MODELING DUALISTIC DEVELOPMENT IN JAPAN

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I. *Introduction*

(1) Purpose of This Study

One of the most distinguished characteristics of the prewar Japanese economy is, in the writers' opinion, the dual structure or the co-existence of the subsistence and capitalist sectors. That is to say agriculture and small scale establishments in non-agriculture belong to the former sector characterized by surplus labor or unlimited supplies of labor (USL), while other industries, mostly based on modern technology, comprise the latter sector characterized by the marginal principle. Such an understanding of the Japanese economy, which is usually referred to as the "classical approach," is in contrast with the "neo-classical approach," which assumes the marginal principle for all industries. (The dual structure in this sense is not and cannot be treated in the latter approach.) Japan has been a battlefield of the controversy between the two approaches. The former approach has been claimed by Lewis, Fei-Ranis, Ohkawa, Minami and others, while the latter approach has been taken by Jorgenson, Kelley-Williamson, and others.[1] There is no need in this paper, however, to argue the applicability (inapplicability) of the classical (neo-classical) approach, because full scale arguments have been made by Minami in his book in 1973.[2]

Relying on his conclusion in that book, that the classical approach was applicable until around 1960, a model with an emphasis on the labor market will be set forth following this approach and estimated using Japanese statistics in Section II. Based on this model some simulation tests will be attempted in Section III. They will shed light on the mechanism and the features of economic growth in prewar Japan. Such a simultaneous equation approach must be much more efficient than ordinary approaches of "comparative statics" and "comparative dynamics," because of simultaneous relations among economic variables. The model estimated in this paper can be taken as an econometric version of the theory of economic developemnt à la Lewis and Fei-Ranis.[3] Simulation study in Section III will

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[1] See Lewis [1958], Fei and Ranis [1964], Ohkawa [1972], Minami [1968] [1973], Jorgenson [1966], and Kelley and Williamson [1974]. Among the economists who claim the classical approach, there is a difference in demarcating the turning point; it is 1916-19 for Fei-Ranis and around 1960 for Ohkawa and Minami.

[2] The assertion of the turning point occurring in about 1960 (Minami [1968] [1973]) 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.

[3] Lewis [1954]. Fei and Ranis [1964].

give a test of applicability of some conclusions, attained by Lewis and Fei-Ranis in their theoretical studies, in light of the Japanese experiences. Major findings and their implications will be summarized in Section IV. Coming to the study in Sections II and III, it may be pertinent to give a survey of the sectoral changes in wages and employment in the last part of this section.[4]

(2) Overview of Sectoral Wages and Employment

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, including government). Wages deflated by the consumer price index (P'_c) given in Panel A of Table 1 demonstrate different pattern of changes among sectors:[5] The exponential rate of growth[6] for the entire period (1906-40) is the highest in M (2.53 percent per annum) and the lowest in A (0.37 percent).[7] S lies between them (1.25 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.

During the downswing in the 1920's big enterprises used some devices to mitigate the

TABLE 1. REAL WAGES BY THREE INDUSTRY GROUP, WAGE DIFFERENTIALS AMONG THREE INDUSTRY GROUPS, AND PERCENTAGE OF SURPLUS LABOR IN SECTOR 1 LABOR FORCE

	1906–10	1911–15	1916–20	1921–25	1926–30	1931–35	1936–40
	A. Real Wages (Yen)						
A	0.78 (0.94)	0.82 (0.96)	0.95 (1.29)	1.10 (1.47)	1.08 (1.36)	0.79 (0.84)	0.90[1] (0.91[1])
M	0.83	0.85	0.99	1.39	1.53	1.60	1.46[1]
S	0.64	0.66	0.82	1.13	1.09	0.89	0.81[1]
	B. Wage Differentials						
M/A	1.06	1.04	1.04	1.26	1.42	2.03	1.62[1]
M/S	1.30	1.29	1.20	1.23	1.40	1.80	1.80[1]
	C. Percentage of Surplus Labor in Sector 1 ($A+S$) Labor Force (%)						
L^*/L_1	59.9	53.2	54.9	68.7	66.3	53.7	43.8

Remarks: Means for respective five years. ([1]stands for 1936-39.) Real wages stand for daily wages for production workers deflated by consumer price index (P'_c). Figures in parentheses are wages deflated by the rural consumer price index (P'_r).

