19262	0.9854	46.90372	0.319669	0.9662
18. Other manufacturing	0.05895	0.85958	0.9947	837.75520	0.144513	0.9618
24. Construction	0.51743	0.65268	0.9929	699.75736	0.226322	0.9887
25. Whole-sale & retail	0.000014	2.01151	0.9546	56.51330	0.588285	0.9066
26. Finance & Insurance	0.03694	0.90130	0.9834	88.03468	0.342658	0.9980
27. Services	0.01688	1.06858	0.9976	520.39903	0.330935	0.9834

Note: The values of each industry in column a_j, b_j, c_j and d_j represent the estimated parameters of the production function. The value of r^* stands for the adjusted correlation coefficient for the degree of freedom.

3. *Properties of Technology and Resource Allocation in Japan*

Table 1-1 shows changes in resource allocation in Japan in terms of the proportion of gross output, labor input and capital input of each sector relative to respective aggregate amounts of the whole economy. As is mentioned above, the concentrated allocation of capital resources to industries classified as types D, B and C in Table 1-1 has been the conspicuous trend. Let us describe these properties of the Japanese economy in terms of the structure of technology estimated in the previous section.

1) Substituting equations (1-1), (1-2) and (1-3) into equation (1-12), we obtain

$$p_j^d = \frac{x_j - \gamma_{sj}}{\gamma_{sj}(a_{jj}^d + t_{Ij} - 1)} \left[\left(\frac{1}{\alpha_j}\right)\left(\frac{c_j}{a_j^{1/\alpha_j}}\right) K_j^{d-b/\alpha} h_j^{*(\alpha-1)/\alpha} x_j^{1/\alpha-1} w_j + \sum^{(i\neq j)} p_i^d a_{ij}^d + \sum p_i^m a_{ij}^m \right]. \quad (1\text{-}16)$$

According to the estimated value of γ_{sj} shown in Table 1-2, the value is fairly larger than the value of x_j. In that case the first term of the right hand side of equation (1-16), $(x_j - \gamma_{sj})/\gamma_{sj}$, will be approximately unity. Although the implication of the time-series movement of these values in the j-th supply equation is important in order to understand the degree of market competitiveness, we shall ignore it for a while until we take it into account in chapter 3. If we can assume that the value $(x_j-\gamma_{sj})/\gamma_{sj}$ is approximately unity, we can pick up two parameter sets which indicate the important components of the partial elasticities, $\partial \log p_j^d/\partial \log K_j$ and $\partial \log p_j^d/\partial \log x_j$ respectively.

(d_j-b_j/α_j) is the exponential parameter of the capital stock K_j in equation (1-16). It indicates the extent to which the supply shifts rightward in response to an increase in capital stock or capacity for the j-th sector. It might be called a parameter of investment efficiency.

$(1/\alpha_j-1)$ is the exponential parameter of the output level in the parenthesis of equation (1-16). It indicates the extent to which the price increases due to a demand pull effect in the j-th sector along the relevant supply curve for the given level of capital stock at the beginning of the year. It might be called a parameter of demand pull effect.

Both parameters representing investment efficiency and demand pull effect obtained from the estimated parameters of the production function are shown in Table 1-3 and Table 1-4. The variation of both parameters among different industrial sectors is shown in Figure 1-1 in which the horizontal axis measures the degree of demand pull effect and the vartical axis the degree of investment efficiency. The position of each industry is plotted roughly along the straight line drawn from the northwest corner to the southeast corner of the diagram. This means that the industries located in the northern part of the straight line have a supply schedule with the properties of "relatively worse investment efficiency and relatively smaller demand pull effect", while the industries located in the southern part have one with properties of "relatively better investment efficiency and relatively larger demand pull effect." When we place industries on the diagram according to the industry types classified in Table 1-1, we can see that industries are allocated with the order of *A*, *E*, *B*, *C* and *D* from the north to the south along the line. Consequently we realize that in the type of resource allocation of postwar Japan in which capital input was unevenly allocated and concentrated into *C* and *D* type industries, efficiency of investment was pursued almost exclusively in these industries at the expense of the expansion of the capacity in industries with relatively less efficient investment.

2) Figures 1-2-1 to 1-2-18 show the supply schedules of various sectors for 1960, 1965, 1970, 1972, 1973 and 1974 drawn by using the empirically estimated parameters; the mark ▲ in the figures represents the time-series movement of the demand-supply equilibria. Supply schedules in food and kindred products, textile, construction, miscellaneous manufacturing and service industries shifted to the left during the period 1960–1973 in spite of the fairly large capital investment. This means that the effect of cost reduction through new investment or expansion of capacity was offset by the increases in factor and material costs, and finally supply prices increased in these sectors. Those industries for which the supply

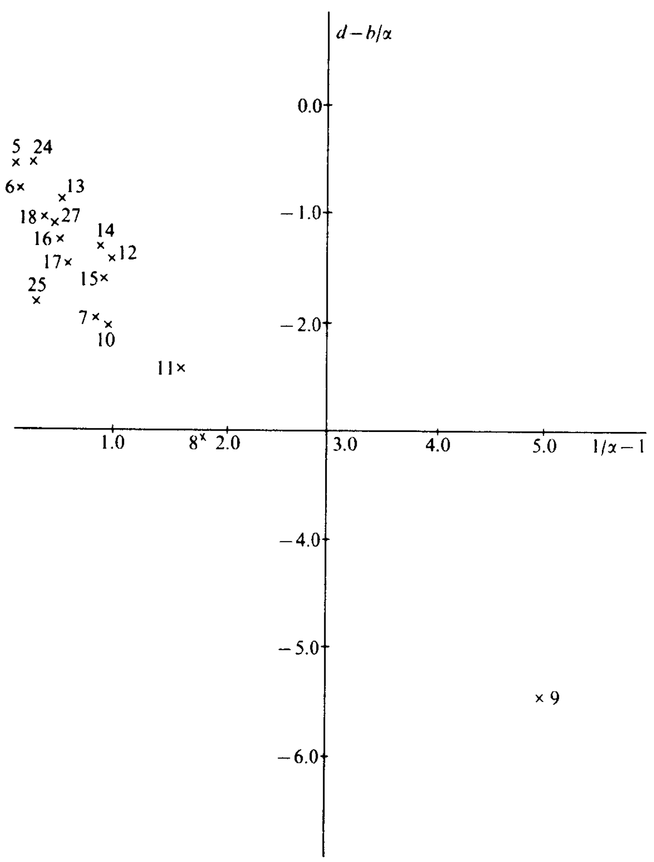

Fig. 1-1. Parameter of Investment Efficiency and Parameter of Demand Pull Effect.

Note: The number attached to the mark × in the figure stands for the number attached to each industry in table 1-2. Vertical axis stands for the degree of the investment efficiency by which the larger absolute value implies the higher investment efficiency. Holizontal axis represents the degree of the demand pull effect by which the larger absolute value implies the larger demand pull effect along a given supply schedule.

schedule shifted upward are classified into Types A and E in Table 1-1. Also Figure 1-1 shows that they have the technological properties of "relatively less efficient investment and relatively smaller demand pull effect", because they are located in the northern part of the straight line in Figure 1-1. On the other hand, in almost all of the industries classified into types B, C and D in Table 1-1, the supply schedule were shifted to the right with an expansion of the capacity during the period 1960–1970.

In almost all industries the supply schedule for 1973 and 1974 shifted upward with an increase in the imported material price during the period of the oil crisis. In many industries the equilibrium point moved in such a way that the price increased rapidly in spite of a decrease in the output level. Here we can see one aspect of so-called "Stagflation."

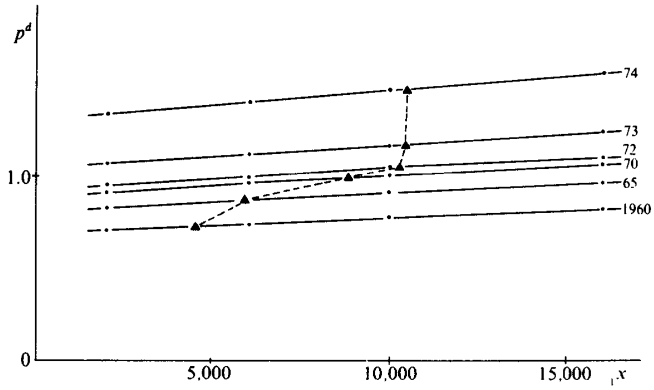

Fig. 1-2-1. Actually Measured Supply Schedules.
⟨5. Food & kindred products⟩

Note to Figures 1-2-1 through 1-2-18:

(1) The vertical axis measures the price index of output of each industry standaridized at 1970 price=1.00, and the horizontal axis measures the level of output in billion yen at 1970 constant prices.

(2) The notation ▲ represents changes in the price corresponding to changes in the observed level of output.

(3) The supply schedule in each year is drawn by the estimated parameters of the production function and the anticipated demand function corresponding to changes in the observed capital stock level. Numbers attached to each schedule represent the year 1960, 1965, 1970, 1972, 1973 and 1974.

