A CONSIDERATION OF THE COMPRESSED PROCESS OF AGRICULTURAL DEVELOPMENT IN THE REPUBLIC OF KOREA

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INTRODUCTION

THE economy of the Republic of Korea has achieved an annual growth rate of 9.4 per cent since the early 1960s. In this period the national economy attained a more sophisticated structure with the core of economic activities shifting from agriculture to manufacturing, effecting an inter-sectoral transfer of resources, particularly of labor force. The sustained outflow of agricultural labor force tightened the agricultural labor market and raised real wages [13]. Stable capital costs, combined with the agricultural wage hike, brought about changes in the relative factor prices in the agricultural sector, which in turn produced a shift in the composition of factor input in the direction of a greater role for capital and, conversely, a smaller proportion for labor. All this is ultimately reflected in changes in the production function, which indicates productive effects of various input factors. This shift in the production function meant productivity enhancement through technological innovation, greatly contributing to the improvement of agricultural income. The structural change of Korean agriculture, thus, is characterized by the completion of the cause-and-effect cycle of inter-industry transfer of production factors, leading to a change in relative factor prices, to factor substitution, and ultimately to higher productivity. The rapid pace at which the above process was carried out must also be noted.

What caused this chain reaction was the strong labor-absorbing capacity of the urban manufacturing sector. As already analyzed by Watanabe [22, Chap. 4], the labor force absorbed in industry came from agriculture, the shift effecting a decline both in agricultural population and the number of farm households ever since 1967. The agricultural population decreased at an average annual rate of 2.98 per cent between 1967 and 1979, faster even than the decrease in Japan during the 1950s, which itself has been said to be the most remarkable phenomenon in the historical experience of capitalist countries. What is more, the change in relative factor prices, the speed at which factor substitution occurred, and the rate of productivity growth were all bigger than those experienced by Japanese agriculture. Agricultural development in Korea, thus, has gone through a compressed process of development in comparison with the agricultural development in early starters including Japan. Watanabe [22, Chap. 1] compares the long-term process of economic development in Korea and Japan, and establishes the category of "compressed-type development" for Korea. We argue that the same categorization can be applied to Korean agriculture in particular, and our overall aim is to examine the process of Korean agricultural development after the Korean War and compare it with the total process of agricultural modernization in Japan since the late nineteenth century.

Thus, this paper first compares the input-output structures of Japanese and Korean agricultures and highlights the compressed development of the late-starting Korean agriculture (Section I). Then the causal chain as observed in Korean agricultural development is examined by estimating its production functions (Section II). This is followed by an analysis of productivity growth and the higher agricultural income brought about by the changes in the input structure (Section III). The last section summarizes the discussion.

I. COMPRESSED PROCESS OF AGRICULTURAL DEVELOPMENT

A. *Input-Output Structure*

It took Korean agriculture only a quarter of a century to achieve the level of production which it took Japanese agriculture ninety years to achieve (see Figure 1). While Japanese agriculture grew at an average annual rate of 1.6 per cent between 1874 and 1969, Korean agricultural growth averaged 7.6 per cent between 1955 and 1979.

The periods charted for the two countries in Figure 1 can both be divided into three phases. In the case of Japan they are: (1) the 1874–1918 stable growth phase; (2) the 1919–49 stagnant growth phase; and (3) the post-1949 high growth phase.[1] During the last phase the rate of growth was far higher than the average 1.6 per cent per annum of U.S. agriculture between 1940 and 1960 [9]. In the case of Korea, the three phases can be designated as (1) the 1955–61 recovery phase, (2) the 1962–67 high growth phase, characterized by vigorous agricultural development policy, and (3) the 1968–79 accelerated growth phase (see Table I).[2]

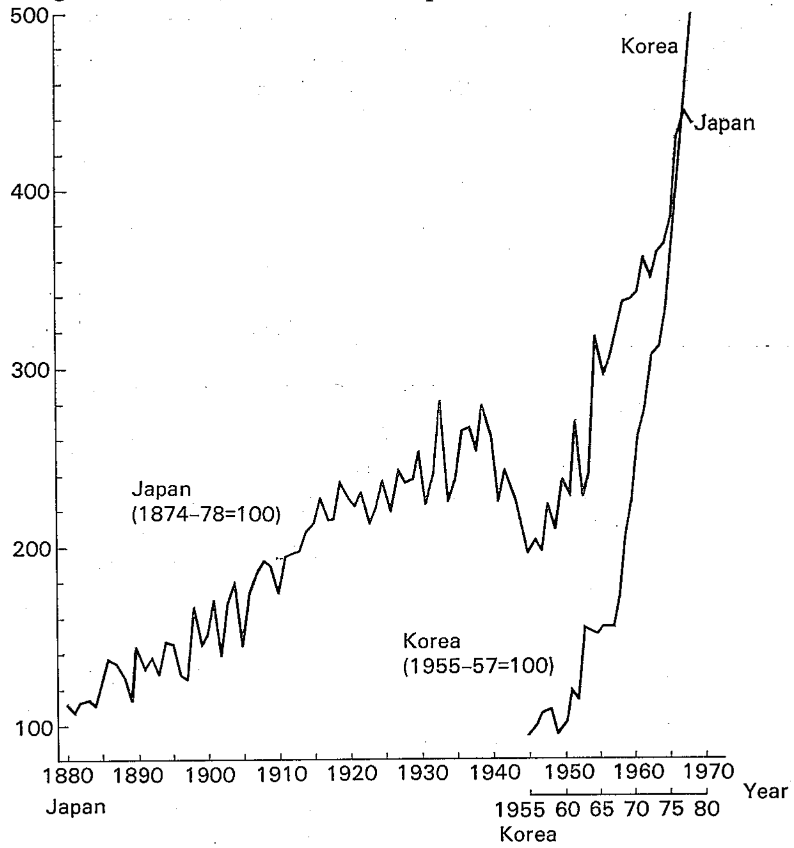
Let us examine the growth in output vis-à-vis inputs. As indicated in Table I, both Japan's postwar high growth and Korea's present accelerated growth are supported by two factors: growing inputs of capital and fertilizers.[3] Calculation of the changes in inputs in the different phases shows the pronounced impact of both more capital and more fertilizer in Japan's high growth phase, the sub-

1 Among numerous attempts to describe Japanese agricultural development by dividing it into various phases, those of Y. Hayami [8, Chap. 2] and K. Ohkawa [18] are most closely related to our own analysis.

2 Professor Ban Sung-Hwan establishes somewhat different phases for Korean agricultural development: (1) the 1954–64 accelerated growth phase, (2) the 1965–73 slower growth phase, and (3) the continuing high growth phase. See [2, Chap. 2].

3 For Japan, fertilizer input is the total cost of purchases of fish meal, soybean cake, chemicals, and other marketed items. For Korea, it is the sum of the three main chemical fertilizer elements.

Fig. 1. Agricultural Production Indices for Japan and Korea (Based on Value Added)



Sources: For Japan [8, Appendix Tables]; for Korea [22].
Notes: 1. For Japan, the real value added is obtained using 1934–36 constant prices.
2. For Korea, the same is derived by deflating the gross value added by the wholesale price index (1970=100).

stantial effect of stagnant growth in inputs of both during the stagnant growth phase, and the impact of increased fertilizer application in the stable growth phase.[4] The Korean case also seems to suggest a growth acceleration corresponding to both capital and fertilizer inputs.

4 Professor Hayami establishes six phases of Japanese agricultural development and finds distinctive input-output relations for each phase [8, Chap. 2]. Professor Ohkawa, on the other hand, utilizes long-range statistics to examine changes in input-output relations, ultimately establishing three phases of growth. He finds close relations between input and output only after 1945, prior to which, particularly between 1877 and 1919, a substantial backlog of agricultural technology knowledge and a high growth potential due to the high knowledge-absorbing capacity of Japanese village communities produced high output with low input, while between 1919 and 1945 the decline in technological potential brought about low output growth despite high growth in input [18]. This conclusion diverges from our own analysis as well as from that of Professor Hayami.

