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MACROECONOMIC STATISTICAL RELATIONSHIPS IN THE JAPANESE ECONOMY

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This paper discusses some statistical relationships observed in the Japanese economy during about the 1960s and 1970s. The statistical facts dealt with in this paper take the form of correlation coefficients between various pairs of macroeconomic time-series variables. The selection criterion for the pairs of economic variables is that they are interesting theoretically. The task of theoretically systematizing the economic facts obtained and examining them in more detail, will be done in a future paper. Along with the correlation coefficient and, in some cases, the corresponding graphs, of each pair of economic variables, some explanation will be provided as to why the pair is interesting.

1. The Average Propensity to Save and Non-Contract Cash Earnings

Let us first look at the following example.

(the personal propensity to save) vs.
(consumer-price inflation)

63.6% (56–81)
62.1% (56–73)

We read such an expression as follows. 'A vs. B' means the pair of variables concerned. In this example A is the personal average propensity to save and B is consumer-price inflation. The sources and detailed statistical definitions of these variables are given in 'The Explanations and Sources of Economic Variables' in Appendix. The figures 63.6% (56–81) refer to the correlation coefficient (R^2) between A and B for the period of 1956 through 1981. Similarly 62.1% (56–73) refers to the correlation coefficient between A and B for the period of 1956 through 1973.

The high positive correlation between the saving ratio and inflation, indicated in Relation (1), is interesting and we continue by investigating the correlation between the following variables.

(the personal propensity to save) vs.
(the rate of increase in the nominal wage-rate)

29.2% (56–81)
81.2% (56–73)
59.9% (74–81) (2)

*) The R^2 values for the correlation between the rate of increase of the consumer price index and the rate of increase in the nominal wage-rate are calculated as 25.6% (52–66), 85.2% (67–73), 95.5% (74–81), and 45.5% (67–81).

Since we also know that there is a fairly high positive correlation between consumer-price inflation and nominal-wage inflation*) Relation (1) may be due to the relation indicated by Relation (2). This does not mean, of course, that we maintain that the causal order is one-way from nominal-wage inflation to consumer-price inflation. In connection with Relation (2), we also have

(the personal propensity to save) vs.
(the non-contract cash earnings ratio)

86.5% (56–81) (3)

The non-contract cash earnings include bonus payments, and the non-contract cash earnings ratio is the ratio of the non-contract cash earnings to total earnings per regular worker. This Relation (3) seems to provide a clue to understanding Relation (1). Relation (3) may be interpreted as follows: When the rate of increase in the nominal wage-rate is high (low), the non-contract cash earnings ratio will be high (low) because the macroeconomic conditions will be good (bad) then. The high non-contract cash earnings ratio means a high ratio of bonus payments to total earnings, and if a major part of the bonus payments is saved then the propensity to save will be high. The first of those two suppositions may be partly sustained by the following correlation.

(the non-contract cash earnings ratio) vs.
(the rate of increase in the nominal wage-rate)

37.9% (54–81) (see Fig. 1)
80.9% (54–73) (see Fig. 1-1) (4)
83.9% (74–81) (see Fig. 1-2)

