Population Migration Away from Agriculture in Japan

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POPULATION MIGRATION AWAY FROM AGRICULTURE IN JAPAN *

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The aim of this paper is to study the outflow of population from farm households[1] during the years 1921-62, with the exception of the decade surrounding World War II. In Section I, changes in the net outflow of farm population are examined with special reference to their relationship with fluctuations in economic activity. The period analyzed may not be sufficient, so two longer series for internal population migration are examined in the later part of this section. The first is the net migration of population into the prefectures containing the six largest cities since 1885. The second is the flow of population into Hokkaido since 1882. Examination of these series may shed light on population migration from agriculture in the earlier years. In Section II, an econometric model of the demand and supply functions for the net outflow of farm population is set forth. By estimating the parameters of this model, the determinants of population outflow from agriculture are delineated.

There are no official data for the net outflow of population from farm households covering both the pre- and postwar periods, and therefore we must first estimate such a series for the years 1921-62. The procedures of estimation are fully explained in Appendices I and II. In Appendix III, an estimation is made of the net migration of population into the prefectures, including those of the six largest cities, for the years 1885-1960. The development of these series is itself an additional important objective of this paper.

I. Economic Fluctuations and Changes in the Rate of Out-Migration from Agriculture

As indicated in Table 1, the farm household population remained constant or showed a slight increase in the prewar period, being 29 million in 1880, according to tentative estimates, and 31 million in 1940—an increase of only 2 million persons over a period of six decades, or 0.1 percent annually. Immediately after World War II, the farm population grew as a result of the large inflow of urban population to agricultural areas, coupled with the return from abroad of a large number of farmers. The farm household population amounted to 38 million by 1950, but then showed a marked decline, decreasing by some 4 million during the decade 1950-60. The annual growth rate was -0.9 percent during this last period.

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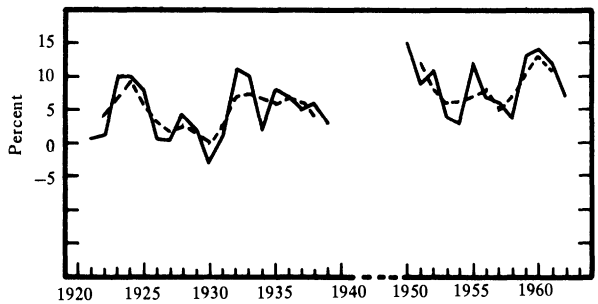
1. "Farm household" *(noka)* means one with any member engaged in agriculture; in the postwar surveys conducted by the Ministry of Agriculture and Forestry, even households with only one person so employed have been included in this category.



Source: Prewar—GDP in 1934-36 prices, as estimated by Kazushi Ohkawa, "Economic Growth in Japan: Basic Statistical Tables," Working Paper prepared for an SSRC Project, mimeo., Table 3; postwar—NDP from the Economic Planning Agency, ***Kokumin Shotoku Hakusho*** [White Paper on National Income Accounts], (1963), pp. 156-57, deflated by their GDP deflator (p. 186).

FIGURE 1.

Growth Rate of Real GDP

TABLE 1.

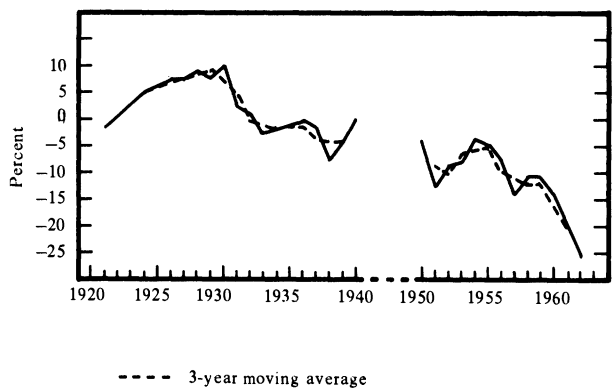
Farm Household Population (Quinquennial)

Year	Population (thousands) Excluding Okinawa Prefecture (1)	Including Okinawa Prefecture (2)
1880	29,438	29,763
1885	29,336	29,659
1890	29,171	29,512
1895	29,181	29,553
1900	29,431	29,833
1905	29,343	29,753
1910	29,534	29,945
1915	29,658	30,083
1920	29,819	30,249
1925	30,273	30,703
1930	31,636	32,095
1935	31,708	32,187
1940	31,391	31,846
1950	37,811	-
1955	36,468	-
1960	34,546	-

Source: Appendix I. Figures for 1880-1915 are tentative estimates.

Such an unprecedented decline in the agricultural population comes from successive large-scale outflows from agricultural to non-agricultural activities, which were caused by the rapid postwar expansion of the Japanese economy. The growth rate of real NDP in the postwar period has been, on the average, higher than that of real GDP for the prewar period, as is indicated in Figure 1. The averages of these growth rates are 9.2 percent and 5.2 percent for the postwar and prewar periods, respectively.

An annual series for farm population estimated for the years since 1920 is shown in Table 2. Figure 2 presents the annual rate of increase of the farm population. Apparently, the growth rate rose during the 1920's and fell in the first half of the 1930's. In the second half of the 1930's, it was constant to decreasing. For the postwar period, the growth rate was fairly constant from 1950 to 1955 and after that showed a remarkable downward shift. On the other hand, the rate of economic growth showed a downward swing in the years prior to 1930 and after that moved upward. After about 1933, it became virtually constant. In the case of the postwar period, the economic growth rate showed downward and upward swings, respectively, for the years prior to 1954 and for subsequent years.



Source: Table 2.

FIGURE 2.

Growth Rate of Farm Household Population

Thus, we find that the growth rate of the farm population and the economic growth rate are inversely related.[2] Such a finding may suggest a close relationship between the net outflow of the farm population and the rate of economic growth. Examination into this relationship is our major concern in this section.

2. The years covered in this estimate are 1921–39 and 1950–62. The year 1940 is omitted here (although it is included in the estimation of the outflow of farm population) because the GDP figure seems to be severely underestimated, since a large amount of military expenditures may be excluded. Estimates are based on three-year moving averages and the relevant periods are therefore 1922–38 and 1951–61. The correlation coefficients of the relationships between the rate of increase in farm household population and the economic growth rate are −0.631** (−0.598) for 1922–38 and −0.617* (−0.559) for 1951–61. The figures in parentheses are the correlation coefficients adjusted for the number of degrees of freedom. The notations ** and * indicate that the correlations are statistically significant at the 99 percent and the 95 percent levels, respectively.

