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ECONOMIC GROWTH CENTER

YALE UNIVERSITY

Box 1987, Yale Station
New Haven, Connecticut

CENTER DISCUSSION PAPER NO. 224

March 1975

WAGES AND EMPLOYMENT IN DUALISTIC DEVELOPMENT: JAPANESE
EXPERIENCE

Ryoshin Minami and Akira Ono

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Wages and Employment in Dualistic Development: Japanese Experience

Ryoshin Minami and Akira Ono

I. Introduction

An econometric study on the labor market or the sectoral changes in wages and employment of prewar Japan is the aim of this paper. The prewar Japanese economy is one of the most interesting experiences to study in the histories of various developed countries because of two distinguishing characteristics of her economy. The first is the emergence and existence of large differences in wages and labor productivity among sectors. It is said that this fact is rather unique to Japan; i.e., no big differentials in wages and productivity were found in any other developed country. The second is the existence of "unlimited supplies of labor" (USL) in the low wage and low productivity sectors (agriculture, services and small-scale enterprises in the other industries). In the controversy on the existence of USL in Japan,¹ one of the authors, on the basis of studies of long-term statistics of wages and labor productivity in agriculture and of wage differentials between skilled and unskilled workers, came to the conclusion that Japan had USL until the late 1950's or the beginning of the next decade (1973, Ch. 12)² Therefore the prewar Japanese economy provides a good chance for economists to apply the theory of economic development à la Lewis (1954;1958) and Fei-Ranis (1964) to real economies. As will be referred to later, these two characteristics are not independent of each other, i.e., it is our understanding that the first is basically dependent upon the second.

In the first part of Section II changes in sectoral wages and employment are surveyed to give an overview of the labor market. The second part is devoted to an econometric study of their determinants.

This study will be carried out by considering the features of the Japanese economy in the framework of the Lewisian theory with two sectors. That is, the economy is divided into two parts: the first, a substitute for the "subsistence sector" (Sector 1), stands for primary and tertiary industries and the second, a substitute for the "capitalist sector" (Sector 2), signifies secondary industry. (Secondary industry here consists of manufacturing, mining, construction, transportation, communication and public utilities.) These substitutions are not sufficient in that small-scale enterprises in secondary industry are classified as part of the capitalist sector. This classification, coming uniquely from a lack of data on these enterprises, however, does not seem to spoil our study to a large extent, because the weight of primary and tertiary industries in Sector 1 is much larger than these enterprises.

The study of the labor market in Section II has a limitation in that any interrelationships between this market and other markets, on capital and output, are not taken into consideration. The importance of this consideration cannot be exaggerated. Especially careful attention should be paid to the change in relative output prices between the two sectors and its impact on the wage determinations. Suppose there was an increase in Sector 1 wages for example. Does this lead to narrowing wage differentials between the two sectors? It is not necessarily true, when the relative prices tend to change in favor of Sector 2. Such a change in the relative prices tends to occur when the growth rate declines in Sector 2 because of a decrease in investment. The decrease in investment is caused by a wage increase in this sector coming from an increase in Sector 1 wages. In order to overcome this difficulty in

the study of Section II, we will set forth in Section III a simultaneous equation model which covers all three markets: labor, capital and output. A final test of this model may provide a test of the applicability of the Lewisian theory to the prewar Japanese economy.

Based on this model some simulation tests will be attempted. These counter-factual studies may shed light on the mechanism and the features of economic growth in pre-war Japan with special reference to the labor market. They are classified into three groups: The first is to test the effects of changes in population and labor supply on economic growth by considering hypothetical economies with zero population growth. The second is to compare economic growth with a constant price of labor supply to the capitalist sector with the actual. This may provide a test for the hypotheses ("cheap labor hypothesis" and the "low-rice-price and low-wage hypothesis") commonly held among Japanese Marxists, which identify the existence of "cheap labor", maintained by import of cheap rice as one of the major factors for the rapid economic growth. Third, the effects of a wage lag and a difference between wages and marginal productivity, which will be revealed in Section II for the capitalist sector, are clarified by considering the economies respectively without a wage lag and without a wage-productivity differential.

It is important to point out that the studies in Section III will be concerned only with long-term changes in the economy; short-run fluctuations associated with business cycles and long-swings are not treated. This is so because our assumption of USL or the assumption of exogenously given wages in Sector 1 refers only to the long-term trend. That is to say, these wages tend to fluctuate in association with short-run changes in demand and supply conditions in the labor market;

i.e., the Sector 1 workers tend to become limited in supply when faced with a tightening labor market even before the "turning point".³

The observation period in this study is limited to 1906-40. There are two reasons why this study starts from 1906.⁴ The first is that statistics on labor and capital by industry group are available from this year. The second is that equilibrium theory does not seem to be applicable during the early phase of modern economic growth, in which the national markets on labor, capital and output did not exist in their full shapes.⁵ Because of these reasons no sophisticated econometric study is possible for these years.⁶ Exclusion of the years after 1940 is due to three reasons. The first is the abnormality in economic conditions during the war years until 1945 and the reconstruction period (1946-53). The second is the disappearance of USL during the late 1950's or the early 1960's; after the turning point our model, an econometric version of the Lewisian theory, loses its applicability. The third is the big changes in economic and social conditions between the pre- and postwar periods.⁷ They make it difficult to estimate equations for the years covering the prewar and the postwar eras.

II. Changes in Sectoral Wages and Employment

(1) Overview

Considering data availability, let us study the changes in wages and employment by three industry groups; A (primary), M (mining, manufacturing, construction and facilitating) and S (other industries, mainly services and commerce). Real wages or average wages and salaries¹ (W') deflated by the consumer price index (P'_c) given in Panel A of Table 1 demonstrate different patterns of changes among sectors:² The exponential rate of growth³ for the entire period (1906-40) is the highest in M (2.1 percent per annum) and the lowest in A (0.5 percent).⁴ S lies between them (1.3 percent). This difference in the rate of growth comes mainly from the fact that wages continued to rise steadily in M, while decreasing in A and, to a lesser extent, in S, for the years since the middle 1920's.

These changes since the middle 1920's seem to be worthy of special attention, because they may have important implications in clarifying the structure of the labor market in Japan. During the downswing in the 1920's big enterprises made some devices to mitigate the decline in profits. They were comprised of mechanization of production processes depending on borrowed technology and rationalization of labor management. Referring to the latter, these enterprises cut down the demand for unskilled labor and kept skilled workers in their own firms. As a device for keeping skilled workers, the lifetime employment system, peculiar to Japan, appeared in this particular period. Consequently, while unskilled workers became redundant or unlimited in supply, skilled workers continued to be limited. This leads us to such important

Table 1: Real Wages by Three Industry Group and Differentials
In Wages, Labor Productivity and Capital-Labor
Ratio Among Three Industry Groups

	1907	1910	1915	1920	1925	1930	1935	1937
A. Real Wages (Yen)								
W'_A/P'_C	125	126	122	145	167	153	131	141
W'_M/P'_C	388	393	419	450	481	590	645	780
W'_S/P'_C	288	281	258	361	451	417	391	337
W'_A/P'_R	146	143	149	201	221	183	136	145
B. Wage Differentials								
W'_M/W'_A	3.10	3.12	3.43	3.10	2.88	3.86	4.92	5.53
W'_M/W'_S	1.35	1.40	1.62	1.25	1.07	1.41	1.65	2.31
C. Labor Productivity Differentials								
$\frac{V_M}{L_M} / \frac{V_A}{L_A}$	2.67	2.87	2.90	3.07	3.65	4.34	4.77	5.33
$\frac{V_M}{L_M} / \frac{V_S}{L_S}$	0.63	0.74	0.82	0.75	0.97	1.34	1.52	1.49
D. Capital-Labor Ratio Differentials								
$\frac{K_M}{L_M} / \frac{K_A}{L_A}$	1.84	2.24	2.72	3.40	3.92	4.30	4.27	4.38
$\frac{K_M}{L_M} / \frac{K_A}{L_S}$	1.25	1.47	1.70	1.97	2.16	2.27	2.22	2.07

Remarks: Seven year averages centered on indicated years. Except for three year averages for 1907 and 1939.

Sources: P'_R (consumer price index for rural areas, 1934-36 = 1): Ono's estimates (Ono & Watanabe forthcoming).

For other variables see Statistical Appendix.

conclusions as follows: 1) The Japanese labor market was a dual structure or a co-existence of markets for unskilled and skilled workers. 2) Almost all the labor force in A and a large portion of the labor force in S was comprised of unskilled workers, whereas in Sector M skilled workers were dominant.

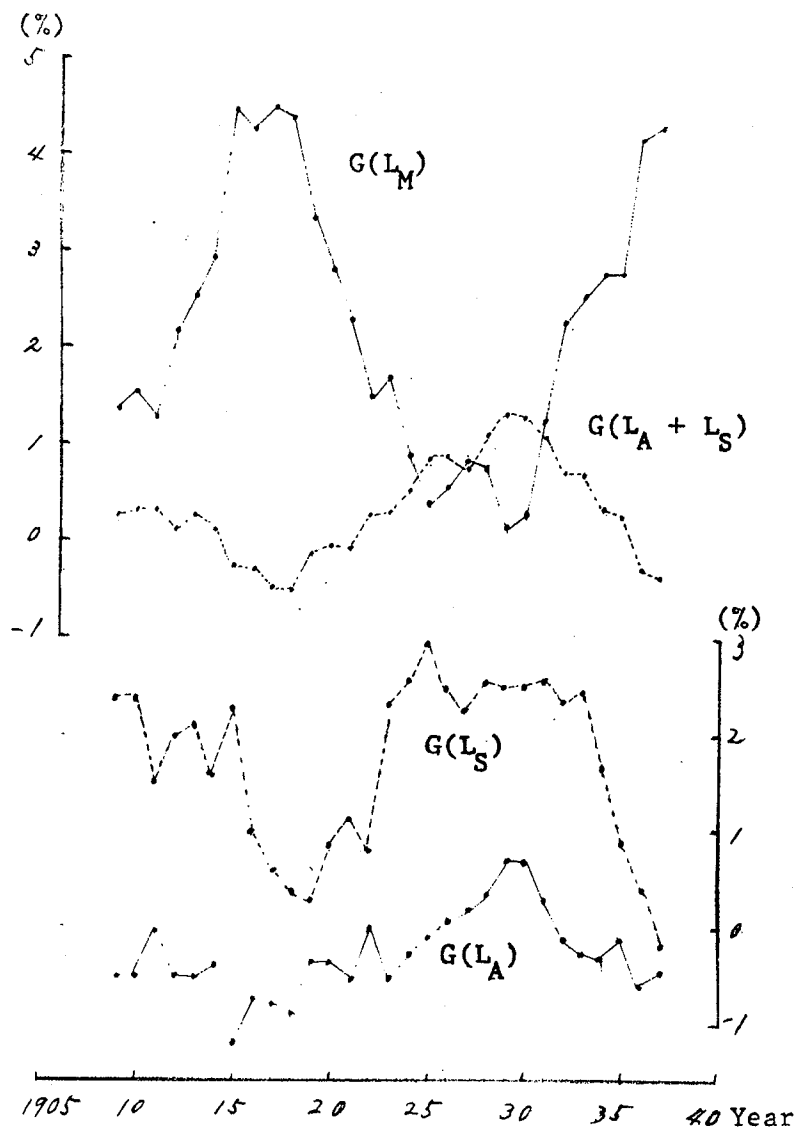
It may be pertinent here to refer to the assertion by Fei and Ranis that the turning point was passed during 1916-19, depending on a big increase in the manufacturing wages (1964, pp. 263-264). This cannot be taken as evidence for passing the turning point, however, because the concept of the turning point must be related with unskilled workers and a large portion of manufacturing workers were skilled. Wages for A and, to a lesser extent, wages for S are better indexes for unskilled worker wages. Depending on these wages, one may state that unskilled workers became limited to some extent during the boom years during and after W.W.I but returned to unlimited supply in the downswing of the 1920's. It means that the turning point, which must be the long-term concept, was not passed at least in the pre-W.W. II period.⁵