Sources: For wage statistics see Minami and Ono [1978]. P'_r is from Ono and Watanabe [1976]. For L and L^* see Statistical Appendix and Section II (1) respectively.

[4] There are two reasons why this study starts from 1906. 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. See Ono and Watanabe [1976] and Ueno and Teranishi [1975], pp. 371-373.

[5] For detailed discussions of the changes in sectoral wages, see Minami [1973], Chs. 7 and 8 and Minami and Ono [1978].

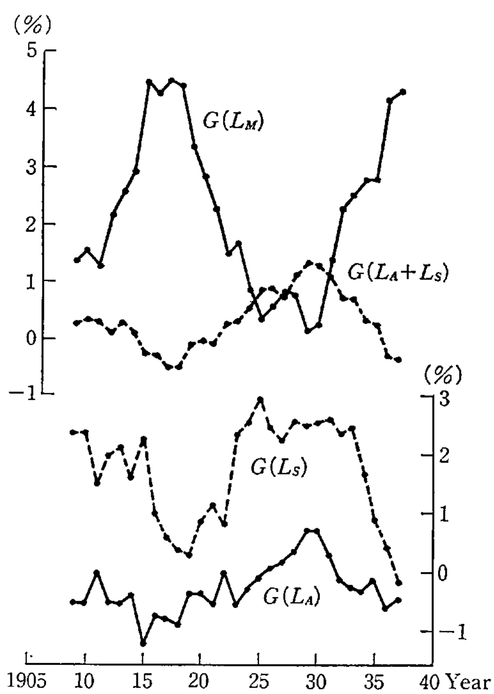
[6] The exponential rate of growth for the variable 'X' is estimated as the parameter 'b' in the regression equation $\ln X_t = a + bt$.

[7] Wages for A deflated by the rural consumer price index (P'_r), which are shown in Panel A, do not show any increasing trend at all. The annual exponential rate of growth for 1906-39 is −0.14 percent.

decline in profits. These were comprised of mechanization of production processes depending on borrowed technology and rationalization of labor management. Referring to the latter, these enterprises reduced 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. 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 first half of the 1930's. This leads us to such important inferences as follows: 1) The Japanese labor market was characterized by a co-existence of separated markets for unskilled and skilled workers. 2) Almost all the labor force in A and a large protion of the labor force in S was comprised of unskilled workers, whereas in Sector M skilled workers were dominant.

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. (All figures are based on seven year averages.) A much more interesting finding is about the pattern of changes in the growth rate of sectoral employment. In Fig.

FIG. 1. GROWTH RATES OF LABOR FORCE BY THREE INDUSTRY GROUP



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

1 the growth rate for Sector M employment (L_M) 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) and therefore L_A+L_S tended to fluctuate in opposite directions from the long swings.[8] These findings are compatible with our assumption that L_M tended to be determined by the demand for labor in Sector M and on the other hand L_A+L_S was determined as a residual.

II. *Modeling*

(1) Labor Market

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

TABLE 2. 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* at current prices (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)
$S=I+I_h+I_{gm}+I_g+B$	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)
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)

[8] Changes in Sector A employment and its determinants have been fully studied in Minami [1973], Ch. 6.

to Sector 2,[9] while the supply of skilled workers in Sector 2 is limited.[10] With these assumptions one may see that we can explain the emergence of wage differentials. 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 the workers are absorbed in Sector 1, a pool of surplus labor.[11]

According to these assumptions Sector 1 wages in terms of its sector products ($W_1 = W_1'/P_1'$), as a substitute for wages deflated by P_c', are exogenously given.[12] 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 basically 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 revenue products of skilled workers.[13] In addition to these basic variables, time trend (t) is included in equation (1) to express a change in the composition of workers by skill. A negative parameter for this variable may imply an increasing weight of unskilled workers. (See Table 3.) The parameter of $W_{2,-1}$ signifies that Sector 2 wages tend to follow the supply price of labor of the Sector 1 workers and the labor productivity in Sector 2 with a lag of about six months. In Sector 2 the

[9] As one of the major evidences for the existence of unlimited supply of labor (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 3), 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.

