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The Distribution of Wage Settlements and Optimum Monetary Policy

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Summary

The optimum monetary policy under such an uneven distribution of wage settlements as examined by Ashenfelter and Pencavel (1975) is analyzed. It is advantageous for risk-averse agents to negotiate wage changes in the periods when a large proportion of workers are involved in wage negotiations. If the authority aims at minimizing the output variation, this advantage produces "bunching" in this distribution. Then, even if the monetary policy takes advantage of the inertia of nominal wage, the neutrality of money partly reappears. This advantage also explains the formation of "spring wage offensive" in Japan.

I. Introduction

The existence of long-term contracts or the inertia of the nominal wage is often cited as an important limitation to the conclusion that monetary policy loses its effectiveness in rational expectations models (Fischer (1977)). Even if these models with long-term contracts in fact assume some suboptimal decision rules (Barro (1977), Sargent (1979), Chap. 16), wage changes occur at discrete intervals in the real world. Therefore, it is important to investigate the circumstances in which firms and workers optimize by fixing prices and wages (Gordon (1981)). For example, Gertler (1982) combines aspects of both the contract and equilibrium methods and explains temporary wage inflexibility in an environment of imperfect information. Furthermore, Gordon (1982) and Rotemberg (1982) present empirical tests of price stickiness. However, we shall not concern ourselves here with this important subject. Instead, our attention is restricted to another problem, that is, the implications of the observation that the number of workers affected by wage settlements shows year-to-year and quarter-to-quarter variations.

For example, in the United States 2.29 millions of workers were affected by wage settlements in 1968, while the corresponding figure for 1971 was only 1.39 millions (See Rowley and Wilton (1977), p.52). Then, there are two questions to be raised regarding this uneven distribution: (i) whether this uneven distribution causes additional instability to the economy and if it does, whether it is possible for the monetary authority to offset this disturbance, and (ii) whether there exists an incentive for such a "bunching" of wage settlements to emerge. In order to disentangle these issues, we shall present a modified Fischer model in

Section II.

As an example of quarter-to-quarter variations in the number of workers affected by wage negotiations, Table 1 reports the distribution of wage settlements in Japan, 1960-78, which records the percentage of workers receiving an increment. The evidence for Japan is the polar case where the interval between settlements is one year almost without exception. The relatively frequent wage revision in Japan has its origin in the hyper-inflation after World War II, and has been maintained thereafter because Japan's economy has experienced relatively high productivity growth and rate of inflation during the 1950's and 1960's. It should be noted that Table 1 shows the tendency to concentration of wage settlements to the second quarter. It is well-known that this tendency has been developed under the political leadership of one of the largest national centers "Sōhyo". However, since this tendency is also observed in non-unionized or small-scale manufacturing sectors (see Table 1), it is desirable to explain this tendency from the economic point of view. That is to say, as before we face the question whether there exists an incentive for such an extremely concentrated seasonal pattern of bargaining as observed in Japan, usually called as "spring wage offensive", to emerge. This issue will be analyzed in Section IV.

Although so far very little is known about the policy implications of the uneven frequency distribution of wage settlements, the information on this distribution has been utilized in recent wage determination literature (see, e.g., Ashenfelter and Pencavel (1975), Matsukawa (1982), Rowley and Wilton (1977) and Smith and Wilton (1978)). Since annual wage rounds and equal sizes of bargaining groups which had been assumed in the overlapping annual wage change models in the 1960's is unrealistic (see, e.g., Rowley and Wilton (1977), Chap. 3), the utilization of this information has improved the statistical efficiency of Phillips curve. This approach, however, is subject to the criticizm that the wage determination structure is completely exogenous to the model and therefore it leaves several important questions unsolved.[1/] In the following sections it will be seen that regardless of the form of the distribution of wage settlements monetary policy is effective in the sense that it can attain the minimum output variances. At the same time we shall show that it is advantageous for the agents to negotiate wage changes in the periods when a large proportion of workers are involved in wage negotiations. Now, suppose that the monetary authority attains the minimum output variations for a given distribution of wage settlements by estimating Ashenfelter-Pencavel type Phillips curve and taking Fischer type monetary policy. Does this policy cause some systematic changes in this distribution? Our analysis in Section III will show that these practices induce further concentration of wage settlements. Then this change in structure necessitates further changes in policy, and at least from theoretical point of view, this iterative procedure leads to an extremely concentrated bargaining pattern, which unfortunately accompanied by unstable price variations. In other words, even if the monetary authority takes advantage of the inertia of nominal wage associated with long-term contracts, the public reconstruct the neutrality of money through changing their timing of bargaining. These issues, in short "Lucas's critique" to Ashenfelter-Fischer-Pencavel model, will be analyzed in Section III. We shall also point out the existence of another policy scheme under which both minimum output and price variations are attained.