A different pattern of changes in sectoral wages give rise to changes in wage differentials among sectors. According to Panel B, the wage ratios of M to A and to S increased in the 1920's and the 1930's. The widening wage differentials were associated with big increases in the ratios of M to A and S in labor productivity (V/L), shown in Panel C, during these decades. These increases depended partly on the widening differentials in the capital-labor ratio

(K/L) among sectors. The capital-labor ratio differentials, calculated in Panel D, showed some increase in the two decades. Another factor for the widening productivity differentials was a difference in the rate of technological progress. This will be clarified through an econometric study in Sector III (1).⁶

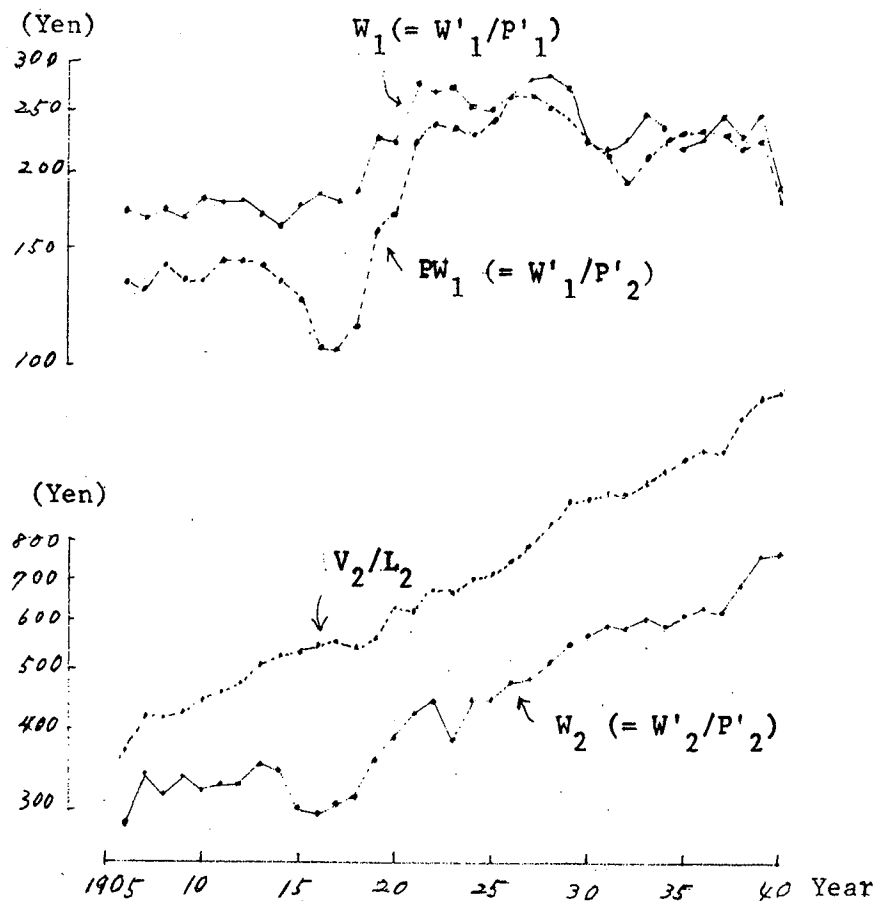
Along with the course of economic development the industrial composition of employment suffered from big changes; employment as a percentage of total employment increased both in Sectors M and S, respectively from 18.4 percent (1909) to 27.9 percent (1937) and from 20.8 percent to 26.8 percent, whereas it decreased in Sector A from 60.8 percent to 45.3 percent.⁷ (All figures are based on seven year averages.) A much more interesting finding is obtained about the pattern of changes in the growth rate of sectoral employment. In Fig. 1 it is easily seen that the growth rate for Sector M employment (L_M) showed fluctuations closely associated with the long-swings. That is to say, it increased sharply during the upswings before 1919 and after 1931, whereas it decreased remarkably during the downswing between these two years. On the other hand both the growth rate of Sector A employment (L_A) and that of Sector S employment (L_S) tended to fluctuate in the opposite directions of the long-swings.⁸ Thus the growth rate of $L_A + L_S$ demonstrated clear negative associations with the long-swings. These findings may signify, in the writers' opinion, that L_M tended to be determined by the demand for labor and on the other hand $L_A + L_S$ was determined as a residual from the total labor supply ($L = L_M + L_A + L_S$).⁹

Fig.1: Growth Rates of Labor Force by the Three Industry Groups



Remarks: $G(X) = 100(X - X_{-1})/X_{-1}$. Figures for 'X' are seven year moving averages.

Fig.2: Real Wages in Both Sectors and Labor Productivity in Sector 2



Sources: See Statistical Appendix.

(2) Econometric Study

The above discussions show that it may not be far from reality to assume that the Sector 1 (Sectors A and S) workers are all unskilled, whereas the Sector 2 (Sector M) workers are composed of two groups-- unskilled and skilled workers, and that unskilled workers in Sector 1 are supplied unlimitedly to Sector 2,¹⁰ while the supply of skilled workers in Sector 2 is limited.¹¹ With these assumptions one may see that we can explain the emergence of wage differentials. This may signify in turn that these assumptions are realistic. An important corollary of these assumptions is that employment in Sector 2 is determined first so that maximum profits are attained and the rest of workers from the total labor supply are absorbed in Sector 1. That is to say the latter sector is a pool of surplus labor or disguised unemployment.¹² This corollary is also consistent with our finding above that employment in Sectors A and S seems to have been determined as a residual.

According to these assumptions Sector 1 wages deflated by the consumer price index (W_1'/P_c') are exogenously given.¹³ (See Table 3 for notations.) To make the model structure simpler, however, let us assume that these wages in terms of Sector 1 products ($W_1 = W_1'/P_1'$) are given.¹⁴ This simplification does not matter eventually, because the two price indexes, consumer prices (P_c') and output prices for Sectors A and S, changed in a similar way to each other. On the other hand, Sector 2 wages in terms of its sector products ($W_2 = W_2'/P_2'$) are a weighted average of the wages for unskilled and skilled

workers. Unskilled worker wages tend to change according to the supply price of labor or Sector 1 wages. Skilled worker wages are determined by their marginal revenue product because of the assumption of limited supplies of labor. Therefore W_2 can be expressed as a function of Sector 1 wages in terms of Sector 2 products

($PW_1 = W_1'/P_2'$) and the average labor productivity in Sector 2 (V_2/L_2), which is a proxy variable for the marginal product of skilled workers.¹⁵ The following is a result of an estimation of this relation with a distributed lag:¹⁶

$$(1) \quad \ln W_2 = 0.252 + 0.101 \ln PW_1 + 0.355 \ln \frac{V_2}{L_2} + 0.494 \ln W_{2, -1}$$

(1.11) (1.97) (3.59) (3.72)

$$\bar{R}^2 = 0.966 \quad d = 1.75$$

To begin with, let us pay attention to the parameter of $W_{2, -1}$.

This parameter signifies that Sector 2 wages tend to follow the labor supply price of the Sector 1 workers and the labor productivity in Sector 2 with a lag of about one year. Next the effects of the other variables (PW_1 and V_2/L_2) on W_2 will be examined in the state of equilibrium ($W_2 = W_{2, -1}$), where equation (1) is rewritten as follows:

$$(1') \quad \ln W_2 = 0.497 + 0.199 \ln PW_1 + 0.700 \ln \frac{V_2}{L_2} .$$

Because of the large parameter for V_2/L_2 and a steadily increasing

trend in this variable (see Fig. 2), it may be expected that this variable explained a major part of an increase in W_2 (see Fig. 2). This fact is much more easily understood by using Table 2 which shows the growth rate in W_2 by components. For the entire period (1906-40) 90 percent of the rate of increase in W_2 was attributable to the growth rate in V_2/L_2 . Only 6 percent of the former was explained by the rate of growth in PW_1 . Equation (1') is also useful for a study of the wage differentials between the two sectors ($W_2/PW_1 = W'_2/W'_1$). Rewriting this, we have

$$(1'') \quad \ln \frac{W_2}{PW_1} = 0.497 - 0.801 \ln PW_1 + 0.700 \ln \frac{V_2}{L_2}.$$

Because of a small difference in the two parameters for PW_1 and V_2/L_2 , one may argue that a widening wage differential, which was already studied in the above section, was mainly dependent on the fact that V_2/L_2 increased much faster than PW_1 .¹⁷ The annual exponential rate of growth is 0.81 percent and 3.78 percent respectively for PW_1 and V_2/L_2 for 1906-40.)

Next let us discuss the changes in W_2 and their determinants by sub-period. Fig. 2 shows that W_2 was really constant before W.W.I and began to increase thereafter. PW_1 decreased somewhat before W.W.I and decreased again after a big increase in the late 1920's. This increase came from two factors; an increase in W_1 and an increase in the relative output price (P).

This increase in PW_1 was expected to contribute to a rise in W_2 to

Table 2: Annual Exponential Rate of Growth in Sector 2
Wages and Its Components

	Growth Rate in Sector 2 Wages		Contributions of Growth Rate in		Error
	Actual	Estimated	Sector 1 Wages	Sector 2 Productivity	
	(1)	(2)	(3)	(4)	(5)
1906-1915	0.72	2.40	-0.22	2.62	-1.58
1915-1920	5.07	3.70	1.33	2.37	1.37
1920-1930	3.70	3.30	0.57	2.73	0.40
1930-1940	3.04	2.23	-0.49	2.72	0.81
1906-1940	2.92 (100.0)	2.80 (95.9)	0.16 (5.5)	2.64 (90.4)	0.12 (4.1)

Remarks: (1) = $\Delta \ln W_2$
(2) = (3) + (4)
(3) = $0.199 \Delta \ln PW_1$
(4) = $0.700 \Delta \ln V_2/L_2$
(5) = (1) - (2)

some extent. For 1915-20, according to Table 2, the contribution of the growth rate in PW_1 (1.33 percent) was not less than half of that of the growth rate in V_2/L_2 (2.37 percent). That is to say, the temporary labor shortage for Sector 1 workers during the boom years pushed up the average wages in Sector 2 and decreased the wage differential. It seems to be important, however, that since the middle 1920's W_2 was pulled down and the wage differential widened again by a decrease in PW_1 .