[10] Note 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]).

[11] Surplus labor or disguised unemployment, which is denoted by L^*, is defined here as the labor force for which marginal productivity is much smaller than wages (W_1).

[12] An 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. The substitution of W_1'/P_1' for W_1'/P_c' is found 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 the equation which explains this variable in the econometric model developed below.

[13] The significance of this formulation is that the wage differential between the sectors tends to emerge with an increase in labor productivity in Sector 2. If 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.

[14] The 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 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. There elasticities are assumed to be constant through time. We have such a partial adjustment model 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 λ is a fraction of the difference between the desired and actual levels in V_2/L_2. 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 3), we can calculate α and λ.

TABLE 3. LIST OF ESTIMATED EQUATIONS

Wage determination function in Sector 2:

(1) $$W_2=-\underset{(1.16)}{28.09}-\underset{(3.29)}{5.56}t+\underset{(3.55)}{0.375}PW_1+\underset{(6.12)}{0.496}\frac{V_2}{L_2}+\underset{(2.95)}{0.330}W_{2,-1}$$ $\bar{R}^2=0.982$, $d=1.72$

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

(2) $$\frac{V_2}{L_2}=\underset{(2.08)}{0.286}W_2+\underset{(10.95)}{0.861}\left(\frac{V_2}{L_2}\right)_{-1}$$ $\bar{R}^2=0.988$, $d=2.14$

Determination function of the labor participation rate:

(3) $$ln\frac{L}{QN}=-\underset{(4.94)}{1.204}+\underset{(1.61)}{0.0477}\,ln\left(\frac{W_1L_1+W_2L_2}{L}\right)_{-1}-\underset{(8.09)}{0.144}\,lnZ$$ $\bar{R}^2=0.959$, $d=0.52$

Production functions:

(4) $$ln\frac{V_1}{h_1L_1}=\underset{(0.21)}{0.865}+\underset{(3.31)}{0.0102}t+\underset{(1.16)}{0.650}\,ln\frac{K_{1,-1}+0.275\,vA}{h_1L_1}$$ $\bar{R}^2=0.794$, $d=0.85$

(5) $$ln\frac{V_2}{h_2L_2}=\underset{(172.96)}{3.602}+\underset{(20.97)}{0.0212}t+0.347\,ln\frac{uK_{2,-1}}{h_2L_2}$$ $\bar{R}^2=0.930$, $d=0.28$

Demand-supply equality for Sector 1 products (determination function of the relative price between the two sectors)

(6) $$ln\frac{V_1}{N}=-\underset{(1.21)}{0.541}-\underset{(6.77)}{0.0150}t+\underset{(11.49)}{1.058}\,ln\frac{V}{N}-\underset{(2.41)}{0.127}\,lnP$$ $\bar{R}^2=0.903$, $d=0.96$

Aggregate saving function:

(7) $$\frac{S}{N}=-\underset{(2.11)}{606}+\underset{(3.64)}{0.249}\frac{V}{N}-\underset{(4.00)}{131}\frac{PW_1L_1+W_2L_2}{PV_1+V_2}+\underset{(2.37)}{1037}Q+\underset{(5.21)}{0.572}\left(\frac{S}{N}\right)_{-1}$$ $\bar{R}^2=0.934$, $d=2.15$

Investment allocation function:

(8) $$\frac{I_2}{I_1}=\underset{(0.06)}{0.0220}+\underset{(2.31)}{2.476}\frac{V_2}{V_1}-\underset{(1.59)}{1.489}\left(\frac{K_2}{K_1}\right)_{-1}+\underset{(8.23)}{0.882}\left(\frac{I_2}{I_1}\right)_{-1}$$ $\bar{R}^2=0.780$, $d=1.75$

Definition equations:

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

(10) $V=V_1+V_2$

(11) $L=L_1+L_2$

(12) $I=I_1+I_2$

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

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

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.

marginal revenue product of skilled and unskilled workers tend to be equal to their respective wages; therefore, it is a case for all workers as a whole. Equation (2) describes this relation.[14] By substituting an estimate for the output elasticity of labor (0.653), which is included in equation (5), 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.[15]

[15] λ and $1-1/\alpha$ (the ratio of wages to marginal labor productivity) are calculated as 0.139 and 0.744, respectively. The latter figure implies that the elasticity of demand for output with respect to price(α) and Lerner's degree of monopoly ($1/\alpha$) are 3.86 and 0.256 respectively.