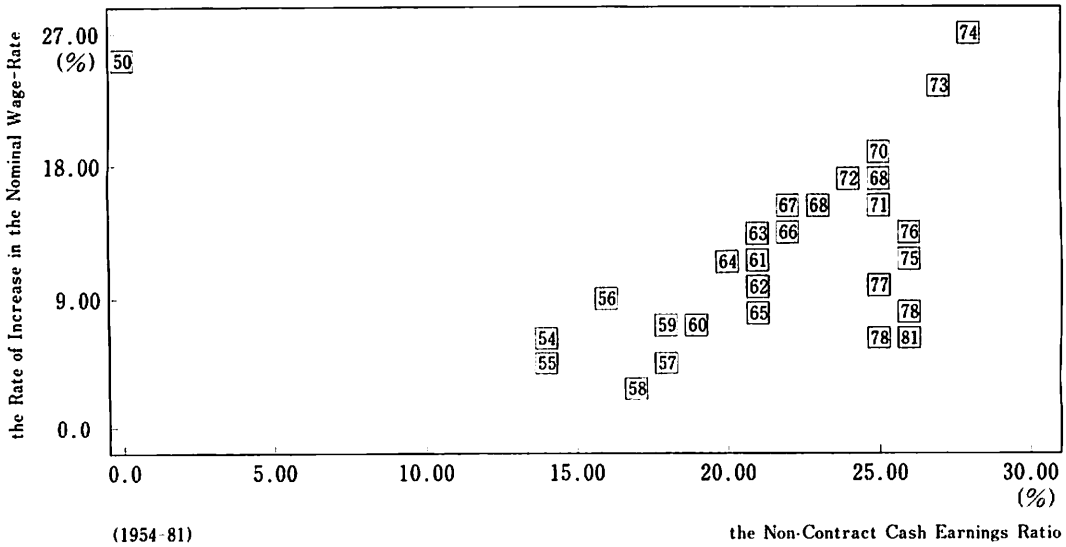

Fig. 1

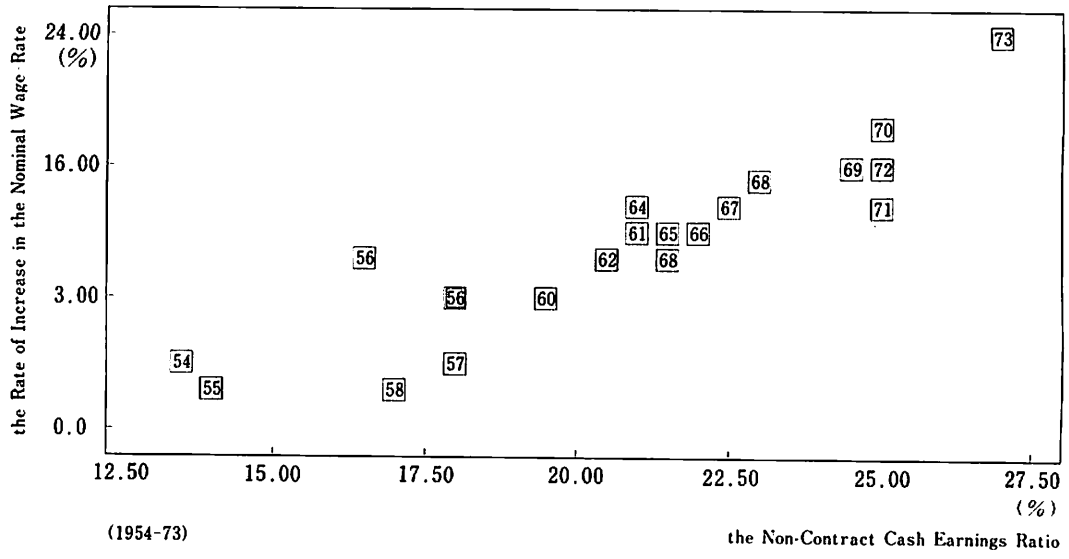

Fig. 1-1

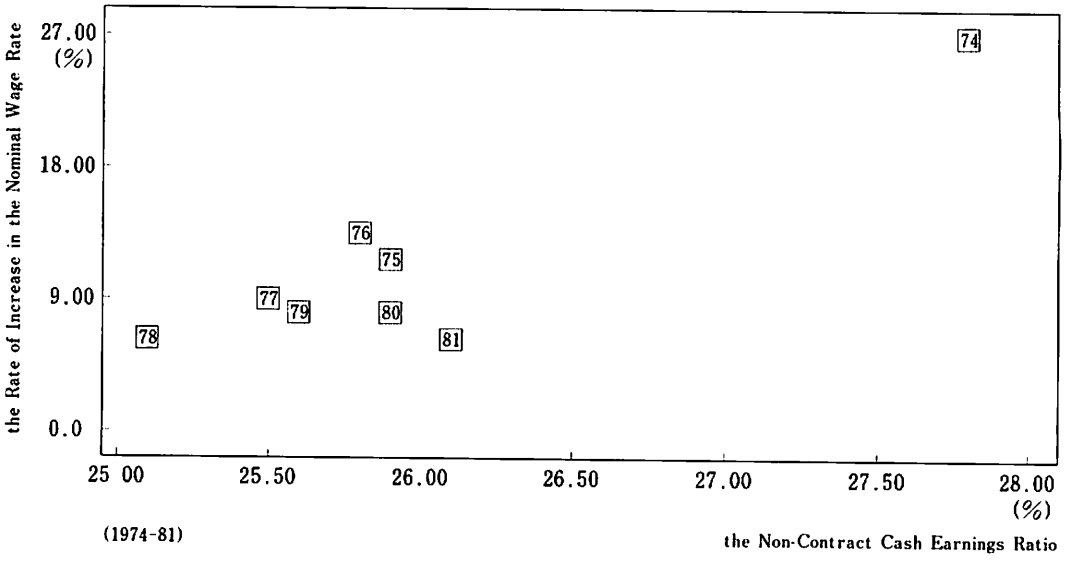

Fig. 1-2

It seems important to distinguish overtime work hours from the non-contract cash earnings in this context. For, as the following result indicates, the correlation between these two is negative for 1954–81.

(the non-contract cash earnings ratio) vs.
(the non-scheduled work hours ratio)

$$-23.7\% \ (54\text{–}81) \tag{5}$$

where the non-scheduled work hours consist of overtime work hours which is called 'zangyô' work hours. Nevertheless it is remarkable to see that

(the non-scheduled work hours ratio) vs.

(the job-offer ratio)

0.0% (56–81) (6)

which indicates that the overall correlation between the non-scheduled work hours ratio and the job-offer ratio (that is, the ratio of job-offers to applicants, of non-regular and part-time workers) is zero. Compare this Relation (6) with the following Relation (7).

(the non-contract cash earnings ratio) vs.
(the job-offer ratio)

37.0% (56–81)
70.0% (56–73) (see Fig. 2-1) (7)
89.0% (74–81) (see Fig. 2-2)

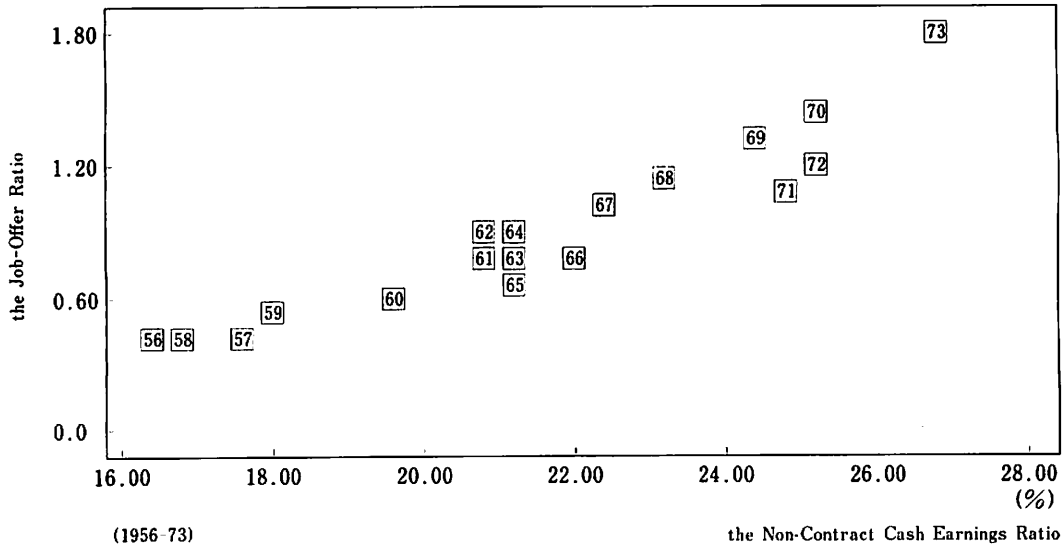

Fig. 2-1

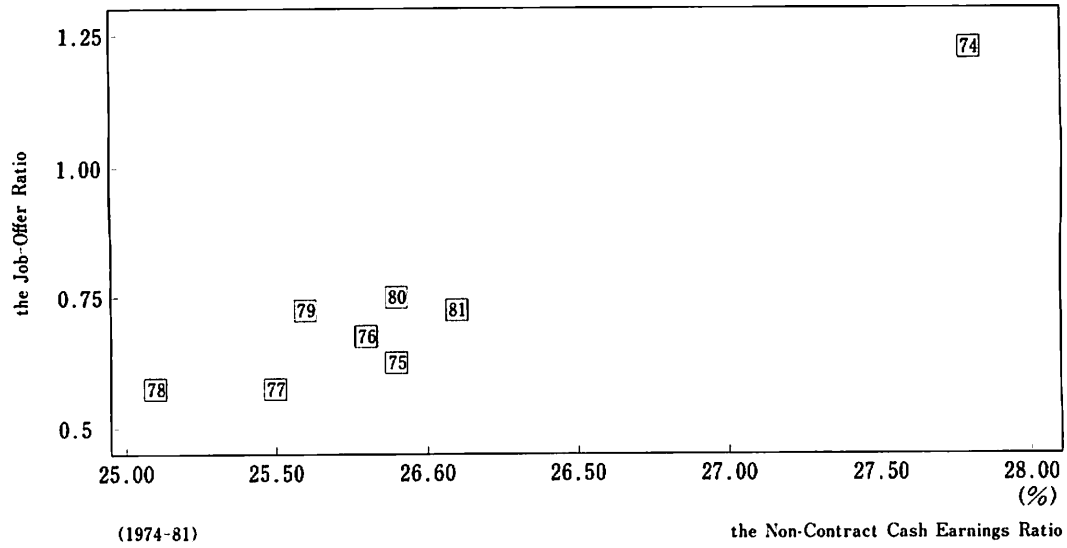

Fig. 2-2

Thus, the better the job-offer condition, the higher the non-contract cash earnings. The close relation between Relations (4) and (7) will be very clearly sustained by Relation (8) in the following section. This Relation (8) indicates that the demand-for-labor condition (which is taken as an important macroeconomic condition) is highly correlated with the rate of increase in the nominal wage-rate.

2. The Job-offer Ratio as an Index of Work Intensity

First let us have a look at the following.