TABLE I

CHANGES IN AGRICULTURAL INPUT AND OUTPUT IN JAPAN AND KOREA

Period	Output Growth Rate (%)	Capital Input (N-fold Increase)	Fertilizer Input (N-fold Increase)
Japan:			
1874–1918	1.89	1.58	5.00
1919–48	0.20	1.01	1.33
1949–67	3.71	2.16	5.01
Korea:			
1955–61	4.48	1.44	1.40
1962–67	5.09	1.69	1.58
1968–79	10.35	2.92	1.80

Sources: For Japan, the same as for Figure 1. For Korea, for capital input up until 1976 [10]; for capital input thereafter [4]; for others [21].

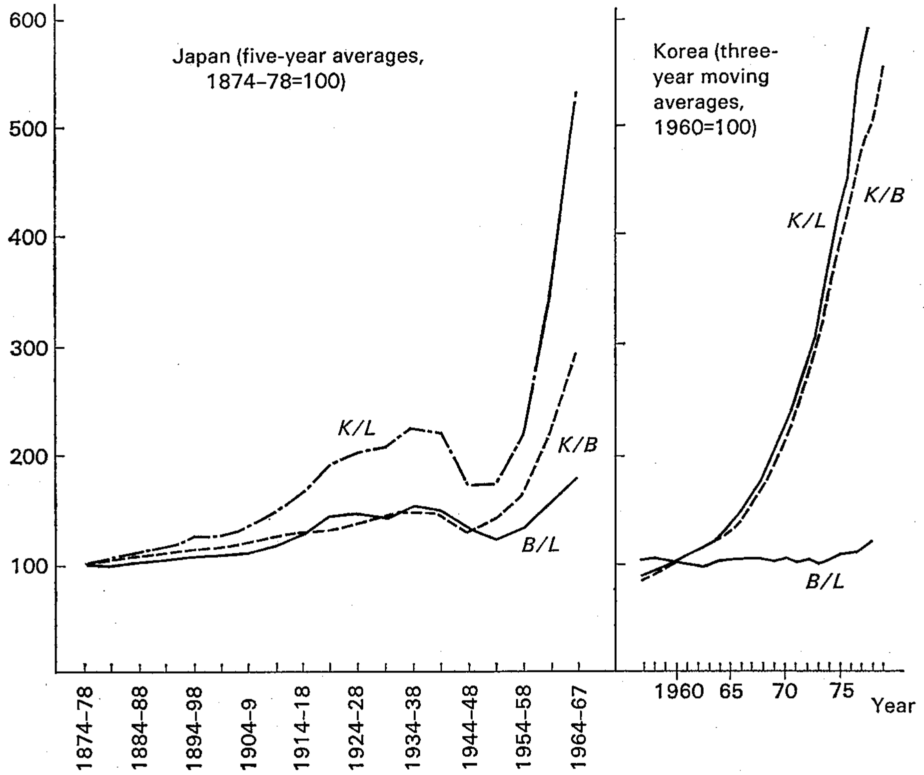
Notes: 1. For Japan, capital refers to the sum total of farm machinery, building, animals, and plants. Both fertilizer and capital are given in 1934–36 constant prices.
2. For Korea, both fertilizer and capital are given in 1970 constant prices.

Let us look at the input changes of land and labor. In Japan, land under cultivation increased between 1874 and 1918 and remained stable thereafter, while labor decreased in the period 1919–48, increased thereafter for a short time, but has been on the decline ever since 1949. The fluctuations, however, have never been violent. In Korea, neither land nor labor has shown any substantial change (see Figure 2). In stark contrast to the minor fluctuations in the supply of land and labor, one is immediately struck by the large increases of capital and fertilizer input in both countries. It is only too clear that Japanese agriculture's postwar high growth as well as Korea's consistent growth have been brought about by rapid increases of these two input factors.

The results of these input changes are rising capital-labor and capital-land ratios. Figure 2 indicates the rapid increase in the capital-labor ratio (K/L) in Japan in the period 1949–67. Decreased labor input is also shown to result in the rise of land-labor ratio (B/L) during the same period. Rising K/L means the substitution of capital for labor, while rising K/B means substitution of capital for land. Both K/L and K/B increased more rapidly in Korea than in Japan.

The changes in output and input analyzed above all point to a shortening of the period in which late-starting Korea achieved what Japan had achieved earlier. The compressed process of agricultural development in Korea is a reflection of the equally compressed process of industrialization, because an accelerated growth of agricultural output means an accelerated change in the input ratios (factor substitution), which reflects the speed of relative-factor-price changes, which in turn is a result of agricultural labor being absorbed by a growing industry and of the greater supply capacity for fertilizers and farm

Fig. 2. Factor Ratios



Sources: For Japan, the same as for Figure 1; for Korea, agricultural work force is based on Chung Young-Il [5, Appendix Table 8]. Chung's estimating method is also applied to the figures obtained from [20].

Notes: 1. K/L=capital-labor ratio, K/B=capital-land ratio, and B/L=land-labor ratio.

2. Only arable land and agricultural labor force are taken into account. The definition of capital is the same as for Table I.

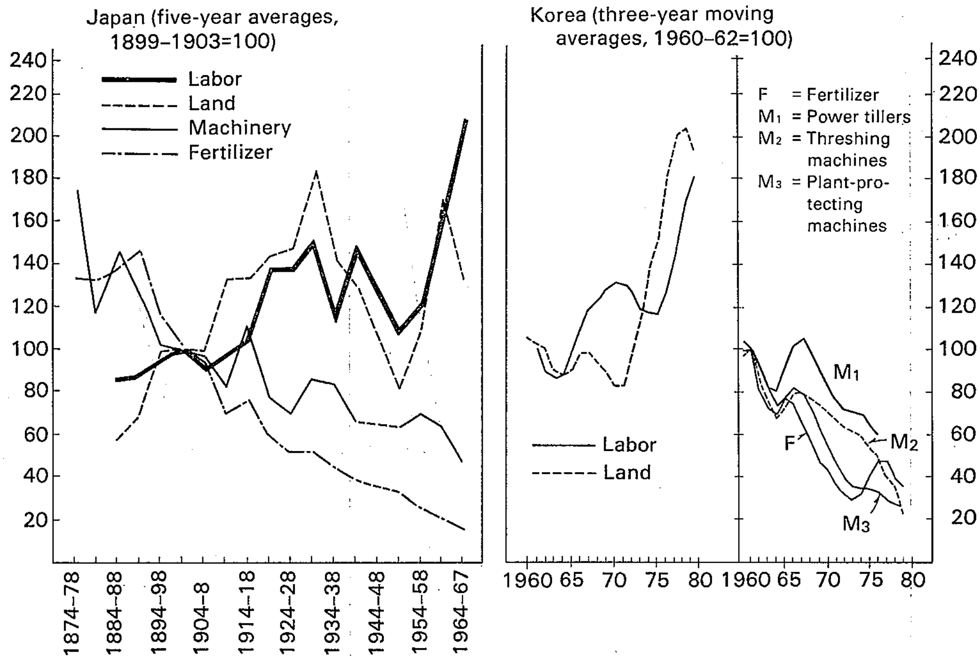
machinery. The signals provided by the compressed industrialization process were received by agriculture through changing relative factor prices which made it possible for agriculture to grow within a shorter span of time.

B. *Relative Factor Prices*

The left graph in Figure 3 gives relative-factor-price indices for agriculture in Japan (prices of input factors and input goods vis-à-vis the prices commanded by the final agricultural products). The relative price of labor started climbing in 1919 and then fluctuated until it started a steady rise in the postwar high growth phase. This movement of the relative price of labor is reflected in labor input, which declined as labor costs rose and increased as they fell.