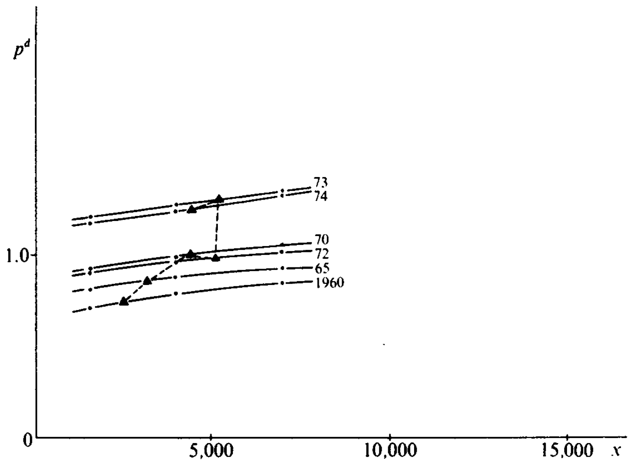

Fig. 1-2-2. Actually Measured Supply Schedules.
⟨6. Textile products⟩

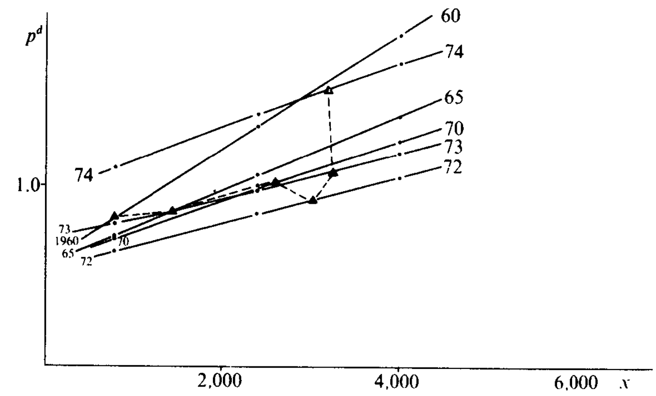

Fig. 1-2-3. Actually Measured Supply Schedules.
⟨7. Paper, pulp and paper products⟩

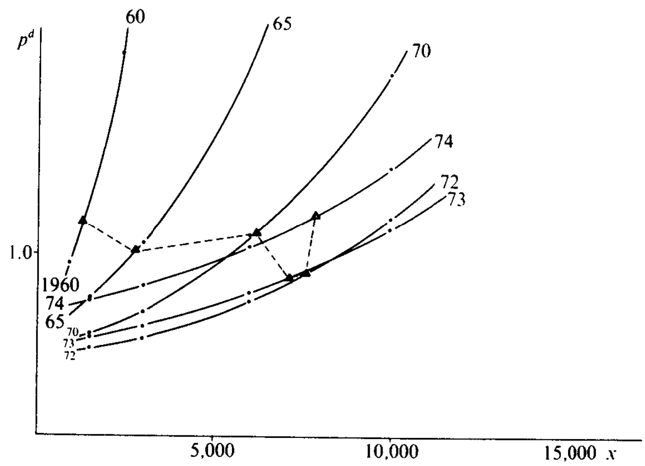

Fig. 1-2-4. Actually Measured Supply Schedules.
⟨8. Chemical and related products⟩

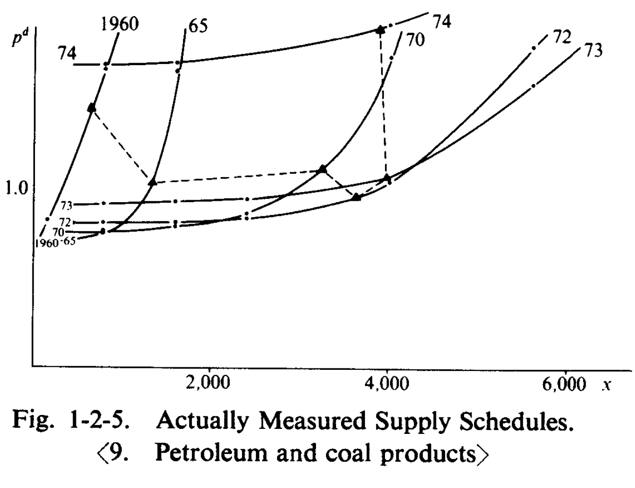

Fig. 1-2-5. Actually Measured Supply Schedules.
⟨9. Petroleum and coal products⟩

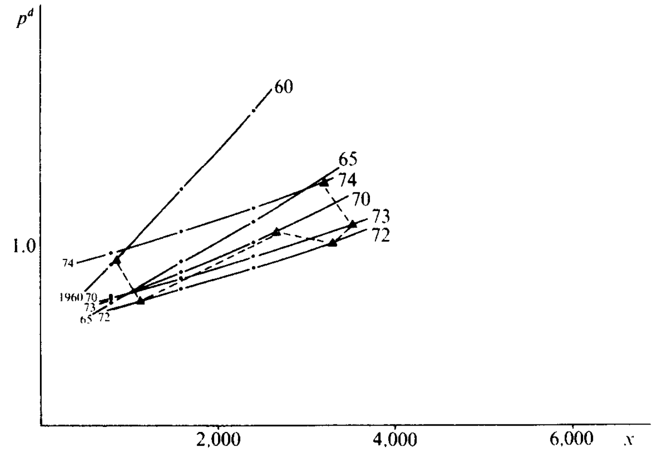

Fig. 1-2-6. Actually Measured Supply Schedules.
⟨10. Stone, clay and glass products⟩

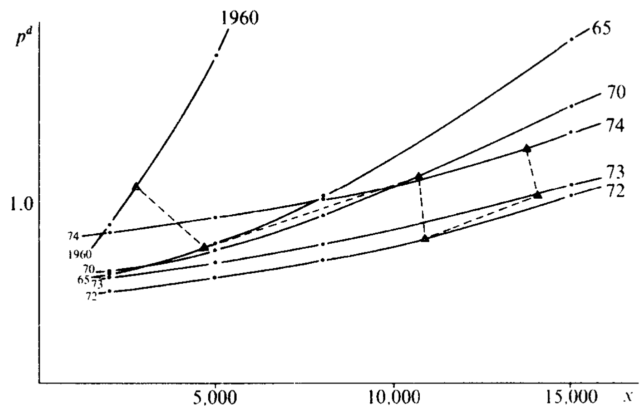

Fig. 1-2-7. Actually Measured Supply Schedule.
⟨11. Iron and steel products⟩

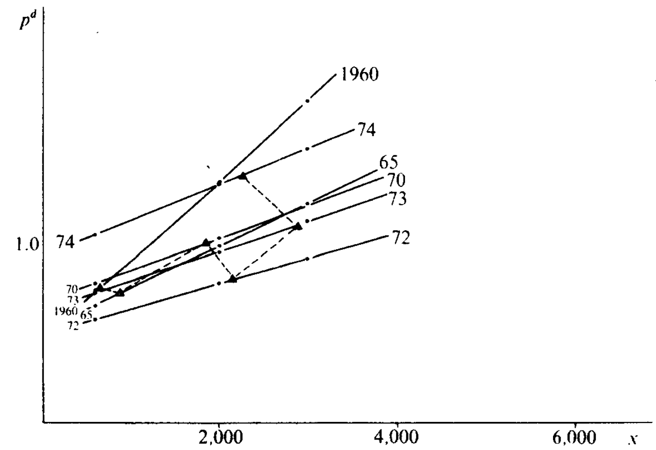

Fig. 1-2-8. Actually Measured Supply Schedule.
⟨12. Non-ferrous metal products⟩

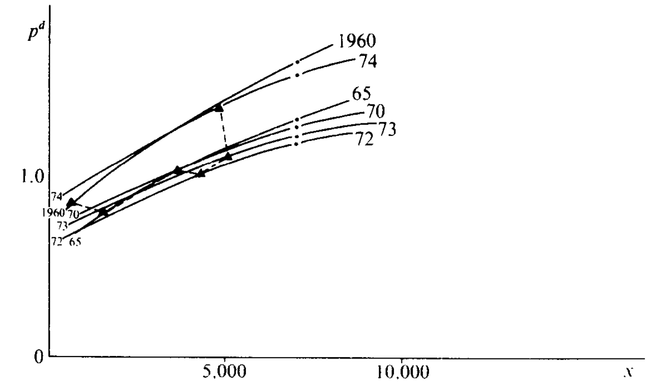

Fig. 1-2-9. Actually Measured Supply Schedules.
⟨13. Fablicated metal products⟩

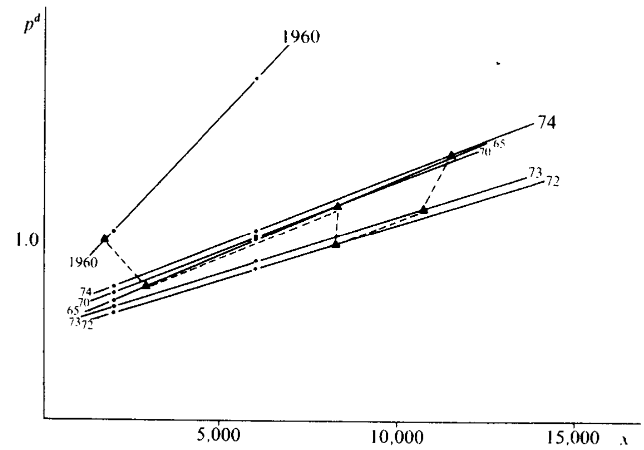

Fig. 1-2-10. Actually Measured Supply Schdules.
⟨14. Machinery⟩

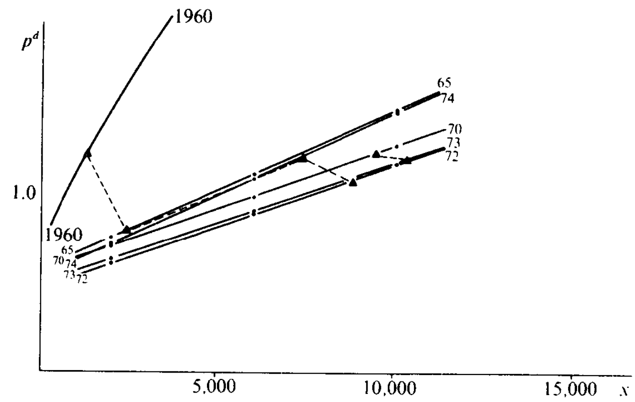

Fig. 1-2-11. Actually Measured Supply Schedules.
⟨15. Electric machinery and equipments⟩