(the job-offer ratio) vs.
(the rate of increase in the nominal wage-rate)

91.1% (56–73) (see Fig. 3-1)
76.2% (74–81) (see Fig. 3-2) (8)

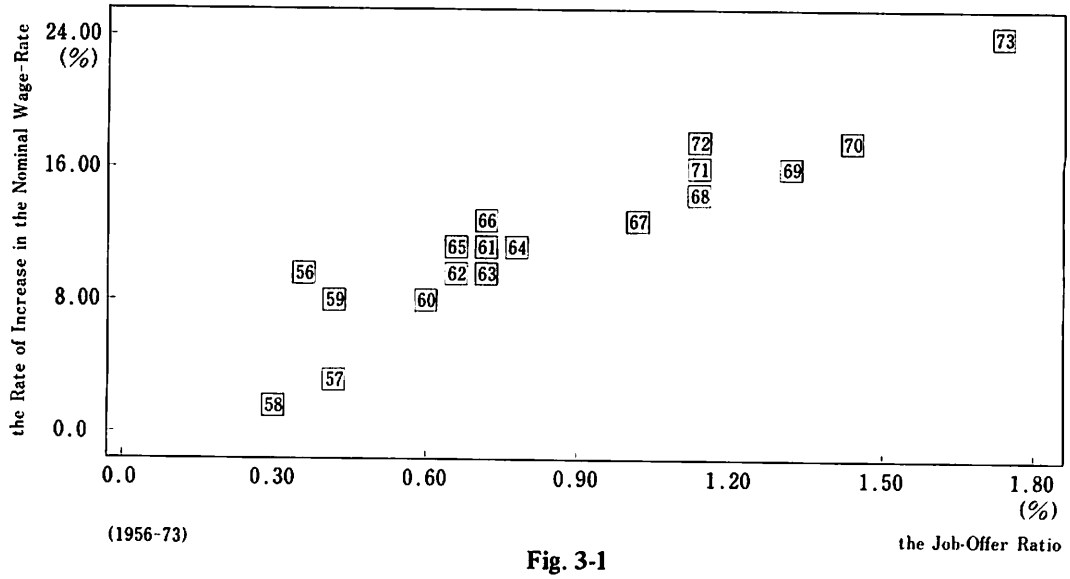

Fig. 3-1

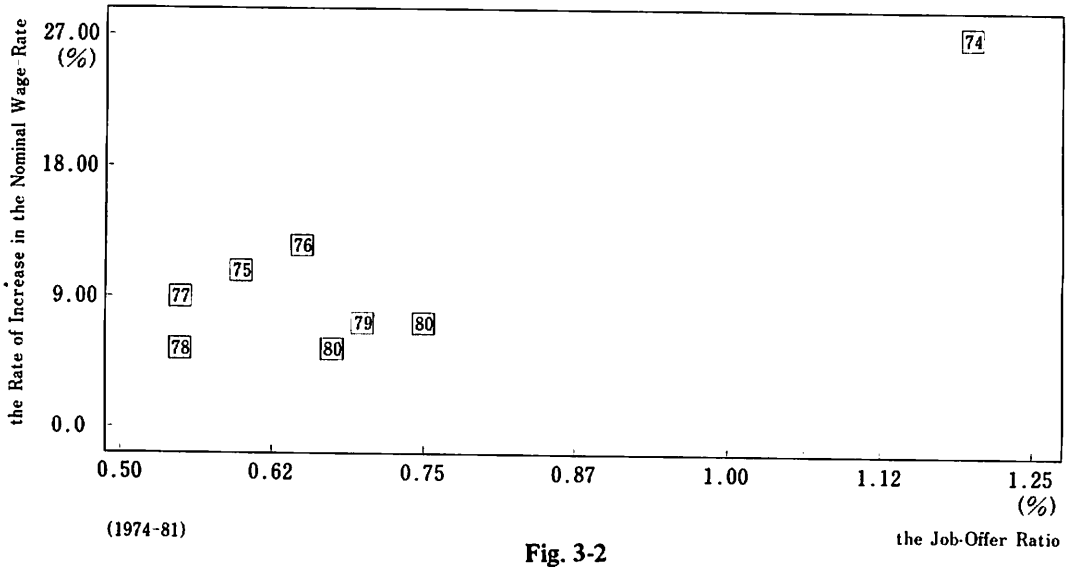

Fig. 3-2

This relation may be said to be an analogue of the Phillips curve which was originally a trade-off relationship between the rate of unemployment and the rate of increase in the nominal wage-rate. The high correlation of Relation (8) can be interpreted to mean that, when the labor market (for part-time workers, etc.) is tight, so that there exists some excess demand in the labor market, and the rate of increase in the nominal wage-rate is greater (which is the Phillips explanation). However, there is another way of explaining Relation (8). That is, some general business condition, such as that measured by the job-offer ratio, will be positively correlated with the revenue conditions of firms. The revenue condition could be improved by not only greater quantities sold but also by an acceleration of the inflation of the prices of the products. When the firm's revenue conditions are better, the labor unions will obtain a higher rate of increase in the nominal wage-rate. This explanation differs from the former explanation in that it does not depend on the assumption that there exists an excess demand (or excess supply) in the labor market whenever the nominal wage-rate increases (decreases). In fact we have the following relationships in favor of this latter explanation.

(the rate of increase in the nominal wage-rate) vs.
(the wholesale-price inflation)

35.6% (52–81) (see Fig. 4)
88.0% (67–73) (see Fig. 4-1) (9)
66.8% (74–81) (see Fig. 4-2)