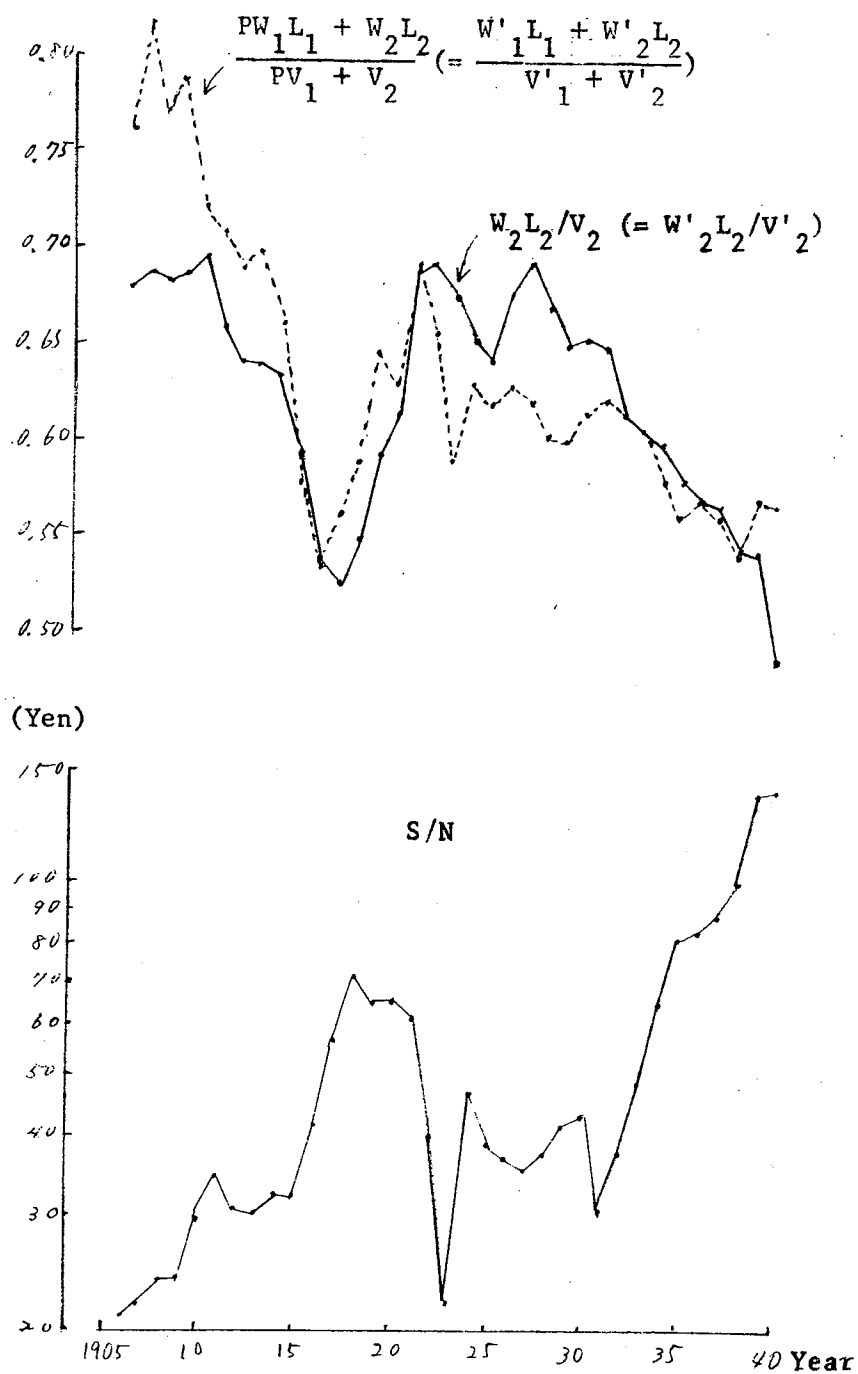
From equation (1') we obtain

$$(1''') \ln \frac{W_2 L_2}{V_2} = 0.497 + 0.199 \ln PW_1 - 0.300 \ln \frac{V_2}{L_2}.$$

This implies that the relative income share of labor in Sector 2 ($W_2 L_2 / V_2 = W'_2 L_2 / V'_2$) tends to increase and decrease by rises in PW_1 and V_2 / L_2 respectively. Because V_2 / L_2 increased much faster than PW_1 , the relative income share showed such a declining trend for the observation period as a whole as is demonstrated in Fig. 3. Since the middle 1920's this trend was accelerated by a decline in PW_1 .

Now we are in a position to treat the allocation of the labor force between the two sectors. In Sector 2 the marginal revenue product of skilled and unskilled workers tend to be equal to their respective wages; therefore, the marginal revenue product of labor in this sector tends to be equal to the average real wages. Estimating this relation, developed in a framework of a partial adjustment model, we have

Fig.3: Relative Income Shares of Labor in the Whole Economy and in Sector 2 and Real Gross Saving Per Capita



Sources: See Statistical Appendix.

$$(2) \quad \frac{V_2}{L_2} = 0.286 W_2 + 0.861 \left(\frac{V_2}{L_2}\right)^{-1.18} \quad \bar{R} = 0.988 \quad d = 2.14$$

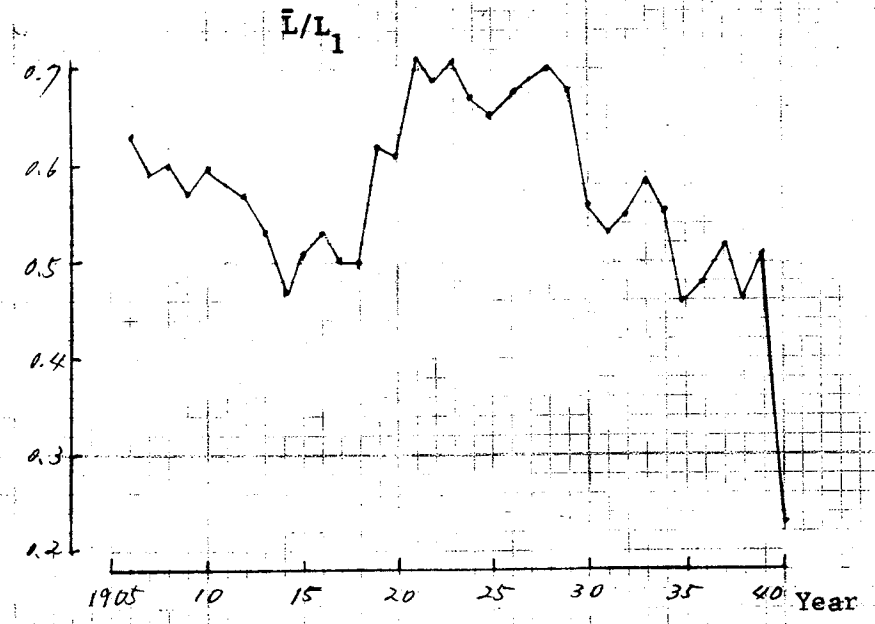
(2.08) (10.95)

By substituting an estimate for the output elasticity of labor (0.653), which is included in equation (5) of Table 4, into this relation, we know that Sector 2 workers are paid on the average only seventy four percent of their marginal productivity in the state of equilibrium.¹⁹ This is an important finding, because, as will be discussed later, the existence or non-existence of a gap between wages and the marginal productivity gives rise to a difference in the results of some simulation tests.

Combining equations (1) and (2), W_2 and V_2/L_2 are determined. From the value for V_2/L_2 and the production function in Sector 2 which relates V_2/L_2 with the capital-labor ratio ($K_{2,-1}/L_2$), the labor force in this sector (L_2) is known. The rest of the workers from the total labor supply (L) determines the employment in Sector 1 (L_1); i.e., $L_1 = L - L_2$ (equation (11)).

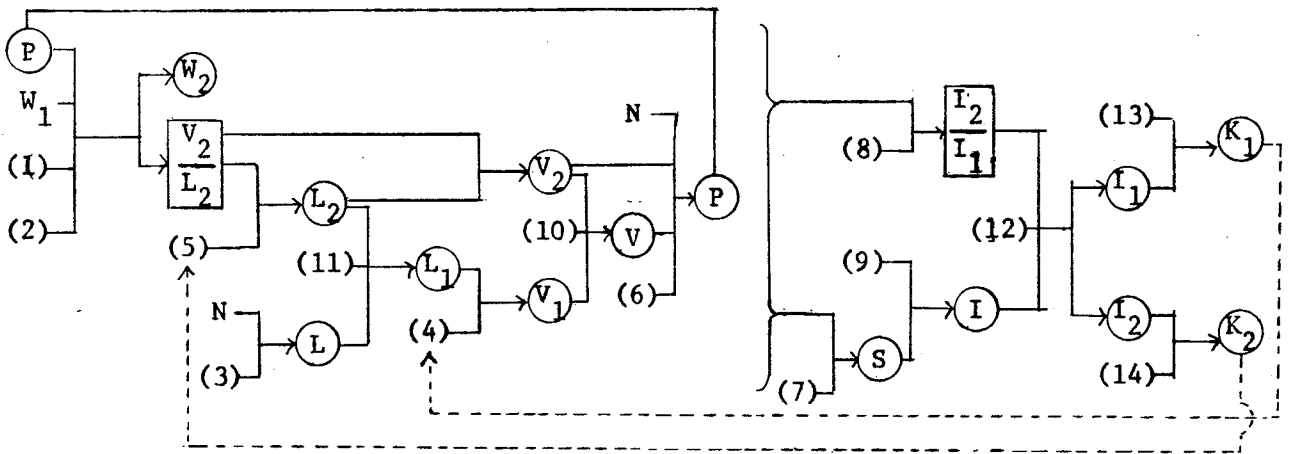
← L_1 is composed of the surplus labor (\bar{L}) and the labor force whose marginal productivity (MPL_1) not smaller than the real wages (W_1). The size of the latter labor force can be calculated from the relation $W_1 = MPL_1$, where MPL_1 is known from the production function (4). By subtracting this labor force from L_1 , \bar{L} is easily obtained. Fig. 4 shows the ratio of \bar{L} to L_1 . This ratio decreased from 60 percent to 50 percent in the upswing (1906-19) including the boom years during and after W.W.I. During the downswing (1919-31) following the boom, it increased from 50 percent to 70 percent and

Fig.4: Ratio of Surplus Labor to Total Labor Force in Sector 1



Sources: See Statistical Appendix.

Fig.5: Flow Chart



remained constant at this level. In the upswing (1931-40) which was mainly dependent upon military expansion, this ratio decreased considerably; it became 50 percent in the late 1930's and lower than 30 percent at the end of this decade. The associations of \bar{L}/L with long-swings came from the negative association between L_1 and long-swings that was studied in (1).

III. Wages and Employment in the National Economy

(1) Structure of the Model

This model is composed of three parts expressing the markets of labor, capital and output.

Labor Market As was mentioned in the last section, equations (1) and (2), together with the equations (5) and (11), determine Sector 2 wages and the labor force allocation between the sectors. Total labor supply is given by the size of working age population (QN) and the labor participation rate (L/QN). The former is given exogenously.¹ The latter comes from equation (3), which relates L/QN positively with the average wages in the total economy in the previous year $(\frac{W_1 L_1 + W_2 L_2}{L})_{-1}$ and negatively with the rate of school attendance (Z).² (See Table 4.)