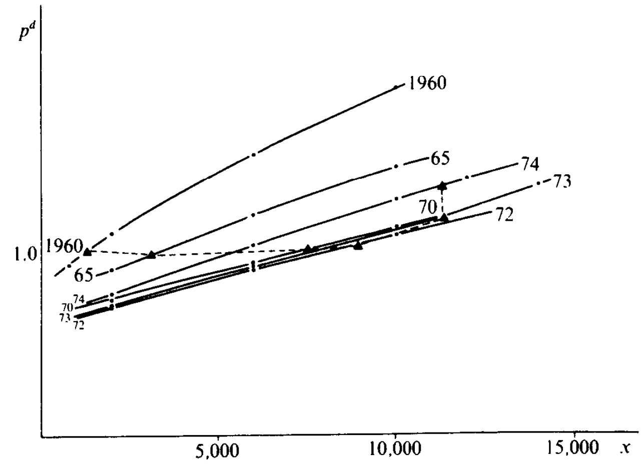

Fig. 1-2-12. Actually Measured Supply Schedules.
⟨16. Transportation equipments⟩

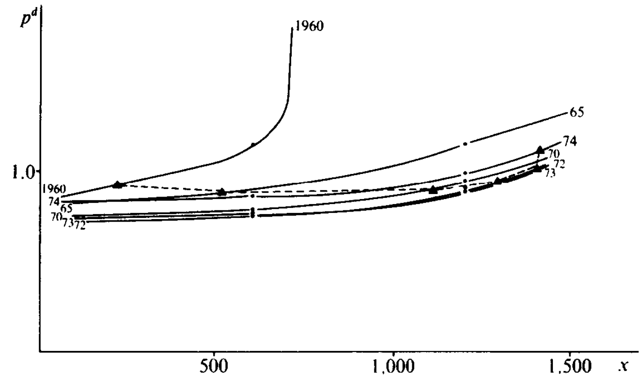

Fig. 1-2-13. Actually Measured Supply Schedules.
⟨17. Precision instruments⟩

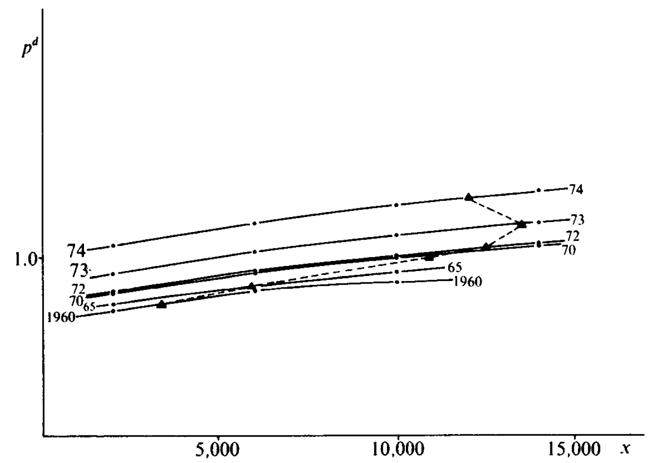

Fig. 1-2-14. Actually Measured Supply Schedules.
⟨18. Other manufacturing industries⟩

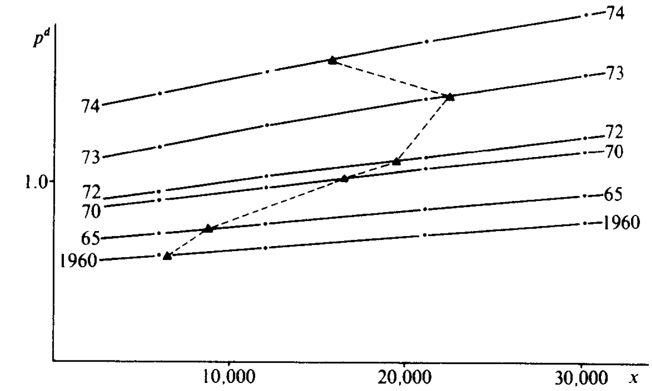

Fig. 1-2-15. Actually Measured Supply Schedules.
〈24. Construction〉

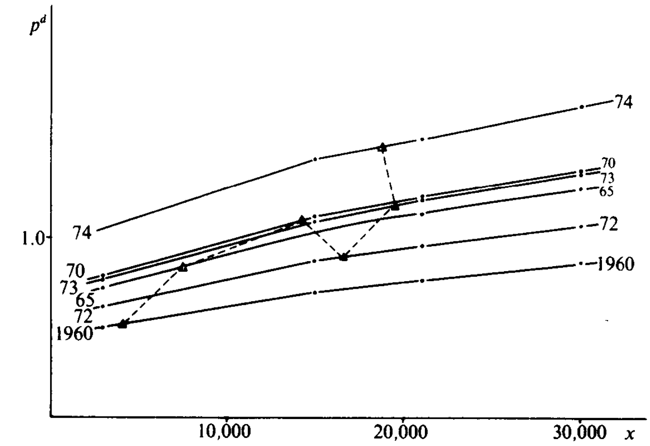

Fig. 1-2-16. Actually Measured Supply Schedules
〈25. Whole-sale and retail trade〉

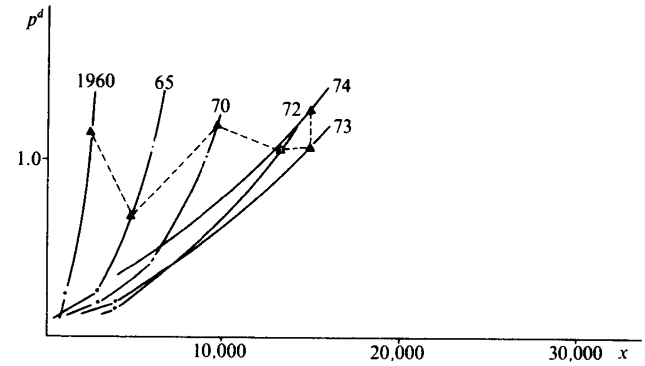

Fig. 1-2-17. Actually Measured Supply Schedules.
〈26. Finance, insurance and real estate〉

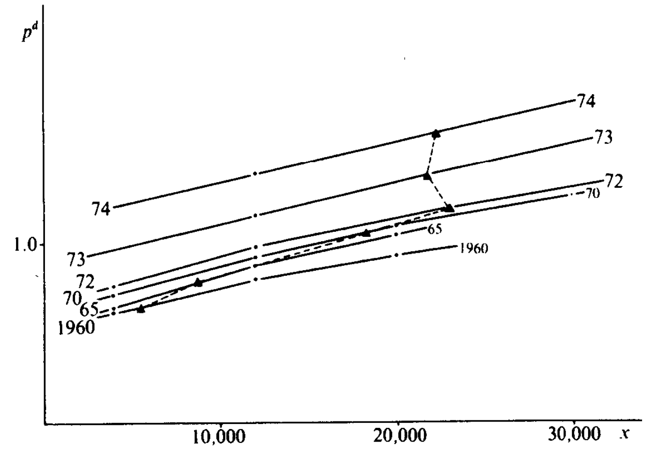

Fig. 1-2-18. Actually Measured Supply Schedules.
⟨27. Service⟩

SECTION 2. GENERAL INTERDEPENDENCE OF THE SUPPLY STRUCTURE IN JAPAN

In the previous section we described the technological properties of Japanese economy using the estimated parameters of the SFS production function and the anticipated demand function. According to the formulation of the supply equation, the supply price of the j-th sector depends simultaneously upon the various variables in markets of intermediate transactions and factor inputs at a given level of capacity. When we consider the determination of the supply price and wages among sectors in view of the general interdependence of the economy, we need to incorporate here the primary sector, that is the sector of agriculture, forestry and fisheries, which has been set aside until now. We guess that the reallocation pattern of the labor force accompanying the process of economic development between the primary sector and other sectors are highly correlated with the mechanism of the determination of the supply price and wage.

According to the allocation pattern of the labor force shown in Table 1-1, employment in agriculture, forestry and fisheries declined rapidly in spite of the conspicuous increase in employment of the non-primary sectors. Let us review briefly the reallocation of the labor force from the primary to the other sectors which took place during the period 1960–1974. The number of employed persons in manufacturing and service industries increased from 29.5 million in 1960 to 45.7 million in 1974, an increase of 16.2 million persons. In contrast, employment in agriculture, forestry and fisheries declined from 14.2 million to 7.6 million or a decrease of 6.6 million. In other words nearly 40 percent of the increase in non-primary employment was supplied from the outflow of the labor from the primary sector. We tried to explain erlier the general interdependence which is seen in the determination of wages and labor allocation by analyzing the observed inter-sectoral movements of labor force in our four sector model.[15] In the observation mentioned previously, the wage level of the non-primary sector moved in parallel with the changes in the value marginal productivity in the primary sector, which we call "marginal supply wage" for leaving the primary sector. This implies that the minimum wage in non-primary sectors is approximately equivalent to the marginal supply wage at which workers leave the primary sector and almost all the increase in non-primary employment was supplied from the outflow of labor from the primary sector.

In item 1 we will give a brief summary of these hypotheses and explain the theoretical framework of the simultaneous determination of supply prices and wages among various sectors. In item 2 we will also estimate parameters of the production function in the primary sector for the period 1960–1972 and empirically confirm the proposed hypotheses.

In order to explain properties of Japanese economy, we will show simulaiton results of our simultaneous determination system which indicate the efficiency of the economy by measuring the degree of price reduction in response to an increase in labor productivity. Can it be written "It will be shown that the efficiency of the Japanese economy (measured by the reduction in supply prices in each sector due to increasing labor productivity) actucally declined gradually over the some period in which the resourse allocation of the Japanese economy became biased and unproportional"?

1. *Simultaneous Determination of Supply Prices and Wages*

Let us summarize the hypothesis of the simultaneous determination of supply prices and wages from the view-point of the allocation of the labor force among various sectors.

When a worker leaves the primary sector seeking employment oppotunities in non-primary sectors, he does not leave unless his expected wage in the non-primary sector is greater than the loss of income due to his migration out of primary sector. The loss of income due to the outflow of the marginal worker from the primary sector may be regarded as being equal to the marginal value added productivity of this worker.

Based upon a conventional proposition we have formulated a production function for the primary sector which is a variation of the Cobb-Douglas function,

$$X_1 = a_1 A^{b_1} (L_1 h_1)^{1-b_1} K_1^{c_1}, \tag{2-1}$$

where X_1 is the annual output of the primary sector, A_1 is the area of cultivated land, L_1 is the number of persons worked, K_1 is the private capital stock.

The gross value added V_1 of the primary sector is given by the product of output X_1 and the value added per unit of output, $(p_1{}^d - \sum p_i{}^d a_{i1}^d - \sum p_i{}^m a_{i1}^m)$. This value V_1 may be interpreted as the income that self-employed households in the primary

[15] See Tsujimura, Kuroda and Shimada (1978).

sector obtain by inputting labor force L_1, including non-paid family workers, into their productive activity. The loss of income due to the outflow of the marginal worker from the labor force L_1 may be regarded as being equal to the marginal value added productivity which is obtained from the formulation of the production function as follows:

$$(2\text{-}2)\qquad \partial V_1/\partial L_1h_1=(1-b_1)(p_1{}^d-\sum p_i{}^d a_{i1}^d-\sum p_i{}^m a_{i1}^m)X_1/L_1h_1$$
$$=(1-b_1)(p_1{}^d-\sum p_i{}^d a_{i1}^d-\sum p_i{}^m a_{i1}^m)a_1A_1{}^{b_1}(L_1h_1)^{-b_1}K^{c_1}.$$

This may be called "the marginal supply wage" at which the labor force is supplied from the primary sector to other sectors. We can observe that the wage level of the non-primary sector moved closely in parallel with the changes in this marginal supply wage. We can give an interpretation of the relation between the migration of the labor force and the determination of the level of wages from this view-point.