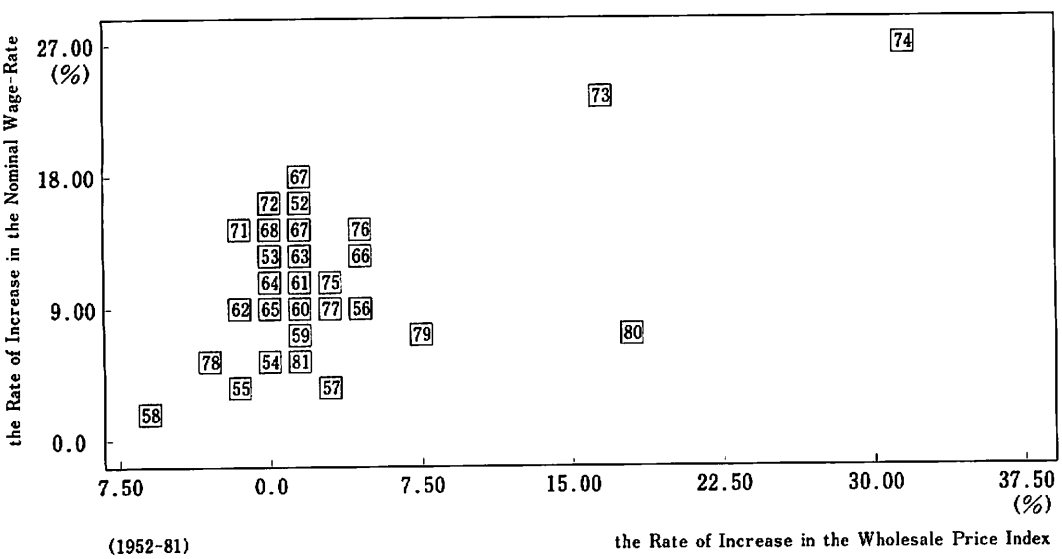

Fig. 4

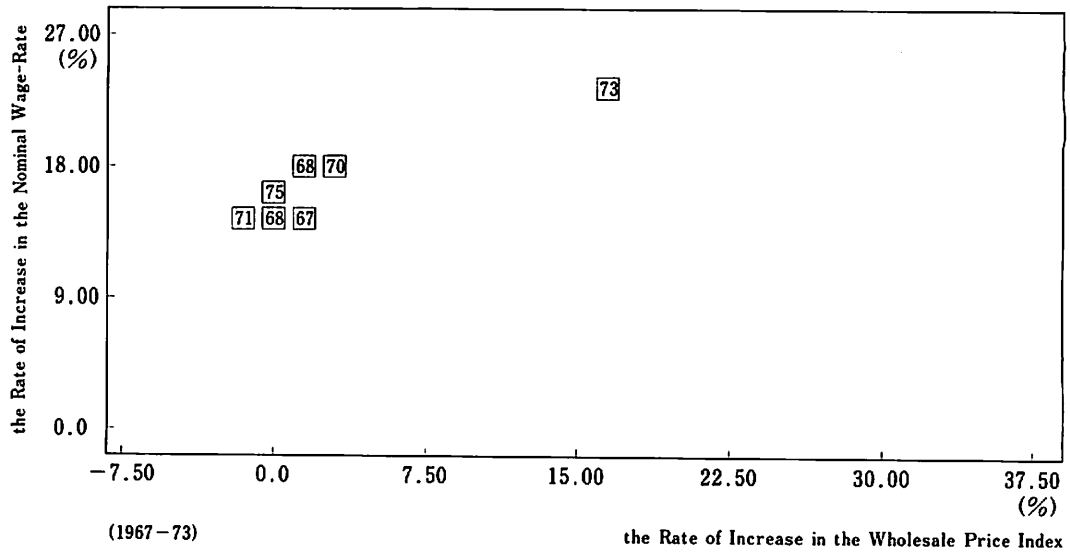
the Rate of Increase in the Nominal Wage-Rate
27.00
(%)
18.00
9.00
0.0
73
68 70
75
71 68 67
−7.50
0.0
7.50
15.00
22.50
30.00
37.50
(%)
(1967−73)
the Rate of Increase in the Wholesale Price Index

Fig. 4-1

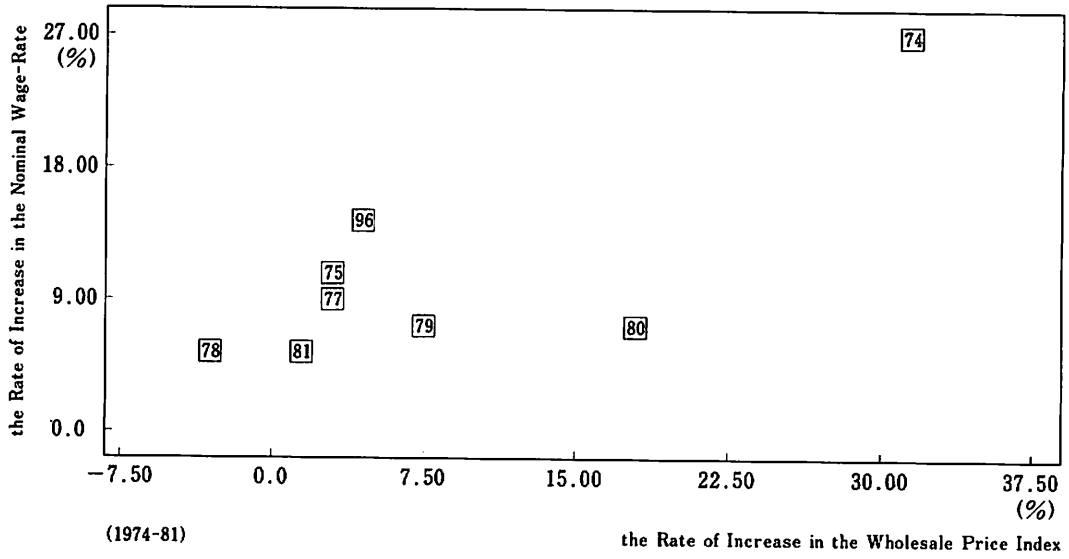
the Rate of Increase in the Nominal Wage-Rate
27.00
(%)
18.00
9.00
0.0
74
96
75
77
79
80
78
81
−7.50
0.0
7.50
15.00
22.50
30.00
37.50
(%)
(1974-81)
the Rate of Increase in the Wholesale Price Index

Fig. 4-2

(the job-offer ratio) vs.
(wholesale-price inflation)

44.4% (58–66)
83.0% (67–73) (see Fig. 5-1) (10)
87.0% (74–81) (see Fig. 5-2)