As far as British, Canadian, and U.S. evidences are concerned, the distribution of wage changes by years as well as by quarters are apparently erratic. This is because length of contract is different among settlements. Suppose that all labor contracts run for, say two years. Then the distribution of wage settelments would be uneven but stable in the sense that the proportion of workers receiving wage increments in, say odd years to total labor force is constant over a long term of years. For simplicity, this paper will proceed as if all labor contracts run for two periods. However, as will be shown in Section V, none of the results in this paper depend on this assumption.

One further complication remains to be considered before we present the model in the following sections. Multi-year contracts usually contain an agreement for several internal increments during their period of currency. In this respect, Fischer's model provides an appropriate framework to analyze the implications of a year-to-year variation in the number of workers affected by settlements. Therefore we shall present a modified Fischer model in Section II. On the other hand, since in one year contracts single increment is usually specified, we have to develop an alternative model in which single wage rate is effective for two periods. The model in Section IV provides such a framework, which is similar to that of Ashenfelter-Pencavel model.

II. The Model with Multi-year Contracts

The framework for this section is analogous to the one developed by Fischer (1977). However, the structure is extended to include factors that have not yet been studied in this context.

It is assumed that the contract drawn up at the end of period t specifies nominal wages for periods $t+1$ and $t+2$. In other words, agents agree to nominal wages one period in advance of the trading period. In this section all labor contracts are assumed to run for two years, while the extension of our model to other cases will be considered in Section V. In fact none of the result of this section depend on the specific length of contract.

Let ${}_{t-i}W_t$, $i=1, 2$ be the logarithm of the wage to be paid in period t as specified in contracts drawn up at $t-i$, and ${}_{t-i}P_i$ be the expectation of the log of the price level P_t to prevail at t, the expectation being held as of the end of time $t-i$. Now, suppose that contracts are set to maintain constancy of the real wage. Then we have:

(1) $\quad {}_{t-i}W_t = {}_{t-i}P_t, \qquad i=1, 2.$[2/]

The aggregate supply of the commodity at date t is assumed:

(2) $\quad Y_t = \lambda_t(P_t - {}_{t-1}W_t) + \lambda_{t-1}(P_t - {}_{t-2}W_t) + u_t,$

where Y_t is the level of output (not its logarithm), u_t is a random term, and λ_t is the proportion of employees whose wage increments are negotiated at time $t-1$. Since all contracts are assumed to run for two years, we set

$$\lambda_t = \lambda \qquad \text{if } t \text{ is odd,}$$

$$\lambda_t = 1 - \lambda \qquad \text{if } t \text{ is even.}$$

The specification of the demand side of the model is:

(3) $\quad Y_t = M_t - P_t - v_t,$

Where M_t is the log of the money stock at t and v_t is a random term. The price at date t is determined to equate supply and demand in the market.

As for the monetary rule, again following Fischer (1977), let us presume that the authority's policy is set on the basis of disturbances which have occurred up to and including time t-i. Of course, the policy rule at even periods may be different from that at odd periods, so that it is specified as

$$(4)\quad \begin{aligned} M_t &= a(L)u_t + b(L)v_t = \sum_{i=1}^{\infty} a_i u_{t-i} + \sum_{i=1}^{\infty} b_i v_{t-i} \quad \text{for odd } t, \\ M_t &= a'(L)u_t + b'(L)v_t = \sum_{i=1}^{\infty} a'_i u_{t-i} + \sum_{i=1}^{\infty} b'_i v_{t-i} \quad \text{for even } t. \end{aligned}$$

The public is assumed to know the parameters of (4).