As in Figure 2-1, suppose that the total size of the labor force is fixed and represented by the horizontal distance between O_1 and O_2. We may depict the down and rightward sloping curve of marginal value added productivity AA′ of the primary sector from the left side, and similarly the down and leftward sloping marginal value productivity curve BB′ of workers of the non-primary sectors as a whole from the right side. The inter-sectoral allocation of labor will be determined at the equilibrium point E_1 or the intersection of AA′ and BB′ with the share of the primary labor force being O_1O_3 and of the non-primary sector labor force O_3O_2. The marginal supply wage will be at the level of w_1.

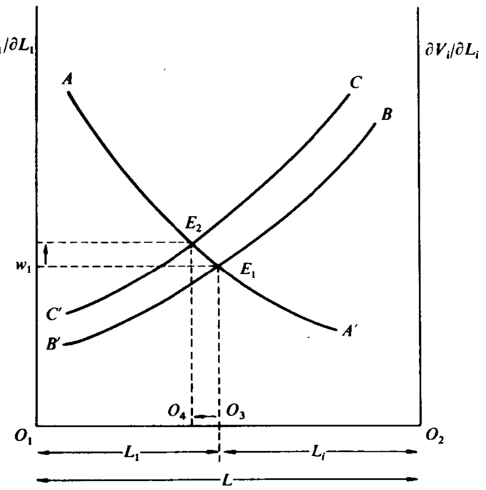

Fig. 2-1. An Illustration of the Equilibrium of the Labor Allocation among Sectors.

If the marginal productivity curve of the non-primary sector shifts from BB′ to CC′ according to the expansion of the capacity while AA′ of the primary sector remains unchanged, the equilibrium point would shift E_1 to E_2 and as many as

O_3O_4 participants in the labor force would move from the primary sector to the non-primary sectors. We can make corespondence between the schedule AA′ and the value added equation (2-2) and the schedule BB′ and the supply equation (1-12) respectively. Then we can describe the simultaneous determination of prices and wages among sectors by expanding this scheme into the multi-sectoral scheme. However we have to put the empirical equation which explains the wage differentials among sectors because time series movements of wages of each sector and the value added marginal productivity are closely parallel though not completely identical with each other. So we set up the linear equation to explain the wage difference among sectors as follows:

$$w_j = a_{0j} + a_{1j}(\partial V_1/\partial L_1 h_1) \qquad j=2, \ldots, n. \tag{2-3}$$

Let us explain the mechanism of the simultaneous determination of prices and wages in which there is 1 primary sector and $n-1$ non-primary sectors. Suppose the production function in the primary sector are described by the Cobb–Douglas production function and the ones in the non-primary sectors are depicted by the SFS production function. Assume the price of the primary sector's product $P_1{}^d$, the total labor force L, the cultivated land A_1 and public capital stock K_{g1} are given exogenously. As the capital stock $K_j(j=1, \ldots, n)$ in each sector is given at the beginning of the year, $L_j(j=2, \cdots, n)$ and $Q_j(j=2, \cdots, n)$ in the non-primary sector will be determined according to the capital stock K_j in equations (1-1) and (1-2). Then there are $3n-1$ unknown variables, $P_j{}^d(j=2, \cdots, n)$, $w_j\ (j=2, \cdots, n)$, V_1/L_1h_1 and $X_j\ (j=1, \cdots, n)$, in the system. On the other hand we have $n-1$ non-primary supply equations, $n-1$ wage differential equations, the value added marginal productivity equation in the primary sector and the definition of the controlled total of labor force. Finally if we assume the level of output $X_j(j=2, \cdots, n)$ to be certain level, the number of remaining unknown variables is $2n$ which is the number of equations. The $2n$ equations will be written in a matrix form as Equation (2-4). Denoting this form simply as

$$A\Gamma = B, \tag{2-5}$$

we can obtain solutions for the $2n$ endogenous variables in the form of $\Gamma = A^{-1}B$ since usually $|A| \neq 0$.

2. *The Measurement of the Investment Efficiency*

Let us estimate the parameters of the production function of the primary sector and obtain the time-series values of the marginal value added labor productivity. Assuming that the primary sector in the theoretical scheme corresponds to the agricultural sector in the classification of 28 industries presented in Table 1-2, we can estimate the parameters of the production function (2-1).

$$\begin{aligned} \log(X_1/L_1h_1) = & -8.497806076 + \underset{(4.546)}{0.73348528} \log(A_1/L_1h_1) \\ & \quad\ \ (4.076) \\ & + \underset{(7.981)}{0.6568056503} \log(K_1+K_{g1}), \qquad R^2=0.9909. \end{aligned}$$

$$
\begin{array}{c}
N\left\{\begin{array}{c} \\ \\ \\ \\ \\ \end{array}\right. \\
K+1\left\{\begin{array}{c} \\ \\ \\ \\ \\ \end{array}\right.
\end{array}
\overbrace{\left(\begin{array}{cccccccc|cccccc}
\frac{1}{A_2} & -a^d_{3.2} & -a^d_{4.2}\cdots & -a^d_{12.2} & -a^d_{15.2}\cdots & & & -a^d_{28.2} & -B_2 & 0\cdots & & & \cdots 0 & 0 \\
-a^d_{2.3} & \frac{1}{A_3} & \ddots & & & & & -a^d_{28.3} & 0 & \ddots & -B_{10} & & & \\
\vdots & & & & & & & \vdots & \vdots & & & & & \\
 & & & & & & & & & & & -B_{12} & & \\
\vdots & & & & & & \ddots & -a^d_{28.27} & \vdots & & & & \ddots & \\
-a^d_{2.28} & -a^d_{3.28} & \cdots & -a^d_{12.28} & -a^d_{15.28}\cdots & -a^d_{27.28} & & \frac{1}{A_{28}} & 0\cdots & & & \cdots 0 & -B_{28} & 0 \\
\hline
0\cdots & & & & & & & \cdots 0 & 1 & 0\cdots & & & 0 & -\alpha_{1.2} \\
\vdots & \ddots & & & & & & \vdots & 0 & 1 & & & 0 & -\alpha_{1.3} \\
\vdots & & & & & & & \vdots & \vdots & & \ddots & & & \vdots \\
\vdots & & & & & & \ddots & \vdots & \vdots & & & & \ddots & \\
0\cdots & & & & & & & \cdots 0 & & & & & & -\alpha_{1.28} \\
C_1a^d_{2.1} & & & C_1a^d_{12.1} & C_1a^d_{15.1} & & & C_1a^d_{28.1} & 0 & 0\cdots & & & \cdots 0 & 1
\end{array}\right)}^{N\qquad\qquad\qquad\qquad K+1}
\left(\begin{array}{c}
p^d_2 \\ \vdots \\ \vdots \\ p^d_{12} \\ p^d_{15} \\ \vdots \\ p^d_{28} \\ w_2 \\ w_3 \\ \vdots \\ w_{10} \\ w_{12} \\ \vdots \\ w_{28} \\ FMPA
\end{array}\right)
=
\left(\begin{array}{c}
p^d_1a^d_{12}+\sum_{i=13}^{14}p^d_ia^d_{i2}+\sum_{i=1}^{28}p^m_ia^m_{i2} \\
\vdots \\
p^d_1a^d_{1.10}+\sum_{i=13}^{14}p^d_ia^d_{i10}+\sum_{i=1}^{28}p^m_ia^m_{i10} \\
p^d_1a^d_{1.11}+\sum_{i=13}^{14}p^d_ia^d_{i11}+\sum_{i=1}^{28}p^m_ia^m_{i11}+B_{11}w_{11} \\
p^d_1a^d_{1.12}+\sum_{i=13}^{14}p^d_ia^d_{i12}+\sum_{i=1}^{28}p^m_ia^m_{i12} \\
p^d_1a^d_{1.15}+\sum_{i=13}^{14}p^d_ia^d_{i15}+\sum_{i=1}^{28}p^m_ia^m_{i28} \\
\vdots \\
p^d_1a^d_{1.28}+\sum_{i=13}^{14}p^d_ia^d_{i28}+\sum_{i=1}^{28}p^m_ia^m_{i28} \\
\alpha_{0.2} \\
\alpha_{0.3} \\
\vdots \\
\alpha_{0.10} \\
\alpha_{0.12} \\
\vdots \\
\alpha_{0.28} \\
(1-a^d_{11})C_1p^d_1-C_1\sum_{i=13}^{14}p^d_ia^d_{i1}-C_1\sum p^m_ia^m_{i1}
\end{array}\right)
$$

N; the number of price for endogeneous sectors
K; the number of wage for exogenous sectors
$FMPA$; the marginal value added productivity of agricultural sector

$$
A_j=\frac{x_j-r_j}{\{\gamma-(1-\lambda)x_j\}(a^d_{jj}+t_{Ij}-1)} \qquad B_j=\left(\frac{1}{\alpha_j}\right)\left(\frac{L_jh_j}{x_j}\right) \qquad C_1=(1-\alpha_1)X_1\Big/h_1\Big(TL-\sum_{i=2}^{28}L_i\Big)
$$

Equation 2-4. The Scheme of Simultaneous Determination of Supply Prices and Wages (This is the example of the case in which P_1, P_{13}, P_{14}, W_{11} are exogenous variable.)

The value in the parentheses stands for t-value of each parameter. Since all of the parameters are statistically significant, we calculate the marginal value added labor productivity corresponding to each observed value in the right-hand side variables of equation (2-2).