The relative price of the scarcest productive factor in Japanese agriculture—land—showed a sharp rise in the 1890s, declined from around the 1930s to the end of World War II, and then started to rise again in the 1950s in the high

Fig. 3. Relative Factor Prices



Sources: For Japan, the same as for Figure 1; for Korea, the same as for Table I.

Notes: 1. The figures for Japan are based on relative prices of various inputs vis-à-vis farm product prices index as estimated by Hayami.

2. For Korea, prices of inputs relative to the price of 100 liters of polished rice are used. The average value of land assets per farm household is divided by the average land-holding to arrive at the price per acre of land. Labor cost is taken as the wage per day per male worker in agriculture. For fertilizer, the price of a twenty-five-kilogram pack of nitrogenous fertilizer (of 46 per cent nitrogen content) is used. Machinery is calculated as the average price per agriculture machine.

growth phase. The reason for declining relative land price in the 1930s might have been the declining productivity of land brought about by the stagnant growth of agricultural production. In general, the factor price for land is determined by the marginal productivity of land, moving in the same direction, and the marginal productivity declines more sharply than the average productivity. As will be described later, the productivity of land in Japan remained stagnant or even declined in the 1930s, when the relative land price also went down, giving rise to the view that the declining land productivity was reflected in its factor price. If, however, we take the secular trends for land and labor, they have both been on the rise, albeit with differences in the upward pace before and after World War II. In prewar years land showed a steeper rise, while in the postwar years relative labor price climbed faster. This is a reflection of the changing relative scarcity of land and labor, with labor becoming more scarce than land after the end of World War II.

In contrast to the rising relative prices of labor and land, the relative prices of fertilizers and farm machinery, particularly the former, showed substantial declines. Declining relative prices of these industrial products result from the different productivities of industry and agriculture. The input pattern in Japanese agriculture, with its intensive use of capital and fertilizer rather than land and labor, was a result of these changes in relative factor prices. And the greater input of fertilizer in comparison even with capital goods again corresponds to the factor price differential between fertilizer and capital. The relative price for fertilizer became lower than those of labor, land, and capital in the 1910s, precisely when a sharp rise of fertilizer input can be observed.

Let us turn now to Korea. As indicated in the right-hand graph of Figure 3, the relative prices of input factors and input goods (vis-à-vis the price of 100 liters of polished rice) show movements similar to those for Japan. The relative price of labor started to rise in the mid-1960s, remained stagnant from the late 1960s until the early 1970s, when labor input increased, and then started a sharp rise in the latter half of the 1970s, reflecting the absolute decline of the agricultural population.[5] The relative price of land also went up sharply in the 1970s, rising even above that of labor in the years 1973–78.

Rising relative prices of land and labor were in contrast to the declines in the relative prices of farm machinery and fertilizer. Between 1960 and 1979 the rate of price increase for fertilizer was only about one-sixth of those for land and labor, that for crop-protection equipment one-sixth, and that for threshing machinery a quarter. These relative factor prices were reflected in the change in the input structure toward a more intensive use of capital and chemical fertilizer rather than labor and land. This trend in Korea was not only quite similar to that experienced earlier in Japan but occurred within a much shorter period of time.

II. ESTIMATE OF THE AGRICULTURAL PRODUCTION FUNCTION

A. *Results of Estimate*

The movements of relative factor prices outlined above should result in corresponding changes in the production function of agriculture through changes in the input structure. Let us therefore examine how the agricultural production function changed.

In this estimate of the production function we apply the linear homogeneous Cobb-Douglas function ($Q=AK^{\alpha}L^{1-\alpha}$). Table II gives the results of estimate by time-series and cross-sectional data. Generally, the coefficient of determination is sufficiently high, and the parameters are significant for all periods except 1975–79. The production elasticity of capital α gradually diminishes from 0.797 in 1960–64 to 0.673 in 1965–69 and to 0.567 in 1970–74. The production elasticity of labor β increases from 0.203 to 0.327 to 0.433 for the three phases between 1960 and 1974, and then rises above the unitary value in 1975–79

5 The demand for labor in sectors other than agriculture, forestry, and fishery, as measured by the average annual rate of growth of employment in these sectors, increased at 9.1 per cent per annum in 1964–68, 5.1 per cent in 1969–73, and 8.3 per cent in 1974–78. This suggests a big impact of these sectors on the relative factor price of labor. See [20].

TABLE II

ESTIMATED PRODUCTION FUNCTION FOR KOREA, 1960–79

Period	Constant	Parameter		R^2
		α	β	
1960–64	0.593 (1.561)	0.797 (5.814)	0.203	0.711
1965–69	0.178 (0.384)	0.673 (3.973)	0.327	0.859
1970–74	2.858 (2.050)	0.567 (6.297)	0.433	0.904
1975–79	−1.255 (−7.593)	−0.038 (−0.396)	1.038	0.867
1960–69	0.364 (1.211)	0.727 (6.660)	0.273	0.654
1970–79	−0.799 (−6.225)	0.309 (5.338)	0.691	0.989
1960–79	−0.619 (−5.647)	0.394 (9.073)	0.606	0.965

Source: [21].

Notes: 1. α=Production elasticity of capital; β=production elasticity of labor $(1-\alpha)$; R^2=adjusted coefficient of determination.

2. Figures in parentheses indicate t-value.

3. In this estimate agricultural production is equated with net agricultural income, arrived at by subtracting from gross revenues all the costs of intermediate input, wages, rental cost, cost of repairs to equipment, and other expenditures. Real agricultural income is arrived at by deflating the result by the total price index at the point of sales from farm households (1975=100).

4. Capital stock is the sum total of land, farm equipment, warehouses, and livestock (large animals and plants), which go to make up the total fixed assets per farm household by which the scale of operation is determined. From this capital stock figure is subtracted a depreciation figure which is calculated through the use of a capital consumption allowance; the result is also deflated by the total price index at the point of purchase by farm households (1975=100). (For animals and plants, the rental index for cattle was used.)

5. Total labor is equated with the total hours per year of agricultural labor input, which is then divided by the average number of workers per farm household for each scale of operation in order to arrive at the average annual working hours per worker. The result is further weighted by assuming a women's wage rate of 80 per cent that for men and adjusting for the proportion of female workers in the work force for each scale of operation, thereby converting the female work force input to its male equivalent.

due to the negative α value. We also note that the order of α and β values reverses, from an α value of 0.727 and β value of 0.273 for 1960–69, to an α value of 0.309 and β value of 0.691 for 1970–79.[6] What are the factors behind these changes in the production elasticities? Generally speaking, changes in production elasticities for various factors are thought to be determined by the degree of technological change and the magnitude of proportionate changes of input. The change in the production elasticity of labor $G(EL)$ is considered to be determined by the degree of labor-using technological innovations BL, substitu-

[6] Among the few estimates of the agricultural production function for Korea, Bai Moo-Ki [1] also notes capital and labor inputs and arrives at a conclusion similar to ours.

tion elasticity σ, and the magnitude of change in labor-capital ratio $G(K/L)$, with the relation expressed thus: $G(EL)=BL+(1-EL)[1/(\sigma-1)]\cdot G(K/L)$.

If the substitution elasticity is assumed to be $0<\sigma<1$ and $G(K/L)>0$, then $G(EL)$ necessarily rises when $BL>0$ or $BL=0$. But even given labor-saving technological innovations ($BL<0$), EL is pushed upward if these innovations are minor or $G(K/L)$ is large.[7]

The changes in the production elasticities of various factors obtained from the estimated production function for Korean agriculture can be assumed to reflect the changes in the relative importance of input items. The rise of β is an indication of the large outflow of agricultural labor force in the industrialization process since the early 1960s, as well as of an improvement of labor input efficiency through a lessening of "over-occupancy."[8] The decline of α, on the other hand, seems to mirror the tightened labor market and rising real wages, promoting substitution of capital for labor, which in turn led to declining profit ratio for capital.