Output Market Outputs of both sectors (V_1 and V_2) are determined in the production functions (4) and (5) respectively. Multi-colinearity among variables makes it difficult to estimate these functions. This is the reason why an arbitrary assumption was made in estimating each of them. That is, two kinds of assets, capital and land, are aggregated into one variable in (4)³ and the output elasticity of capital was taken from a cross-sectional study of manufacturing⁴ in (5). In spite of these weaknesses in estimating procedure, these estimations may reveal factors for the widening labor productivity differential between the two sectors $(\frac{V_2}{h_2 L_2} / \frac{V_1}{h_1 L_1})$. The first factor was a gap in the rate of growth in total factor productivity between the two

Table 3: List of Notations

Subscript (j)	1 = subsistence sector 2 = capitalist sector
$V = \sum V_j, V_j = V'_j / P'_j$	GDP at constant (1934-36) prices
V'_j	GDP (million yen)
$I = \sum I_j, I_j$	private fixed investment at constant prices (million yen)
I_h	housing investment at constant prices (million yen)
I_{gm}	military expenditure at constant prices (million yen)
$I_g = \sum I_{gj}, I_{gj}$	government fixed investment at constant prices (million yen)
B	surplus on current account at constant prices (million yen)
$S = I + I_h + I_{gm} + I_g + B$	private gross saving at constant prices (million yen)
$W_j = W'_j / P'_j$	real wages
W'_j	money wages (yen)
$P = P'_1 / P'_2$	relative price index (1934-36=1)
P'_j	output price indexes (1934-36=1)
P'_c	consumer price index (1934-36=1)
$L = \sum L_j, L_j$	the number of employees (million persons)

Table 3: List of Notations (cont'd.)

\bar{L}	surplus labor in Sector 1 (million persons)
N	total population (million persons)
Z	rate of school attendance
Q	rate of working age population
$K = \sum K_j, K_j$	gross capital stock at constant prices (million yen)
A	area of cultivated land (thousand hectares)
h_j	labor hours per year (1934-36=1)
u	utilization rate of capital asset in Sector 2
v	utilization rate of land
δ_j	rate of discard of capital stock
t	year (1 35 for 1906 ...40)

Table 4: List of Estimated Equations

Wage determination function in Sector 2:

$$(1) \quad \ln W_2 = 0.252 + 0.101 \ln PW_1 + 0.355 \ln \frac{V_2}{L_2} + 0.494 \ln W_{2,-1}$$

(1.11) (1.97) (3.59) (3.72)

$\bar{R}^2 = 0.966$
d = 1.75

Profit maximization condition (demand function for labor) in Sector 2:

$$(2) \quad \frac{V_2}{L_2} = 0.286 W_2 + 0.861 \left(\frac{V_2}{L_2} \right)_{-1}$$

(2.08) (10.95)

$\bar{R}^2 = 0.988$
d = 2.14

Determination function of the labor participation rate:

$$(3) \quad \ln \frac{L}{QN} = -1.204 + 0.0477 \ln \left(\frac{W_1 L_1 + W_2 L_2}{L} \right)_{-1} - 0.144 \ln Z$$

(4.94) (1.61) (8.09)

$\bar{R}^2 = 0.959$
d = 0.52

Production functions:

$$(4) \quad \ln \frac{V_1}{h_1 L_1} = 0.865 + 0.0102t + 0.650 \ln \frac{K_{1,-1} + 0.275 vA}{h_1 L_1}$$

(0.21) (3.31) (1.16)

$\bar{R}^2 = 0.794$
d = 0.85

$$(5) \quad \ln \frac{V_2}{h_2 L_2} = 3.602 + 0.0212t + 0.347 \ln \frac{u K_{2,-1}}{h_2 L_2}$$

(172.96) (20.97)

$\bar{R}^2 = 0.930$
d = 0.28

Determination function of the relative output price between the two sectors (demand function for Sector 2 products):

$$(6) \quad \ln P = 3.312 - 0.932 \ln N + 0.464 \ln V_2 - 0.368 \ln V + 0.739 \ln P_{-1}$$

(1.23) (1.15) (1.44) (1.01) (5.49)

$\bar{R}^2 = 0.778$
d = 1.24

Table 4 List of Estimated Equations (continued)

Aggregate saving function:

$$(7) \quad \frac{S}{N} = -606 + 0.249 \frac{V}{N} - 131 \frac{PW_1 L_1 + W_2 L_2}{PV_1 + V_2} + 1037Q + 0.572 \left(\frac{S}{N}\right)_{-1}$$

(2.11) (3.64) (4.00) (2.37) (5.21)

$$\bar{R}^2 = 0.934$$

$$d = 2.15$$

Investment allocation function:

$$(8) \quad \frac{I_2}{I_1} = 0.0220 + 2.476 \frac{V_2}{V_1} - 1.489 \left(\frac{K_2}{K_1}\right)_{-1} + 0.882 \left(\frac{I_2}{I_1}\right)_{-1}$$

(0.06) (2.31) (1.59) (8.23)

$$\bar{R}^2 = 0.780$$

$$d = 1.75$$

Definition equations:

$$(9) \quad S = I + I_h + I_{gm} + I_{g1} + I_{g2} + B$$

$$(10) \quad V = V_1 + V_2$$

$$(11) \quad L = L_1 + L_2$$

$$(12) \quad I = I_1 + I_2$$

$$(13) \quad K_1 = I_1 + I_{g1} + (1 - \delta_1) K_{1,-1}$$

$$(14) \quad K_2 = I_2 + I_{g2} + (1 - \delta_2) K_{2,-1}$$

Remarks: Estimated by OLS.

\bar{R}^2 and d stand for the determination coefficient adjusted by the degree of freedom and the Durbin-Watson statistics, respectively. Student t -values are shown in parentheses under the respective parameters.

Panel A, sectors (Column (3),/Table 5); i.e., this rate in Sector 2 (2.11 percent per annum) was twice the rate in Sector 1 (1.02 percent). This gap explained 44.5 percent of the difference in the rate of growth in labor productivity (Panel B). Technological progress in Sector 2 was very quick because it was dependent on "borrowed technology"; the modern industries introduced technology developed in the West.⁵ On the other hand technologies utilized in Sector 1 were almost indigenous. This fact was typically the case for prewar agriculture, which depended on seed improvements and the introduction of much more intermediate goods like fertilizer, insecticides and so forth.⁶ The second was a gap in the growth rate of the ratio of non-labor inputs (capital and land in Sector 1 and capital in Sector 2) to labor inputs; it was much higher in Sector 2 (4.68 percent) than in Sector 1 (0.42 percent). This gap, cancelling out the difference in the output elasticity to non-labor inputs (0.650 and 0.347 for Sectors 1 and 2 respectively), gave rise to a difference in the growth rate of labor productivity. (The growth rate of labor productivity explained by the increase in the non-labor to labor ratio was 0.27 percent and 1.62 percent in Sectors 1 and 2 respectively (Column (4)). The former gap explained 55.1 percent of the latter difference (Panel B). Therefore it can be stated that the difference in the rate of capital accumulation (2.67 percent and 6.46 percent for Sectors 1 and 2 respectively), which, together with a slow increase in cultivated land area (vA), gave rise to a difference in the growth rate of the non-labor to labor ratio, is worthy of special attention. That is to say, in studying the emergence and existence

Table 5: Annual Exponential Growth Rates in Labor Productivity in Both Sectors and Their Components: 1906-40

	Growth Rate in Labor Productivity		Contributions of Increase in		Error
	Actual	Estimated	Total Factor Productivity	Ratio of Non-Labor Inputs to Labor Input	
	(1)	(2)	(3)	(4)	(5)
A					
Sector 1	1.39 (100.0)	1.29 (92.8)	1.02 (73.4)	0.27 (19.4)	0.10 (7.2)
Sector 2	3.84 (100.0)	3.73 (97.1)	2.11 (54.9)	1.62 (42.2)	0.11 (2.9)
Difference	2.45	2.44	1.09	1.35	0.01
B					
(Sect. 2- Sect. 1)	(100)	(99.6)	(44.5)	(55.1)	(0.4)

Remarks: (1) = $\Delta \ln V_j / h_j L_j$

(2) = (3) + (4)

(3) = parameters of variable 't' in production functions.

(4) = $0.650 \Delta \ln \frac{K_{1,-1} + 0.275vA}{h_1 L_1}$ for Sector 1 and

$0.347 \Delta \ln \frac{uK_{2,-1}}{h_2 L_2}$ for Sector 2.

(5) = (1) - (2)

of dual structure, proper consideration of investment allocation is needed.

It is assumed that the products of the two sectors are put on the market, where the relative price (P) changes flexibly so that the market is always cleared instantaneously.⁷ That is to say, we assume that supply and demand tend to be equal to each other with respect to both of the two sector products. Owing to Walras' Law, however, one can drop one of the two output markets; here the market for Sector 1 products is eliminated. From the two functions for supply of and demand for Sector 2 products, one may have a relation of P with the population size (N), the amount of Sector 2 products (V_2) and GNP (V).⁸ Equation (6) is the result of estimation of this relation with a distributed lag added. This relation signifies that P tends to increase along with the process of industrialization or a rise in the weight of V_2 in V.

Capital Market Aggregate gross saving (S) is determined through a saving function, which relates per capita saving (S/N) with per capita GNP (V/N), the relative income share of labor in the total economy

$(\frac{PW_1L_1 + W_2L_2}{PV_1 + V_2})$ and the ratio of working age population (Q). Equation (7)

is the estimate of this function with a distributed lag. First, attention should be paid to the parameter for V/N . In the state of equilibrium ($S/N = (S/N)_{-1}$), this parameter is 0.582. This implies that the long-term marginal propensity to consume is 0.418. The latter figure seems to be too small; inclusion of government saving in S may be responsible for this result.⁹ Second, the estimated negative

parameter for $\frac{PW_1L_1 + W_2L_2}{PV_1 + V_2}$, which is highly significant, signifies that the increasing trend and fluctuations related to long-swings (rises in upswings and declines in downswings) in S/N were partly attributable to a decreasing trend and fluctuations associated with long-swings (declines in upswings and rises in downswings) in

$\frac{PW_1L_1 + W_2L_2}{PV_1 + V_2}$ respectively.¹⁰ (See Fig. 3.) These associations between savings and the relative income share, which come from the fact that the propensity to save is much lower in wage income than in non-wage income,¹¹ are very important in that through these associations income distribution tends to affect the rate of capital accumulation and the rate of economic growth. Third, the statistically significant parameter for Q implies that the propensity to save is much higher in the working age population. This relation seems to be reasonable because children are typical consumers.¹²

Substituting S into relation (9), the saving-investment identity, private fixed investment (I) is obtained. In this relation housing investment (I_h), military expenditure (I_{gm}), government fixed investment¹³ (I_{g1} and I_{g2}) and net exports (B) are given from outside of the model.

