Research article

Estimates of Factor Shares for Rice Production in Japan for the Period of 1922-1944

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Received 20 February 2021 Accepted 6 December 2021 (*Corresponding Author)

Abstract The After World War I, the development of the agriculture sector was delayed in contrast with the rapid growth of the industrial sector. Japanese agriculture accelerated by innovation after the economic revitalization following World War II. It clarifies the production structure of the rice production in Japan, and there is this study before the end of World War II after the First World War end during the analysis period. This study clarifies a change of factor shares of the rice production sector in this time. The purpose of this study is to elucidate the characteristics of the production structure of the rice production in Japan from 1922 through 1944, and the agriculture in Japan at this time is considered to be in a developing stage. The historic change of the rice production in Japan gives a suggestion for agriculture development in modern Asia. The measurement of factor shares of the rice production in the analysis period applies "a method to estimate land income as rest." In addition, it measures the Cobb-Douglas's type amount of production formation function. It clarify the contribution of the production input. The changes of factor shares are as follows. The change of factor shares is land, labor, fertilizer, cost of draft animals, agricultural machinery, materials, building for agriculture, seed in order of the average value from 1922 through 1944. As for the development of production technological system, it is a technological innovations land-saving and fertilizer-using. The results of estimate by the amount of production formation function are as follows. In the periods of 1922-1944, the input of the labor is excess level, the input of the fertilizer is under level and the input of the land is equilibrium level.

Keywords Japan rice production, factor shares, amount of production formation function

INTRODUCTION

World War I, the development of the agriculture sector was delayed in contrast with the rapid growth of the industrial sector. Japanese agriculture accelerated by innovation after the economic revitalization following World War II. It clarifies the production structure of the rice production in Japan, and there is this study before the end of World War II after the First World War end during the analysis period. It corresponds to the Meiji period and the prewar age of the Showa period, and this period is a stagnation period of agricultural production. This study clarifies a change of factor shares of the rice production sector in this time. The purpose of this study is to elucidate the characteristics of the production structure of the rice production in Japan from 1922 through 1944, and the agriculture in Japan at this time is considered to be in a developing stage. The historic change of the rice production in Japan gives a suggestion for agriculture development in modern Asia. The measurement of factor shares of the rice production in the analysis period applies "a method to estimate land income as rest." In addition, it measures the Cobb- Douglas's type amount of production formation function. It clarifies the contribution of the production input.

OBJECTIVE

The main object of this study is to analyze the measurement of factor shares of the rice production. In analysis, the measurement of factor shares of the rice production applies "a method to estimate land income as rest." In addition, it measures the Cobb-Douglas's type amount of production formation function. It clarifies the contribution of the production input. The data applying to analysis are as follows. Ishibashi 1961. "Teikoku Nokai Kome Seisanhi Cyousa Syusei (Imperial Agricultural Organization cost of rice production investigation collection)" is from 1922 to 1948 (Natl. Res. Inst. of Agricultural Economics) (Natl. Res. Inst. of Agricultural Economics publication, the 207th). A period of estimation of factor shares and the amount of production formation function by estimate is 1922 through 1945. Sample data are thyme series data for 24 years.

METHODOLOGY

The Estimates of Factors Share

The measurement of factor shares of the rice production in the analysis period applies "a method to estimate land income as rest." It is presented by the following:

$$Factor\ shares L = (PL \cdot L)/(P \cdot Q) \quad (1)$$

$$Factor\ shares K = (PK \cdot L)/(P \cdot Q) \quad (2)$$

$$Factor\ shares V = (PV \cdot L)/(P \cdot Q) \quad (3)$$

$$Factor\ shares S = 1-(PL \cdot L)/(P \cdot Q)-(PK \cdot L)/(P \cdot Q)-(PV \cdot L)/(P \cdot Q) \quad (4)$$

where Q is output; P output price; L labor input; K capital input; V fertilizer input; S land input; LP labor input price; KP capital input price; VP fertilizer input purice and S land input price (Hayami and Ruttan, 1985).

Amount of Production Formation Function

The function type assumed is the Cobb-Douglas's type production function. The function to estimate is the next formula (Tsuchiya, 1976).

$$X = A \cdot L^{\alpha} \cdot V^{\gamma} \cdot S^{\delta} \quad (5)$$
$$(0 < \alpha, 0 < \gamma, 0 < \delta,\ \alpha + \gamma + \delta \fallingdotseq 1)$$

It is presented by the following:

$$\ln X = \ln A + \alpha \ln L + \gamma \ln V + \delta \ln S + \zeta \quad (6)$$

where X is output; L labor input; V fertilizer input; S land input.