Let us see, then, if inter-sectoral transfer of labor did occur, particularly out of the agricultural sector. The 1963–80 employment structure in Korea shows a decline of labor force employed in the agriculture, forestry, and fishery sector from 63 per cent of the total in 1963 to 50 per cent in 1970, and a further fall to 34 per cent in 1980. This indicates that a strong labor absorbing capacity of the manufacturing sector and a substantial "derived demand" for labor in the services sector effected a large outflow of labor from the primary sector.[9] The average annual growth rate of employment in various sectors in the period 1963–80 was 10 per cent in mining and industry, 6 per cent in services, and a negative figure, -0.2 per cent, in agriculture, forestry, and fishery.

If we assume now that the net outflow rate of labor from industry (GL_j-GL) equals the difference between the growth rate of employment in this sector (GL_j) and the growth rate of employment in the economy as a whole (GL), then we see that labor flowed from the primary sector (GL_a-GL) at an average annual

7 For details, see [15].

8 The term "over-occupancy" or "over-occupied" is used in the sense defined by Professor Ohkawa. He argues that although the agricultural sector is generally inefficient in labor use due to low productivity and the existence of disguised unemployment or underemployment, it becomes an "over-occupied" sector if full employment in the Keynesian sense is assumed. See [17, Chap. 6].

9 "Derived demand" in the services sector is "derived" from expanding production and the consequent expanding employment in manufacturing, which prompts expansion of the services sector and of its employment capacity. This concept was first applied to the services sector by W. Galenson [6]. Applied to the case of Korea it yields the following employment function:

$$\log(L_s)_t=43.50+0.52\log(L_m)_{t-1},$$
$$(18.99)(16.79)$$
$$R^2=0.943$$

where figures in parentheses are t-values.

This means that, *ceteris paribus*, at least 50 per cent or so of the additional employment in the services sector in 1963–80 ($\Delta L_s/L_s$) "derived" from additional employment in the manufacturing sector ($\Delta L_m/L_m$).

TABLE III

NATIONAL AVERAGE INPUT-OUTPUT INDICES PER FARM HOUSEHOLD IN KOREAN AGRICULTURE

Period	Y (1,000 Won)	K (1,000 Won)	B (Pyeong)	L (Hour)	$\overline{W}$ (Won)	K/Y	L/Y	K/L	K/B	B/L
1963–65	504	38	2,766	2,093	729	0.08	4.15	0.02	0.01	1.32
1966–70	497	66	2,943	1,923	855	0.13	3.87	0.03	0.02	1.53
1971–75	658	153	2,950	1,663	1,148	0.23	2.53	0.09	0.05	1.77
1976–79	800	246	3,001	1,603	1,669	0.31	2.00	0.15	0.08	1.87

Source: Same as for Table I.

Notes: 1. Y=net agricultural income; K=fixed capital; B=arable land; L=labor input; $\overline{W}$=average real wage for men and women in agriculture.
2. Single average for each period.
3. 1 pyeong=3.3 square meters.

rate of 3.8 per cent over the total time span covered, while it flowed into the mining and industrial sector (GL_i-GL) at a rate of 6.5 per cent per year and into the manufacturing sector (GL_m-GL) in particular at the high rate of 6.8 per cent annually. In the services sector the net inflow rate (GL_s-GL) was 2.6 per cent on the average. Thus, we may surmise that the labor force that left the primary sector mostly entered the manufacturing sector. The absolute number of workers moving among various sectors, derived by multiplying these labor outflow indices by the total number of employed, gives a figures of approximately 200,000 a year moving out of the primary sector in the 1960s and of over 300,000 a year for the 1970s [13].

Such a large outflow of labor from agriculture dissolved the hitherto perpetual over-occupancy in that sector and subsequently invited increases of real wages.[10] Table III shows the average input-output indices of Korean farm households, drawing our attention to a nearly 2.5-fold rise of the average daily real wage ($\overline{W}$) in agriculture from 729 won in the period 1963–65 to 1669 won in the period 1976–79.

The accelerated outflow of labor and wage rise in the agricultural sector in the 1960s and 1970s served to promote factor substitution in the sector. Table III shows a marked decrease of labor input per farm household from 2,093 hours in the early 1960s to 1,603 hours in the late 1970s, while capital input rose from 38,000 won to 246,000 won during the same period, a 6.5-fold increase. These changes lowered the labor coefficient (L/Y) by half and pushed up the capital coefficient (K/Y) by about four times, at the same time pushing

[10] Since the outflow of labor from agriculture is a declining function of the underemployment rate $G(Eu)$ in the same sector, it can be expressed as follows in relation to the rate of change of real wages:

$$\log G(\overline{W})_t = 0.144 - 0.895 \log G(E_u)_{t-1}.$$
$$(-14.937)$$
$$R^2 = 0.937$$

A 10 per cent decrease in the underemployment rate can be interpreted as identical to a 9 per cent rise of real wages in the same sector (between 1963 and 1980).

TABLE IV

ESTIMATED PRODUCTION FUNCTION IN KOREA BY SCALE OF OPERATION, 1960–79

Scale of Operation (ha)	Constant	Parameter		R^2
		α	β	
0 –0.5	−0.355 (−2.051)	0.452 (6.443)	0.548	0.733
0.5–1.0	−0.202 (−1.463)	0.513 (8.554)	0.487	0.825
1.0–1.5	−0.871 (−0.735)	0.553 (10.084)	0.447	0.868
1.5–2.0	−0.047 (−0.331)	0.586 (8.162)	0.414	0.808
2.0–	0.110 (0.981)	0.663 (10.800)	0.337	0.882

Source: Same as for Table I.
Note: Same as for Table II.

up both the capital-labor ratio (K/L) and the capital-land ratio (K/B), and even the land-labor ratio (B/L).

Let us turn to the issue of technological innovation. From the Cobb-Douglas type production function the growth rate of output can be expressed as $\dot{Q}/Q = \dot{A}/A + \alpha(\dot{K}/K) + \beta(\dot{L}/L)$, where the superscript • indicates the incremental change in each. The average farm household during the 1960–79 period achieved an annual production growth rate of 4.19 per cent, while the capital stock growth rate was 5.85 per cent, and the labor input growth rate 2.81 per cent.[11] Thus, 67.06 per cent (2.81/4.19) of the production growth can be attributed to technological progress. Because neutral technological progress is assumed here, it can be seen to have been embodied in both capital and labor, in such forms as improved varieties of seed, rationalized management, more education and improved skills. Furthermore, since it is a result of the factor substitution of capital for labor, it can also be described as biased toward a more intensive use of capital. We should also note that the contribution of technological progress is close in magnitude to that in the Japanese case, where 75 per cent of production expansion in agriculture can be attributed to technological progress deriving from the changes in factor input through the prewar period [8, p. 99]. This is another indication of similarity between the patterns of agricultural development of the two countries.

B. *The Production Function by Scale of Operation*

Table IV gives the agricultural production function by scale of operation, and indicates that the parameter α is significant for each scale of operation and that the coefficients of determination are sufficiently high. Parameter α is on the rise as the scale of operation progresses from small to large, i.e., the smaller the scale of operation, the lower is α, and vice versa. On the other hand, β is

11 The rate of technological progress ($\dot{A}/A$) can be derived by subtracting the contributions of capital and labor from the production increase (see the growth accounting approach of Grilliches in [7]). The rate of technological progress can be obtained by converting it to $(\dot{A}/A) = (\dot{Q}/Q) - \alpha(\dot{K}/K) - \beta(\dot{L}/L)$.

higher for smaller scale operations, and vice versa. This is paradoxical because one would normally expect the reverse to be true.