The way in which fixed private investment (I) is allocated between the two sectors, as was already pointed out, is believed to play one of the key roles in explaining dual structure. Depending on previous studies of investment decisions, the following two variables, together with the investment allocation in the previous year ($(I_2/I_1)_{-1}$), are considered to explain I_2/I_1 . This first variable is the output ratio between the sectors (V_2/V_1). The relationship between I_2/I_1 and V_2/V_1 may be considered to reflect the "profit principle" of investment decisions. The second is the capital stock ratio between the sectors in the previous year ($(K_2/K_1)_{-1}$). The association between I_2/I_1 and $(K_2/K_1)_{-1}$, if it is a negative one, may stand for the "capital stock adjustment principle." Equation (8) shows that both of the two principles (profit and stock adjustment) worked in this economy.¹⁴

Besides the equations which were referred to above, another five relations are needed to complete the model. Equations (10), (11) and (12) give the definitions of V , L and I respectively. Equations (13) and (14) show that the capital stock in the respective sectors is the sum of fixed private investment (I_1 and I_2), fixed government investment (I_{g1} and I_{g2}) and the difference between the capital stock in the previous year ($K_{1,-1}$ and $K_{2,-1}$) and the capital stock discarded in the current year ($\delta_1 K_{1,-1}$ and $\delta_2 K_{2,-1}$).

The structure of this model may be easily understood by the flow chart presented as Fig. 5. To begin with, suppose the value for P is provisionally given. As W_1 is given exogenously, equations

(1) and (2) can be solved with respect to W_2 and V_2/L_2 . Substituting the value of V_2/L_2 into equation (5), we get L_2 and hence V_2 also. Subtraction of L_2 from L , which is given from equation (3), yields L_1 . Substituting the value for L_1 into equation (4), V_1 is obtained. At the given levels of V_1 and V_2 , equation (6) determines P . This value for P does not necessarily coincide with its provisional value. Computation is repeated until these values become equal to each other. In this way eight endogenous variables (V_1 , V_2 , V , L_1 , L_2 , L , W_2 and P) are finally determined. Substituting some of them into equation (7), we have the equilibrium value of S . Hence, by using equation (9), we get the funds available for private investment expenditures for capital equipment (I). These expenditures are divided between the two sectors through equation (8). I_1 and I_2 are added to the capital stock of both sectors in the previous year to give the capital stock in the current year (K_1 and K_2) in equations (13) and (14) respectively. K_1 and K_2 are utilized in the next year for producing larger amounts of output in equations (4) and (5) respectively.

Goodness of fit of this simultaneous equation model is evaluated by a final test. Ratios of the estimates in the final test to the actual values for respective endogenous variables are calculated for respective sub-periods in Column (1) of Table 6 to give a broad view of the performance of this model. More accurate information is available from the Theil's inequality coefficients for the entire period shown in Column (2). Some variables, such as fixed investment in both sectors and savings, show

Table 6: Comparison of Final Test Results with Actual Values

	Ratio of Final Test to Actual (1)			Inequality Coefficient
	I	II	III	(2)
V ₁	1.002	0.991	1.054	0.083
V ₂	1.093	0.852	1.026	0.114
V	1.029	0.935	1.041	0.054
K ₁	0.972	0.976	1.035	0.039
K ₂	1.081	0.884	0.938	0.085
K	1.028	0.925	0.982	0.047
L ₁	1.010	1.103	1.064	0.078
L ₂	0.987	0.669	0.834	0.240
L	1.002	0.995	1.002	0.009
I ₁	1.050	0.750	1.489	0.403
I ₂	1.109	0.499	0.915	0.277
I	1.091	0.593	1.047	0.238
S	1.109	0.585	1.045	0.220
W ₂	1.115	1.205	1.017	0.153
P	1.158	0.877	0.790	0.202

Remarks: Figures in (1) and (2) stand for \bar{X}/X
and $\sqrt{\frac{35}{\sum_{t=1}^{35} (\bar{X}_t - X_t)^2} / \frac{35}{\sum_{t=1}^{35} X_t^2}}$ respectively, where \bar{X}

and X are the estimates in final test and the actual values respectively. Figures for \bar{X} and X in (2) are the means of respective sub-periods.

I, II and III signify 1906-20, 1921-30 and 1931-40, respectively.

considerable discrepancies especially for 1921-30. It may be stated, however, that this model succeeds in tracing observed values as far as their long-term tendencies are concerned. This fact indicates that our basic assumptions such as the applicability of the theory of economic development with USL are not far from reality.

(2) Simulation Analysis

Now we are in a position to make simulation tests based on the model estimated above. By comparing the values which are estimated under hypothetical assumptions with the values in the final test, one may argue about the effects of these assumptions on the growth and structure of the economy. Table 7 gives ratios of the former values (simulation test) to the latter values (final test) for endogenous variables and some combinations of them for sub-period III (1931-40), this ratio being called the S-F ratio in short. Because the former is equal to the latter in the initial year, **this ratio larger (smaller)** than unity signifies that this variable increases much faster (more slowly) in the hypothetical case than what it actually did.

Population and Labor Supply In Test A the total population (N) is assumed to be constant at the 1906 level (47.198 million persons).¹⁵ Three major findings are noted here. 1) The S-F ratio for V shows that the rate of economic growth is much lower with slower population growth. Considering the ratios for L, K, and S it is known that the lower rate of economic growth comes from a slower increase in labor supply and that the slower increase of population tends to stimulate savings and capital accumulation. The latter result comes from the

Table 7: Means of the Ratios of Simulation Test to Final Test for 1931-40 (S-F Ratios)

	SIMULATION TESTS					
	A	B	C	D	E	F
V_1	1.04	1.11	0.98	1.03	1.02	0.56
V_2	0.56	1.24	1.59	1.14	0.95	2.91
V	0.81	1.17	1.27	1.08	0.99	1.66
K_1	1.52	1.37	1.14	1.13	1.05	0.72
K_2	0.90	1.45	1.61	1.21	0.95	1.92
K	1.20	1.41	1.38	1.18	1.00	1.34
L_1	0.75	1.00	0.84	0.97	1.01	0.28
L_2	0.44	1.14	1.58	1.10	0.95	3.62
L	0.68	1.03	1.00	1.00	0.99	1.03
V/N	1.20	1.17	1.27	1.08	0.99	1.66
I_1	2.22	1.36	0.74	1.03	1.11	0.19
I_2	0.62	2.11	2.33	1.45	0.93	3.04
I	1.14	1.87	1.82	1.31	0.99	2.11
S	1.14	1.88	1.82	1.31	0.99	2.12
PW_1	1.88	1.22	1.78	1.05	0.90	3.55
W_2	1.34	1.10	1.05	1.04	0.99	1.11
W_2/P	0.72	0.90	0.60	0.88	1.10	0.31
$(W_1L_1+W_2L_2)/P/L$	0.77	0.99	0.81	0.93	1.03	0.71
$W_2/(PW_1)$	0.72	0.90	0.79	0.99	1.10	0.31
P	1.88	1.22	1.74	1.17	0.90	3.55
$(W_1L_1)/V_1$	0.73	0.90	0.64	0.84	0.99	0.47
$(W_2L_2)/V_2$	1.04	1.01	1.05	1.00	0.99	1.37
$(PW_1L_1+W_2L_2)/(PV_1+V_2)$	0.82	0.96	0.84	0.92	0.99	1.03
\bar{L}/L_1	0.38	0.84	0.15	0.69	0.99	-4.70

Remarks: Tests A: N is constant. B: Q is constant.

C: W_1 is constant. D: 1906 level of W_1 is 150 yen.

E: No wage lag in Sector 2.

F: W_2 is equal to the marginal labor productivity in Sector 2.

fact that a decrease in the total population decreases the basic consumption of the economy.¹⁶ Per capita income (V/N) and real wages in Sector 2 (W_2) tend to increase with the slower increase of population.

2) The relative price (P) is raised considerably, which is attributable to the fact that a decrease in N causes a decrease in the demand for Sector 2 products.¹⁷ Because of this increase, the Sector 2 wages (W_2/P) and the average wages in the total economy ($(W_1L_1 + W_2L_2/P)/L$), both in terms of Sector 1 products, which may be taken as indexes for wages deflated by consumer prices, and the wage differential between the sectors ($W_2/(PW_1)$) tend to decline. The relative income share of labor decreases in Sector 1 and in the total economy, while it remains almost constant in Sector 2.

3) Employment decreases much faster in Sector 1 than Sector 2, causing a decline in the proportion of surplus labor (\bar{L}/L_1).

Implications of these findings are as follows: The first finding implies that if the rate of population increase had been much higher in Japan, the rates of growth in GDP and per capita GDP would have been, respectively, higher and lower than what they were. The fact that the rate of economic growth in Japan was high compared with other countries, whereas such was not the case for the rate of population increase,¹⁹ seems to show at a glance a non-existence of the relationship between economic growth and population increase. This view has been revealed to be superficial. The second finding indicates the important role of a change in relative prices on the wage differential. That is to say the wage differential may decrease even before the turning point

depending on a change in P .²⁰ The third finding seems to support the commonly held view that an increase of surplus labor can partly be attributed to rapid population growth and implies that the turning point can be reached with a lower rate of population increase. In light of the conclusion a decline in the rate of population increase in the postwar period may be identified as one of factors for passing the turning point in about 1960.²¹

An implicit assumption of the discussion above is that a change in the rate of population growth does not alter the age composition of population. However a decrease in the rate of population growth is sometimes followed by aging of the population, which is simply expressed by a rise in Q . Effects of a rise in Q are clarified by Test B, in which Q is assumed to be constant at the 1906 level in place of its actual decreasing trend.²² The increase in Q tends to stimulate the economic growth through the two ways; to increase labor supply and to accelerate savings by shifting the saving of function upward. Hence the positive effect of a rise in the rate at population growth on the rate of economic growth should be discounted to some extent, if a rise in the former rate is followed by a decline in Q .