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, the labor force in this sector (L_2) is known. The employment in Sector 1 (L_1) is determined as $L_1=L-L_2$ (equation (11)). L_1 is composed of the surplus labor (L^*) and the labor force whose marginal productivity (MPL_1) is 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). The ratio of L^* to L_1, which is shown in Panel C of Table 1, shows a negative relation to long swings. This relation comes from the negative association between L_1 and long swings that are studied in Section I (2). Total labor supply (L) is given by the size of working age population (QN), which is given exogenously,[16] and the labor participation rate (L/QN). The latter comes from equation (3), which relates L/QN positively with the average wages in the economy in the previous year $\left(\left(\frac{W_1L_1+W_2L_2}{L}\right)_{-1}\right)$ and negatively with the rate of school attendance (Z).

(2) Other Markets

Output Market: Outputs of both sectors (V_1 and V_2) are determined by 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)[17] and the output elasticity of capital was taken from a cross-sectional study of manufacturing in (5).[18] One of the interesting findings here is a gap in the rate of growth in total factor productivity between the two sectors; 1.02 percent and 2.11 percent in Sectors 1 and 2 respectively. This gap explains 44.5 percent of the difference in the rate of growth in labor productivity. Products of the two sectors are put on the market, where the relative price (P) changes flexibly so that the market is cleared.[19] 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 equilibrium conditions for the two output markets; here the market for Sector 2 products is eliminated. From the demand function for Sector 1 products and the equality of supply and demand, we have equation (6) which relates V_1/N with V/N, P and t.[20] Time trend is included to explain exogenous factors affecting the demand for Sector 1 products; i.e., changes in the

[16] We assume that N and Q are exogenously given. This is because we consider that the 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 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. In the model by Fei-Ranis, population is explicitly treated as an exogenous variable ([1964], p. 228).

[17] The 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 (*LTES*, Vol. 9, p. 221).

[18] Means of the annual cross-sectional estimates by 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 their sum (0.9560) one may obtain the elasticities under the assumption of constant returns to scale.

[19] A 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.

[20] The demand function for Sector 1 products is expressed as $X^d=F_1(V/N, P, t)$, where the first derivatives for V/N and P are positive and negative respectively. 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 1 products. Substituting V_1 for X, we have $V_1=F_1(V/N, P, t)$. An implicit assumption in this formulation is that consumption behavior is the same between the labor force components in the two sectors.

taste of consumers, foreign trade and so forth. V_1 and V_2 being given by production functions, P is determined through this equation. An implication of this equation is that P tends to increase along with the process of industrialization or a rise in V_2 as a percentage of V.

Capital Market: Gross saving (S) is determined through a saving function (7). The long-term marginal propensity to save is calculated as 0.582, which seems to be too large; inclusion of government saving in S may be responsible for this result.[21] The negative parameter for the relative income share of labor in the economy as a whole $(PW_1L_1+W_2L_2)/(PV_1+V_2)$ signifies that the increasing trend and fluctuations related to long swings in S/N were partly attributable to a decreasing trend and fluctuations negatively associated with long swings in the relative share respectively. 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,[22] are very important in that through these associations income distribution tends to affect the rate of capital accumulation and the rate of economic growth. The parameter for the ratio of working age population (Q) implies that the propensity to save is higher accordingly as the share of working age population is larger.