TABLE 2.

Farm Household Population and Its Net Outflow and Out-migration Velocity

Year	Population (thousands)	Net Outflow		Out-migration velocity (percent)
		Volume (thousands)	Rate (percent)	
1920	29,819	-	-	-
1921	29,796	429	14.4	30.7
1922	29,829	358	12.0	25.3
1923	29,915	314	10.5	21.9
1924	30,081	247	8.1	16.6
1925	30,273	291	9.6	19.7
1926	30,502	284	9.3	18.9
1927	30,746	215	7.0	14.1
1928	31,038	194	6.2	12.5
1929	31,307	172	5.5	10.9
1930	31,636	161	5.1	9.9
1931	31,747	349	11.0	21.5
1932	31,809	468	14.7	28.5
1933	31,761	527	16.6	31.6
1934	31,728	447	14.1	26.5
1935	31,708	536	16.9	31.4
1936	31,719	431	13.3	25.0
1937	31,667	519	16.4	29.9
1938	31,430	550	17.5	31.6
1939	31,354	367	11.7	21.0
1940	31,391	383	12.2	21.8
1949	37,958	-	-	-
1950	37,811	798	21.1	38.6
1951	37,345	1,027	27.5	49.3
1952	37,048	834	22.5	39.6
1953	36,786	725	19.7	34.2
1954	36,649	568	15.5	26.5
1955	36,468	605	16.6	28.0
1956	36,216	630	17.4	29.1
1957	35,737	797	22.3	36.7
1958	35,374	739	20.9	34.0
1959	35,015	714	20.4	32.8
1960	34,546	801	23.2	36.8
1961	33,851	1,016	30.0	46.8
1962	33,011	1,152	34.9	53.4

"Net outflow" is outflow minus inflow. "Out-migration velocity" is net outflow divided by the ratio of non-farm population to total population. Non-farm population is total population minus farm population.

Sources: Appendix I for farm household population; Appendix II for its net outflow; and Figure 3 for total population.

The estimates for net outflow (outflow minus inflow) of population from farm households are given in Table 2. Net outflow was, on an average, 360,000 persons per year in the prewar period and more than twice that in the postwar years, averaging 800,000. However, these figures are not sufficient as indicators of the "propensity to migrate." They must be deflated with some measure of population in order to obtain good indicators.

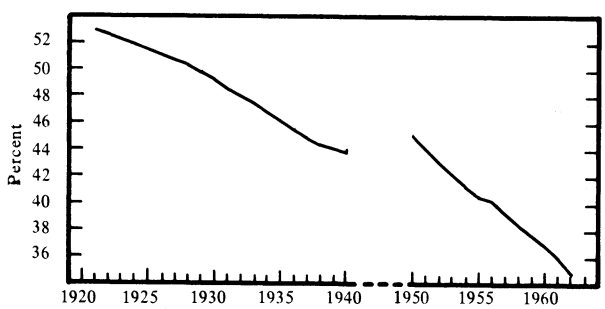
The first and most familiar indicator is the net outflow rate, m. This is the net outflow, M, divided by the farm population, P_a — $m = M/P_a$. But this concept has another bias, because of farm population (or non-farm population) to total population has shifted considerably during the years in question (see Figure 3). In consideration of this tendency, a second indicator, the out-migration velocity, v, is defined.[3] It is the net outflow rate deflated by the ratio of non-farm population, P_n; to total population, P, i.e.:

$$v = M \frac{P}{P_a P_n}$$

where P is total population ($= P_a + P_n$). Substituting into this expression the definition of m, we get

$$v = m \frac{P}{P_n}$$

Figures for these indicators have been calculated and are shown in Table 2. The average net outflow rate was 0.11 percent and 0.20 percent, respectively, in the prewar and postwar periods. And the average out-migration velocity was 2.25 percent and 3.74 percent, respectively, for two periods. Thus it may be stated that the "propensity to migrate" of the farm population has nearly doubled in the postwar years. The increase in the propensity to migrate in the postwar period depends partly on the increase in the level of economic activity, as measured by the rate of economic growth during this period.

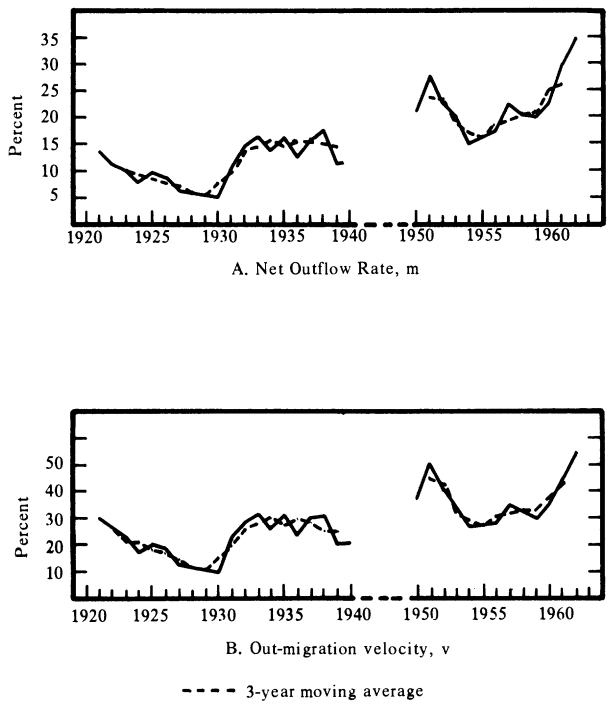


Sources: See Table 2 for farm household population. Figures for total population are those compiled by the Cabinet Bureau of Statistics, *Nippon Tokei Nenkan* [Japan Statistical Yearbook], No.15 (1964), p. 11.

FIGURE 3.

Farm Household Population as a Percentage of Total Population

3. "Out-migration velocity" is "-migration velocity," a concept originally proposed by D. J. Bogue in "Method of Studying Internal Migration," Working Paper prepared for a regional seminar on population in Central and South America, December 1955.