The random terms u_t and v_t are each governed by a first-order autoregressive process

$$(5)\quad \begin{aligned} u_t &= \rho_1 u_{t-1} + \varepsilon_t \qquad |\rho_1| < 1 \\ v_t &= \rho_2 v_{t-1} + \eta_t \qquad |\rho_2| < 1 , \end{aligned}$$

where ε_t and η_t are mutually and serially uncorrelated stochastic terms with expectation zero and finite variances σ_ε^2 and σ_η^2, respectively. It should be noted that the same first-order Markov process is assumed for both odd t and even t.

To close the model formed by equations (1) - (5), we posit that expectations about the logarithm of the price level are rational. The attractive aspect of the solution of this system is the relative ease with which the solution for, say even t can be obtained by substituting λ with $1-\lambda$ in the solution for odd t. Therefore, we first solve this system for odd periods.

Eliminating Y_t between (2) and (3), we obtain the market-clearing condition:

$$(6)\quad P_t = \frac{1}{2} M_t + \frac{\lambda}{2}\, {}_{t-1}P_t + \frac{1-\lambda}{2}\, {}_{t-2}P_t - \frac{u_t+v_t}{2} \quad .$$

Now taking expectations as of the end of peiod t-2, and noting that $E_{t-2}({}_{t-1}P_t) = {}_{t-2}P_t$, we have:

$$(7)\quad {}_{t-2}P_t = {}_{t-2}M_t - {}_{t-2}u_t - {}_{t-2}v_t \; .$$

Again taking expectations as of the end of peiod t-1, and using (7), we get:

$$(8)\quad {}_{t-1}P_t = \frac{1}{2-\lambda}\left\{{}_{t-1}M_t + (1-\lambda)({}_{t-2}M_t - {}_{t-2}u_t - {}_{t-2}v_t) - ({}_{t-1}u_t + {}_{t-1}v_t)\right\}.$$

Substituting (7) and (8) into (6), the results for price is:

$$(9)\quad P_t = \frac{M_t}{2-\lambda} + \frac{1-\lambda}{2-\lambda}\,({}_{t-2}M_t - {}_{t-2}u_t - {}_{t-2}v_t) - \frac{\lambda}{2(2-\lambda)}({}_{t-1}u_t + {}_{t-1}v_t) - \frac{u_t+v_t}{2} \quad .$$

Combining with (33), the result for output is:

$$(10)\quad \begin{aligned} Y_t &= M_t - P_t - v_t \\ &= \rho_1^2 u_{t-2} + \frac{(1-\lambda)a_1+\rho_1}{2-\lambda}\,\varepsilon_{t-1} + \frac{1-\lambda}{2-\lambda}\,(b_1 - \rho_2)\eta_{t-1} + \frac{1}{2}(\varepsilon_t - \eta_t), \end{aligned}$$

which follows since ${}_{t-1}u_t = \rho_1 u_{t-1}$, ${}_{t-1}v_t = \rho_2 v_{t-1}$, ${}_{t-2}u_t = \rho_1^2 u_{t-2}$, and ${}_{t-2}v_t = \rho_2^2 v_{t-2}$; and since $M_t - {}_{t-2}M_t = a_1\varepsilon_{t-1} + b_1\eta_{t-1}$. The asymptotic variance of Y for odd t can then be calculated as

$$(11)\quad \sigma_1^{\;2} = \left[\frac{1}{4} + \frac{\{(1-\lambda)a_1+\rho_1\}^2}{(2-\lambda)^2} + \frac{\rho_1^{\;4}}{1-\rho_1^{\;2}}\right]\sigma_\varepsilon^2 + \left[\frac{1}{4} + \frac{(1-\lambda)^2(b_1-\rho_2)^2}{(2-\lambda)^2}\right]\sigma_\eta^{\;2} \; .$$ [3/]