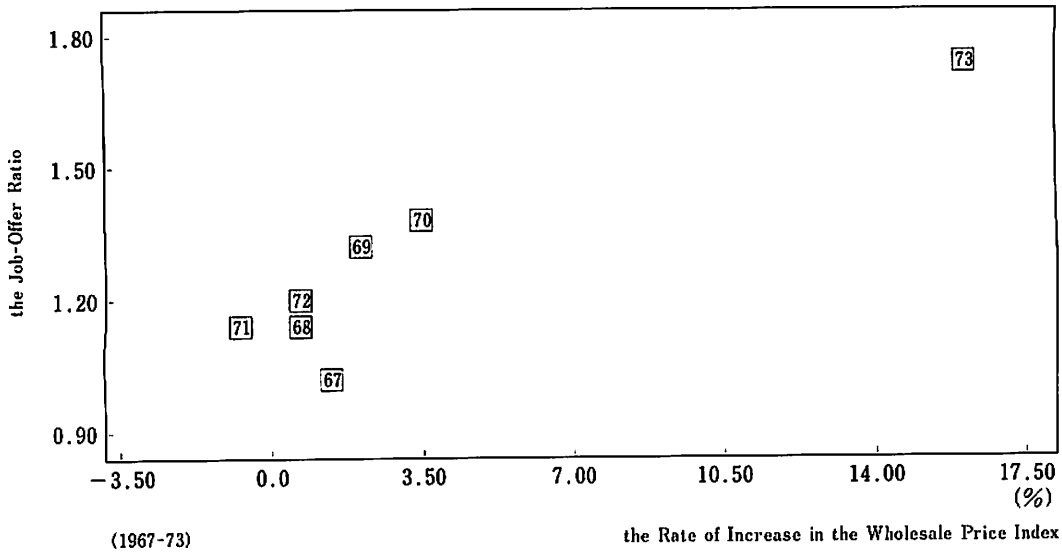

Fig. 5-1

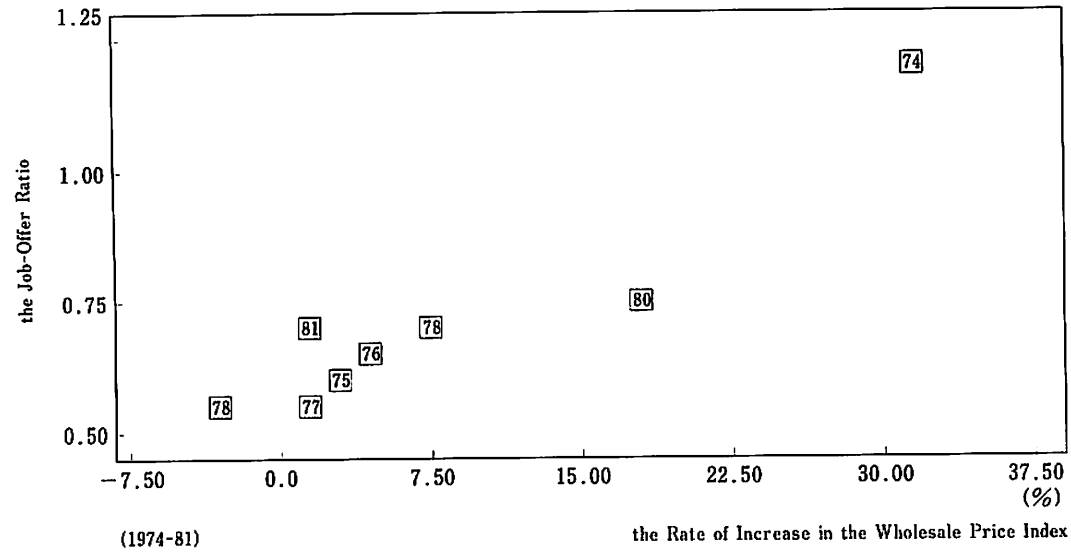

Fig. 5-2

Behind Relation (9), that is, the correlation between the wage-rate inflation and the wholesale-price inflation, both the commodity market and the labor market (in the aggregate) should be considered. The cost effect of a rise in the nominal wage-rate is to shift upward the supply curves for all commodities, which tends to raise the general level of (wholesale) prices. Further, commodity price inflation tends to shift up the marginal efficiency schedule for capital (i.e., the demand curve for investment) and hence to shift up the demand curve for labor. Therefore price-inflation has a tendency to raise the nominal wage-rate determined in the labor market. The latter causal effect from price-inflation to wage-inflation may be connected with the Phillips-Mundell effect, that is, when the expected price-inflation is high, the demand for commodities is strong. This effect is also related to Relation (10) above. A rise in the expected rate of price-inflation tends to shift up the demand curve for investment. Hence it also tends to shift up both the aggregate demand curve for commodities and the demand curve for labor. Therefore it tends to raise the job-offer ratio. We assume here that when the actual wholesale-price inflation rate is high, the expected wholesale-price inflation is also high, so that the actual inflation tends to be correlated positively with the job-offer ratio.

However, the causal order from the job-offer ratio to inflation cannot be easily neglected. When the demand for labor is strong, the wage-inflation will be high, so that the price-inflation will be also high due to cost effects.

Directly related to the title of this section is the following.

(the job-offer ratio) vs. (the operating ratio)

67.8% (61–81) (see Fig. 6) (11)

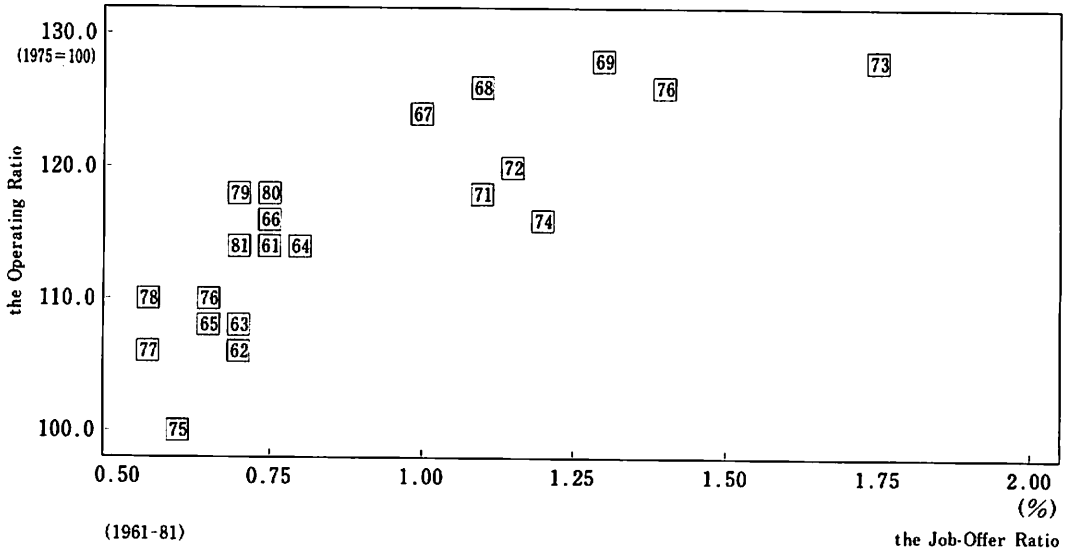

Fig. 6

The operating ratio or, capacity utilization rate, is defined as the degree of utilization of production capacity, that is, the ratio of the production index to the production capacity index. The operating ratio is high when the existing capital stock (machinery, equipment and buildings for productive use) is heavily utilized. Relation

(11) indicates that production capacity is more heavily utilized when the demand for labor, for both regular and part-time worker, is stronger. Production capacity is more utilized when and only when labor is more intensively employed. 'Employed' means here that potential productivity, mainly of regular workers, is realized. More intensive use of the work hours of the average regular worker, rather than extra or additional work hours, is what it means to say that labor is more intensively employed. The above Relation (9) is significant in that it statistically connects the degree of work intensity of an average work hour of a regular worker with the demand-and-supply condition of the non-regular labor market indicated by the job-offer ratio. By Relation (11) we can examine the demand condition of not only non-regular, but also regular labor, as indicated by the job-offer ratio.

The job-offer ratio, or the ratio of job-offers to applicants, indicates a measure of strength of the demand for non-regular workers, those people who are between jobs and part-time workers. It does not include new graduates. It does not directly measure demand conditions for regular workers. However, since the operating ratio and the degree of utilization of production capacity will be high when the job-offer ratio is high (Relation (11)), the job-offer ratio may also be viewed as an indicator of demand conditions for regular workers. Those (regular) already employed workers may be functioning as flexible, buffer-like suppliers of additional labor, additional in the sense of an addition to the intensity of work included in one unit of absolute work time. The additional labor in this sense will be inevitably concealed behind the statistical figures of the job-offer ratio. The job-offer ratio often takes a figure widely different from unity, and we would not be wrong in taking it as implying a relatively large excess of total demand (supply) over total supply (demand) of labor.

3. The Job-offer Ratio and Inflation

Along with Relation (10) we also have the following relationships (12), (13), and (14).

(the job-offer ratio) vs. (consumer-price inflation)

$$\begin{matrix} 55.5\%\ (56\text{–}74) \\ 50.3\%\ (58\text{–}66) \\ 88.6\%\ (67\text{–}73) \\ 69.3\%\ (74\text{–}81) \end{matrix} \qquad (12)$$

The demand-for-labor condition indicated by the job-offer ratio is also highly correlated with foreign economic conditions such as the import- and export-price inflations.

(the job-offer ratio) vs. (import-good price inflation)

$$\begin{matrix} 77.0\ \%\ (58\text{–}66) \\ 84.0\%\ (67\text{–}73) \\ 79.4\%\ (74\text{–}81) \end{matrix} \qquad (13)$$

and (the job-offer ratio) vs. (export-good price inflation)

$$\begin{matrix} 13.4\%\ (58\text{–}66) \\ 81.3\%\ (67\text{–}73) \\ 97.2\%\ (74\text{–}81) \end{matrix} \qquad (14)$$

As statistically verified below (Relation (15)), the import-good price inflation and the export-good price inflation are highly correlated with each other, so that we may regard both of these measures as indicators of the world economic condition. From this viewpoint, Relations (13) and (14) can be interpreted to signify the same thing: that the domestic demand-for-labor is highly affected by conditions of the world economy.