It is generally thought that small-scale farming units use greater proportions of unpaid family workers with the result that marginal productivity of labor is relatively low. Table V does indicate higher labor-land ratios for farm households with less than 0.5 hectare of land. But if we take as standard labor-land ratios those of households with 2.0 hectares and over (that ratio being designated as unitary), then smaller agricultural units show rapidly declining ratios while their labor and per-land-unit fixed capital tend to rise. This seems to be the result of the following process: when rapid industrialization in the 1960s (with manufacturing production growing at an annual rate of 17 per cent) increased the demand for labor, the major part of the outflow of labor from agriculture originated with these smaller farm units, and the resulting shortage of labor among smaller units, coupled with rising real wages, forced them to quickly substitute capital for labor.

Figure 4 gives a graphic representation of this process. Farm households are divided into four strata, for each of which the pace of factor substitution is indicated for the four phases of development. Among the rather similar patterns of factor substitution for all four strata, the case of stratum I, households with the smallest landholdings (less than 0.5 hectare), stands out in that its labor input per unit product (L/Y) consistently declined from the late 1960s (I_1) to the late 1970s (I_3) while its corresponding capital input per unit product (K/Y) increased quite rapidly—almost twice as fast as strata III and IV (see III_3 and IV_3). Slower rates of labor outflow from the other three strata (II, III, and IV) are reflected in the slower paces of substitution of capital for labor for each unit of production.

In fact these differences in the speed of labor outflow among different strata of farm households gradually pushed up the share of middle-sized (1.0–1.5 hectares) and large-sized (1.5 hectares and over) farm households vis-à-vis farm households as a whole, and this stands in particular contrast to the rapidly declining share of the smaller (0.5–1.0 hectare) and smallest (less than 0.5 hectare) units. Also, despite the declining number of employed per farm household for all strata taken as a whole, the proportion of the total farm population associated with the smallest landholdings dropped sharply—from 34 per cent in the early 1960s to 25 per cent in the late 1970s—while for those strata with landholdings of 0.5 to 1.0 hectare and 1.0 to 2.0 hectares it rose from 32 per cent and 26 per cent to 36 per cent and 31 per cent, respectively, during the same period (see Table VI). The proportion for the largest landholding category (2.0 hectares and over) remained unchanged at the 8 per cent level throughout the period. These phenomena seem to indicate substantial productivity gains by the smallest farm units in Korea, with raised farm income, increased farm surpluses and improved management capacity. We are thus forced to undertake a close reexamination of the conventional image of traditional agricultural management by the smallest landholders where, according to the popular notion,

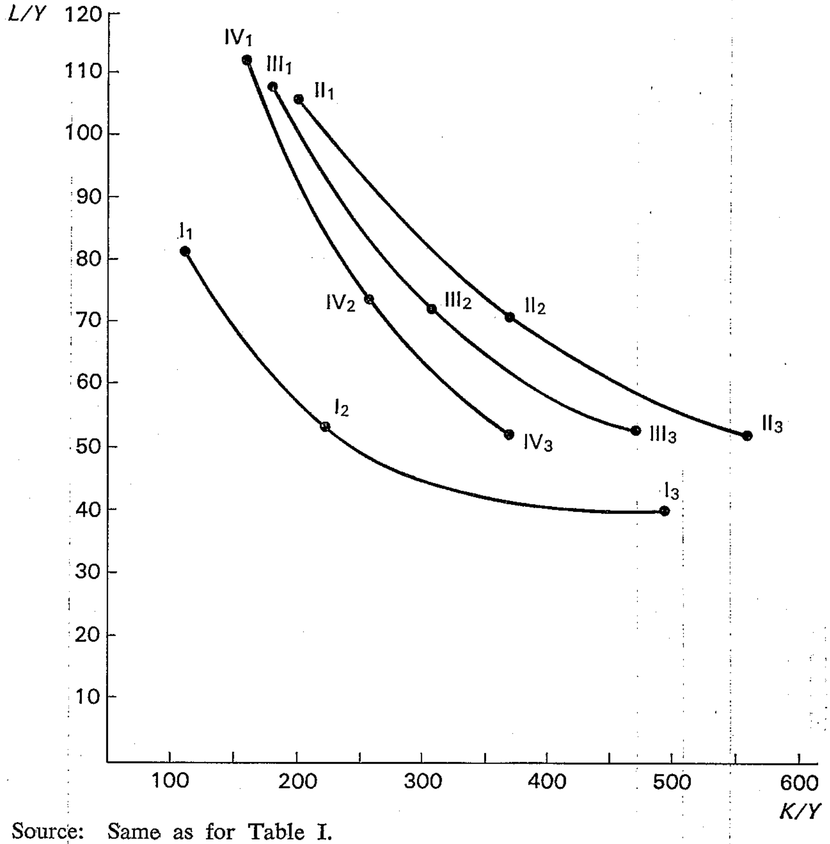
TABLE V

CHANGING FIXED CAPITAL EXPENDITURE IN KOREAN AGRICULTURE PER UNIT OF LABOR AND LAND ACCORDING TO SCALE OF OPERATION, 1960–79

Period	Scale of Operation (ha)					Relative to Those on Landholdings of 2.0 ha and Over			
	–0.5	0.5–1.0	1.0–1.5	1.5–2.0	2.0–	–0.5/2.0–	0.5–1.0/2.0–	1.0–1.5/2.0–	1.5–2.0/2.0–
Capital expenditure per unit of labor (won per hour of labor input)*:									
1960–64	9.3	11.3	14.8	22.6	19.8	0.47	0.57	0.75	1.14
1965–69	12.7	21.0	25.0	30.4	32.0	0.40	0.66	0.78	0.95
1970–74	39.3	57.1	63.0	64.5	82.0	0.48	0.70	0.77	0.79
1975–79	112.3	119.2	131.7	156.2	154.6	0.73	0.77	0.85	1.01
(1960–79)	35.1	46.0	58.6	61.8	65.0	0.54	0.71	0.90	0.95
Capital expenditure per unit of land (won per pyeong of arable land)*:									
1960–64	12.9	11.9	12.9	15.9	12.1	1.07	0.98	1.07	1.31
1965–69	16.0	20.0	19.7	20.9	18.4	0.87	1.09	1.07	1.14
1970–74	38.2	45.6	43.7	36.9	38.2	1.00	1.19	1.14	0.97
1975–79	96.9	81.9	75.4	79.9	63.6	1.52	1.29	1.19	1.26
(1960–79)	39.7	40.1	38.4	38.3	33.5	1.19	1.20	1.15	1.14
Labor/land ratio (hours of labor per 10 pyeong of arable land):									
1960–64	13.9	10.5	8.8	7.0	6.1	2.28	1.72	1.44	1.15
1965–69	12.7	9.5	7.9	6.9	5.7	2.22	1.67	1.39	1.21
1970–74	9.7	8.0	6.9	5.7	4.7	2.06	1.70	1.47	1.21
1975–79	8.7	6.9	5.7	5.1	4.1	2.12	1.68	1.39	1.24

Source: Same as for Table I.
* 1975 constant prices.

Fig. 4. Combination Patterns of Input Coefficients by Scale of Operation in Korean Agricultural Sector (1960–64 average=100)



Source: Same as for Table I.
Note: I=less than 0.5 ha, II=0.5–1.0 ha, III=1.0–1.5 ha, and IV=1.5 ha and over. Suffix 1=1965–69 average, 2=1970–74 average, and 3=1975–79 average.

the constant input of unpaid family workers pushes marginal productivity of labor down to a minimum.

We arrive at the following provisional conclusions from our analysis so far. In Korean agriculture, the smaller the scale of operation the more rapid the speed of labor outflow (from the pool of family workers), and consequently the faster the pace of factor substitution between labor and capital. This pushes the production elasticity of capital downward and that of labor upward. Conversely, the greater the scale of operation, the slower the speed at which labor flows out, and the slower the rate of factor substitution. This pushes the production elasticity of capital upward and that of labor downward.