The monetary authority chooses a_1 and b_1 to minimize the variance of Y. If $\lambda \neq 1$, from (11) the variance of Y is minimized by setting $(1-\lambda)a_1 + \rho_1 = 0$, and $b_1 - \rho_2 = 0$, so that we have:

$$(12)\quad a_1 = -\frac{\rho_1}{1-\lambda}\;,\; b_1 = \rho_2\;,\; a_2 = b_2 = a_3 = b_3 = \cdots\cdots = 0\;,$$

which yields $\sigma_1^2 = [\frac{1}{4} + \frac{\rho_1^4}{1-\rho_1^4}]\sigma_\varepsilon^2 + \frac{1}{4}\sigma_\eta^2$. As was pointed out in Fischer (1977), the disturbances ε_{t-1} and η_{t-1} can be wholly offset by monetary policy. On the other hand, the u_{t-2} disturbance was known when the older labor contract was drawn up and cannot be offset by monetary policy because it is taken into account in wage setting. It should be noted that this minimum output variance does not depend on λ, while the variance of P_t depends on λ. In fact under the optimum monetary policy characterized by (12), (9) can be rewritten as

$$(13) \quad P_t = -\frac{2-\lambda}{1-\lambda}\rho_1^2 u_{t-2} - \frac{\rho_1}{1-\lambda}\varepsilon_{t-1} - \frac{1}{2}(\varepsilon_t + \eta_t) .$$

Therefore the variance of price is:

$$(14) \quad \sigma_2^2 = \left[(\frac{2-\lambda}{1-\lambda})^2 \frac{\rho_1^4}{1-\rho_1^2} + (\frac{\rho_1}{1-\lambda})^2 + \frac{1}{4}\right]\sigma_\varepsilon^2 + \frac{1}{4}\sigma_\eta^2 .$$

So far our attention has been concentrated on the solution for odd periods. As mentioned above, the solution for even periods can be obtained by substituting λ with $1-\lambda$ in (9) - (14). That is to say,

$$(9') \quad P_t = \frac{M_t}{1+\lambda} + \frac{\lambda}{1+\lambda}({}_{t-2}M_t - {}_{t-2}u_t - {}_{t-2}v_t) - \frac{1-\lambda}{2(1+\lambda)}({}_{t-1}u_t + {}_{t-1}v_t) - \frac{u_t+v_t}{2} .$$

$$(10') \quad Y_t = \rho_1^2 u_{t-2} + \frac{\lambda a_1' + \rho_1}{1+\lambda}\varepsilon_{t-1} + \frac{\lambda}{1+\lambda}(b_1' - \rho_2)\eta_{t-1} + \frac{1}{2}(\varepsilon_t - \eta_t)$$

$$(11') \quad \sigma_3^2 = \left[\frac{1}{4} + \frac{(\lambda a_1' + \rho_1)^2}{(1+\lambda)^2} + \frac{\rho_1^4}{1-\rho_1^4}\right]\sigma_\varepsilon^2 + \left[\frac{1}{4} + \frac{\lambda^2(b_1-\rho_2)^2}{(1+\lambda)^2}\right]\sigma_\eta^2$$

$$(12') \quad a_1' = -\frac{\rho_1}{\lambda}, \; b_1' = \rho_2, \; a_2 = b_2 = a_3 = b_3 = \cdots\cdots = 0$$

$$(13') \quad P_t = -\frac{1+\lambda}{\lambda}\rho_1^2 u_{t-2} - \frac{\rho_1}{\lambda}\varepsilon_{t-1} - \frac{1}{2}(\varepsilon_t + \eta_t)$$

(14') $$\sigma_4^{\,2} = \left[\left(\frac{1+\lambda}{\lambda}\right)^2 \frac{\rho_1^{\,4}}{1-\rho_1^{\,2}} + \left(\frac{\rho_1}{\lambda}\right)^2 + \frac{1}{4} \right] \sigma_\varepsilon^{\,2} + \frac{1}{4}\sigma_\eta^{\,2}$$