	(yen/man-hour)		(yen/man-hour)
1960	7.6518	1968	27.8056
1961	8.7953	1969	32.0378
1962	11.5445	1970	34.7934
1963	13.1416	1971	42.0007
1964	15.5923	1972	51.3172
1965	18.3992	1973	66.4320
1966	22.4513	1974	82.6824
1967	27.1036		

The marginal value added labor productivity that was only 7.6518 yen per man-hour in 1960 increased to 82.6824 yen in 1974, which is more than ten times the value of 1960.

We can confirm by the estimation of the wage differential equation (2-3) for each sector that the wage level in the non-primary sector moved closely in parallel with changes in the marginal value added labor productivity in the primary sector during the period 1960–1974. The results are shown in Table 2-1. These obser-

TABLE 2-1. RESULTS OF THE WAGE DIFFERENTIAL EQUATION

	$w_j = a_{0j} + a_{1j}(\partial V_1/\partial L_1 h_1)$		
	a_{0j}	a_{1j}	r^*
5. Food & kindred pro.	$.31376\times10^{-3}$	103.69145	0.9908
6. Textile products	$-.12151\times10^{-4}$	104.94967	0.9896
7. Pulp & paper pro.	$-.28638\times10^{-4}$	103.18203	0.9811
8. Chemical	$.95005\times10^{-4}$	146.92737	0.9897
9. Petroleum	$.156914\times10^{-2}$	172.77171	0.9770
10. Stone, clay & glass	$.20055\times10^{-3}$	110.07968	0.9937
11. Iron and steel	$.54019\times10^{-4}$	157.99809	0.9841
12. Non-ferrous metal	$.45526\times10^{-3}$	89.70952	0.9893
13. Fablicated metal	$.262231\times10^{-3}$	104.35523	0.9941
14. Machinery	$.140222\times10^{-3}$	174.77479	0.9841
15. Electric machinery	$.404517\times10^{-3}$	107.73840	0.9855
16. Transportation equip.	$.417151\times10^{-3}$	184.27002	0.9954
17. Precision instruments	$.149484\times10^{-4}$	138.48494	0.9943
18. Other manufacturing	$-.118971\times10^{-3}$	112.92405	0.9936
24. Construction	$.401742\times10^{-3}$	121.06688	0.9951
25. Whole-sale & retail	$-.458173\times10^{-4}$	105.61119	0.9858
26. Finance & Insurance	$.531030\times10^{-3}$	189.89977	0.9943
27. Services	$.430139\times10^{-3}$	116.61284	0.9966

Note: The values of each industry in column a_{0j} and a_{1j} stand for the estimated parameters of the wage differential equations. The value of r^* stands for the adjusted correlation coefficient for the degree of freedom.

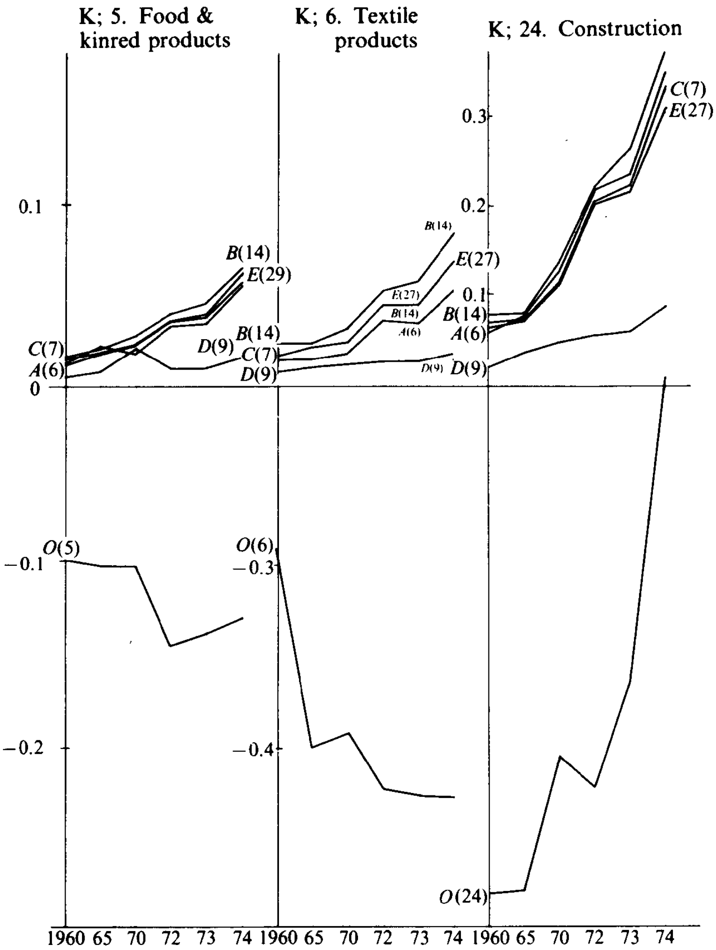

Fig. 2-2-1. The Own and Cross Elasticity of the Price with Respect to the Expansion of the Investment—Type A Industries.

Note to Figures 2-2-1 through 2-2-5:

Each figure represents the time-series movement of its own and cross elasticity of price with respect to an increase in investment in the k-th industry. Each elasticity measures the degree of price reduction which stem from the improvement in labor productivity in the k-th industry due to investment, which is calculated by solving the simultaneous equation (2-4). Vertical axes measure the value of the elasticity for years 1960, 1965, 1970, 1972, 1973, and 1974 indicated at the bottom of each Figure. Symbol $A(j)$, $B(j)$, $C(j)$, $D(j)$ and $E(j)$ represent the time-series fluctuations of the cross elasticity of the j-th industry with respect to the investment of the k-th industry, which is indicated at the top of each Figure. Number j corresponds to the industry number shown in Table 1-2. Symbol $O(k)$ stands for its own elasticity of price and number K also stands for the industry number.

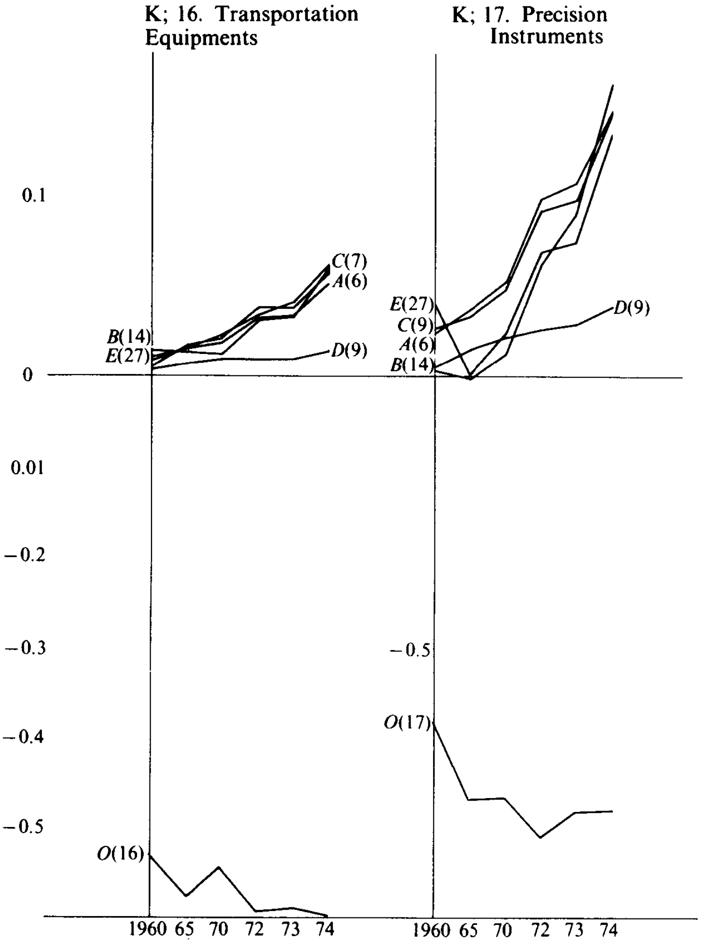

Fig. 2-2-2. The Own and Cross Elasticity of the Price with Respect to the Expansion of the Investment—Type B Industries.

vations imply that the marginal value added labor productivity in the primary sector that we called as "marginal supply wage" determines the lower boundary of the wage level in the non-primary sectors in the process of postwar economic development during which the migration of labor from the primary sector to non-primary sectors was continuing.

The equations which we have discussed earlier as the supply equation in the non-primary sectors are simply the equalities of marginal productivity with respect to man-hour labor input $L_j h_j$ at a given level of K_j. Then the diagrammatical analysis of Figure 2-1 of the equilibrium of marginal value added productivity among sectors can be directly translated into the simultaneous determination equation system of wages and prices, which is then combined with the empirically estimated wage differential equations.

In order to test the validity of the simultaneous determination scheme, we treated nine industrial sectors: forestry, fisheries, mining, electricity, gas, water

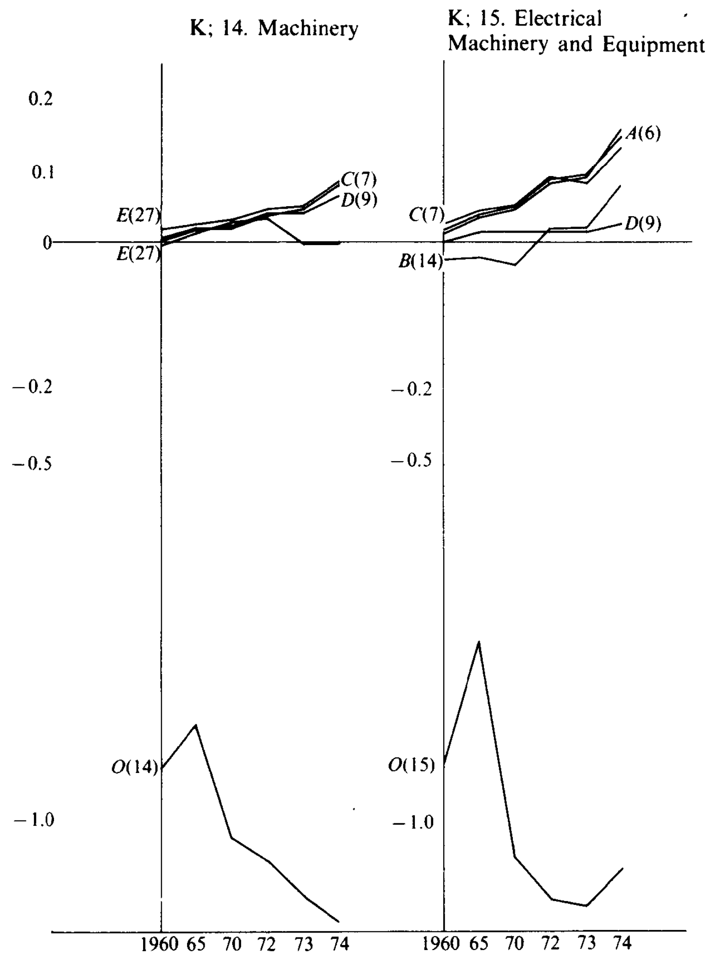

Fig. 2-2-2. Continued.

supply, transportation, communication and the public services as exogenous sectors. The number of endogenous industries is 19 including agricultural sector. Using estimated parameters we can determine simultaneously wages and prices of 19 industries by the equation system (2-5). Results of interpolation and extrapolation tests are reasonably satisfactory.