Such a state of affairs in the Korean case runs generally counter to the experiences of other developing countries in Asia. Industrialization in these other Asian countries, because of its protectionist approach, was in many cases biased toward capital intensiveness, which did not match the factor endowment of these

TABLE VI

CHANGING SHARES OF OVERALL EMPLOYMENT ACCORDING TO SCALE OF OPERATION

(%)

Period	Scale of Operation (ha)			
	-0.5	0.5–1.0	1.0–2.0	2.0–
1960–64	34.2	31.5	25.8	8.5
1965–69	29.6	31.1	30.3	9.0
1970–74	27.2	32.5	31.6	8.7
1975–79	25.4	35.5	31.2	7.9

Notes: 1. Figures show the share of total agricultural labor force for each category, derived by multiplying the number of households in each category by the average number of employed per household in that category.
2. Single averages for each period.

countries. Such industrialization produced little employment absorbing capacity and prolonged the state of over-occupancy in agriculture.[12] This only operated toward a heavier population pressure on available agricultural land, resulting in stagnation or relative decline of labor productivity and real wages in agriculture.[13] Thus, as time went on, the marginal productivity of agricultural labor declined while that of capital rose, resulting in worsened income distribution for the agricultural sector.

The chain of events from inter-sectoral factor movements to changes in relative factor prices, to factor substitution, and to changes in the production function should reflect an important underlying element of improved productivity.

III. AGRICULTURAL PRODUCTIVITY AND INCOME

A. *Choice of Technology and Agricultural Productivity*

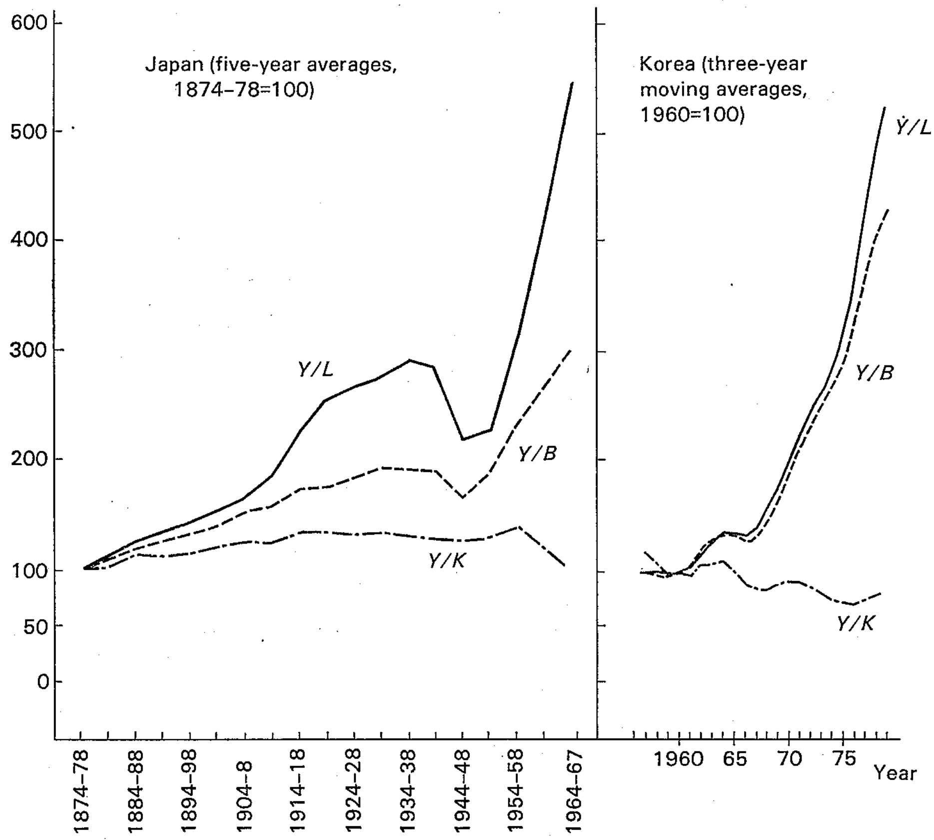
Agricultural labor productivity can be expressed by the identical equation: $Y/L \equiv (Y/B) \cdot (B/L)$, reflecting the fact that it can be improved through the raising of land productivity by the adoption of land-saving technology as well as through higher land-labor ratios (B/L) achieved through the adoption of labor-saving technology.

In the case of Japan (see Figure 5), the index for labor productivity was higher than that for land productivity, particularly in the postwar years. The same can be said of Korea, especially in the period of the very conspicuous spurt since 1968. Converted to growth-rate terms the variables in the above identical equation yield the following results: In Japan the 10.2 per cent rise of labor productivity during the period 1874–1968 was brought about 66 per cent by improvement of land productivity and 34 per cent by higher land-labor

[12] For a discussion of industrialization and employment in developing countries since the 1950s, see W. Morawetz [16].

[13] See Watanabe [23].

Fig. 5. Factor Productivity (Based on Value Added)



Source: Same as for Table I.
Note: Value added is measured in 1934–36 constant prices for Japan and in 1970 constant prices for Korea.

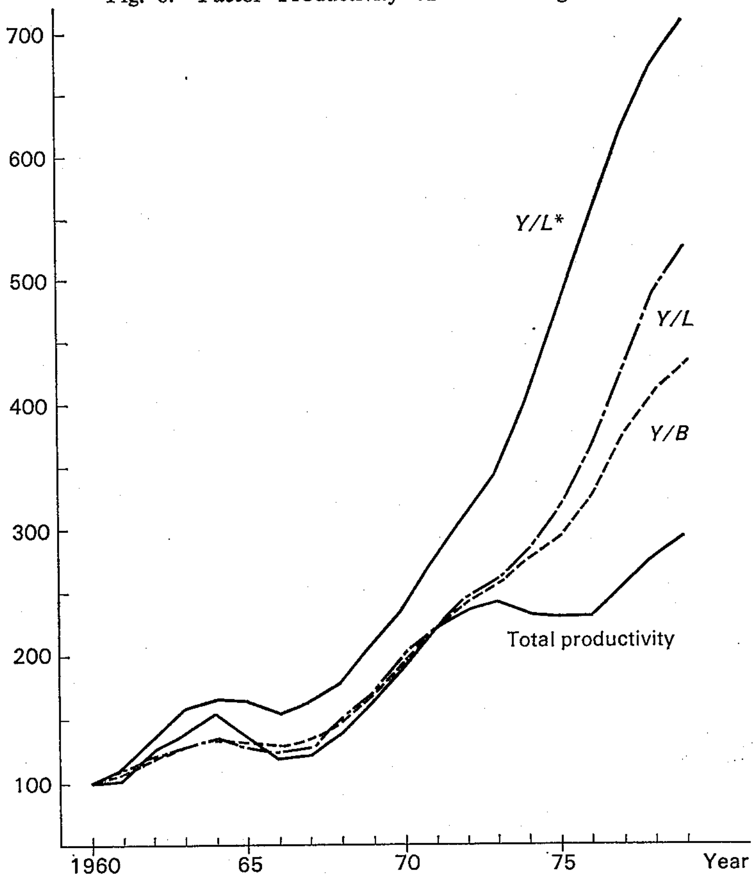
ratio,[14] while in Korea the 7.7 per cent growth of labor productivity between 1956 and 1979 is attributable by as much as 90 per cent to improvement of land productivity and by only 10 per cent to higher land-labor ratio.[15] Both Japan and Korea chose land-saving technologies as the main approach to improving land productivity and, ultimately, higher labor productivity. But Japan relied on labor-saving technologies and improvement of the land-labor ratio to a much greater extent than did Korea.

According to Professor Hayami's estimates [8], the total productivity of Japan during the prewar years followed a pattern of improvement similar to that of land productivity but after the end of World War II the hitherto parallel relations

[14] The average growth rate of land productivity in Japan between 1974 and 1968 was 6.67 per cent, and the rate of increase of the land-labor ratio was 3.5 per cent (as estimated from Figures 2 and 5).