Labor Supply Price Sector 1 wages (W_1) may be taken as the price of labor supply, because this sector was a major source of labor supply. To clarify the effects of a change in this price two tests are carried out: In Test C, W_1 is assumed as constant at the 1906 level (175 yen) and in Test D the absolute level of W_1 is reduced by 25 yen throughout

the observation period (this means that the initial level was 150 yen). Both of these tests give similar findings: 1) V, K, I and S increase much faster in these hypothetical cases. Labor's relative share decreases in Sector 1 and in the total economy, while remains almost constant in Sector 2. Hence it may be stated that if the labor supply price is much lower than what it was, the relative income share of labor becomes much lower, and savings, investment, capital and consequently output of the economy increase much faster. 2) Another important result is a big increase in P , which comes from a much faster increase in V_2 than V_1 . This increase gives rise to an increase in the supply price of labor to Sector 2 in terms of its sector products (PW_1), although W_1 is much lower for this decade in these tests than what it actually was, and therefore an increase in W_2 . On the other hand the increase in P gives rise to decreases in W_2/P and $(W_1L_1 + W_2L_2/P)/L$. Because of a decline in W_2/P , $W_2/(PW_1)$ decreases and remains constant in tests C and D respectively. 3) The decrease in \bar{L} is also worthy of special attention. It becomes zero, which implies that the turning point is passed, in 1937 and 1940 in Tests C and D respectively. The decrease in \bar{L} depends on a decrease in L_1 which is caused by an increase in L_2 . That is, much faster capital accumulation in Sector 2 gives rise to an increase in the demand for labor and causes declines in L_1 and \bar{L} . After the turning point is passed, unlimited supplies of labor cease to be available for rapid expansion of Sector 2.²³

The first finding seems to be consistent with the so-called "cheap labor hypothesis", which is widely held among Japanese Marxists.²⁴ They claim that one of the main reasons for the high rate of economic growth of Japan was the existence of "cheap labor", which decreased labor's relative share of income and stimulated the rate of capital accumulation.²⁵ What is implied by the second and the third findings is, as was pointed out by Lewis himself (1954, pp. 431-435), a higher rate of economic growth with a slower wage increase will be faced sooner or later with such bottle-necks as an increase in the price of labor supply to the capitalist sector in terms of its sector products and a disappearance of the unlimited supplies of labor. The capitalist class and the pro-capitalist government, as a device to the first bottle-neck (an increase in the price of labor), tend to introduce a policy to import cheap agricultural products from colonies. This policy is expected to mitigate the increase in P and PW_1 . This was the case for Japan: A decline in the growth rate of rice output and an increase in demand for rice forced the rice price to rise, culminating in the rice riots of 1918 and therefore the government embarked upon a program to develop Korea and Taiwan as a major suppliers of rice to Japan. This led to deterioration of rice prices, tending to mitigate an increase in the relative price between agriculture and industry.²⁶ It is believed among the economists who assert the cheap labor hypothesis that this policy contributed to industrial growth by mitigating an increasing trend in the supply price of labor in terms of industrial products.²⁷

That is to say, such an evaluation of the rice import policy is integrated in the cheap labor hypothesis, which is the reason why this hypothesis is usually referred to as the "low-rice-price and low-wage hypothesis". Testing this hypothesis is the next problem to be studied.

This test can be carried out by using the model in which P is assumed to be an exogenous policy variable.²⁸ (Table 8 shows the results of the final test for the new model. Compared with figures in Table 6 this model demonstrates a better performance.) Table 9 gives S-F ratios for the two tests based on this model: Tests C' and D' are correspondent to Tests C and D respectively, except that P is exogenous in Tests C' and D'. Comparison should be made between Tests C and C' and also between Tests D and D'. The S-F ratio is much higher for V_2 , V and so forth and lower for PW_1 and W_2 in Tests C' and D' than in Tests C and D respectively. Thus it may be safely stated that an increasing trend in PW_1 and W_2 which is expected to appear in the higher rate of economic growth with a slower wage increase can be mitigated by means of eliminating the increase in the relative price based on a policy to change the composition of commodity imports. In short, the low rice price and low wage hypothesis seems to be acceptable in light of the Japanese experience.

As a device to the second bottle-neck (an exhaustion of USL), the government is presumed by Lewis to take a policy to utilize cheap laborers in its colonies. This was also the case for Japan. Laborers from Korea and Taiwan were forced to work in Japan under the terrible working conditions. Concerning with the disappearance of USL, Tests C' and D' demonstrate such an interesting result that USL disappears

Table 8: Comparison of Final Test Results with Actual Values: When the Relative Price is Exogenous

	Ratio of Final Test to Actual (1)			Inequality Coefficient
	I	II	III	(2)
V ₁	0.994	0.976	1.049	0.081
V ₂	1.171	1.010	1.017	0.102
V	1.046	0.990	1.034	0.053
K ₁	0.996	0.973	0.997	0.027
K ₂	1.109	0.983	0.996	0.045
K	1.038	0.978	0.997	0.022
L ₁	0.989	1.053	1.079	0.060
L ₂	1.055	0.826	0.797	0.177
L	1.002	0.996	1.003	0.009
I ₁	1.046	0.720	1.356	0.316
I ₂	1.241	0.952	0.898	0.273
I	1.178	0.865	1.003	0.201
S	1.194	0.850	1.001	0.194
W ₂	1.063	1.195	1.093	0.150

Remarks: See Table 6.

Table 9: Means of the Ratios of Simulation Test
to Final Test for 1931-40 (S-F Ratios):
When the Relative Price is Exogenous

	SIMULATION TESTS	
	C'	D'
V_1	0.84	0.93
V_2	2.24	1.66
V	1.49	1.26
K_1	1.05	1.00
K_2	1.72	1.47
K	1.41	1.26
L_1	0.58	0.80
L_2	2.57	1.77
L	1.01	1.01
V/N	1.49	1.27
I_1	0.51	0.63
I_2	3.00	2.18
I	2.23	1.70
S	2.24	1.70
PW_1	0.76	0.47
W_2	0.86	0.94
W_2/P	0.86	0.94
$(W_1L_1+W_2L_2/P)/L$	1.27	1.15
$W_2/(PW_1)$	1.13	1.05
P	1.00	1.00
$(W_1L_1)/L_1$	0.52	0.77
$(W_2L_2)/L_2$	0.99	1.00
$(PW_1L_1+W_2L_2)/(PV_1+V_2)$	0.83	0.90
\bar{L}/L_1	-0.61	0.53

Remarks: Tests C' and D' are correspondent to Tests C and D respectively.

much earlier in these tests than in Tests C and D respectively, because L_2 increases and L_1 decreases much faster in the former tests. (For instance the turning point is passed in 1937 and 1933 respectively in Tests C and C'.) This implies that import policy of cheap agricultural products can mitigate an increasing trend in the supply price of labor to the capitalist sector on the one hand, but on the other hand it tends to accelerate a decreasing trend of USL by stimulating the economic growth. Here the capitalists are in a dilemma.

Labor Market Structure Referring to the wage determination function (1), it has been found that W_2 increases with a lag behind the increases in PW_1 and V_2/L_2 . Also in the demand function for labor (2), we have found a difference between W_2 and the marginal labor productivity ($\beta V_2/L_2$) in Sector 2. Tests E and F are concerned with the hypothetical cases, respectively, without the wage lag and without a difference between W_2 and $\beta V_2/L_2$ in the state of long-run equilibrium. That is to say, in equation (1) W_2 is assumed to be equal to $W_{2,-1}$ and in equation (2) the elasticity ^{of} demand for output (α) is assumed to be infinite or the parameter for W_2 is assumed to be 0.213²⁹ in a place of the actual value (0.286). In Test E all S-F ratios are almost equal to unity, which means that absence of the wage lag does not make a big difference in the performance of growth and structure of the economy.

In Test F, however, big changes are found between the actual and hypothetical cases. An increase in α makes the demand function for labor in Sector 2 shift upwards, which increases L_2 and decreases L_1 . These changes in employment structure are responsible for the fact that V_1

decreases and V_2 increases. The rate of economic growth increases because industrialization stimulates savings and investment. V/N and W_2 increase, whereas W_2/P , $(W_1L_1 + W_2L_2/P)/L$ and $W_2/(PW_1)$ tend to decrease. These decreases are caused by a big increase in P , which comes from the larger increase in V_2 than V_1 . Labor's relative income share decreases in Sector 1, increases in Sector 2 and remains almost constant in the total economy. Because of the big decline in L_1 , \bar{L} tends to decrease and becomes negative in 1934. That is to say, if the output market were fully competitive or wages just equal to marginal productivity were paid in pre-war Japan, this economy could have passed the turning point sometime in the 1930's.

IV. Concluding Remarks

In the first half of this paper the changes in sectoral wages and productivity were overviewed and an econometric explanation for them was attempted, both for the years 1906-40 in Japan. The latter study had a difficulty in that interrelationships between the labor market and the other markets of capital and output were not taken into consideration. To overcome this difficulty, in the latter half of this paper, a simultaneous equation model which covers all of these markets has been developed. This model, which is characterized with USL in a part of the economy, can be taken as an econometric formulation of the Lewisian theory of economic development.

Major findings obtained from simulation tests based on this model are as follows:

- 1) The rate of economic growth is positively correlated with the rates of increase in population and labor supply.
- 2) If the price of labor supply increased much more slowly and/or the initial level of this price, which was inherited from the last century, were much lower, the rate of economic growth would have been much higher. This conclusion may support the so-called "cheap labor hypothesis" which identifies "cheap labor" as one of the major factors for the Japanese high rate of growth.
- 3) The higher rate of growth is associated with much faster growth of the capitalist sector than the subsistence sector in terms of output, employment and capital stock; in short, rapid industrialization or capitalization. One of the major consequences of rapid industrialization is a change in the terms of trade against the capitalist sector.

This raises the supply price of labor to this sector in terms of its products. Faced with this problem, the pro-capitalist government begins to import cheap subsistence goods from colonies. This was what actually happened in Japan: importing rice from her colonies depressed the increasing trend in the supply price of labor and avoided a decrease in the rate of economic growth. In short, the so-called "low-rice-price and low-wage hypothesis" is found to be the case. The change in the terms of trade, on the other hand, decreases the wage differential between the sectors. This conclusion is of great interest in showing the possibility of a narrowing wage differential even before the turning point.

4) In cases of a higher rate of economic growth, the sizes of the labor force and surplus labor both in the subsistence sector tend to decrease because of a big increase in the demand for labor in the capitalist sector. This implies that the size of the subsistence sector labor force would have decreased absolutely even in the prewar years in Japan if the rate of economic growth were much higher than what it actually was. This result is inconsistent with the assertion by some agricultural economists that the constant and the decreasing trends of the agricultural labor force in the prewar and the postwar periods respectively are dependent on the existence and non-existence of primogeniture in these respective periods.¹

5) The turning point would have been passed much earlier, say even in the prewar period, under some favorable conditions; i.e., with the lower rate of population increase, with the lower supply price of labor, with a competitive output market (or without a difference between wages and marginal productivity in the capitalist sector), and so forth.

These conclusions may impress the readers in that the suppositions made by Lewis in his theoretical studies and some hypotheses obtained intuitively by the Japanese Marxists on the Japanese economy have been revealed to be correct. It is not the main purpose of this paper to test the applicability of the classical and the neo-classical approaches, but the fact mentioned above may signify that the former approach describes well the growth and the structural changes in the Japanese economy for the prewar period. A difference between the Lewisian theory and the Marxian economics lies in the fact that the latter theory cannot explain the turning point.² The turning point was actually passed in about 1960, in spite of a pessimistic forecast by Marxists on the economic development in Japan (Minami 1973, p. 17).

STATISTICAL APPENDIX

(Notation Used Below is Explained in Table 3)

In this estimation procedure we rely mainly on the results of the joint project of estimating long-term economic statistics in Japan carried by many scholars including the present authors. The results of this project are published in fourteen volumes (Chōki Keizai Tōkei (Estimates of Long-Term Economic Statistics of Japan since 1868) ed. by K. Ohkawa, M. Shinohara and M. Umemura, Tōyō Keizai Shinpō Sha, 1965-). These results do not, however, provide all data sufficient to estimate our model. Therefore many works are needed in adjusting these basic data and estimating new statistical series. Below A, M and S stand for the primary, secondary (mining, construction manufacturing, and facilities) and tertiary industries (services) respectively.

(1) GDP at 1934-36 prices (V_j) (million yen): Ohkawa's estimates (Ohkawa & others 1974, p. 227). Figures for government are included.