Using the simultaneous determination system we can measure the efficiency expressed in terms of a reduction in prices due to an increase in productivity which proceeds expansion of capacity.

Rearranging equations (1-1) and (1-2), we obtain

$$(2\text{-}6) \qquad Q_j/L_j=(a_j/c_j)K_j^{b_j-d_j} \quad \text{or} \quad K_j=(a_j/c_j)^{1/(b_j-d_j)}(Q_j/L_j)^{1/(b_j-d_j)}.$$

We can estimate for each sector the amount of investment necessary to increase labor productivity by one percent. Then we can obtain the elasticity of a price reduction with respect to the expansion of investment which generates a one

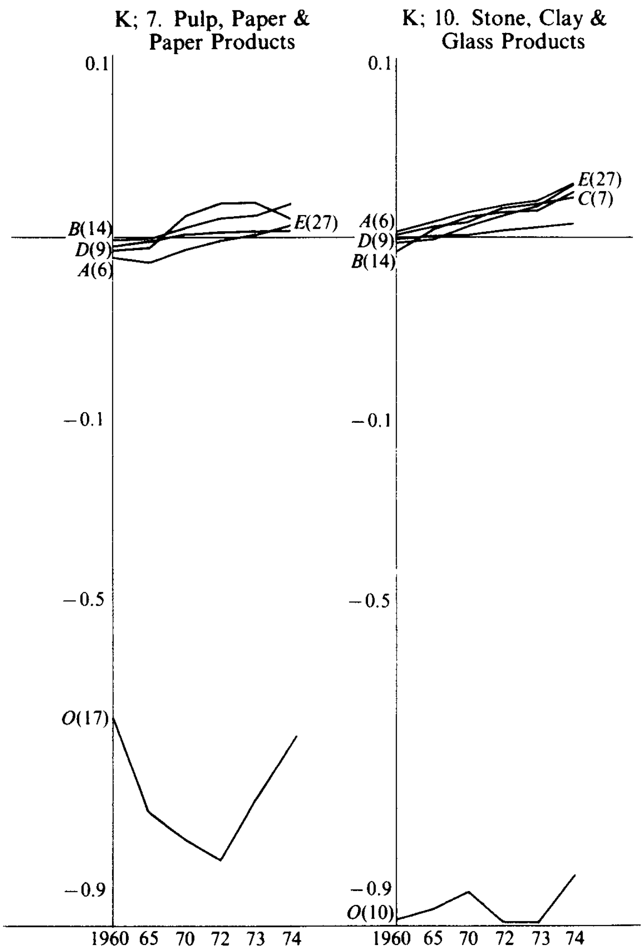

Fig. 2-2-3. The Own and Cross Elasticity of the Price with respect to the Expansion of the Investment —Type C Industries.

percent increase in labor productivity using the simultaneous determination system (2-5) which depits the interdependence within the economy.

In Figure 2-2-1 to 2-2-5, the time series movements of the elasticities of price reduction of the j-th industry with respect to the expansion of investment for the k-th industry are drawn for 1960, 1965, 1970, 1972, 1973 and 1974. When investment increases and consequently so does productivity in a certain sector the supply price of the sector will be reduced as can be seen in the supply equation (1-10). On the other hand the number of workers in the primary sector will decrease because workers in the non-primary sectors increase due to the expansion of capital stock. A decrease in the number of workers in the primary sector will induce an increase in the level of its marginal value added labor productivity and thereby increase the level of wages in the non-primary sectors. These movements seem to be working in the direction in which price will be increasing in the non-

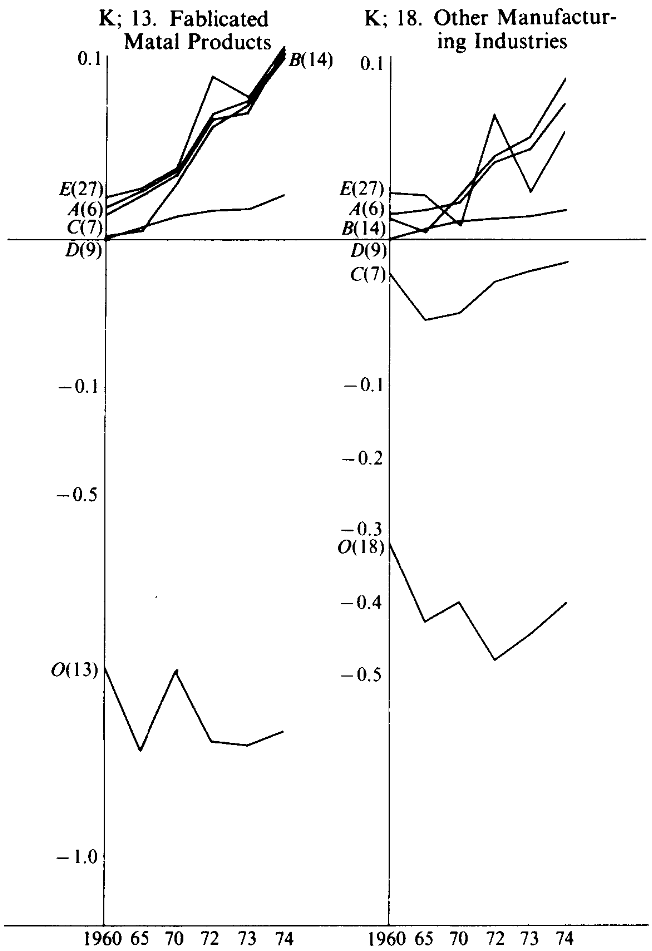

Fig. 2-2-3. Continued.

primary sector contrary to the trend of the price decrease by the improvement of labor productivity with the expansion of the investment. Such price movements in the non-primary sectors will be reflected again to the primary sector through the fluctuation of the unit value added ratio. Such direct and indirect impact on prices in every sector with respect to the expansion of the investment of the k-th industry can be calculated within the general interdependency of the economy by using the simultaneous equation system (2-5).

The number K in each figure stands for the number of the industry in which the investment is expanded in order to improve its labor productivity. The impact on prices of the other industries by the expansion of the investment of the k-th industry will be shown in the figure by choosing the representative industry from each type of industries in Table 1-1. The symbol $O(k)$ represents the impact on its own supply price by the expansion of the investment of the k-th industry. Symbols $A(j)$, $B(j)$, $C(j)$, $D(j)$ and $E(j)$ in each k-th figure stand for the cross elasticity of the price of the j-th industry with respect to the investment of the k-th

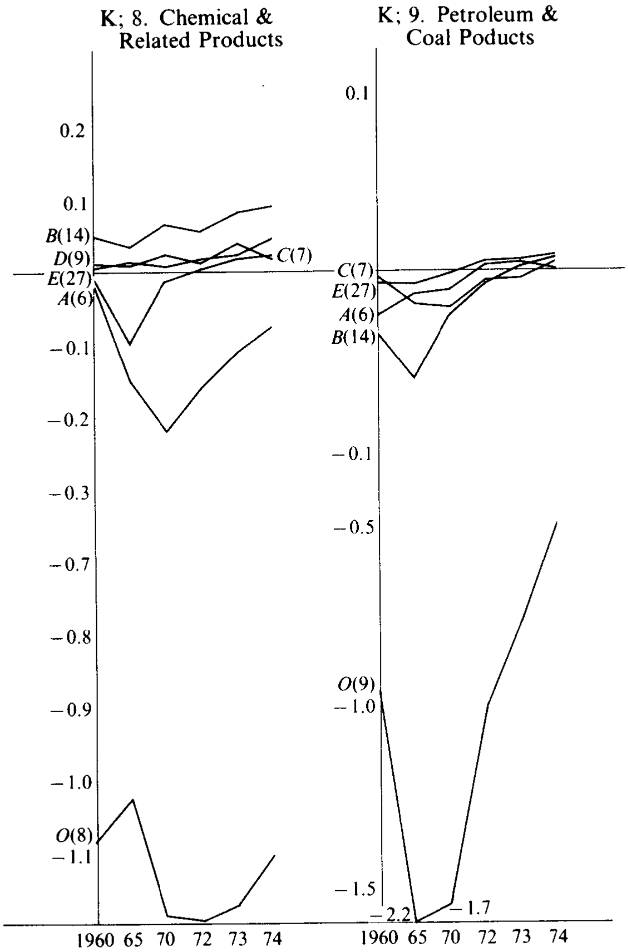

Fig. 2-2-4. The Own and Cross Elasticity of the Price with respect to the Expansion of the Investment —Type D Industries.

industry. The number in the parentheses corresponds to the industry number shown in Table 1-1.

Properties of the technology of the industry in the postwar Japan obtained from these figures will be summarized as follows:

(1) The expansion of the investment for a one percent increase in the labor productivity of the *k*-th industry induced a decrease in its own supply price in all of the industries and all of the time-series movements except the construction industry in 1974. These trends can be seen in the negative sign of each industry's own price elasticity in each figure. The price elasticity for the construction industry in 1974 showed a positive sign which implies an increase in its own supply price in spite of the expansion of investment for a one percent increasing of the labor productivity.