Source: See Table 2.

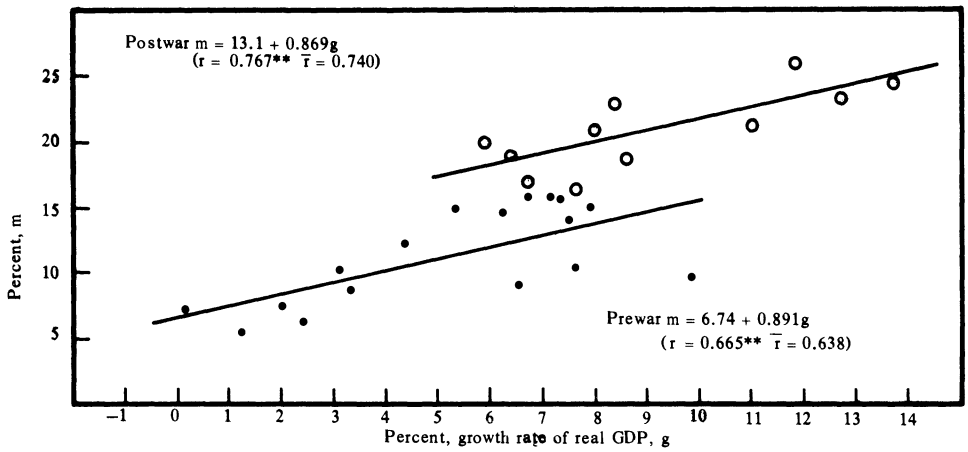
FIGURE 4.

Net Outflow Rate and Out-migration Velocity of Farm Household Population

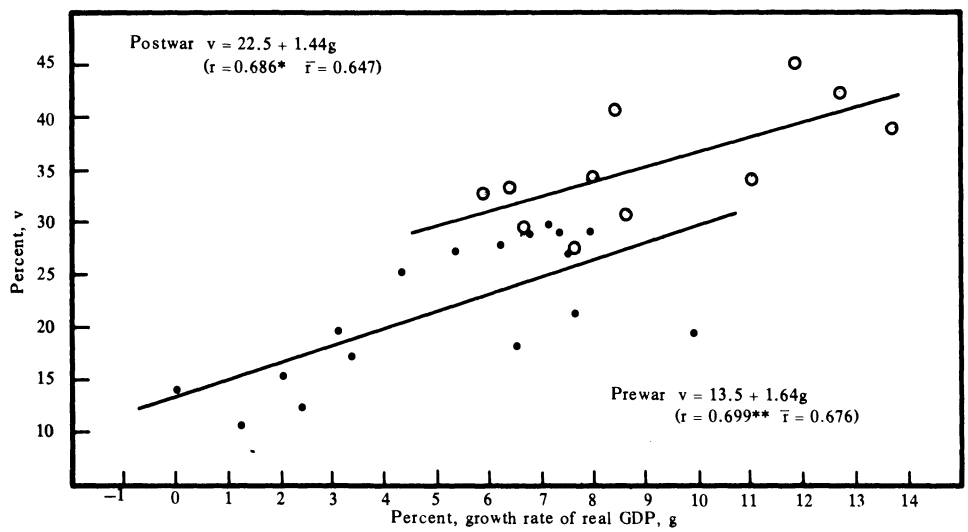
But our major concern here lies in an examination of the changes in the two indicators. It can be seen in Figure 4 that these indicators show fluctuations corresponding to those in the economic growth rate shown in Figure 1; the rate of outflow and the out-migration velocity declined in the 1920's, while the growth rate of real GDP was falling. In 1930, at the bottom of the Depression, they both reached their lowest points.[4] Subsequently, the net outflow rate and the out-migration velocity, together with the economic growth rate, showed a spurt and reached peaks in the years following 1933. In the postwar years, both sets of series showed U-shape curves, with their lowest points around 1954.

We may therefore state that changes in outflow of agricultural population are closely related to changes in economic activity. Figure 5 illustrates this relationship more clearly. There is a high correlation between both the net outflow rate, m, and out-migration velocity, v, of the farm household population, and the economic growth rate, g, in both the prewar and postwar periods. Furthermore, it is also noteworthy that the estimated parameters of both

4. It should be noted that even in the Depression, when real GDP decreased remarkably (see Figure 1), there was some net outflow of population from farm households. This may reflect the fact that pre-modern non-agricultural enterprises are a pool for absorbing unemployment, just as is agriculture, and may absorb some of the population moving out of agriculture. In a word, the dual structure in non-agricultural industries—the coexistence of modern and pre-modern enterprises—is one basis for the steady outflow of agricultural population.



A. Net Outflow Rate, m



B. Out-migration Velocity, v

Figures for net outflow rate, out-migration velocity, and growth rate of real GDP are three-year moving averages. Years estimated are 1922-38 and 1951-61 (see note 2). The notations r and $\bar{r}$ show the correlation coefficient and that adjusted by the number of degrees of freedom, respectively.

FIGURE 5.

Relation between Net Outflow Rate and Out-migration Velocity of Farm Household Population and the Growth Rate of Real GDP

m and v are almost equal between the prewar and postwar periods;[5] i.e., an increase in the economic growth rate brings an almost identical rise in the "propensity to migrate" in both periods. These relationships suggest that one of the reasons why the level of the propensity to migrate in the postwar period was on the average higher than that for the prewar period is the average economic growth rate which was higher after the war than before the war. But part of the difference is in the intercept of the estimated regression equations for the two periods.[6] In Section II we show that this differential mainly depends on the fact that the wage differentials between the agricultural and non-agricultural sectors increased in the postwar period.