Substituting S into relation (9), the saving-investment identity, private fixed investment (I) is obtained, as housing investment (I_h), military expenditure (I_{gm}), government fixed investment (I_{g1} and I_{g2}) and net exports (B) are given from outside of the model. I is allocated into the two sectors based on equation (8). Considering the "capital stock adjustment principle" in investment behavior, the output ratio (V_2/V_1) and the capital stock ratio in the previous year $((K_2/K_1)_{-1})$ are taken to explain I_2/I_1.[23] Another five equations are needed to complete the model. Equations (10), (11) and (12) give the definitions of V, L

TABLE 4. RESULTS OF THE FINAL TEST—THEIL'S INEQUALITY COEFFICIENT

V_1	0.086
V_2	0.113
K_1	0.136
K_2	0.106
L_1	0.064
L_2	0.210
I_1	0.425
I_2	0.399
S	0.277
W_2	0.071
P	0.387

[21] Especially, a rapid increase in 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.

[22] In his theory Lewis assumes that all savings are done by people who receive profits or rents ([1954], p. 417 [reprint version]). Our saving function is a general formulation of his view. 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.

[23] Unfortunately there are no explicit arguments on the investment allocation in the theories by Lewis and Fei-Ranis, in which it is simply assumed that all savings are invested in the capitalist sector. This assumption is not realistic.

and I respectively. Equations (13) and (14) show the relation between investment and capital stock. Comparison between generated and actual figures for respective endogenous variables will help us evaluate a fitness of this model to the economy. (See Table 4.) Except for I_1, I_2, P and S, fitness of the model is pretty good.

III. *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 several 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 5 gives ratios of the former values (simulation test) to the latter values (final test) for endogenous variables and some combinations of them for the last decade (1931-40), this ratio being called the *S-F* ratio in short. Because the former is equal to the latter in the initial year, the *S-F* ratio larger (smaller) than unity signifies that the variable in question increases much faster (more slowly) in the hypothetical case than what it actually did.

(1) Population and Labor Supply

In Test A the total population (N) is assumed to be constant at the 1906 level in place of the actual increasing trend.[24] Two major findings are noted here. 1) The rate of growth in *GDP* (V) is much lower with slower population growth. This comes from the fact that a negative effect of a slower increase in labor supply tends to offset a positive effect of the slower increase of population which stimulates savings (by decreasing basic consumption) and capital accumulation. V/N and W_2 tend to increase with the slower increase of population. 2) Sector 1 employment (L_1) decreases because of a larger decrease in labor supply (L) than a decrease in the demand for labor in Sector 2 (L_2). Owing to a decrease in L_1, labor productivity in Sector 1 (V_1/L_1) increases, leading to decreases in the size and the proportion of surplus labor (L^* and L^*/L_1). Surplus labor in expected to disappear or the turning point is passed in 1940 in this hypothetical case.[25]

Implications of these findings are as follows:[26] 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 actually were. The fact that the rate of economic growth in Japan was higher than in any other countries, whereas her rate of population increase was not high in international comparison,[27] 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 seems to

[24] The annual exponential rate of growth of N is 1.29 percent.

[25] After 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 and 8).

[26] In 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. That is to say, the model is consistent in that endogenous variables move in the opposite direction. This is the case for all simulation tests below.

[27] Kuznets [1971], Tables 1 and 3.

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 could have been reached earlier if the rate of population increase had been lower. In light of the conclusion a decline in the rate of population increase in the post World War II period may be identified as one of the factors for passing the turning point in about 1960.[28]

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 based on a decrease in the birth rate is usually followed by aging of the population, which is simply expressed in our model by a rise in Q. Effects of a rise in Q are clarified by Test B, in which Q is assumed constant at the 1906 level in place of its

TABLE 5. MEANS OF THE RATIOS OF SIMULATION TESTS TO FINAL TEST FOR 1931-40 (S-F RATIOS)