[15] The growth rate of labor productivity throughout the period under consideration was 7.7 per cent, and the growth rate of land productivity and the rate of increase of the land-labor ratio were respectively 6.91 per cent and 0.79 per cent (as estimated from Figure 2).

Fig. 6. Factor Productivity of Korean Agriculture



Source: Same as for Table I.

Notes: 1. Three-year moving averages, 1960=100.

2. L^* denotes hours worked, which is the total labor input derived by first dividing the total number of hours worked per farm household on the average by the average number of employed per household, and then multiplying this by the total agricultural work force.

3. The total input index used in the computation of productivity is derived by weighting the four input items (capital, land, labor, and fertilizer) by their relative factor prices.

between the two ceased to be observable. This indicates the choice of technology geared toward land-saving before the war and toward labor-saving after the war, which corresponds to our own conclusion.[16] In the Korean case, the total prod-

[16] The labor productivity indicated in the left chart in Figure 5 may tend to be too high for prewar days and too low for postwar days because, while the working population experienced no large numerical change from the prewar to postwar periods, the hours put in by postwar labor dropped rapidly. Measured in hourly terms, therefore, the development pattern of Japanese agriculture should reveal itself more markedly, with labor productivity through land-saving technologies rising even more rapidly during the prewar days and through labor-saving technologies rising more rapidly in the postwar days.

uctivity[17] improved together with land productivity until the early 1970s, and then the two started to diverge around the middle of the 1970s (see Figure 6). Thus, the story of Korean agricultural development as told by the trend of total productivity suggests a land-saving pattern until the early 1970s, followed by a labor-saving pattern thereafter. This seems a plausible scenario because the Korean labor force has gone through a decline in absolute terms from the middle of the 1970s, and the 12.2 per cent annual improvement of labor productivity in the period 1974–79 is about 28 per cent attributable to the rising land-labor ratio which grew 3.4 per cent annually. We also note the stagnation in fertilizer input (a typical land-saving technology) in the 1970s, contrasted by the rapid dissemination of labor-saving technologies from the late 1960s to the early 1970s and by an unmistakable trend from manually operated to motorized farm machinery since about the mid-1970s.

The similar pattern of technological development in Japan and Korea, from a land-saving to a labor-saving orientation, is definitely a consequence of the parallel movement of relative factor prices in the two countries. Furthermore, the more compressed process of relative-factor-price changes in Korea enabled that country to traverse within about a quarter of a century the process of technological choice which engaged Japan for ninety years—ever since the beginning of the Meiji era. The process of technological improvement was also compressed in Korea.

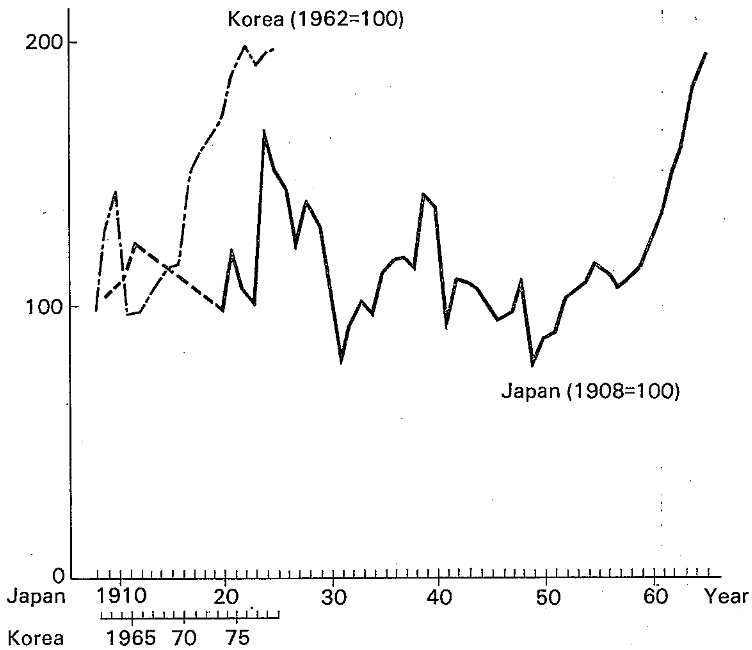
B. *Improvement of Farm Income*

The compressed development of Korean agriculture presents itself in the form of a sharp rise in the incomes accruing to farm households. Figure 7 shows the average real gross incomes per farm household for Japan and Korea. Prewar Japan witnessed violent fluctuations, such as the drop in 1931 to about a half of the prewar peak achieved in 1924. Postwar days saw a more stable movement of farm income, especially after the late 1950s, when a consistent rise can be observed. It has since attained a two-fold increase over the lowest prewar level. In Korea farm income hit bottom in 1965 and then started to rise, accelerating in the 1970s, and achieving a nearly two-fold improvement by 1976. In order to verify the improvement of economic welfare which such higher incomes are naturally thought to bring about, let us examine the movement of Engel's coefficient.[18] Fluctuations of farm income in prewar Japan are reflected in an

17 Total productivity in Korea is obtained by dividing the total production index by the total input index. The total input index is obtained by weighting the four input factors, capital, land, labor, and fertilizer according to the relative factor prices shown in Figure 3, i.e., total input$=\sum_i (W_{i,t}/W_{i,0})\cdot(Q_{i,t}/Q_{i,0})$, where $W_{i,t}$ indicates the relative price of factor i in year t and $Q_{i,t}$ the input volume of factor i in year t.

18 A survey, conducted in 1979, of how farmers themselves perceive changes in their standard of living yielded some interesting results. The proportions of respondents perceiving their living standard as having improved in comparison with five years earlier were 91 per cent among the smallest farm units with less than 0.5 hectare of land, 89.5 per cent among those with 0.5 to 1.0 hectare, 88.9 per cent among those with 1.0 to 2.0 hectares, and 87.9 per cent among those with 2.0 hectares and over. The smaller the scale of operation, the more farmers thought their living standard had improved. See [14].

Fig. 7. Total Revenue Index per Farm Household



Sources: For Japan [3]; for Korea, the same as for Table I.
Note: For Japan, deflated by the implicit deflator (1934–36=100) in [19, pp. 306–7]; for Korea, deflated by the price index of agricultural purchases at the household level; 1975=100.

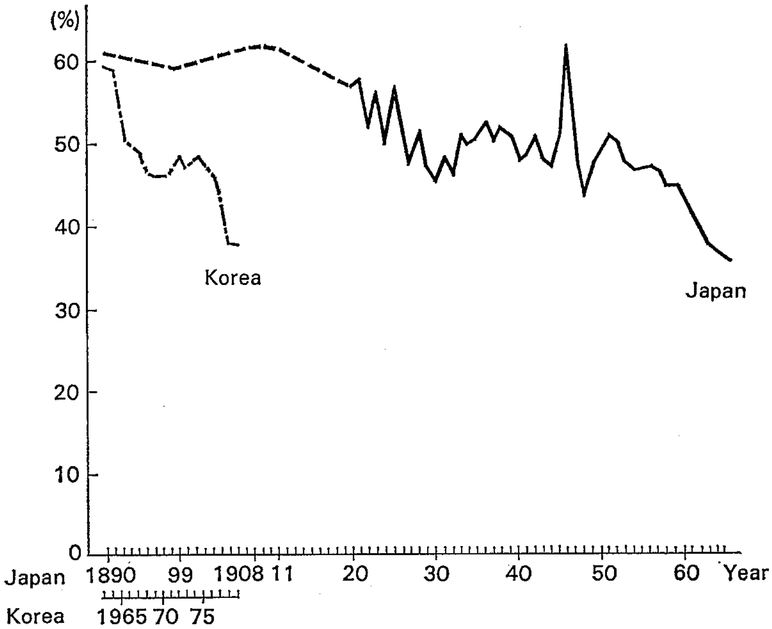
equally unstable Engel's coefficient, but it started to see a sustained decline after the war, reaching 50 in 1950 and dropping as low as 36 in 1965. For Korea it was 59 in 1963, about the level it was in Japan in 1910, but went down to 38 in 1978, a level comparable to that for Japan in the 1960s. In the comparative declines in Engel's coefficient we again see sign of the compressed agricultural development experienced in Korea (Figure 8).