We have not tried to discuss the net outflow of farm household population prior to 1920, because we do not have comparable indicators for that period. But examination of population migration from rural to urban districts may give some indication of the outflow of agricultural population in the years not covered by the previous discussion.[7]

Table 3 presents estimates of population and the volume and rate of net migration into the prefectures containing the six largest cities for the period 1885 to 1960. This figure for net migration may be taken as an indicator of the population migration from rural to urban areas.[8] In this series, the net migration rate shows fluctuations around an upward trend during prewar period,[9] which seem to correspond to fluctuations in economic activity. The relationship is seen more clearly in Figure 6, which indicates deviations from the trend in both the net migration rate and the economic growth rate.[10]

In considering the outflow of the rural population, migration to frontiers, as well as to urban areas, should not be ignored. Hokkaido was the most important frontier district.[11] In the prewar period, the government promoted population migration to Hokkaido as one measure directed at the problem of over-population in the older areas. Figure 7 depicts the inflow to Hokkaido in five-year moving averages.[12] Figure 8 shows the deviations from trend in the five-year moving averages; here, too, a close relationship can be found between the changes in population migration and those in the economic growth rate.

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5. The difference between the parameters for the postwar period and those for the prewar (the values of *t*-statistics are −0.096 for *m* and −0.420 for *v*) is not statistically significant at the 99 percent level.

6. For instance, the difference in the net outflow rate for the postwar period from that for the prewar period is explained as follows. Substituting the average figures for the economic growth rate—5.2 and 9.2 percent, respectively, in the prewar and postwar periods—into the estimated regression equations for these periods, we obtain averages for net outflow rate of 21.1 and 11.4 percent. If we substitute the difference in the average rates of economic growth for the two periods—9.2 − 5.2 = 4.0 percent—into the prewar regression equation, we get a difference in net outflow rate of 3.5 percent. Therefore, the difference of 9.7 percent (21.1 − 11.4) in the net outflow rate for the postwar period from that for the prewar period may be divided into two components: the first, 3.5 percent, is derived from the difference in the economic growth rate for the two periods, and the second, 6.2 percent, comes from the difference in the intercepts of the estimated regression equations.

7. In reality, the net migration of population to urban districts (see Figure 6) shows changes similar to those in net outflow of farm household population (see Figure 4) for the years 1920–40.

8. Trends in internal population migration in Japan have been surveyed by Irene B. Taeuber, *The Population of Japan* (Princeton, 1958), Part IV. For recent trends, see Minoru Tachi, "Regional Income Disparity and Internal Migration of Population in Japan," *Economic Development and Cultural Change*, XII, No. 2 (January 1964).

9. But the figures for 1910–15 and 1915–20 are probably under- and over-enumerated, respectively.

10. Trends in urbanization may depend mainly on non-economic factors. This is why we are concerned here only with the fluctuations around the trend. Changes in urbanization are examined here in terms of net migration rate, but not in terms of migration velocity; if the latter were used, almost the same results would be obtained.

11. For population migration to Hokkaido, see Tachi, *op. cit.*, Part V; and Yuzo Yamada, *Nippon Kokumin Shotoku Suikei Shiryo* [Sources for Estimating National Income in Japan] (Tokyo, 1951).

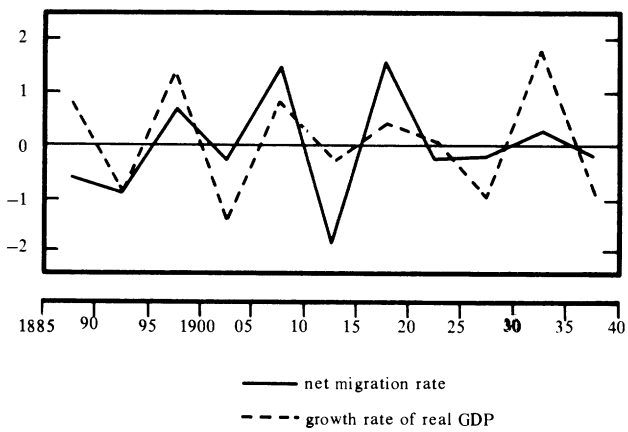
12. We are concerned here with "inflow" and not "net migration" because, in the writer's opinion, considerable under-enumeration is found in the data for "outflow."

TABLE 3.

Population and Its Net Migration
in the Prefectures Containing the Six Largest Cities (Quinquennial)

Year	Population (thousands)	Net Migration	
		Volume (thousands)	Rate (percent)
1885	7,190		
1890	7,487	180	5.0
1895	7,821	156	4.2
1900	8,647	544	14.0
1905	9,570	532	12.4
1910	10,841	771	16.2
1915	11,463	- 6	0
1920	13,289	1,375	24.0
1925	15,142	1,108	16.6
1930	17,335	1,105	14.6
1935	19,996	1,463	16.8
1940	22,455	1,450	14.5
1945	15,439	-8,135	-72.4
1950	21,157	4,176	54.0
1955	24,899	2,327	22.0
1960	28,737	2,500	20.0

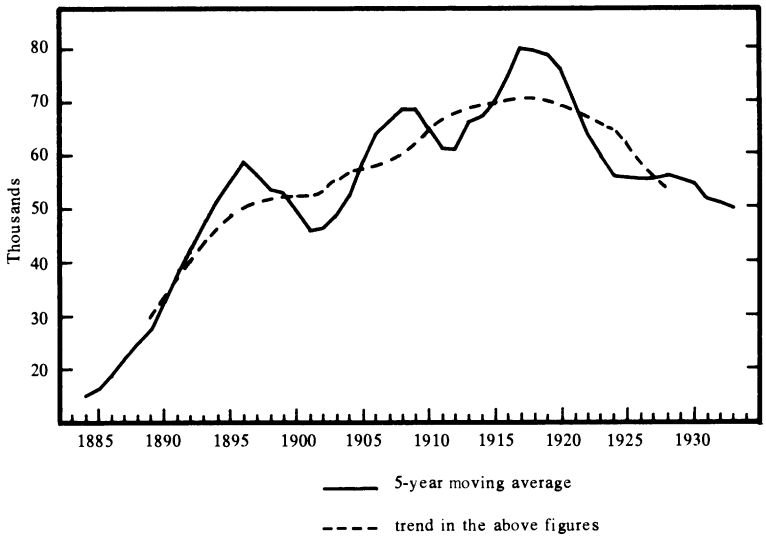
Source: Appendix III. The prefectures in question are Tokyo, Kanagawa (Yokohama City), Aichi (Nagoya City), Kyoto, Osaka, and Hyogo (Kobe City).



Sources: Table 3 for net migration, and Figure 1 for growth rate of real GDP.