In summary, as long as the monetary authority desires to choose money supply rule in order to minimize the variance over time of Y_t, and as long as $\lambda \neq 0, 1$, the "bunching" in bargaining pattern does not cause any difficulty. On the other hand, price variances (14) and (14') involve the parameter λ, so that the "total variance" of P, defined as $\sigma_2^2 + \sigma_4^2$, is also a function of λ. Now, it is clear that this function is symmetric around $\frac{1}{2}$, convex on (0, 1), [4/] and that the limits when λ approaches to 0 and 1 are $+\infty$. Therefore, this function assumes the minimum at $\frac{1}{2}$. This implies that an uniform distribution of wage settlements is the most desirable from the point of view of the price stability. Furthermore, the variance of $P_t - P_{t-1}$, or "the rate of inflation" also assumes its minimum at $\lambda = \frac{1}{2}$. In fact from (13) and (13'), we have:

(15) $$P_t - P_{t-1} = \frac{\rho_1[-\frac{2-\lambda}{1-\lambda}\rho_1 + \frac{1}{\lambda} + \rho_1 L]}{1-\rho_1 L}\varepsilon_{t-2} + \left(\frac{1}{2} - \frac{\rho_1}{1-\lambda}\right)\varepsilon_{t-1}$$

$$+ \frac{1}{2}\eta_{t-1} - \frac{1}{2}\varepsilon_t - \frac{1}{2}\eta_t, \qquad \text{if } t \text{ is odd,}$$

(15') $$P_t - P_{t-1} = \frac{\rho_1[-\frac{1+\lambda}{\lambda}\rho_1 + \frac{1}{1-\lambda} + \rho_1 L]}{1-\rho_1 L}\varepsilon_{t-2} + \left(\frac{1}{2} - \frac{\rho_1}{\lambda}\right)\varepsilon_{t-1}$$

$$+ \frac{1}{2}\eta_{t-1} - \frac{1}{2}\varepsilon_t - \frac{1}{2}\eta_t, \qquad \text{if } t \text{ is even.}$$

Then its "total variance" is given by

$$\sigma_5^2 = \left[2\rho_1^4 + \frac{1}{2} + \frac{\rho_1^2}{1-\lambda_1^2}\left\{\left(\frac{1}{\lambda} - \frac{2-\lambda}{1-\lambda}\rho_1 + \rho_1^2\right)^2 + \left(\frac{1}{1-\lambda} - \frac{2-\lambda}{1-\lambda}\rho_1 + \rho_1^2\right)^2 + \left(\frac{1}{2} - \frac{\rho_1}{\lambda}\right)^2\right\}\right]\sigma_\varepsilon^2 + \frac{1}{2}\sigma_\eta^2 ,$$

which is also symmetric around $\frac{1}{2}$ and convex.

It is clear that in equation (2) the second term, which can be rewritten as $(1-\lambda)(P_t - {}_{t-2}P_t)$, represents the effects of the inertia of the nominal wage. Now suppose that the proportion of workers involved in wage negotiations during even periods approaches to unity, that is, λ goes to unity. Then at odd periods the second term disappears and equation (2) reduces to the Lucas supply function, and hence the monetary policy is wholly anticipated by the public. Since any predictable change in the rate of monetary growth has 100 percent of its effect on inflation even in the short run, the variance of price level $\sigma_2^2 + \sigma_4^2$ as well as that of inflation σ_5^2 will be increased, even if these variances at even periods are decreased. In other words, as is clear from equation (10), the behavior of real output becomes invariant to the monetary policy in odd periods, as λ approaches to unity. To put the point in a more general way, if the distribution of wage settlements shows an extreme "bunching" in particular periods, the neutrality of money appears in the adjacent periods, and the policy ineffectiveness proposition developed by Sargent and Wallace (1975) becomes applicable at least to these adjacent periods.