(import-good price inflation) vs.
(export-good price inflation)

48.6% (58–66)
86.4% (67–73) (15)
87.7% (74–81)

At the beginning of Section 2, we saw the high correlation between the job-offer ratio and the nominal-wage inflation, and considered two possible explanations. The second of those appears more persuasive than before, if we take foreign economic factors in consideration. This is because the nominal-wage inflation is somewhat correlated with the import-good price inflation.

(import-good price inflation) vs.
(the rate of increase in the nominal wage-rate)

40.0% (53–73)
50.5% (74–81) (16)

Two viewpoints regarding Relation (16) are possible. One is to view it as fairly correlated, and the other is to view it as a low correlation. From the first view, the correlation between the job-offer ratio and the nominal-wage inflation (Relation (8)) looks about the same as the correlation between the job-offer ratio and the import (or export)-good price inflation (Relation (13) or (14)) and we may explain the former in a way similar to that of the explanation for the latter. That is, the demand-for-labor condition indicated by the job-offer ratio is good if the demand for commodities is strong, and the commodity demand will be strong when the domestic and world price inflations, including the nominal-wage inflation, are high. The second explanation in Section 2 says that the business conditions (or the level of commodity-demand) is good if domestic price inflation is high, and we may extend such a proposition to the world economy. Namely, when the import or export-good price inflation is high, world commodity demand is strong, so that the domestic job-offer ratio is high. And behind this proposition, the Phillips-Mundell relation may be considered as its possible thoeretical basis.

On the other hand, if we take the second view to regard Relation (16), as being not highly correlated, it will be more persuasive to say that stronger domestic demand for goods and labor raises wage-inflation. For, if the correlation between the nominal-wage inflation and the world price inflation is not strong, whereas the correlation between the former and the job-offer ratio *is* strong (Relation (8)), then we will have to say that it will be the job-offer ratio rather than the world price inflation that more strongly explains the movement of nominal-wage inflation.

Above, we distinguished between two views as to how strongly to regard the correlation in Relation (16). Now let us turn to Relation (10) in Section 2. As stated in that section, there can be two explanations for this Relation (10), one is to explain it by the causal order from wholesale-price inflation to the job-offer ratio,

and the other is to explain it by the reverse order. The first is related to the Phillips-Mundell effect. Relation (10), concerning the relationship between the job-offer ratio and the domestic price inflation, provides percentage figures as large as those which Relations (13) or (14) show (which relate the job-offer ratio to foreign price inflation). In this connection we also have

(wholesale-price inflation) vs.
(import-good price inflation)

88.9% (53–81)
76.1% (53–73)
92.9% (74–81) (17)

(wholesale-price inflation) vs.
(export-good price inflation)

16.2% (53–57)
59.3% (58–66)
74.6% (67–73)
90.5% (74–81) (18)

We remark that the correlations between the domestic wholesale-price inflation and the foreign inflation rates are higher in the more recent periods than in earlier ones.

Together with these relationships (17) and (18), Relation (10) in Section 2 seems very similar to Relations (13) and (14). And a similar economic logic can be considered behind any one of those three relationships. That is, the higher is the rate of inflation, the better will be the domestic demand for labor. Furthermore, if we can assume that the domestic economic conditions have little influence on world inflation (the so called 'small country' assumption), we cannot help but explain Relations (13) and (14) by the causal order from world inflation to the job-offer ratio. And the Phillips-Mundell effect (see the part of Section 3 below Relation (10)) would be relevant in this context. By Relations (17) and (18), we will argue that wholesale-price inflation occurs because world inflation occurs for we will not be able to argue the other way around by the small-country assumption. The high correlation of Relation (10) in Section 2 will then be explained by the causal order from wholesale-price inflation to the job-offer ratio.

However it is still an open question as to whether the small-country assumption applies to the Japanese economy, and it should be investigated as to what periods it may be so regarded. Therefore, it is still to be decided which causal ordering is the stronger in explaining Relation (10) in Section 2.

4. Economic Growth and the Labor Productivity

Along with Relation (11) in Section 2, we also have

(the operating ratio) vs.
(the rate of increase in labor-productivity)

43.3% (61–81)
47.4% (61–73)
21.0% (74–81) (19)

which shows that the rate of increase in labor-productivity (production per worker) is positively correlated with the operating ratio. The reason for this result may be clarified by the following.

(the rate of increase in labor-productivity) vs.
(the rate of increase in industrial production)

80.2% (61–81) (20)

That is, the rate of increase in labor-productivity is high when the rate of increase in the level of real industrial production is high. In other words, labor-productivity increases more when the demand for commodities rises at a greater pace, and the operating ratio and the job-offer ratio are both large.

In the process of economic growth, the level of real investment (per year) will increase at a more or less steady rate and the rate of increase in real investment may be expected to be positively correlated with the demand-for-labor condition. However we have the following result.

(the rate of increase in real private investment) vs.
(the job-offer ratio)

0.0% (56–81) (21)

This result is contrary to the above expectation. In a similar sense we also have

(the rate of increase in real GNP) vs.
(the job-offer ratio)

0.0% (56–81) (22)

However it is remarkable and, in a sense, a little surprising that the rate of increase in real private investment is highly positively correlated with *the rate of increase* in the level of the job-offer ratio itself.

(the rate of increase in real private investment) vs.
(the rate of increase in the job-offer ratio)

63.7% (57–81) (see Fig. 7) (23)

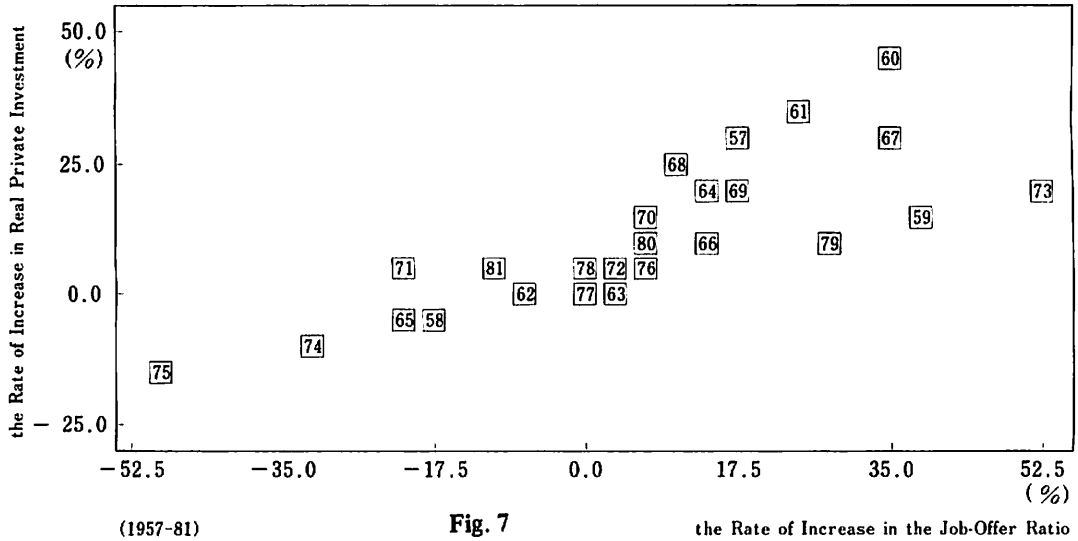

Fig. 7

The result of such a high correlation does not differ even in the case in which investment covers not only private but also public investment as well as housing (that is, covers all 'real domestic capital formation').