Examination of the Contribution of the Production Input

The marginal productivity of input X is MPX. P is an output price. PX is X input price. In the case of ①: MPX> (PX/P), the input of X is under. In the case of ②: MPX = (PX/P), the input of the factor of production is equilibrium. In the case of ③: MPX <(PX/P), the input of the agent of production is excess. It is represented by the following. ④Value of production elasticity of X>factor shares X. ⑤Value of production elasticity of X= factor shares X. ⑥Value of production elasticity of X<factor shares X.

Data Collection

As for the data, Miyuki Ishibashi et al,"Imperial Agricultural Organization cost of rice production investigation collection", the sample data are thyme series data for 24 years. The index to use for estimation is an unpolished rice yield ("koku"≒140-150kg), product value (Japanese yen), seed costs, manure costs, wages, material costs, labor force of livestock costs, agricultural machinery costs, building for agriculture. These variables are numerical value per "tan" (≒10a). The variable data of the measurement of the amount of production formation function are as follows. Q is the amount of production. Here, it adopted an unpolished rice yield. L is wages. It adopted the total of family labor and the employment labor. V is an ordinary input. It adopted seed and sapling costs, manure costs, agriculture drug costs, and the total of material costs. S is rice paddy area. It is measured using the variable shown above. The data of the Miyuki Ishibashi great work "Imperial Agricultural Organization cost of rice production investigation collection" were displayed by a "tan," and therefore it took advantage, and, on the occasion of a measurement, the numerical value was converted the planted area around one farmhouse. Therefore, the numerical value multiplied the planted area by it and converted it into numerical value per one farmhouse.

RESULTS AND DISCUSSION

The Development of Rice Production in Japan (1881-2012)

The analysis object period of this study is 1922-1944. In the history of Japanese agriculture, it confirms a characteristic of this time. A change of the rice production in Japan from 1881 through 2012 is shown in the figure. 1881 is standard age (1881 = 1.0). The development of rice production in Japan for the period of 1881-2012 is shown in Fig. 1.

World War I brought a boom after the war for Japan. By the progress of the industrial division, the Industrial production value overtook an agricultural production value after the World War I. The development of the agriculture sector was delayed under the parasitic landlord system in comparison with the rapid development of the industrial sector (Teruoka, 2008). After World War II, the Japanese economy continued rapid growth during a period from 1955 through 1973 (High economic growth period). In this time, the agriculture sector drastically improved production by the spread of artificial manure, pesticide, and agricultural machines. However, the consumption of rice was delayed, so there was overproduction. Therefore, a policy of reducing the rice acreage was started in 1970 (Hayami and Yamada, 1991).

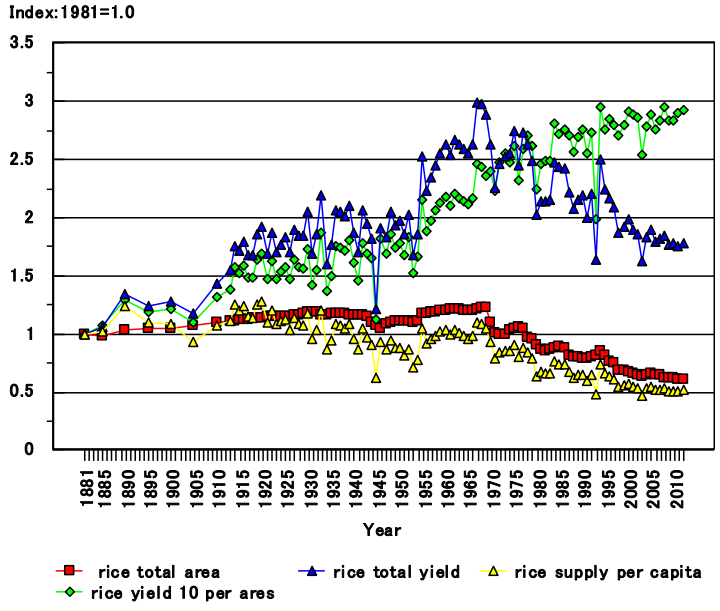

Fig. 1 Development of rice production in Japan (1881-2012)

The Change of the Element Input of the Rice Production (1922-1944)

A change of the element input of the rice production from 1922 through 1944 is shown in Fig. 2. In this Figure, the change of the input standard of each agent of production is shown in the standard in 1922 (1922 = 1.0).