III. The Stability of the Structure

In the previous section the distribution of wage settlements was regarded as completely exogenous to the system. In this section we show that λ might vary systematically with changes in the stochastic processes facing agents. This is the basic message of Lucas's (1976) criticism of procedures for econometric policy evaluation. We begin with calculating the mean-square error of one-step and two-step forecasts. From (9) and (9') we have:

$$(16) \quad P_t - {}_{t-1}P_t = -\frac{1}{2}(\varepsilon_t + \eta_t), \qquad \text{for all } t.$$

Therefore, the mean-square error of one-step forecast is the same for all t. On the other hand, we have:

$$(17) \quad P_t - {}_{t-2}P_t = \frac{a_1-\rho_1}{2-\lambda}\varepsilon_{t-1} + \frac{b_1-\rho_2}{2-\lambda}\eta_{t-1} - \frac{\varepsilon_t+\eta_t}{2} \qquad \text{if } t \text{ is odd,}$$

$$(17') \quad P_t - {}_{t-2}P_t = \frac{a_1'-\rho_1}{1+\lambda}\varepsilon_{t-1} + \frac{b_1'-\rho_2}{1+\lambda}\eta_{t-1} - \frac{\varepsilon_t+\eta_t}{2} \qquad \text{if } t \text{ is even.}$$

Thus, the mean-square error of two-step forecast is:

$$(18) \quad E(P_t - {}_{t-2}P_t)^2 = \left[\left(\frac{a_1-\rho_1}{2-\lambda}\right)^2 + \frac{1}{4}\right]\sigma_\varepsilon^2 + \left[\left(\frac{b_1-\rho_2}{2-\lambda}\right)^2 + \frac{1}{4}\right]\sigma_\eta^2 \quad \text{if } t \text{ is odd,}$$

$$(18') \quad E(P_t - {}_{t-2}P_t)^2 = \left[\left(\frac{a_1'-\rho_1}{1+\lambda}\right)^2 + \frac{1}{4}\right]\sigma_\varepsilon^2 + \left[\left(\frac{b_1'-\rho_2}{1+\lambda}\right)^2 + \frac{1}{4}\right]\sigma_\eta^2 \quad \text{if } t \text{ is even.}$$

By changing the sign, we recall from (1) that these forecast errors are the logarithms of the real wage which employees receive at time t on a contract made at the end of time t-i. That is to say,

$$(19) \quad {}_{t-i}W_t - P_t = {}_{t-i}P_t - P_t, \qquad i=1,\ 2.$$

Suppose that the monetary authority takes the optimum policy given by (12) and (12'). Now, consider the case in which $\lambda > \frac{1}{2}$, or the wage negotiations covering a large proportion of workers occur at even periods. The variance of the log of the real wage received in the first year of the contract is the same for all t because one-step forecast error of (16) is independent of λ. On the other hand, the variance of the log of the real wage received in the second year of the contract depends on λ. In fact using (12) and (12'), (18) and (18') can be rewritten as

$$(20) \quad E(P_t - {}_{t-2}P_t)^2 = \left\{\frac{\rho_1^2}{(1-\lambda)^2} + \frac{1}{4}\right\} \sigma_\varepsilon^2 + \frac{1}{4}\sigma_\eta^2 \qquad \text{if } t \text{ is odd,}$$

$$(20') \quad E(P_t - {}_{t-2}P_t)^2 = \left\{\frac{\rho_1^2}{\lambda^2} + \frac{1}{4}\right\} \sigma_\varepsilon^2 + \frac{1}{4}\sigma_\eta^2 \qquad \text{if } t \text{ is even.}$$