(the rate of increase in real domestic capital formation) vs.
(the rate of increase in the job-offer ratio)

61.9% (57–81) (24)

In part, the percentage figure in Relation (24) is as high as that of Relation (23) because the share of private investment in total capital fomation is large. In a similar sense we also have

(the rate of increase in real private capital formation) vs.
(the rate of increase in the job-offer ratio)

61.4% (57–81) (25)

These results may indicate that the level of the job-offer ratio fluctuates in a business cycle, rising in the phase of recovery or expansion and falling in the phase of recession or contraction. The economy will keep growing, on an average, in such a 'business cycle', so that real investment itself will also tend to grow. Thus *the rate of increase* in the job-offer ratio may be viewed as an indicator of a different aspect of business conditions than the job-offer ratio itself. Now it is interesting to see that

(the rate of increase in labor-productivity) vs.
(the rate of increase in the job-offer ratio)

88.1% (61–81) (see Fig. 8) (26)

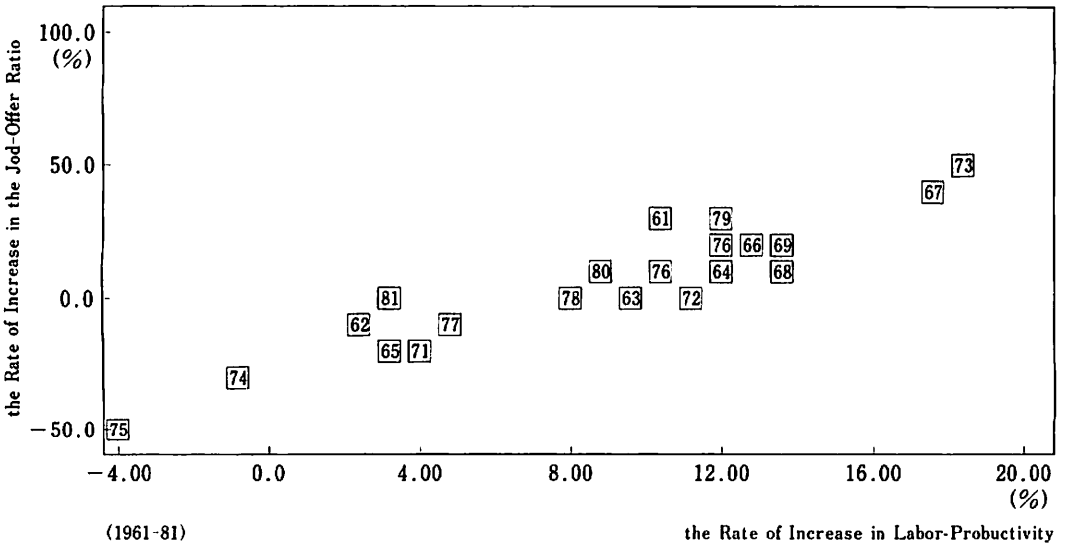

Fig. 8

that is, the rate of increase in labor-productivity is strongly correlated with the index of the *change in* the demand-for-labor condition. If we take the level of the job-offer ratio itself instead of its rate of increase, we have the following result.

(the rate of increase in labor-productivity) vs.

(the job-offer ratio)

28.8% (61–73)
−8.6% (74–81) (27)

See also Relation (19). Though Relation (19) shows a fairly good correlation (43.3%) between the operating ratio and the rate of increase in labor-productivity, the picture of the business cycle amid general economic growth, discussed above, will be further confirmed by the following result.

(the rate of increase in the operating ratio) vs.
(the rate of increase in labor-productivity)

83.4% (62–81) (see Fig. 9)
98.4% (62–66)
90.5% (67–73)
97.0% (74–81) (28)

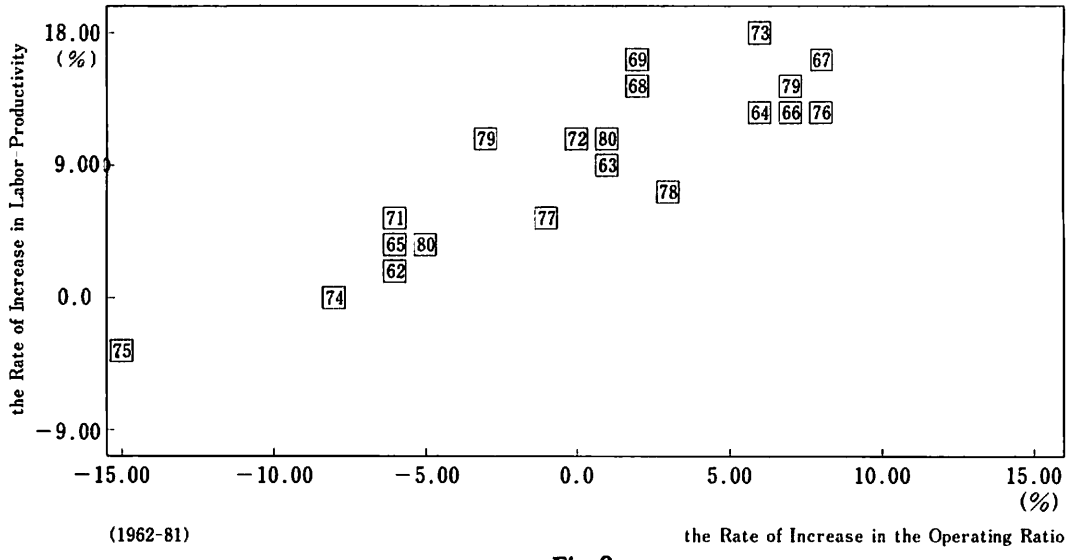

Fig. 9

Thus the operating ratio tends to increase more in the phase of recovery or expansion and less (algebraically) in the phase of recession or contraction, around the general trend of steady economic growth.

The following Relation (29) seems understandable as consistent with Relation (23) and (26).

(the rate of increase in real private investment) vs.
(the rate of increase in labor-productivity)

61.9% (61–81) (29)

It is interesting to see that

(the rate of increase in the job-offer ratio) vs.
(the rate of increase in the operating ratio)

77.4% (62–81) (see Fig. 10) (30)