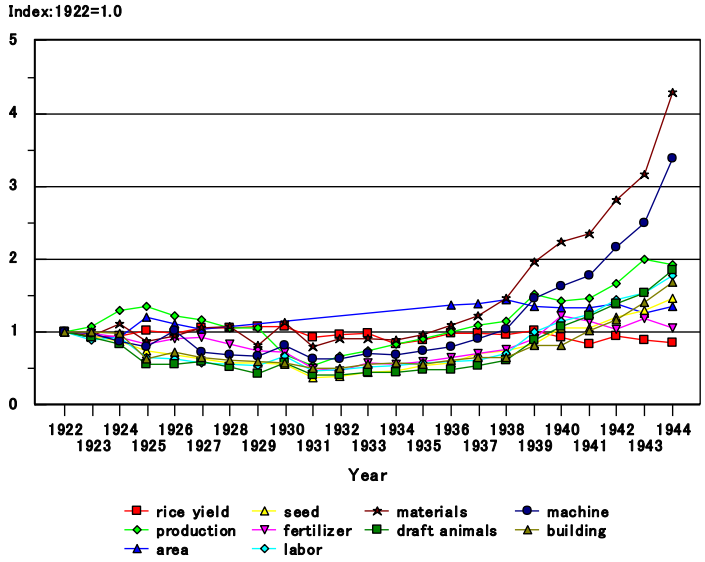

Fig. 2 The change of the element input of the rice production (1922-1944)

Table 1 Changes in factor shares for rice production in Japan (1922-1944)

Year	seed (%) ①	fertilizer (%) ②	labor (%) ③	materials (%) ④	draft animals (%) ⑤	machine (%) ⑥	building (%) ⑦	land (%) ⑧
1922	0.0147	0.2250	0.4618	0.0199	0.0651	0.0314	0.0341	0.1480
1923	0.0129	0.2047	0.3835	0.0173	0.0561	0.0286	0.0318	0.2651
1924	0.0100	0.1611	0.3294	0.0170	0.0419	0.0210	0.0259	0.3936
1925	0.0081	0.1410	0.2265	0.0129	0.0268	0.0184	0.0159	0.5503
1926	0.0082	0.1676	0.2392	0.0155	0.0302	0.0261	0.0204	0.4928
1927	0.0080	0.1787	0.2306	0.0182	0.0333	0.0194	0.0190	0.4928
1928	0.0081	0.1762	0.2454	0.0200	0.0319	0.0206	0.0200	0.4777
1929	0.0082	0.1606	0.2421	0.0154	0.0269	0.0202	0.0196	0.5070
1930	0.0121	0.2416	0.4498	0.0331	0.0548	0.0374	0.0293	0.1420
1931	0.0103	0.2035	0.4021	0.0291	0.0490	0.0359	0.0312	0.2389
1932	0.0089	0.1599	0.3420	0.0271	0.0400	0.0296	0.0263	0.3662
1933	0.0088	0.1740	0.3275	0.0245	0.0390	0.0295	0.0254	0.3712
1934	0.0081	0.1497	0.2992	0.0212	0.0347	0.0260	0.0232	0.4378
1935	0.0088	0.1457	0.2974	0.0210	0.0350	0.0255	0.0212	0.4454
1936	0.0085	0.1451	0.2762	0.0217	0.0315	0.0248	0.0208	0.4714
1937	0.0095	0.1455	0.2633	0.0223	0.0320	0.0263	0.0204	0.4806
1938	0.0096	0.1500	0.2819	0.0252	0.0352	0.0283	0.0193	0.4505
1939	0.0082	0.1355	0.3058	0.0258	0.0386	0.0303	0.0185	0.4374
1940	0.0109	0.1933	0.3753	0.0312	0.0494	0.0361	0.0198	0.2839
1941	0.0105	0.1748	0.3872	0.0316	0.0540	0.0377	0.0236	0.2805
1942	0.0107	0.1417	0.4049	0.0336	0.0543	0.0408	0.0240	0.2900
1943	0.0095	0.1328	0.3571	0.0315	0.0499	0.0393	0.0241	0.3557
1944	0.0112	0.1232	0.4231	0.0440	0.0624	0.0549	0.0296	0.2515

Note: ⑧＝1−(①+②+③+④+⑤+⑥+⑦)

The Cange of Fctor Sares of the Rice Poduction (1922-1944)

Table 1 shows the change of factor shares is land, labor, fertilizer, cost of draft animals, agricultural machinery, materials, building for agriculture, seed in order of the average value from 1922 through 1944. The change of these factor shares becomes land, labor, manure, labor force of livestock, agricultural machinery, materials, a building, the seed in order of a standard level. Factor

share of the capital such as labor force of livestock, agricultural machinery, the building shows a low value. On the other hand, labor, land and factor share of ordinary input materials such as the manure shows a high value. The period for the analysis was the time when it could not expect the expansion of the land area. Under such situations, the change of factor shares of the agent of production shows that the following production engineering system has been developed. As for the development of production technological system, it is a technological innovations land-saving and fertilizer-using (Sawada, 1991).