Under the assumption $\lambda > \frac{1}{2}$, (20') is smaller than (20). Then we can conclude that the variance of the log of the real wage recieved in the second year of the contract is smaller for those agents whose wage negotiations occur at even periods. This is because the actual two-step forecast error is realized at t+2, which is also even, is smaller than that realized at odd periods. Since λ is the proportion of employees whose wage increments are negotiated at even period, this result implies that the variation of the log of real wage is smaller for those agents whose nominal wages are set when a large proportion of workers are involved in wage negotiations. If we assume that the workers are risk-averse, the smaller variance of real wage in the second year of contract is the advantage for them. Therefore, there exists incentive for agents to settle their wage during the periods when a large proportion of workers are involved in wage negotiations. To put the point in a different way, if $\lambda > \frac{1}{2}$, from (14) and (14') the variance of price is larger in odd periods than in even periods. However, this volatile movement of price can be wholly anticipated and incorporated in the nominal wage of those who are involved in wage negotiation in even periods. Of course, they cannot take into account the movement of price in even periods, but it is relatively stable. On the other hand, the nominal wage of those who are involved in wage negotiations in odd periods is insured against the relatively stable movement of price during even periods but not against the volatile one during odd periods. This leads to the conclusion that it is advantageous for agents to negotiate their wage during the periods when a large proportion of workers are involved in wage negotiations.

Although we have shown these results under the assumption that the monetary authority takes the optimum policy given by (14) and (14'), the same results can be obtained in the other policy schemes. For example, suppose that the authority takes the naive policy, which accomodates and counteracts the disturbances in the same way between odd and even periods. That is to say, we assume that $a_1 = a_1' = -2\rho_1$, and $b_1 = b_1' = \rho_2$. If the authority takes this policy, the two-step forecast error can be rewritten as

$$(21) \quad E(P_t - {}_{t-2}P_t)^2 = \left[\left(\frac{3\rho_1}{2-\lambda}\right)^2 + \frac{1}{4}\right]\sigma_\varepsilon^2 + \frac{1}{4}\sigma_\eta^2 \qquad \text{if } t \text{ is odd,}$$

$$(21') \quad E(P_t - {}_{t-2}P_t)^2 = \left[\left(\frac{3\rho_1}{1+\lambda}\right)^2 + \frac{1}{4}\right]\sigma_\varepsilon^2 + \frac{1}{4}\sigma_\eta^2 \qquad \text{if } t \text{ is even.}$$

Clearly (21) $\gtreqless$ (21') according to $\lambda \gtreqless \frac{1}{2}$, so that we obtain the same conclusion as the case of the optimum monetary policy.

Now, our economy has three equilibria, i.e., those associated with $\lambda=0$, $\lambda=1$, and $\lambda=\frac{1}{2}$. In the first two the monetary policy loses its effectiveness. In the last one, which might be called "Fischer equilibrium", the monetary policy is effective and the price variation is minimized. Unfortunately, however, this equilibrium is unstable and once it is disturbed, the economy goes to the other two equilibria. In other words, even if the authority can take advantage of wage inertia, the public partly reconstructs the neutrality of money through changing their timing of bargaining.

So far we have assumed that the monetary authority chooses the feedback rule in order to minimize the variance of output. Even if the authority is assumed to choose it to minimize some more general loss function, the same "time inconsistency" will occur. However, we shall not concern ourselves here with this mathematically complicated problem. Instead, we investigate still another policy scheme in which the "Fischer equilibrium" can be maintained. Choose a_1, a_1', b_1, b_1' to satisfy

$$(22) \quad \frac{a_1 - \rho_1}{2 - \lambda} \gtreqless \frac{a_1' - \rho_1}{1 + \lambda} \quad \text{and} \quad \frac{b_1 - \rho_2}{2 - \lambda} \gtreqless \frac{b_1' - \rho_2}{1 + \lambda}$$

$$\text{according to} \quad \lambda \gtreqless \frac{1}{2} .$$

Then from (18) and (18'), it becomes disadvantageous to negotiate wages during the period when a large proportion of workers are involved in wage negotiation. Therefore this policy alters the distribution of wage settlements, and the economy can be guided toward the "Fischer equilibrium". The monetary authority can attain both minimum output variations and price variations in the long-run, at the cost of temporal increase of output variance. In other words, if the monetary authority takes into account the risk aversiveness of the public, at least from purely theoretical point of view, it can maintain the most desirable state of the economy.