FIGURE 6.

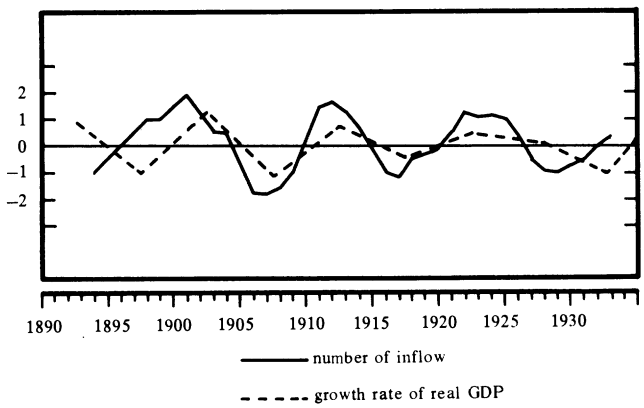
Cyclical Variations from Trends in Net Migration Rate of Population in the Prefectures containing the Six Largest Cities and in the Growth Rate of Real GDP



Source: Department of Home Affairs, *Hokkaido Iju-Sha Su* [Number of Migrants to and from Hokkaido], 1882-1935. The trend is the 11-year moving average of figures in five-year moving averages.

FIGURE 7.

Inflow to Hokkaido



Source: Figure 7 for the five-year moving average figures for inflow and their trend; and Figure 1 for the growth rate of real GDP. Represents deviations of five-year moving averages from the trend.

FIGURE 8.

Cyclical Variations from Trend in Inflow to Hokkaido and in the Growth Rate of Real GDP

II. Determinants of Population Migration out of Agriculture

The close relationship between population migration out of agriculture and the economic growth rate, g, signifies that population migration depends on the number of "employment opportunities," that is, upon upward shifts in the demand function for labor in non-agricultural industries.[13] As an index of employment opportunities, we have taken the growth rate of real GDP in non-agricultural industries, g_n.[14] Estimating the relationships of the net outflow rate, m, and the out-migration velocity, v, to the growth rate, g_n, (in three-year moving averages) for the years 1922-61 (omitting 1939-50), the correlation coefficients are:

0.771** (0.761) for m
0.785** (0.776) for v[15]

The figures in parentheses are the correlation coefficients adjusted by the number of degrees of freedom. The correlations are statistically significant and show that close relationships exist between the propensity to migrate of the farm population and the growth rate in non-agriculture.

The analyses above have explored the demand side of population migration. Next, the determinants on the supply side must be considered. First we shall examine the effect of real wages in non-agricultural industries, w_n, on population migration. As depicted in Figure 9, real wages increased slightly during the prewar period and sharply during the postwar period. A linear regression of the net outflow rate and out-migration velocity with real wages in non-agriculture yields the following correlation coefficients:

0.800** (0.782) for m
0.716** (0.688) for v

Next, the relationships of net outflow rate and of out-migration velocity to relative real wages in non-agriculture and agriculture (w_a), w_n/w_a, is examined. (The real wage in agriculture, as shown in Figure 9, remained virtually constant during the years under consideration.[16]) Estimating these relationships, high correlation coefficients are obtained:

0.897** (0.888) for m
0.984** (0.983) for v

Thus we can state that propensity to migrate can be expressed as a function either of real wages in non-agricultural industries or of the ratio of these wages to agricultural wages.[17]

13. Outflow of population from farm households does not necessarily correspond to the labor force movement from agricultural to non-agricultural industries. But in the writer's opinion it may serve as a proxy for the latter.

14. Data used for g_n are similar to those of the growth rate in real GDP, g (see Figure 1)..

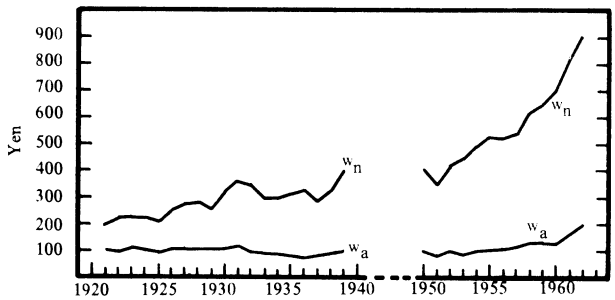
15. Estimating these relations separately for the prewar and postwar periods, the following correlation coefficients are obtained:

Prewar	Postwar	
0.580* (0.544)	0.784** (0.759)	for *m*
0.634** (0.605)	0.701** (0.663)	for *v*

See note 2 above for the notations * and **.

16. Agricultural wages are only a proxy for w_a. In principle, figures for the wage earnings of the agricultural labor force should be used. In dealing with this, however, some sort of imputating calculation, which may not be free of arbitrariness, is needed. Therefore, in the writer's opinion, the use of agricultural wages is more adequate.

17. Tests of this hypothesis, which may be called the "relative income hypothesis concerning population migration," have been attempted by Tachi, *op. cit.;* Shunsaku Nishikawa, "Domestic Labor Migration in Japan," *Keio Business Review,* No. 1 (1962); and others in Japan. But their attempts are all based on interregional, rather than intersectoral, population migration.



w_n = real wages in non-agriculture; wage earnings per employee in non-agriculture deflated by the price index for manufactures (1934-36 = 1).

w_a = real wages in agriculture; average of wages by sex in agriculture deflated by the price index for agriculture (1934-36 = 1).

Source: wage earnings in non-agriculture—Yuzo Yamada, *Nippon Kokumin Shotoku Suikei Shiryo* [Sources for Estimating National Income in Japan] (Tokyo, 1951), p. 75, for the prewar period, and the Economic Planning Agency, *op. cit.*, p. 87, for the postwar period; employment in non-agriculture—Kazushi Ohkawa et al., *The Growth Rate of the Japanese Economy since 1878* (Tokyo, 1957), p. 145, for the prewar period, and the Economic Planning Agency, *op. cit.*, p. 87, for the postwar period; wages in agriculture by sex—Ryozaburo Minami and Minoru Tachi, eds., *Jinko Toshika no Riron to Bunseki* [Theories and Analyses of Urbanization] (Tokyo, 1965), pp. 193-94; price index for non-agriculture and agriculture—Ohkawa et al., *op. cit.*, Table 16.