(2) Components of GDE (I , I_h , I_{gm} , I_g , B) at 1934-36 prices (million yen): Ohkawa & others (1974, pp. 213, 219, 221).¹

I is divided into I_1 and I_2 as follows: I_1 is the sum of investment in Sectors A and S ($I_A + I_S$). I_A is available from Ohkawa's estimates. I_S is estimated by multiplying fixed investment for the non-primary sector (I_{M+S}) by the ratio of I_S to I_{M+S} . This ratio is calculated from investment figures by industry groups prepared by Chōki Keizai Tōkei Iinkai (1968, p. 163). I_A and I_{M+S} are from Ohkawa & others 1974, p. 218. I_2 is estimated as $(I - I_1)$.

Next I_g should be divided into I_{g1} and I_{g2} : I_{g1} is estimated by multiplying I_g by the ratio of I_{g1} to I_g . This ratio is obtained as the ratio of ΔK_{g1} to ΔK_g . K_g stands for government gross capital stock and K_{g1} signifies government capital stock related to Sectors A and S ($K_{gA} + K_{gS}$). Figures for K_g , K_{gA} and K_{gS} (at 1960 prices) are available from the estimates by Chōki Keizai Tōkei Iinkai (1969, p. 168). I_{g2} is calculated as $(I_g - I_{g1})$.

(3) Gross saving at 1934-36 prices (S) (million yen): Gross saving, which is defined as a difference between GDE and consumption expenditures (private and government), is calculated as $I + I_h + I_{gm} + I_g + B$.²

(4) Relative price index (P) (1934-36 = 1): This is calculated as P_1'/P_2' , where P_1' and P_2' are obtained as V_j'/V_j respectively. V_j' (NDP at current prices) and V_j (NDP at 1934-36 prices) are from Ohkawa and others (1974, pp.202 and 226).

(5) Consumer price index (P_c') (1934-36 = 1): This is calculated as C'/C , where C' and C stand respectively for personal consumption expenditure at current prices and that at constant prices. C' and C are from Ohkawa & others (1974, pp. 178 and 213).

(6) Wages (W_1) at 1934-36 prices (yen): This is obtained as W_1'/P_1' . W_1' is calculated as the weighted average of wages in Sectors A and S; that is,

$$W_1' = \frac{W_A' L_A + W_S' L_S}{L_A + L_S}.$$

As for W_A' we use annual contract worker wages in agriculture (Umemura and others 1966, pp. 220-221). W_S' is obtained by dividing the relative income share of labor by the nominal labor productivity, both in S sector. The

relative income share is from our own estimates (Minami & Ono 1975; forthcoming).

(7) Wages (W_2) at 1934-36 prices (yen): This is calculated as $W_2 = W_2' / P_2'$. W_2' is obtained by dividing the relative income share of labor by the nominal labor productivity both in M sector.³ The relative income share of labor is based on our estimates (Minami & Ono 1975; forthcoming).

(8) Total population (N) (million persons): For 1920-40 estimates by the Sōri-fu Tōkei-kyoku (1970) are used. For 1905-19 it is estimated by linking the S. T. estimate with the estimates by Akasaka, which will be published in Umemura (forthcoming).

(9) Proportion of working age population (Q): This is calculated as $Q = QN/N$, where QN signifies population aged fifteen years or more. QN is obtained in the way similar to N.

(10) Rate of school attendance (Z): this is obtained as $Z = ZQN/QN$, where ZQN and QN stand for the number of school attendance and the number of production age population, respectively. ZQN is available from Akasaka's estimates, which will be included in Umemura (forthcoming).

(11) Number of employees (L_j) (million persons): This is available from Minami (1973, p. 313). Figures for government employment are included.

(12) Gross capital stock at 1934-36 prices (K_j) (million yen): This is available from Chōki Keizai Tōkei Inkaï (1968, p. 161). Figures for the government are included.

(13) Area of cultivated land (A) (thousand hectare): This is from Umemura & others (1966, pp. 216-217).

(14) Labor hour index (h_1) (1934-36 = 1):

h_1 : It is calculated as a weighted average of two indexes for Sectors A and S. The weights are L_A and L_S . The index for Sector A is calculated as the labor input index divided by L_A . The labor input index of Sector A is from Shintani (1973, pp. 77-79). The index for Sector S is assumed to be the same as the index for manufacturing.

h_2 : Labor hours per year for 1923-40 are calculated as monthly labor days x 12 x daily labor hours based on figures for manufacturing in Nippon Rōdō Undō Shiryō Iinkai (1959, pp. 222). Labor hours for 1905-22 are estimated by linking them with figures for manufacturing in Tokyo City (Tokyo Shi Tokei Nenpyō (Annual Statistical Tables of City of Tokyo)).

(15) Utilization rate of capital assets in Sector 2 (u): It is assumed that there exists a normal level for the capital-output ratio. We fit an equation $\frac{V_2}{K_2} = a_0 + a_1t + a_2t^2 + \dots + a_5t^5$ to the observed values of V_2/K_2 . The discrepancies between the actual values of V_2/K_2 and its estimated values are regarded as expressing the fluctuations of capital utilization. The rate u is calculated from the ratio of the actual values to the estimated values.

(16) Utilization rate of land (v): This is calculated as vA/A , where vA and A stand for land input and land area respectively. vA is from Shintani (1973, pp. 89-91).

(17) Rate of discard of capital stock (δ_j): This is calculated from equations (13) and (14).

FOOTNOTESSection I

¹Minami surveyed this controversy and gave critical comments to the authors who shared different opinions from him (1968, pp. 395-398, 1973, Ch. 14).

²This assertion seems to be favorably accepted in and out of the academic circle in Japan partly because it is consistent with the widely held view that her economy shifted from a labor surplus to a labor shortage phase at that time.

³Changes of unskilled worker wages in association with long-swings were studied by Taira (1970). They are not inconsistent, in our opinion, with our understanding that the turning point was not passed until the late 1950's or the beginning of the next decade, because the concept of the turning point should be a long-term and trend-related economic phenomenon (Minami 1973, p. 72).

⁴Data for 1905 is also used because of the one year lag specification in several regressions.

⁵A recent study by Ono and Watanabe shows big differences in per capita income and consumer prices between rural and urban areas in the early phase of modern economic growth; i.e., per capita income in urban areas was as high as three times that of in rural areas and consumer prices in some urban areas were more than twice of those in rural, both in the 1880's. These facts signify a lack of nation-wide markets for labor and output. Along with the development of modern transportation facilities, however, these regional disequilibria tended to decrease (forthcoming, Figs. 1 & 2).

⁶The brave attempt by Kelley-Williamson (1974) to apply an econometric model to early Meiji years should be appraised in this context. See Ueno and Teranishi (1975, pp. 371-373).

⁷In estimating equations by prewar and postwar era, one may find gaps in the value of parameters between the two eras. These gaps may reflect changes in economic and social conditions.

FOOTNOTESSection II

¹Compensation for labor input by self-employed and family workers is imputed and included in this wage statistic.

²For detailed discussions on the changes in sectoral wages, see Minami (1973, Chs. 7 & 8) and Minami & Ono (forthcoming).

³The exponential rate of growth for the variable 'X' is estimated as the parameter 'b' in the regression equation $\ln X_t = a + b t$.

⁴Due attention should be paid to the existence of a rural-rurban differential in consumer prices during the early stage of economic development (footnote 5 of Section I) and its narrowing along the course of formation of a national market (Ono & Watanabe forthcoming). Wages for a deflated by the rural consumer price index (P'_r), which are shown in Panel A of Table 1, do not show any increasing trend at all. The annual exponential rate of growth is calculated to be 0.05 percent. For details, see Minami & Ono (forthcoming).

⁵For detailed discussions on the Fei-Ranis demarcation of the turning point, see Minami (1973, Ch. 14).

⁶From the study in Section III (1), it will be known that 45 percent and 55 percent of the difference in the rate of growth of labor productivity between the two sectors, A + S and M, is explained respectively by a

difference in the rate of growth in total factor productivity or the rate of technological progress and a difference in the rate of growth of the ratio of non-labor inputs to labor input. For such a particular period as the 1920's, however, technological progress in the modern manufacturing industries seemed to play a decisive role in giving birth to a widening differential in labor productivity between A + S and M. In the following table the annual rate of growth of labor productivity and its components in manufacturing and mining industries is calculated by ten year periods under the assumption of perfect competition.

Annual Rate of Growth in Labor Productivity in Manufacturing and Mining Industries and Its Components

	Growth Rate in Labor Productivity $G\left(\frac{V}{hL}\right)$ (1)	Contributions of Increase in	
		Total Factor Productivity (2) = (1) - (3)	Capital-Labor Ratio $(1-\beta) G\left(\frac{vK}{hL}\right)$ (3)
1907-10	4.23 (100.0)	2.79 (66.0)	1.44 (34.0)
1911-20	2.28 (100.0)	1.55 (68.0)	0.73 (32.0)
1921-30	6.45 (100.0)	5.45 (84.5)	0.99 (15.5)
1931-40	5.11 (100.0)	3.43 (67.1)	1.69 (32.9)

Remarks: G(X) stands for an average of the percentage increases in the variable 'X' $(100 \times (X - X_{-1})/X_{-1})$ for respective decades.

Sources: For V (gross domestic product at 1934-36 prices), L (the number of employees), K (gross capital stock at 1934-36 prices) and h (labor hour index), see the Statistical Appendix.

v (utilization rate of capital): Konosuke Okaka's estimates (Ohkawa & Minami 1975, Appendix Table 4 on p. 575).

β (Labor's relative share of income): Minami & Ono's estimates, which are similar to the estimates mentioned in the Statistical Appendix.

For V, K, L and β , the figures for manufacturing and mining are used, whereas for h and v the figures for manufacturing are utilized.

Because of a lack of perfect competition, which will be referred in Section III (2), the figures in Columns (2) and (3) are not free from some bias. It may be safely stated, however, that the rate of technological progress was the highest in the 1920's and accounted for a major part of the labor productivity increase for this decade.

⁷These changes in sectoral distribution of labor are associated with changes in sectoral distribution of capital and output. This relationship is easily seen in Ohkawa & Rosovsky (1973, Table 4.1 on p. 71).

⁸Changes in Sector A employment and its determinants have been fully studied by Minami (1973, Ch. 6).

⁹The same conclusion has been reached by Ohkawa (1974, Ch. 3).

¹⁰As one of the major evidences for the existence of USL, Minami pointed out the fact that real agricultural wages were much higher than marginal labor productivity (1973, pp. 205-206). The same conclusion has been obtained in the present study; i.e., the output elasticity of labor in Sector 1 is estimated to be 0.350 (equation (4) in Table 4), whereas the relative income share of labor in this sector is 0.604, 0.704 and 0.568 on the average for 1906-20, 1921-30 and 1931-40 respectively.

¹¹Note that the hypothesis of unlimited supplies of labor formulated by Lewis refers to unskilled labor, whereas limited supplies of skilled labor are also assumed by Lewis (1954, p. 406 (reprinted version)).

¹²Surplus labor or disguised unemployment, which is denoted by \bar{L} , is defined here as the labor force for which marginal productivity is much smaller than wages (W_1), or the difference between the size of the labor force whose marginal productivity is equal to W_1 and the total Sector 1 labor force (L_1).

¹³An explanation for determination of the "subsistence level" or the "institutional wages" (W_1'/P_1') is not attempted in this study. This level is considered to be dependent upon various factors, economic as well as non-economic. A wide-range study covering economics as well as the other social sciences is needed in this respect.