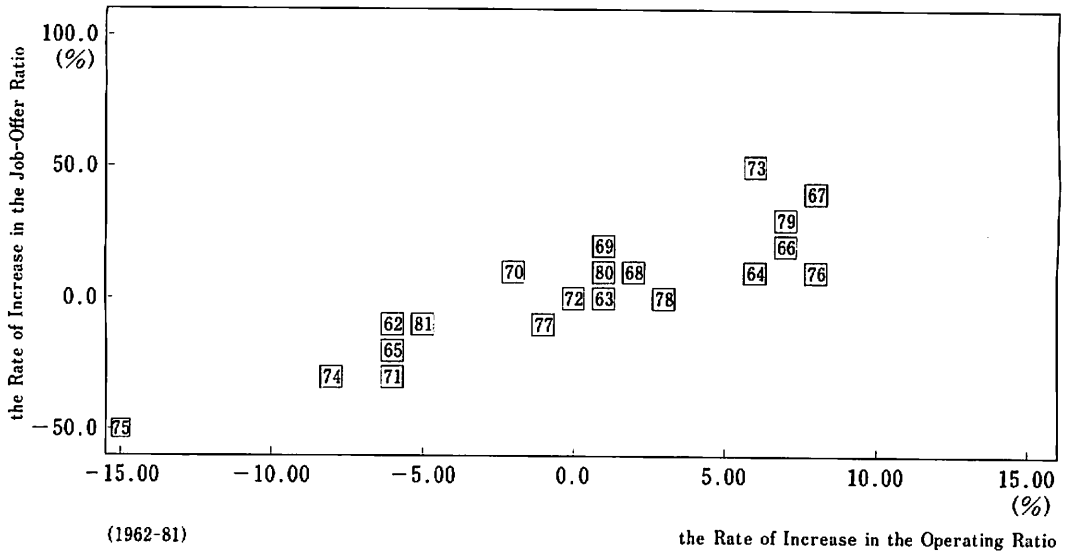

Fig. 10

this compares with Relation (11) in Section 2, which relates the job-offer ratio and the operating ratio themselves, and gives a correlation coefficient of 67.8% (61–81).

5. The Increase in Labor Productivity and the Rate of the Wage Inflation

Let us look at the following relation.

(the rate of increase in labor-productivity) vs.
(the rate of increase in the nominal wage-rate)

$$\begin{aligned} &2.0\%\ (61\text{–}81)\\ &35.9\%\ (61\text{–}73)\\ &-20.7\%\ (74\text{–}81) \end{aligned} \qquad (31)$$

Macroeconomics often teaches that the higher the rate of increase in labor-productivity, the higher will be the rate of increase in the nominal wage-rate. But this conventional assertion may be empirically rejected by the above Relation (31). However, when we consider the first differences in wage-inflation, we get the following result of Relation (32).

(the increase from the previous year of the rate of increase in the nominal wage-rate) vs.
(the rate of increase in labor-productivity)

$$\begin{aligned} &54.4\%\ (61\text{–}81)\quad \text{(see Fig. 11)}\\ &69.8\%\ (61\text{–}66)\\ &69.1\%\ (67\text{–}73)\\ &39.4\%\ (74\text{–}81) \end{aligned} \qquad (32)$$

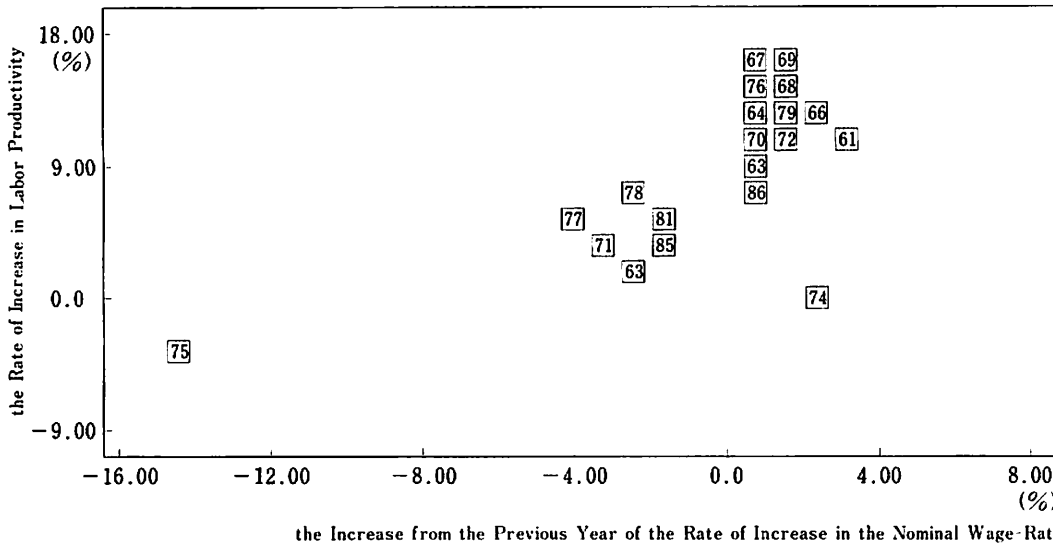

Fig. 11

It is remarkable to see that the *increase* in the rate of increase in the nominal wage-rate is significantly and positively correlated with the rate of increase in labor-productivity (The increase of the wage-inflation may of course take negative values). This Relation (32) may be understandable as consistent with Relation (8) in Section 2 and Relations (28) and (30). The rate of increase in labor-productivity is high when the rate of increase in investment is high. The growth rate of the level of production, and hence the rate of increase in labor-productivity, will be higher if the growth rate of demand for commodities is higher. And the growth rate of investment is higher when the growth rate of demand for commodities is higher. But the growth rate of investment is highly correlated with the (rate of) *increase* in the job-offer ratio rather than with the job-offer ratio itself (Relation (23)). The job-offer ratio is strongly correlated with wage-inflation, so that we also have a similar high correlation between them in incremental terms. Hence Relation (32). This refers us back to Relation (29) above. In a theoretical model of steady economic growth, labor-productivity may rise at a constant rate, and investment may rise also at a constant rate. From a different standpoint, investment raises productivity. Thirdly, as indicated above, the aggregate demand for commodities tends to keep step with the level of investment. These three factors seem to lie behind Relation (29).

Appendix

The Sources and Explanations of the Economic Variables

(1) personal propensity to save: *Keizai Yoran*, the Economic Planning Bureau, defined as personal saving divided by personal disposable income.
(2) consumer-price inflation: *Economic Statistics Annual*, the Bank of Japan, defined as the rate of increase in the consumer price index for all of Japan,

compared with the figure of the year before.

(3) rate of increase in the nominal wage-rate: *ESA*, compared with the figure of the year before, manufacturing.

(4) non-contract cash earnings ratio: *ESA*, defined as the average non-contract cash earnings divided by total earnings for regular worker.

(5) non-scheduled work hours ratio: *ESA*, defined as non-scheduled average monthly work hours for regular workers, divided by total average monthly work hours, all industries except services.

(6) job-offer ratio: *ESA*, defined as the ratio of job-offers to applicants.

(7) wholesale-price inflation: *ESA*, defined as the rate of increase in the wholesale price index, compared with the figure of the year before.

(8) operating ratio: *ESA*, defined as the ratio of the index of production to the index of productive capacity (both seasonally adjusted) to the production capacity index using comparable commodities.

(9) import-good price inflation: *ESA*, defined as the rate of increase in the import price index, compared with the figure of the year before.

(10) export-good price inflation: *ESA*, defined as the rate of increase in the export price index, compared with the figure of the year before.

(11) rate of increase in labor-productivity: *ESA*.

(12) rate of increase in industrial production: *ESA*, defined as the rate of increase in the index of industrial production, in mining and manufacturing, compared with the figure of the year before.

(13) real private investment: *ESA*, defined as the real gross fixed capital formation of machinery and equipment in the private sector, an item included in real gross domestic capital formation.

(14) real domestic capital formation: *ESA*, defined as real gross domestic capital formation of private and government sectors including increase in inventories.

(15) real private capital formation: *ESA*, defined as the real gross fixed capital formation of the private sector including private residential investment, machinery and equipment.