FIGURE 9.

Real Wages in Non-Agricultural and Agricultural Industries

We have examined separately some of the factors affecting population migration out of agriculture. Next, to achieve a more comprehensive analysis of migration, a model consisting of simultaneous equations, that is, of both demand and supply functions for farm population migration, is constructed and its parameters estimated.

Assuming that the demand for net outflow of farm household population, m_d, depends on two variables, real wages, w_n, and the growth rate of real GDP, g_n, both in non-agricultural industry, and that the supply, m_s, depends on real wages in non-agriculture, w_n, as well as those in agriculture, w_a, we have:

$$m_d = f_d(w_n, g_n)$$

$$m_s = f_s(w_n, w_a).$$

Here we specify the model in logarithmic form:

$$(1) \quad \log m_d = \alpha_1 \log w_n + \alpha_2 \log(100 + g_n) + \alpha_0 + u \ ^{18}$$

18. The figure in parentheses, $100 + g_n$, is the percentage ratio of real GDP for a particular year to that for the preceding year.

(2) $\log m_s = \beta_1 \log w_n + \beta_2 \log w_a + \beta_0 + v$

In this model the variable w_n is endogenous. The parameters α_1 and β_1 are assumed to be negative and positive, respectively. That is, as wages in non-agricultural industries rise, the demand for labor and consequently for agricultural population decreases in these industries, while the inclination of farm population to move away from agriculture increases. Under these conditions, equilibrium is stable. In Figure 10, $m_d(1)$ and $m_s(1)$ depict, respectively, the demand and supply functions at instant 1.

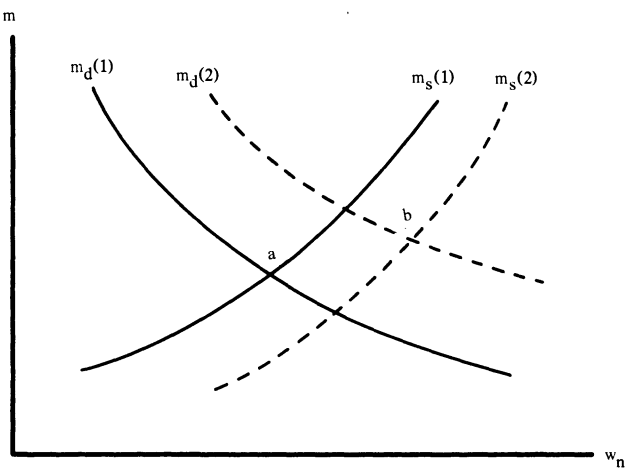


FIGURE 10.

Demand and Supply Functions of Net Outflow Rate of Farm Household Population

Variables g_n and w_a are exogenous,[19] and their parameters α_2 and β_2 are expected to be positive and negative, respectively. That is, the demand function shifts upward when the growth rate in non-agriculture rises; the supply function shifts downward as real wages in agriculture increase. These relationships can be seen in Figure 10. The demand schedule shifts upward from $m_d(1)$ to $m_d(2)$, and the supply schedule shifts downward from $m_s(1)$ to $m_s(2)$, owing to the rise in these exogenous variables. So the equilibrium point moves from a to b. α_0 and β_0 are constants; u and v are random variables assumed to be normally distributed with a zero mean and finite variance.

In the equilibrium state, we have the following relation:

(3) $m_d = m_s = m,$

where m is the observed net outflow rate. From the relations given in (1), (2), and (3), the following equations in reduced form are obtained:

19. The assumption that agricultural wages are exogenously given comes from our understanding that the agricultural wage force has been unlimited. It should be noted that the concept of "unlimited supplies of labor" can be established so long as the agricultural wage rate is given from outside the system, even if the wage rate shows some changes. See Kazushi Ohkawa, "Economic Growth in Japan: Basic Statistical Tables," Working Paper prepared for an SSRC project (mimeo.).

(4) $\log w_n = A_1 \log(100 + g_n) + A_2 \log w_a + A_0$

(5) $\log m = B_1 \log(100 + g_n) + B_2 \log w_a + B_0$.

A_i and B_i ($i = 0, 1, 2$) are defined below.[20] Regressing w_n and m on $(100 + g_n)$ and w_a for the same period as that in the previous regression analyses, parameters A_i and B_i are estimated.[21] And from these estimates of A_i and B_i, parameters α_i and β_i are obtained. Thus, equations (1) and (2) become

(1)' $\log m_d = -0.206 \log w_n + 10.366 \log(100 + g_n) - 19.399$

(2)' $\log m_s = 1.928 \log w_n - 2.428 \log w_a + 1.044$

Substituting v_d, v_s and v, respectively, for m_d, m_s, and m in equations (1), (2), and (3), and repeating the estimation procedures for the previous parameters, we get the following relations:

(1)'' $\log v_d = -0.290 \log w_n + 9.584 \log(100 + g_n) - 17.326$

(2)'' $\log v_s = 1.682 \log w_n - 2.244 \log w_a + 1.574$.[22]

From these results, we may conclude that, first, with a rise in real wages in non-agricultural industries, the demand of these industries for agricultural population decreases, and the supply of agricultural population to non-agricultural industries increases. The supply is, however, much more sensitive than is the demand to non-agricultural wages. (A 1 percent rise in w_n follows an increase in m_s of 1.928 percent, but a decrease in m_d of only 0.206 percent.) Second, the demand of non-agricultural industries for agricultural population depends on the level of economic activity in the former. Third, a rise in agricultural wages decreases the inclination of agricultural population to move out of agriculture. Fourth, combining the second and third points above, the inclination to move out of agriculture depends on the relative wages in non-agricultural to those in agricultural industries.[23]

Finally, we would like to specify the relative contribution of each of the explanatory variables in the demand and supply functions. First, substituting the average figures for

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20. $A_1 = \dfrac{\alpha_2}{\beta_1 - \alpha_1}$, $A_2 = -\dfrac{\beta_2}{\beta_1 - \alpha_1}$, $A_0 = \dfrac{1}{\beta_1 - \alpha_1}\,[(\alpha_0 + u) - (\beta_0 - v)]$,

$B_1 = \dfrac{\alpha_2\beta_1}{\beta_1 - \alpha_1}$, $B_2 = -\dfrac{\alpha_1\beta_2}{\beta_1 - \alpha_1}$, $B_0 = \dfrac{1}{\beta_1 - \alpha_1}\,[(\alpha_0 + u)\beta_1 - (\beta_0 + v)\alpha_1]$.