Naturally, these improvements in farm incomes in both Japan and Korea are not only a reflection of the process of development from changing relative factor prices all the way to higher productivity, but also seem to be the result of the common government policy of supporting the price of rice. The big impact of this policy on the price of rice in postwar Japan is well known: the violent fluctuations experienced before the war were replaced by stability. Since the 1960s the government's purchasing price has been higher than its selling price, and even a downward rigidity seems well established.[19] Thus, price stability attained under the government policy induced increased production of rice, contributing to higher farm incomes.

Like Japan, Korea has also adopted a policy of rice price support but the Korean case is characterized by a large difference in the prices supported in the

[19] For changes in the rice price in Japan, see Hayami [8, pp. 177–86].

Fig. 8. Engel's Coefficient for Farm Households



Source: Same as for Figure 7.
Note: Same as for Figure 7.

1960s and the 1970s.[20] Under the dual market system for grains effected in Korea in which the government purchases them at its support price while a free market also operates, the price commanded in the free market was always higher than the government price before 1968, although the government activity worked to depress the free market price. But since 1968 the government has consistently maintained a higher purchase price for rice than that in the free market. Korea's industrializing efforts after 1962, based on expanding exports of labor-intensive products, called for checks on rising wages in order to maintain competitive power, and the price of rice (as one of the wage goods) had to be controlled, although the mechanism of stable price leading to production expansion and ultimately to higher farm incomes was maintained, albeit not very vigorously (see Figure 7 for the continuing rise of real incomes). But income expansion of urban households stemming from rapid industrialization increased the income gap between urban and rural areas, inevitably leading to a call for the provision of incentives for production expansion. The result was the 1968 policy change regarding the rice price support.

It was possible for Korea to rapidly narrow the income gap between urban and rural areas as well as among different strata of farm households with differ-

[20] The ratio of the Korean government's purchasing price of grains to the selling price was on the average 88.9 per cent for 1961–69, and 109.9 per cent for 1970–80. This is another indication of the strong price support policy of the government in the 1970s. See Huh Shin-Haeng [11, Table 5-6].

TABLE VII

FARM HOUSEHOLD SURPLUS BY SCALE OF OPERATION

(%)

Period	Scale of Operation (ha)				
	-0.5	0.5–1.0	1.0–1.5	1.5–2.0	2.0–
1963–64	11.0	62.6	116.6	264.9	450.1
1965–69	20.9*	68.9*	125.4	237.5	382.5
1970–74	25.8	69.7	132.3	200.8	246.1
1975–79	38.9	76.9	117.0	167.1	240.2

Source: Same as for Table I.
Note: The ratio of surplus per farm household vis-à-vis national average (in 1975 constant prices).
* Four-year average excluding 1965.

ent scales of operation. Despite the various difficulties in comparing household income levels between urban and rural areas,[21] it is estimated that the per capita annual real income of farm households in the period 1965–71 was on the average 68 per cent of the per capita real income of urban wage earning and salaried worker families, while in the period 1971–79 it was 80 per cent of the latter.[22] It should also be noted that the improvement of farm income generally was achieved simultaneously with reduction of the income discrepancy among farm households with different scales of operation. Table VII compares farm incomes for five different scales of operation, expressed in terms of the ratio of household surpluses to the national average (surpluses are measured by subtracting households expenditures from farm household incomes for the five categories). The table indicates a substantial improvement for the smallest farm households, the ratio rising from 11 per cent in the early 1960s to about 40 per cent toward the end of the 1970s. On the other hand, households with 1.5 to 2.0 hectares saw their ratio decline from 265 per cent to 167 per cent during the same period, while the ratio for the biggest landholders (2.0 hectares and over) went through an even larger relative decline from 450 per cent to 240 per cent. The ratio of household budget surplus of farm households with less than 0.5 hectare to that of those with 2.0 hectares and over dropped by more than half—from 439 per cent in the early 1960s to 201 per cent in the late 1970s.

IV. CONCLUSIONS AND SUMMARY

(1) The expansion of agricultural production that took Japan ninety years (1874 to 1967) to achieve was accomplished in as few as twenty-five years in Korea.

[21] Constraining factors in the urban-rural household income comparison include the differences in price levels and income composition in the two spheres, and—in the specifically Korean situation—a possible bias creeping into the selection of households surveyed. For details, see Kim Byung-Tae [12].

[22] The deflators used were the comprehensive price index for farm household purchases for rural areas and, for urban areas, the retail price index for all cities (1975=100 for both cases). Household incomes are calculated on the basis of data from [21] for rural areas and [20] for urban areas.

Moreover, Korea has not only achieved overall agricultural production expansion in a compressed manner but also specific aspects of agricultural expansion such as changes in capital-labor ratio, capital-land ratio, and other input items. Rapid overall development was a reflection of the far quicker change in input structure.

(2) Factor substitution is a result of changes in the relative prices of production factors manifesting themselves in a relatively lower price of capital vis-à-vis labor and land. These changes of relative factor prices were brought about by strengthening supply capacities of such agricultural input goods as chemical fertilizer, insecticides, and farm machinery, as well as by the increasing employment absorbing capacity of the industrial sector. Thus, the compressed industrial development of Korea, as briefly outlined at the beginning of this paper, made itself felt in the agricultural sector by causing rapid changes in relative factor prices relating to farm input, contributing to the similarly compressed development of Korea's agriculture.

(3) Estimates of the production function for Korean agriculture indicate lower production elasticity of capital and conversely higher production elasticity of labor as time went by. This points to a dissolution of over-occupancy in agriculture. In the earlier over-occupied agriculture, with its disguised unemployment, labor efficiency was low and capital efficiency high. On the other hand, rising real wages due to labor outflow caused changes in relative factor prices, resulting in the rapid substitution of capital for labor. This raised the productive efficiency of labor, but at the same time served as one factor behind a lower rate of return on capital.

(4) Estimates of production function by the scale of operation indicate a lower production elasticity of capital for smaller farms than for larger units. Likewise, the production elasticity of labor is higher for smaller farm units than it is for larger ones. The reasons for this observed phenomenon, which contradicts the popular perception of agriculture in developing countries, deserve some explanation. An overwhelming portion of the labor force that flowed out of Korean villages into urban industrial sectors derived from families with in the smallest farm units, and this not only did away with over-occupancy in this category of farm households but also created a relative labor shortage and rising real wages at the same time. This in turn pressed these small farm units to substitute capital for labor, lowering the rate of return on capital so engaged, but raising the production efficiency of labor. On the other hand, since the labor drain from larger farm units was slower, they also substituted capital for labor at a slower pace. This served to maintain a high profit ratio for the capital in this scale of operation but also worked to keep labor efficiency at a low level.

(5) Changes in the production function create improvement in productivity. This is because changes in the relative factor prices promote the adoption of technologies which tend to save scarce production factors. The principal pattern of choice of technology in Korean agriculture shifted from an earlier opting for land-saving technologies (the improvement of land productivity leading to greater labor productivity), but after the early 1970s labor-saving technologies gradually gained favor. This transformation of the pattern of technology choice from

land-saving to labor-saving also characterized Japanese agricultural development in the Meiji era. But the Korean experience has been more strongly compressed than the Japanese.

(6) Improved productivity increased farm incomes and rapidly lowered the Engel's coefficient, an indication of rising economic welfare. This again occurred at a far quicker pace in Korea than in Japan. Growing income surpluses of the average farm household and the closing of the gaps in farm household income surplus between the various scales of operation suggest the welfare implications of Korean agricultural development.

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