¹⁴This assumption is found also in a formulation of the Lewisian theory by Fei-Ranis (1964). By means of this assumption we can drop one variable (P_c'/P_2') and one equation which explains this variable in the econometric model developed below.

¹⁵If statistics for wages and the size of the labor force for both skilled and unskilled workers in Sector 2 were available, a wage determination function could be estimated for each of the two types of workers. A function for these two types of workers combined is set forth in this paper because of a lack of these statistics.

¹⁶The effect on W_2 of a change in the composition of workers, skilled and unskilled, is neglected in this formulation for the sake of simplicity.

¹⁷Our explanation of the emergence of wage differentials is different from that explanation which insists on the existence of wage differentials for the same quality of labor. We should rather admit that our explanation might describe only one aspect of the phenomenon.

¹⁸The equilibrium condition in Sector 2 is written as

$$\left(1 - \frac{1}{\alpha}\right) \beta \left(\frac{V_2}{L_2}\right)^* = W_2.$$

The left hand side of the above equation represents an equilibrium value of the marginal revenue product of labor, where α is the elasticity of demand for output with respect to price, and β is the output elasticity with respect to labor. These elasticities are assumed to be constant through time (the constancy of β comes from the assumption of a Cobb-Douglas production function in Sector 2). By transforming this we get

$$\left(\frac{V_2}{L_2}\right)^* = \frac{1}{\left(1 - \frac{1}{\alpha}\right) \beta} W_2.$$

$\left(\frac{V_2}{L_2}\right)^*$ is the desired level of average labor productivity which leads to maximum profit at the prevailing level of wages. The partial adjustment model is written as

$$\left(\frac{V_2}{L_2}\right) - \left(\frac{V_2}{L_2}\right)_{-1} = \lambda \left\{ \left(\frac{V_2}{L_2}\right)^* - \left(\frac{V_2}{L_2}\right)_{-1} \right\} ,$$

where V_2/L_2 is the actual level of average productivity which is realized every year, and λ is a fraction of the difference between the desired and actual levels. Combining the above two equations, we have

$$\frac{V_2}{L_2} = \frac{\lambda}{\left(1 - \frac{1}{\alpha}\right) \beta} W_2 + (1 - \lambda) \left(\frac{V_2}{L_2}\right)_{-1}.$$

By estimating this equation and using an estimate for β in the production function (equation (5) in Table 4), we can calculate α and λ .

¹⁹From the two relations of $\frac{\lambda}{\left(1 - \frac{1}{\alpha}\right) 0.653} = 0.264$ and $1 - \lambda = 0.875$,

α and $1 - \frac{1}{\alpha}$ are calculated as 0.139 and 0.740, respectively. The latter figures implies that the elasticity demand for output (α) and Lerner's degree of monopoly ($1/\alpha$) are 3.85 and 0.260 respectively.

FOOTNOTESSection III

¹In spite of an attempt by Klein and Shinkai to treat the total population as an endogenous variable (1963, pp. 6-7), we assume that the total population (N) as well as the ratio of working age population to the total population (Q) are exogenously given. This is because we consider that this assumption is rather realistic in the observation period and consistent with the theories of Lewis and Fei-Ranis: Lewis admitted the possibility of a decline in the death rate and consequently of a rise in the natural rate of increase with rising per capita income (1954, pp. 404-405 [reprint version]); however, such a notion is not integrated into his theory of economic development (Jorgenson 1967, p. 293). In the model by Fei-Ranis, population is explicitly treated as an exogenous variable (1964, p. 228).

² $\left(\frac{W_1 L_1 + W_2 L_2}{L}\right)_{-1}$ and Z increased 2.27 percent and 3.58 percent per annum respectively for 1906-40. Other things being equal, the former increase gave rise to a 0.11 percent increase of L/QN, while the latter decreased L/QN by 0.52 percent. As a net result of these opposite effects L/QN was expected to decrease by 0.41 percent. (The actual decrease for L/QN was 0.41 percent.)

³The constant (0.275) attached to the variable A in the production function of Sector 1 stands for the value of land assets per thousand hectare at 1934-36 million yen (Umemura & others 1966, p. 221).

⁴Means of the annual cross-sectional estimates by M. Shinohara (1949, p. 209) for the output elasticities of capital and labor in manufacturing for 1929-40 are 0.3321 and 0.6239 respectively. Dividing these figures by the sum of them (0.9560) one may obtain the elasticities under the assumption of constant returns to scale. They are 0.347 and 0.653 respectively.

⁵The importance of the concept of borrowing technology in understanding the Japanese economy has been stressed by not a few authors (i.g., Ohkawa & Rosovsky 1973, Ch. 4).

⁶Many studies have been made of technological progress in agriculture. For instance Hayami & Yamada (1968).

⁷A theoretical basis for this formulation of relative price determination is found in Fei-Ranis (1964, pp. 155-159). This formulation is believed to hold in the prewar Japanese economy.

⁸The demand for Sector 2 products (X^d) is assumed to depend on three variables: GDP at constant prices (V), the total population (N), and relative prices (P); i.e., $X^d = F_1(V, N, P)$, where the first derivatives for V, N and P are all positive. In equilibrium we have $X^d = X^s = X$, where X^s and X stand for the supply of and the actual quantity (domestic production + import-export) of the Sector 2 products. For simplicity we substitute V_2 for X . Consequently, we have $V_2 = F_1(V, N, P)$ or $P = F_2(V, N, V_2)$. First derivatives for V and N , and V_2 in the last function are expected to be negative and positive respectively.

⁹Especially, a rapid increase in military expenditure (I_{gm}) during the years of military expansion seemed to give an upward bias to the estimate of the propensity to save. Estimating the saving function by using $S-I_{gm}$ in a place of S , the marginal propensity to save in a long-run equilibrium state decreases to 0.337. Inclusion of military expenditure in our saving concept is dependent on our understanding that military expenditure was financed by government bonds which were conceived as saving when held by households.

¹⁰In the consumption function estimated by Klein and Shinkai for the Japanese economy during 1930-59 as well, the variable of the ratio of non-wage to wage income is included (1963, p. 9).

¹¹Our result may look similar to the savings function in the Cambridge school theory of economic growth; i.g., Kaldor (1957). If savings data were available for different income groups, we could estimate different savings functions for the respective groups. Also it should be interesting to estimate these functions by sector, if savings data by sector were available, because it was believed that the considerable amount of savings in agriculture was flowed into non-agriculture in the early phase of modern economic growth (Ohkawa & Rosovsky 1960).

¹²In the state of equilibrium one may know that the increase in V/N for the observation years (186 yen) increased S/N by 108 yen and the decrease in $\frac{PW_1 + W_2L_2}{PV_1 + V_2}$ (0.201) increased S/N by 61 yen, other things being equal. On the other hand the decrease in Q (0.017) gave rise to a decline in S/N by 40 yen. These three effects account for an increase of S/N by 129 yen. (The actual increase was 116 yen.) Here it should be specially noted that the positive effect on savings by worsening

labor's share was not small.

¹³Statistics used in this model include figures for the government. This inclusion comes from a convenience for data estimation.

¹⁴In his recent study for 1886-1938, Ishiwata claims the applicability of the profit principle both in the non-primary and the total economy (1975). Concrete conclusions have not, however, been attained with respect to the capital adjustment principle. In the state of equilibrium ($\frac{I_2}{I_1} = (\frac{I_2}{I_1})_{-1}$) it is known that, other things being equal, the rise in V_2/V_1 from 1906 to 1940 (0.909) increased I_2/I_1 by 19.08, whereas the increase in $(\frac{K_2}{K_1})_{-1}$ decreased it by 12.85. The net increase caused by changes in the variables was 6.23, which was comparable with the actual increase of 4.96.

¹⁵The annual exponential rate of growth of N is 1.29 percent.

¹⁶The negative constant of the saving function (7) should be noted here.

¹⁷See the negative parameter for N in the determination function of the relative price (6).

¹⁸See figures in Kuznets (1971, Tables 1 & 3).

¹⁹In addition to Test A, which provides the case with zero population growth, we have attempted some simulation tests for hypothetical cases of population increase at alternative rates of growth (1 and 2 percent per annum) and obtained just the opposite conclusions to those in Test A. This signifies that the results of Test A are reversible. This is the case for all simulation tests below.

²⁰When the turning point is passed or unskilled workers become limited in supply, wage differentials between skilled and unskilled workers are expected to decrease (Minami 1973, pp. 77-78). Refer to footnote 23.

²¹Lewis predicted that Japan would reach the turning point sometime in the 1950's on the basis of the rapid decline in the crude birth rate following W.W.II (1958, p. 29). Comments on this view are found in Minami (1973, pp. 237-246).

²² Q decreased from 0.649 in 1906 to 0.633 in 1940.

²³After the turning point is passed, W_1 is no longer exogenous. It is expected to increase in parallel fashion with the marginal productivity of labor in Sector 1. What actually happened after the turning point about 1960 was a rapid increase in real wages for unskilled workers and narrowing wage differentials (see Minami 1973, Chs. 7 & 8).

²⁴This view has been expressed also by some non-Marxists (e.g., Shinohara 1961; 1962).

²⁵In addition to this explanation for the high rate of economic growth, the Marxists and some non-Marxists claim that "cheap labor" tends to stimulate economic growth by decreasing export prices and expanding exports. This possibility was not taken into consideration in this study, because in our model foreign trade is treated exogenously. If this were considered in the study, the negative relation between the supply price of labor and the rate of economic growth would have been much clearer.

²⁶For details see Hayami & Ruttan (1970, p. 570).

²⁷For instance see Shinohara (1961, Ch. 10).

²⁸This assumption corresponds to eliminating equation (6) in the original model presented in Table 4.

²⁹Substituting λ (0.139) and β (0.653) into the relation $\lambda / [(1 - \frac{1}{\alpha})\beta]$, it becomes $0.213 / (1 - \frac{1}{\alpha})$. The latter is 0.213 when $\alpha = \infty$.

FOOTNOTESSECTION IV

¹See Minami (1973, Ch. 6) for a survey on this assertion and critical comments on it.

²One of the most important conclusions of Marx's theory is that the "industrial reserve army" is being continuously expanded in a capitalist economy.

FOOTNOTES

Statistical Appendix

¹Partly because inventory investment is not explicitly included in GDE but only partly included in fixed capital formation and consumption expenditures, GDE seems to be underenumerated (Ohkawa & others 1974, p. 70). This fact being considered, it is assumed that statistical discrepancies between GDP and GDE all belong to GDE.

²This way of estimating S signifies that statistical discrepancies are assumed to belong to consumption expenditures.

³Denoting factor income in Sector j by Y'_j , W'_j is estimated as $\frac{W'_j L_j}{Y'_j} / \frac{V'_j}{L_j}$, where $\frac{W'_j L_j}{Y'_j}$ stands for the relative income share of labor.

The former expression is rewritten as $W'_j \cdot \frac{V'_j}{Y'_j}$. Therefore it should be noted that our estimates for W'_j to be used in this study are not free from a discrepancy between the two estimates for GDP and factor income. Comparison between the two is made in Minami and Ono (forthcoming).

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