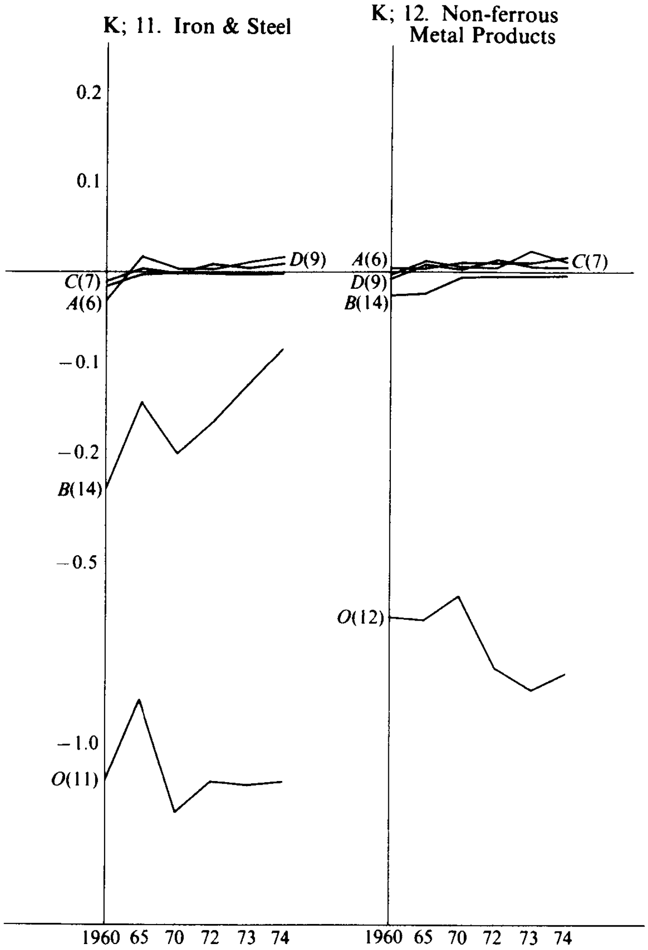

Fig. 2-2-4. Continued.

(2) The cross elasticity of price with respect to the investment of the k-th industry showed a positive sign, which means there was a price increase in the k-th industry in spite of the trend of the each industry to decrease its own supply price, in almost all of the industries except B, C, and D type industries.

(3) The cross elasticity with a positive sign has the upward trend over time, which implies the diminishing efficiency of the price reduction by the improvement of the labor productivity.

(4) The value of the cross elasticity increased over time for all industries, and for some industries the cross elasticity even changed from negative to positive. This fact also implied the diminishing efficiency of the investment in terms of the price reduction in the economic system.

We can attribute the trend of the diminishing efficiency of the investment in terms of the price reduction to the rudimentary properties of the Japanese economic structure. As we mentioned earlier the simulations in which we calculated

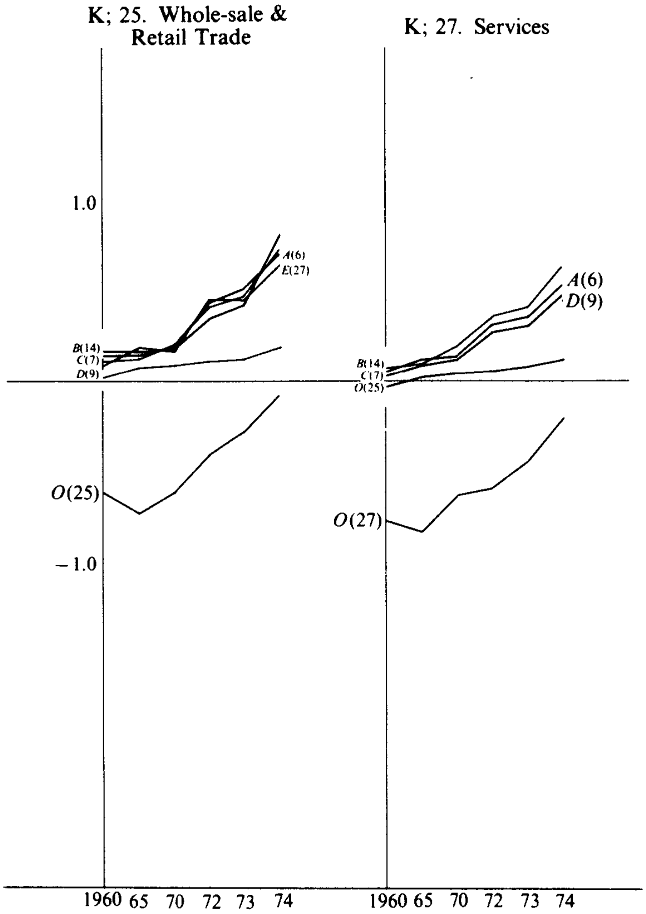

Fig. 2-2-5. The Own and Cross Elasticity of the Price with respect to the Expansion of the Investment —Type E Industries.

the efficiency of the investment were pursued by using a simultaneous equation system. Thus the results of the simulation depend upon three aspects of the economy by which we would like to depict the structure of the general interdependence of the Japanese economy.

The first aspect is the technological properties of each industry, which are shown in the estimated values of the parameters of the production function. The second is results of the resource allocation in the time-series movement of Japan, which have a bias toward the D-type industry as can be seen in Table 1-1. Finally the third point is the properties of the labor reallocation between the indigenous sector and the modern sector in the process of the development of the Japanese economy.

As was pointed out in Figure 1-1 we can place industries in order of the values of two parameters. One parameter indicates the degree of the right-ward shifts of the supply schedule with respect to an increase in the capital stock in

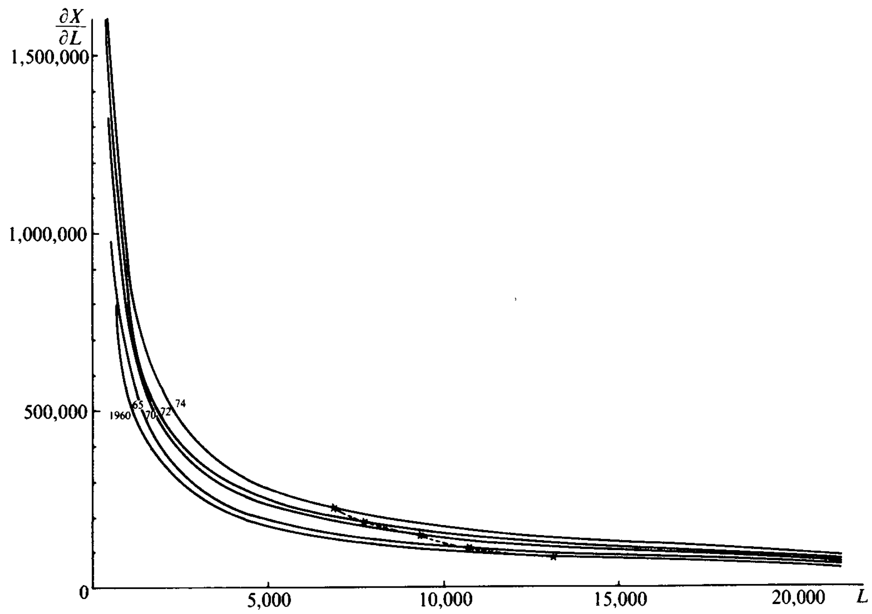

Fig. 2-3. The Estimated Physical Marginal Productivity Curves.

$$\frac{\partial X_1}{\partial L_1}=a_1(1-b_1)A_1^{b_1}L_1^{-b_1}h_1^{1-b_1}(K_1+K_{1g})^{c_1}$$

the j-th sector. The other parameter indicates the degree of price increase with respect to the demand pull effect of the j-th industry along with the relevant supply curve at a given level of capital stock. According to the results of the resource allocation of Japan the investment of the industries classified in A and E type industries in Table 1-1 which have properties like "relatively worse investment efficiency and relatively smaller demand pull effect" has been relatively smaller than investment of other industries. Then such industries were left behind in the process of economic development because technological differences have been amplified over time. Such trends are indicated by the upward shift of the supply schedule over time, which implies the diminishing of the real supply capacity in some industries, as can be seen in Figure (1-2-1)–(1-2-18). One of the reasons why the efficiency of the price reduction with respect to the expansion of the investment has gradually diminished in the Japanese economy seems to the existence of a biased resource allocation and the technological state producing a lower investment efficiency which in turn is amplified by a biased resource allocation.

Such a bias seems to be observed in the resource allocation between the primary and non-primary industries. And it is quite important to analyze the reasons for the diminishing of the efficiency of investment because it is closely related to the determination of wages and prices. From the estimated time-series movement of the marginal value-added labor productivity in the primary sector, we determine that the increments in the marginal value-added labor productivity became larger every year. This implies that even if the number of workers migrating from the primary to non-primary sectors are intact in each developing process of the economy, the increments of the marginal value-added labor productivity from the last decrease of workers grew gradually larger in the mature stages of the developing economy. Consequently even if the efficiency of the investment in each non-primary sector remains at the same level year by year, the wage level in the non-primary sectors will increase with the increasing of the marginal value-added labor productivity through the simultaneous relationship among sectors. Then the effect of the price reduction by the expansion of capacity in the non-primary sectors will be offset by an increase in wages and materials costs.[16]

[16] Figure 2-3 shows the estimated physical marginal productivity curves of agriculture sector and the crosses (×) mean the observed points for each year. Judging from this figure, we can see that the crosses are plotted at the points where the curves get sharper year atter year.
The column (1) and (2) of Table 2-2 shows increments of marginal value added and physical labor productivity from 1960 to 1974.