	A	B	C	D	E	F	G
V_1	0.90	1.14	1.05	1.01	0.89	0.81	0.83
V_2	0.84	1.07	1.11	0.99	1.09	1.77	1.85
V	0.87	1.11	1.08	1.00	0.99	1.28	1.33
K_1	1.12	1.38	1.19	1.03	0.72	0.86	0.91
K_2	1.08	1.32	1.30	0.99	0.93	1.42	1.63
K	1.10	1.35	1.24	1.01	0.83	1.16	1.29
L_1	0.67	1.06	0.99	1.01	0.83	0.63	1.64
L_2	0.74	0.95	1.03	0.98	1.20	1.99	1.97
L	0.69	1.03	1.00	1.00	1.01	1.01	1.01
V_1/L_1	1.35	1.08	1.07	1.00	0.95	1.29	1.31
V_2/L_2	1.15	1.12	1.09	1.00	9.91	0.89	0.94
V/L	1.27	1.07	1.09	1.00	0.98	1.27	1.32
V/N	1.28	1.11	1.08	1.00	0.99	1.28	1.33
I_1	1.17	1.65	1.22	1.02	0.65	0.51	0.59
I_2	1.07	1.63	1.46	1.00	0.83	1.82	2.09
I	1.09	1.63	1.41	1.00	0.79	1.54	1.78
S	1.09	1.63	1.41	1.00	0.79	1.54	1.78
W_1	1.00	1.00	0.76	1.00	1.00	1.00	0.76
PW_1	0.86	0.81	0.96	0.91	2.29	1.06	0.93
W_2	1.16	1.12	1.11	1.00	1.15	0.88	0.92
W_2/P	1.30	1.33	0.83	1.10	0.49	0.82	0.73
$(W_1L_1+W_2L_2/P)/L$	1.20	1.14	0.81	1.05	0.75	1.15	0.98
$W_2/(PW_1)$	1.30	1.33	1.09	1.10	0.49	0.82	0.95
P	0.86	0.81	1.27	0.91	2.29	1.05	1.22
$(W_1L_1)/V_1$	0.74	0.93	0.71	1.00	1.05	0.78	0.58
$(W_2L_2)/V_2$	1.01	1.00	1.02	1.00	1.25	0.99	0.98
$(PW_1L_1+W_2L_2)/(PV_1+V_2)$	0.89	0.97	0.85	1.00	1.11	0.94	0.86
L^*	0.18	0.90	0.16	1.00	1.02	0.27	−0.37
L^*/L_1	0.26	0.85	0.16	0.99	1.09	0.40	−0.60

Remarks: Tests A: N is constant. B: Q is constant.
C: W_1 is constant D: No wage lag in Sector 2.
E: W_2 is equal to the marginal labor productivity in Sector 2.
F: Annual rate of growth in V_1/N is raised exgenously by 1.0%.
G: W_1 is constant in Test F.

[28] Lewis 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.

actual decreasing trend.[29] 1) The increase in Q tends to stimulate the rate of growth in V through the two ways; to increase labor supply and to accelerate savings by shifting the saving function upward. Hence the decreasing effect of a reduction in the rate of population growth on the rate of economic growth should be discounted to some extent, if a reduction in the former rate is followed by a rise in Q. 2) The increase in Q tends to stimulate the demand for labor in Sector 2 and to decrease surplus labor. Therefore the decreasing effect of a decline in the growth rate of population on the surplus labor is much larger actually than is expected in Test A.

(2) Supply Price of Labor

To clarify the effects of a change in W_1, the supply price of labor, it is assumed as constant at the 1906 level in Test C.[30] 1) V, K, I and S increase much faster with this assumption. Labor's relative share decreases in Sector 1 and in the economy as a whole, while it remains almost constant in Sector 2. Hence it may be stated that if the supply price of labor 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) P increases, because of a much faster increase in V_2 than V_1. This increase gives rise to decreases in W_2/P and $(W_1L_1+W_2L_2/P)/L$. In spite of a decline in W_2/P, $W_2/(PW_1)$ increases because of the assumption of constant W_1. 3) L^* decreases and becomes zero in 1939. That is, much faster capital accumulation in Sector 2 gives rise to an increase in the demand for labor in this sector and causes declines in L_1 and L^*. After the turning point is passed, USL ceases to be available for rapid expansion of Sector 2.