The Eamination of the Estimated Result of the Amount of Production Formation Function

The measurement results of the amount of production formation function are as follows.

$$\begin{array}{llll} lnX= & +0.0097 & +0.1233lnL & +0.3609lnV \quad +0.3627lnS \\ & (0.0051) & (0.4687) & (1.4125) \quad (0.5920) \end{array} \qquad (7)$$

$R^2 = 0.6030$

Firstly, the value of A is 0.0097. It is supposed that this suggests the existence of the neutral technological change. Secondly, the value of α is 0.1233. Thirdly, the value of γ is 0.3609. As for the fourth, a value of δ is 0.3627. As for the fifth, α+γ+δ is 0.8468, and the values are less than 1. It is similar to the linear homogeneous production function. This means that the constant returns to scale. This conclusion supports an original hypothesis. In other words, there are not the economies of scale in this production stage.

Examination of the Contribution of the Production Input

In a C-D's type production function, a value of the production of agent of production X elasticity and the distribution diagram of agent of production X have a characteristic to be equal. From it, the economical analysis of the input standard of the factors of production is possibility. It compares the value of the factors of production of factor share and the value of the production elasticity by the estimated result of the C-D's type amount of production formation function. And it adds economical analysis about the element input standard of each agent of production.

As for the labor input standard, an estimate of the labor (α) for 0.1233, as for the factor share of the labor are 1922-1930: 0.3120, 1931-1940: 0.3171, 1941-1944: 0.3931 and 1922-1944: 0.3283. In all periods, the numerical value of factor share is higher than a value of the production of factors of production elasticity, it is in this way supposed that the quantity of throwing down standard of factors of production is an excessive tendency.

As for the manure input standard, an estimate of the manure (γ) for 0.3609, as for the factor share of the labor are 1922-1930: 0.1841, 1931-1940: 0.1602, 1941-1944: 0.1431 and 1922-1944: 0.1666. In all periods, the price of the production of factors of production elasticity is higher than a value of factor shares of factors of production. It is in this way supposed that the quantity of throwing down standard of factors of production is a too few tendencies.

As for land input standard, an estimate of the land (δ) for 0.3627, as for the factor share of the labor are 1922-1930: 0.3855, 1931-1940: 0.3983, 1941-1944: 0.2944 and 1922-1944: 0.3752.

The period of 1941-1944 years, the price of the production of factors of production elasticity is higher than a value of factor shares of factors of production. It is supposed that the input standard of factors of production is a too few tendencies. However, in other time, as for the value of the production of factors of production elasticity, the value of factor share of factors of production is almost balanced. It is supposed that the input standard of factors of production is balanced.

The results of estimate by the amount of production formation function are as follows. In the periods of 1922-1944, the input of the labor is excess level, the input of the fertilizer is under level and the input of the land is equilibrium level.

CONCLUSION

The purpose of this study is to elucidate the characteristics of the production structure of the rice production in Japan from 1922 through 1944. The measurement of factor shares of the rice production in the analysis period. In addition, it measures the Cobb-Douglas's type amount of production formation function. It clarifies the contribution of the production input. The changes of factor shares are as follows. The change of factor shares is land, labor, fertilizer, cost of draft animals, agricultural machinery, materials, building for agriculture, seed in order of the average value from 1922 through 1944. As for the development of production technological system, it is a technological innovations land-saving and fertilizer-using. The results of estimate by the amount of production formation function are as follows. In the periods of 1922-1944, the input of the labor is excess level, the input of the fertilizer is under level and the input of the land is equilibrium level.

As a result of analysis, for the increase of the agricultural production, it was suggested that the development of the technique to reduce the limitation of the factor of production was important. The development of the agriculture section is important in economic development in modern Asia. When it thinks about a strategy of the agriculture development in modern Asia, it is suggested that it is necessary to consider the direction of the change of the production technique.

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