TABLE 2-2. THE INCREMENTS OF MARGINAL LABOR PRODUCTIVITY IN AGRICULTURAL PRODUCTS SECTOR

	(1) $\partial^2 V_1/\partial L_1^2$	(2) $\partial^2 X_1/\partial L_1^2$
1960	−1.79211	−4.79045
1961	−2.00883	−5.18253
1962	−2.51568	−5.51586
1963	−2.90763	−6.06532
1964	−3.47993	−6.84068
1965	−4.09509	−7.47918
1966	−5.03769	−8.16541
1967	−6.29632	−9.32511
1968	−6.89383	−10.11202
1969	−7.66229	−10.48431
1970	−8.27516	−11.39014
1971	−10.11069	−13.17283
1972	−13.22324	−16.68773
1973	−18.10856	−19.48911
1974	−23.73013	−21.59427

SECTION 3. THE ACUTE "POLY-POLISTIC" BEHAVIOR OF THE FIRM

In order to describe the mind of suppliers such as their anticipation about the price elasticity of the market demand and their conjecture about the behavior of his competitors, we specified an anticipated demand function (1-7). With this specification, we also intended to avoid *a priori* assumption about the conditions of the market such as perfect competiton or monopoly. The price flexibility of the supply price, measured by our anticipated demand function, can be divided into market sensitivity λ_j and the price elasticity of the market demand function η_j, and can be indicated as follows:

$$\delta_1=\frac{\partial p_j^d}{\partial x_j}\cdot\frac{x_j}{p_j^d}=-\frac{x_j}{x_j-\gamma_{sj}}=\frac{\lambda_j}{\eta_j}. \tag{3.1}$$

According to the value of the estimated parameter γ_{sj} in Section 2, the absolute values of δ_1 were quite small for all industries. This implies that firms have been regarding the markets as being fairly competitive in almost all industries for the postwar period. In spite of this result that we obtained from analysis of our anticipated demand function, producers in fact have often limited their supplies by raising the prices of their products have during periods of excess demand in the market, as in the period of a few years shortly before the 1973 oil crisis in Japan. This behavior is understood as a natural consequence of the profit maximizing behavior when the firm recognizes an abnormally large excess demand in the market. Such behavior has to be distinguished from the pursuit of oligopolistic or monopolistic power because a firm will take such action even in a highly competitive market with a large number of competitors. Ragner Frisch called it the acute poly-polistic behavior of the firm. We tried to confirm the occurrence of such acute poly-polistic behavior using our supply equation. While we can obtain the time-series values of δ_1^t or λ_j^t/η_j^t by using the estimated parameter γ_{sj}, we can also interpolate the time-series values of $\partial p^d/\partial x_j\cdot x_j/p^d$ by using the supply equation as follows:

$$\frac{\partial p_j^d}{\partial x_j^d}\cdot\frac{x_j^d}{p_j^d}=\frac{1}{(1-a_{jj}-t_{Ij})}\left[\left(\frac{1}{\alpha_j}\right)\left(\frac{Lhw}{x_j}\right)+\sum^{(i\neq j)}p_i^d a_{ij}^d+\sum p_i^m a_{ij}^m\right]\Big/p_j^d-1 =\delta_2^t. \tag{3-2}$$

Using time-series observations of Lhw, $\sum p_i^d a_{ij}^d$, $\sum p_i^m a_{ij}^m$, a_{jj}^d, and x_j^d for each industry on equation (3-2), we can estimate the values of δ_2^t. Wihle the movement of δ_1^t in equation (3-1) reflects the average perception of firms about the conditions of the market, the values of δ_2^t express changes of the overall perception of the firm about the market condition.

The occurrence of the acute poly-polistic behavior can be confirmed by checking whether the time-series movement of the discrepancy between δ_1^t and δ_2^t is correlated to changes in the profit rate for each industry. We used the following formula as the index of discrepancy between δ_1 and δ_2.

$$\delta=\delta_1/\delta_2, \tag{3-3}$$

where $\delta>1$ implies the occurrence of polypoly situation in which firms limit their supplies by raising their supply prices above the normal prices and $\delta<1$ implies that the firms sell their products by reducing their supply prices below the normal price. The normal supply price means the level of the price which is postulated by our estimated supply equation (1-12) for each sector.

Using profit rate as a proxy for the ratio of business surplus to total sales for each sector, we calculated the correlation coefficient between the time series data of profit rate and δ.

		Correlation Coefficient
A-Type	Food and kindred	0.9522
	Textile products	0.9218
	Construction	0.9665
B-Type	Precision instruments	0.0374
	Transportation equipment	0.9721
	Electric machinery	0.8454
C-Type	Pulp, paper and paper products	0.047
	Stone, clay and glass products	0.076
	Fabricated metal products	0.010
	Other manufacturing industries	0.4288
D-Type	Chemical and related products	0.3427
	Iron and steel	0.2128
	Petroleum and coal products	0.1672
E-Type	Wholesale and retail trade	0.9404
	Service industries	0.9405

In almost all of the industries except the industries classified in Type C and Type D, a high correlation coefficient between the movement of profit rate and δ was observed. Although the reasons why a high correlation coefficient was not observed in Type C and D industries have to be analyzed more precisely, we might guess at this stage that it is closely related to the difference in the bargaining position of both sellers and purchasers in the market for these industries. In C and D-Type industries their products are mostly primary intermediate goods which are supplied to other manufacturing industries, while products of other types of industries are supplied to final purchasers. It may be reasonable to guess that the bargaining power of sellers and purchasers are more or less equal in Type C and D industries unlike the cases of other type industries.

If the bargaining power of sellers and purchasers are equal, it is difficult for sellers to limit their supplies by raising their supply prices acutely above their normal prices. Assuming the occurrence of the acute poly-polistic behavior of the firm according to our empirical observation, we can rearrange our supply equation by using δ as follows:

$$(3\text{-}4) \qquad p_j{}^d = \frac{1}{\{1+\delta[-x_j/(x_j-\gamma_{sj})]\}} \cdot \frac{1}{(1-a^d_{jj}-t_{Ij})} \cdot \left[\left(\frac{1}{\alpha_j}\right)\left(\frac{Lhw}{x_j}\right) + \sum^{(i\neq j)} p_i{}^d a^d_{ij} + \sum p_i^m a^m_{ij}\right],$$

where if $\delta=1$, (3-4) becomes the equation (1-12), and if $\delta>1$, (3-4) implies that firm strictly limits his supply by raising its own supply price above the normal price ($\delta=1$).

The profit rate can be defined as follows;

$$(3\text{-}5) \quad \Pi_r = (\text{Business surplus})/(\text{Total sales})$$
$$= 1 - \frac{(Lhw + \sum p_i{}^d a^d_{ij} x_j + \sum p_i{}^m a^m_{ij} x_j + t_{Ij} p_j{}^d x_j)}{p_j{}^d x_j}$$
$$= 1 - \frac{((1-\delta)x_j - \gamma_{sj})(1-a^d_{jj}-t_{Ij})(Lhw + \sum p_i{}^d a^d_{ij} x_j + \sum p_i{}^m a^m_{ij} x_j)}{(x_j-\gamma_{sj})((1/\alpha)Lhw + \sum p_i{}^d a^d_{ij} x_j + \sum p_i{}^m a^m_{ij} x_j)}.$$

The elasticity of the profit rate with respect to changes in δ can be obtained as follows:

$$(3\text{-}6) \qquad \frac{\partial \Pi_r}{\partial \delta} \cdot \frac{\delta}{\Pi_r} = \frac{x_j}{x_j-\gamma_{sj}} \cdot (1-a^d_{jj}-t_{Ij}) \cdot \frac{(Lhw/x_j) + \sum p_i{}^d a^d_{ij} + \sum p_i{}^m a^m_{ij}}{(1/\alpha_j)(Lhw/x_j) + \sum p_i{}^d a^d_{ij} + \sum p_i{}^m a^m_{ij}} \cdot \frac{\delta_j}{\Pi_r}.$$

The elasticity of the profit rate with respect to δ at 1970 showed the highest value of 0.9909 in construction industry and the lowest value of 0.1634 in petroleum and coal products industry. It is interesting to note that in industries where we observe relatively high correlation coefficients between time-series movements of the profit rate and the value of δ, we also observe the higher elasticity of the profit rate with respect to changes in the value of δ. In order to examine properties of time-series movements of the elasticity, we differentiated the partial derivative $\partial \Pi_r/\partial \delta$ with respect to the capital stock for each industry.

$$(3\text{-}7) \qquad \left.\frac{\partial(\partial \Pi_r/\partial \delta)}{\partial K}\right|_{h=h^*} = -\frac{abK^{b-1}h^*\gamma_{sj}}{(x-\gamma_{sj})^2}(1-a^d_{jj}-t_{Ij}) \cdot \left(\frac{(Lhw/x) + \sum p_i{}^d a^d_{ij} + \sum p_i{}^m a^m_{ij}}{(1/\alpha)(Lhw/x) + \sum p_i{}^d a^d_{ij} + \sum p_i{}^m a^m_{ij}}\right) + \left(\frac{\mathrm{B}}{[(1/\alpha)/(Lhw/x) + \sum p_i{}^d a^d_{ij} + \sum p_i{}^m a^m_{ij}]^2}\right),$$

where

$$B = \left(\frac{c_j}{a_j}\right)(d_j-b_j)K_j^{d-b-1}w\left(1-\frac{1}{\alpha}\right)(\sum p_i{}^d a^d_{ij} + \sum p_i{}^m a^m_{ij}) \cdot \left(\frac{x_j}{x_j-\gamma_{sj}}\right)(1-a^d_{jj}-t_{Ij}).$$

According to the estimated parameters, the right-hand side of equation (3-7) is positive. This implies that the incentive of the firm to limit its supply by raising the supply price and increase profits grows stronger with accumulation of capital stock.

CONCLUDING REMARKS

This paper has two purposes. The first purpose is to propose an analytical framework by which we can depict the supply structure of the ecnomy. The second purpose is to explain the time-series movements of the supply structure of the Japanese economy by applying our analytical tool to industry data during the period 1960 to 1974. This experiment also offered a test of the empirical validity of our theoretical framework. The reader must be reminded that the analytical framework of our present study is highly restricted by our assumptions: we treated an industry as equivalent to a single firm and regard the continuous curve measured at the industry level as the supply curve of the firm. We used the production function and profit maximization behavior of a single representative firm as a theoretical model to be applied to the aggregate data of each industry.

In spite of such approximation we were still able to test at least partially the empirical validity of our tool and deduce some interesting properties of the supply structure of the Japanese economy. First of all, we were able to rank industries according to the values of two parameters in Figure 1-1. When evaluating resource allocation during the postwar period having these technological properties in mind, we can say that the efficiency of investment has been pursued vigorously through the expansion of productive capacity even at the cost of expanding the capacity of industries with relatively less efficient effect of investment.

Consequently supply schedules in industries with technological property such that "relatively worse investment efficiency and relatively smaller demand pull effect" shifted to the left-hand side during the period 1960–1970 in spite of fairly large capital investment. Moreover, from the viewpoint of the interdependence of the supply structure we may say that such a biased resource allocation has given rise to a reduction in efficiency of investment.

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