21. (4)' $\log w_n = \underset{(1.551)**}{4.859} \log(100 + g_n) + \underset{(0.381)**}{1.138} \log w_a - \underset{(3.619)*}{9.583}$ $\quad R = 0.662 \quad \bar{R} = 0.610$

(5)' $\log m = \underset{(1.503)**}{9.367} \log(100 + g_n) - \underset{(0.370)}{0.234} \log w_a - \underset{(3.113)**}{17.430}$ $\quad R = 0.780 \quad \bar{R} = 0.750$

22. These are obtained from relation (4)' and the following equation:

(5)'' $\log v = \underset{(1.215)**}{8.173} \log(100 + g_n) - \underset{(0.299)}{0.330} \log w_a - \underset{(2.516)**}{14.544}$ $\quad R = 0.805 \quad \bar{R} = 0.780.$

23. The findings already obtained, that m and v depend on g_n, w_n, and w_n/w_a, have been more precisely re-examined here.

$\log w_n$ and $\log(100 + g_n)$ into the demand functions (1)' and (1)'', the following table is obtained:[24]

Equation (1)' : m_d

	$\alpha_1 \log w_n$	$\alpha_2 \log(100 + g_n)$	$\alpha_0 + u$	Total	log m
Entire period	-0.527	21.071	-19.399	1.145	1.145
Prewar period	-0.504	20.998	-19.399	1.095	1.032
Postwar period	-0.563	21.185	-19.399	1.223	1.320

Equation (1)'' : v_d

	$\alpha_1 \log w_n$	$\alpha_2 \log(100 + g_n)$	$\alpha_0 + u$	Total	log v
Entire period	-0.745	19.481	-17.326	1.410	1.410
Prewar period	-0.712	19.413	-17.326	1.375	1.322
Postwar period	-0.795	19.587	-17.326	1.466	1.547

With respect to both m_d and v_d, the values of $\alpha_1 \log w_n$ are extremely small, and those of $\alpha_2 \log (100 + g_n)$ are large. For instance, in the case of m_d, the value of $\alpha_1 \log w_n$ is only -0.527, and that of $\alpha_2 \log(100 + g_n)$ is 21.071. Dividing this period into prewar and postwar categories, we see that the values of $\alpha_1 \log w_n$ do not vary between the two; on the other hand, those of $\alpha_2 \log(100 + g_n)$ increase remarkably. In the case of m_d, the gap in $\alpha_1 \log w_n$ between these periods is only 0.059, and that in $\alpha_2 \log(100 + g_n)$ is 0.187. Accordingly, it is the increase in the level of $\alpha_2 \log(100 + g_n)$ in the postwar period which is responsible for the rise in the net outflow rate and the out-migration velocity in this period.

Second, the values of $\beta_1 \log w_n$ and $\beta_2 \log w_a$ in the supply function are calculated as follows:

Equation (2)' : m_s

	$\beta_1 \log w_n$	$\beta_2 \log w_a$	$\beta_0 + v$	Total	log m
Entire period	4.946	-4.844	1.044	1.146	1.145
Prewar period	4.730	-4.808	1.044	0.966	1.032
Postwar period	5.279	-4.900	1.044	1.423	1.320

Equation (2)'' : v_s

	$\beta_1 \log w_n$	$\beta_2 \log w_a$	$\beta_0 + v$	Total	log v
Entire period	4.315	-4.479	1.574	1.410	1.410
Prewar period	4.127	-4.445	1.574	1.256	1.322
Postwar period	4.606	-4.530	1.574	1.650	1.547

Consider the figures for $\beta_1 \log w_n$. With respect to both m_s and v_s, $\beta_1 \log w_n$ shows large values. This is contrary to the situation with the demand function, where the values

24. In this table, the figures under "log *m*" and "log *v*" are the averages of logarithmic figures for observed *m* and *v*, respectively.

of $\alpha_1 \log w_n$ are negligible. In the case of m_s, $\alpha_1 \log w_n$ is -0.527 and $\beta_1 \log w_n$ is 4.946. That is, the supply is sensitive to real wages in non-agriculture, but demand is not. Furthermore, the differences in $\beta_1 \log w_n$ between prewar and postwar times (0.543 for the case of m_s and 0.479 for the case of v_s) should be noted. They follow the differences in the net outflow rate and in out-migration velocity between the two periods. On the other hand, the values of $\beta_2 \log w_a$ remain almost the same.

In conclusion: (1) the demand in non-agricultural industries for the agricultural population mainly depends on the level of economic activity in the former; wage rates in non-agriculture are not relevant to demand. (2) The supply of agricultural population to non-agricultural industries is sensitive to wages both in non-agricultural and in agricultural industries. That is, as the former increase and/or the latter decrease, the percentage of the agricultural population which moves out of agriculture into non-agriculture increases. In other words, the "propensity to migrate" increases with the relative rise in the wages of the non-agricultural industry to those in agriculture. (3) Particularly, the increase in outflow of the agricultural population for the postwar period has depended on the increase in economic activity in non-agricultural industries and on the rise in the real wage rate in these industries (and therefore on the increase in the relative wages of non-agriculture to those of agriculture), respectively from the view points of the demand and supply sides of population migration.

APPENDIX I.
MEASUREMENT OF FARM HOUSEHOLD POPULATION

1949–62

A few surveys on farm household population *(noka jinko)* have been conducted by the Ministry of Agriculture and Forestry. They are not comparable year by year as they stand, because their coverage and method of measurement vary from year to year. But for three years—1950, 1955 and 1960—the data seem to be substantively comparable.[25]

In the intervening years, the farm population has been estimated by linking it with the "rice producer's household population" (*Kome seisan shotai jinko)* in the Food Agency's *Beikoku no Shuka Haikyu Shiryo Chosa Hokoku* [Survey of Data for Preparation of Rice Collection and Distribution] from 1949. The subjects surveyed are the population of households having a rice production greater than 0.2 *tan* (0.0 *tan* before 1951).[26] This survey resembles a census, so to speak, in that it is comparatively detailed and has continuity. Furthermore, since the rice producers' household population represents about 90 percent of the total farm population, we believe it reflects realistically the changes in the farm population.