The first finding seems to be consistent with the assertion by Lewis which identifies USL as one of the factors for the high rate of economic growth. According to him USL tends to decrease labor's relative share of income and stimulate the rate of capital accumulalion.[31] What is implied by the second and the third findings is, as was pointed out by Lewis himself, that 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 real wages in the capitalist sector in terms of its sector products and a disappearance of USL.[32] The capitalist class and the pro-capitalist government begin to import cheap agricultural products from colonies as a device to the first bottle-neck. This policy is expected to mitigate the increase in P and W_2. This was the case for Japan: The government embarked upon a program to develop Korea and Taiwan as major suppliers of rice to Japan since between 1910 and 1920. This mitigated the increase in the relative price between agriculture and industry.[33] Thus one may presume that this policy contributed to industrial growth by reducing the upward trend in the wages in the industrial sector in terms of its own products.[34]

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[29] Q was 0.649 in 1906 and 0.633 in 1940.

[30] The annual exponential rate of growth of W_1 for 1906-40 is 1.19 percent.

[31] Lewis [1954], pp. 416-420 and 448 (reprint version). This view corresponds to Shinohara's assertion that "cheap labor" accelerated savings and economic growth through a decline in the relative income share of labor in the Japanese economy [1961] [1962]. In addition to this explanation for the high rate of economic growth he claims that "cheap labor" tended to stimulate economic growth by decreasing export prices and expanding exports. This possibility is 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.

[32] Lewis [1954], pp. 431-435 (reprint version).

[33] Hayami and Ruttan [1970], p. 570.

[34] This presumption is seen in Shinohara [1961], Ch. 10.

This hypothesis can be endorsed in Tests F and G. In Test F it is assumed that the annual growth rate in the supply of Sector 1 products per capita is rasied by 1.0% by importing agricultural products.[35] With this assumption V_2 and V increase and W_2 decreases. In Test G, W_1 is assumed constant in addition to the assumption in Test F. By comparing this test with Test C, we can say that the growth rates in V_2 and V are higher and those in P and W_2 are lower in Test G. Thus it may safely be stated that the increasing trend in W_2, which occurs if the rate of wage increase in Sector 1 is lowered, can be mitigated by the suppressing effect of rice import policy on the relative output price.

As a device to the second bottle-neck, the government is presumed by Lewis to utilize cheap laborers in its colonies by encouraging immigration from the colonies and / or exporting capital to them.[36] This was the case for Japan: That is, it is well known that Korean workers were forced to work in Japan under terrible working conditions and Japanese investment in Korea and Taiwan increased from 1920, rapidly after 1931.[37] Concerning the disapperance of USL, Test G demonstrates the very interesting result that USL disappears much earlier (1926) in this test than in Test C (1939), because L_2 increases and L_1 decreases much faster in the former test. This implies that an import policy of cheap agricultural products can mitigate the 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 economic growth. Here the capitalists are in a dilemma.

(3) Labor Market Structure

Tests D and E are concerned with the hypothetical cases, respectively, without a lag in wage determination in Sector 2 and without a difference between W_2 and $\beta V_2/L_2$ in the state of long-run equilibrium. In Test D 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 E, however, big changes are found between the actual and hypothetical cases. 1) Owing to an increase in the elasticity of demand for output (α) or an increase in the ratio of wages to marginal productivity $1-(1/\alpha)$,[38] W_2 and $(W_2L_2)/V_2$ tend to rise, leading to decreases in S and I. 2) An increase in α makes the demand function for labor in Sector 2 to shift upwards, which increases L_2 and decreases in L_1. These changes in sectoral employment are responsible for a decrease in V_1 and an increase in V_2. V does not change significantly because a negative effect of a decrease in I on V and a positive effect of the change in employment structure on V tend to be cancelled out. 3) A decrease in V_1/L_1 gives rise to increases in L^* and L^*/L_1. 4) Because of an increase in V_2/V_1, P tends to increase, followed by an increase in PW_1 and decreases in W_2/P, $(W_1L_1+W_2L_2/P)/L$ and $W_2/(PW_1)$. The increase in PW_1 accelerates the increasing trend in W_2. Thus it may safely be stated that if the output market in the capitalist sector were competitive in prewar Japan, the relative income share of labor would have been much higher, and wage differential between the sectors would have been much smaller; in short, income distribution would have been less unequal.[39]

[35] This assumption means that a parameter for t in equation (6) is assumed to be -0.0250 in place of actual value (-0.0150).
[36] Lewis [1954], pp. 436-437 and 449 (reprint version).
[37] Yamamoto [1975], p. 77.
[38] The latter assumption ($W_2=\beta V_2/L_2$) stands for that α is infinite.
[39] See Ono and Watanabe [1976] for the long-run changes in income distribution of Japan.

IV. *Concluding Remarks*

The 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 supply price of labor had increased much more slowly, the relative income share of labor would have been smaller, saving and investment would have been larger, and therefore the rate of economic growth would have been much higher. This conclusion may imply that USL could be one of the major factors for the Japanese high rate of growth. 3) In cases of a higher rate of economic growth, the size of the labor force in the subsistence sector tends to decrease because of a big increase in the demand for labor in the capitalist sector. This implies that the number of workers in agriculture would have decreased absolutely even in prewar 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 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.[40] 4) The turning point would have been passed much earlier, say even in the prewar period, under some favorable conditions; i.e., with a lower rate of population increase, with a 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 findings may impress the readers in that the major conclusions by Lewis and Fei-Ranis in their theoretical works have been confirmed in light of the Japanese experiences. In spite of a big dispute on the classical (or labor surplus) approach, its applicability to the prewar Japanese economy has been revealed in this study. We dare to say, with a slight hesitation, that this conclusion may imply that the classical approach is of use also studying the present developing countries.

Statistical Appendix

We rely mainly on our *LTES* series (*Estimates of Long-Term Economic Statistics of Japan since* 1868, ed. by Ohkawa, Shinohara and Umemura, [1965-]). However, many works are needed in adjusting these basic data and estimating new statistical series.

(1) V_j, I, I_h, I_{gm}, I_g and B are from *LTES*, Vol. 1, pp. 213, 219, 221 and 227. I is divided into $I_1=I_A+I_S$ and $I_2=I_M$ as follows: I_S is estimated by multiplying I_{M+S} by the ratio of I_S to I_{M+S}. This ratio is calculated from investment figures by industry groups in *Chōki Keizai Tōkei Iinkai* [1968], p. 163. I_A and I_{M+S} are from *LTES*, Vol. 1, p. 218. I_g is divided into I_{g1} and I_{g2} by utilizing government gross capital stock figures related to the two sectors in *Chōki Keizai Tōkei Iinkai* [1969], p. 168. Inventory is not included because of a lack of the data.

(2) 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 *LTES*, Vol. 1, pp. 202 and 226. P_c' is calculated as C'/C, where C' and C stand respectively for personal consumption expenditure at current

[40] Minami [1973], Ch. 6.

prices and that at constant prices in *LTES*, Vol. 1, pp. 178 and 213.

(3) W_1' is calculated as the weighted average of wages in Sectors A and S. As for W_A' we use annual contract worker wages in agriculture (*LTES*, Vol. 9, pp. 220-221). W_S' is obtained by dividing the relative income share of labor (Minami and Ono [1978]) by the nominal labor productivity, both in S sector. W_2' is calculated in a similar way to W_S'.

(4) N and QN are basically from *Sōri-fu, Tōkei-kyoku* [1970]. ZQN is available from *LTES*, Vol. 2. L_j is from Minami [1973], p. 313.

(5) K_j is from *Chōki Keizai Tōkei Iinkai* [1968], p. 161 and A is from *LTES*, Vol. 9, pp. 216-217.

(6) h_1 is a weighted average of two indexes for Sectors A and S. The index for Sector A is calculated as the labor input index (Shintani [1973], pp. 77-79) divided by L_A. The index for Sector S is assumed to be the same as the index for manufacturing. h_2 is calculated based on the monthly labor days and the daily labor hours for manufacturing in *Nippon Rōdō Undō Shiryō Iinkai* [1959], p. 222. u is calculated under the assumption that there exists a normal level for the capital-output ratio. An equation $(V_2/K_2)=a_0+a_1t+a_2t^2+\ldots+a_5t^5$ is fitted 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 the ratio of the actual to the estimated values. v is calculated as vA/A, where vA stands for land input (Shintani [1973], pp. 89-91).

(7) S and δ_j are calculated following the relations (8) and, (13) and (14) respectively.

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