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25. The data for 1950 and 1960 are from census figures, while the 1955 figures are based on a 1/5 sample.

26. The discontinuity of this series is corrected for by adjusting the data before 1951 to the level since 1952. See Ryoshin Minami, "Noka Jinko Ido no Suikei to Bunseki [Analysis and Measurement of Farm Household Population Migration]," *Hitotsubashi Ronso* (November 1964). One *tan* = 0.245 acres.

1887–1940

Data on farm population are not available, but the number of farm households by prefectures from 1880 to 1940 has been estimated by M. Umemura and S. Yamada.[27] These estimates rely on the *Noji Tokei* [Agricultural Statistics] of the *Nokai Chosa* [Agricultural Association Survey]. By multiplying the number of households of each prefecture by the respective family size estimates, the farm population can be estimated.

For family size, we substitute "the number of persons per household by the labor force status (agriculture) of the household head" in the *National Population Censuses* for 1920 and 1930. Family size may be estimated for other census years by linking it with family size of the rural population by prefecture in the 1925, 1935, and 1940 *Censuses*. Intercensus years are estimated by linear interpolation. In the precensus years, family size by prefecture is assumed to be constant at the 1920 level. As this assumption is somewhat rigid, the estimates of farm population before 1920 cannot be expected to show short-term changes. The total estimated farm household population is shown in Tables 1 and 2.[28]

APPENDIX II.
MEASUREMENT OF NET OUTFLOW OF FARM HOUSEHOLD POPULATION

1950–1962

Information is available for the postwar period from numerous surveys conducted by the Ministry of Agriculture and Forestry. For 1950–52 there is the *Actual Condition Survey on Agriculture* [Nogyo Dotai Chosa]; after 1952, the *Survey on Population Change* [Ido Jinko Chosa]; and after 1958, the *Survey on Working Status of Farm, Forestry, and Fishery Households* [Noringyoka Shugyo Doko Chosa]. But, in the writer's opinion, some difficulties exist with regard to their levels and continuity. We estimate the net outflow on the basis of the so-called "vital statistics method."[29] In this method, time series data on the agricultural population and its natural rate of increase are necessary. Data on population are supplied in Appendix I. The crude natural rate of increase in the postwar period is assumed to be equal to that of the total population in the *Vital Statistics* [Jinko Dotai Chosa] prepared by the Ministry of Health and Welfare. This assumption may not be erroneous, since the vital rates have become almost equal among the different sectors in the postwar period.

1921–1940

As data are unavailable for the prewar period, net outflow is estimated in the same manner as for the postwar years. It must be noted, however, that there is a great difference between the crude birth or death rate of the agricultural population and that of the nonagricultural or total population. We substitute the usable crude birth and death rate of the

27. Mataji Umemura and Saburo Yamada, *Noka Kosu no Suikei, 1880–1940* [Estimates of Farm Households, 1880–1940], Working Papers D–12 (1962) and C–9 (1963), mimeo.

28. The series by prefecture appear in Ryoshin Minami, *Noka Jinko no Suikei 1880–1940* [Estimates of Farm Household Population, 1880–1940], Working Paper of the Rockefeller Project at Hitotsubashi University D–35 (1964), mimeo.

29. Net outflow can be estimated by deducting the natural increase in population.

rural population[30] for those of the agricultural population. These figures are obtained for each census year. For other years, they are estimated by linking them with the crude birth and death rate of the total population.

The estimates of net outflow are summarized in Table 2.

APPENDIX III.
MEASUREMENT OF NET MIGRATION INTO PREFECTURES CONTAINING THE SIX LARGEST CITIES (QUINQUENNIAL)

For the measurement of the net migration of population in the prefectures under consideration, data on population and vital statistics by prefecture are necessary.

Population—Quinquennial

1920–60: Data are available from *Censuses*.

1885–1915: Estimates of "presently resident population" *(Genju Jinko)* by prefecture, derived from "population in the place of registration" *(Honseki Jinko)*, prepared by the Cabinet Bureau of Statistics, are available since 1885. It is generally agreed, however, that these series contain substantial under-enumerations. Recently the Institute of Population Problems assessed the total population from 1870 to 1920 by demographic methods and found that the CBS figures are under-enumerated by about one million persons in 1885.[31] Hence, assuming that the degree of under-enumeration does not differ among the prefectures, we estimated the series of population in each prefecture by multiplying the CBS series of presently resident population in the prefecture by the ratio, in that particular year, of the IPP estimates of total population to the CBS estimates of total presently resident population.

Natural Increase (Quinquennial)

1920–60: Vital statistics by prefecture are available.

1900–20: Official statistics by prefecture are also available for this period, but the IPP estimates show that they are not free from under-enumerations in earlier years. Therefore, we assess the number of births or deaths by multiplying the official figures by the ratio of the IPP estimates of births or deaths of total population to the official figures of births or deaths of total population.

1855–1900: As official data by prefecture are not available, we estimate the birth or death rate by prefecture by linking it with the IPP series of that of total population.

The estimates of population and net migration are shown in Table 3.[32]

30. Estimated by Masao Ueda, "Nippon no Jinko Toshika [Urbanization in Japan]," in Ryoazburo Minami and Minoru Tachi, eds., *Jinko Toshika no Riron to Bunseki* [Theories and Analyses of Urbanization] (Tokyo, 1965), p. 24.

31. Japan, Ministry of Health and Welfare, Institute of Population Problems, *Meiji Shonen Iko Taisho 9–Nen ni Itaru Danjo Nenrei–Betsu Jinko Suikei ni Tsuite* [Population Estimates by Sex and Age from the 1870's to 1920], Research Series No. 145 (1962), mimeo., p. 43.

32. Figures by prefecture are given in Ryoshin Minami, "Jinko Toshika no Keiko to Hendo [Trends and Fluctuations in Urbanization]," *Keizai Kenkyu* [Economic Review] (January 1965), pp. 79–80.

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