IV. The Model with Annual Wage Rounds

So far we have assumed that labor contracts drawn up at the end of time t-1 specify different nominal wages for time t and t+1. To explain the effects of uneven seasonal pattern of wage settlements, however, it seems essential to take into account the fact that nominal wages are fixed for at least one year. Therefore as a model with uneven seasonal pattern of wage settlements, the one presented in the previous section is of somewhat limited applicability. Now we present another model which assumes that nominal wages are fixed for one year and that price variation is more sensitive. We chose a biannual model instead of quarterly model for expositional convenience, the same notations as in the previous section being utilized.

Again agents agree to nominal wages one period in advance of the trading period and the wage-setting interval lasts two periods. More specifically, it is assumed that the money wage is predetermined as follows:

$$(23)\quad {}_{t-1}W_t = {}_{t-1}W_{t+1} = \frac{1}{2}(P_{t-1} + {}_{t-1}P_t).$$

This specification is similar to that used in the estimation of the Phillips curve in the sense that nominal wages are assumed to be set in order to catch up with past price change as well as to maintain the real wage against future price changes. It should be noted that we used geometric mean in the right hand side of (20) instead of arithmetic mean. As for ${}_{t-1}P_t$, again we assume that expectations are rational.

Then, our supply curve is:

$$(24)\quad Y_t = \lambda\{P_t - \frac{1}{2}(P_{t-1} + {}_{t-1}P_t)\} + (1-\lambda)\{P_t - \frac{1}{2}(P_{t-2} + {}_{t-2}P_{t-1})\} + u_t .$$

In equation (23), we assumed another "stickiness" in the wage determination because the nominal wage is partially indexed to the past price changes. Although this assumption makes the following calculation complex, the solution seems to afford a sound basis for the analysis of the real economy. In fact there are various empirical papers which provide evidence that supports such a persistence as incorporated in our supply function (24). (See, e.g., Rotemberg (1982).)

Combining with the demand side of the economy specified in equation (3), we obtain the market-clearing condition:

$$(25)\quad 2P_t - \frac{\lambda}{2} P_{t-1} - \frac{1-\lambda}{2} P_{t-2} - \frac{\lambda}{2}\, {}_{t-1}P_t - \frac{1-\lambda}{2}\, {}_{t-2}P_{t-1} = X_t,$$

where $X_t = M_t - u_t - v_t$.

As before we solve this model for odd periods. Taking projections of both sides against information available at time $t-1$ gives

$$(26)\quad {}_{t-1}P_t = [(2 - \frac{\lambda}{2}) - \frac{1-\lambda}{2}L]^{-1}\{[\frac{\lambda}{2} + \frac{1-\lambda}{2}L]\, LP_t + {}_{t-1}X_t\}$$

$$= [(2 - \frac{\lambda}{2}) - \frac{1-\lambda}{2}L]^{-1}\{[\frac{\lambda}{2} + \frac{1-\lambda}{2}L]\, LP_t + M_t - u_t - v_t + \varepsilon_t + \eta_t\},$$

which follows since ${}_{t-1}X_t = M_t - u_t - v_t + (u_t - \rho_1 u_{t-1}) + (v_t - \rho_2 v_{t-1})$.

Substituting this solution for ${}_{t-1}P_t$ and ${}_{t-2}P_t$ into (25) gives

$$(27)\quad [(4-\lambda) - L - (1-\lambda)L^2]P_t = 2M_t + (\frac{\lambda}{2} + \frac{1-\lambda}{2}L)(\varepsilon_t + \eta_t) - 2(u_t + v_t).$$

Combining with (3), we obtain:

$$(28)\quad [(4-\lambda) - L - (1-\lambda)L^2]Y_t = [(2-\lambda) - L - (1-\lambda)L^2]M_t$$

$$- (\frac{\lambda}{2} + \frac{1-\lambda}{2}L)(\varepsilon_t + \eta_t) + 2u_t - [(2-\lambda) - L - (1-\lambda)L^2]v_t$$

Using (4) and (5), we can write this alternatively as

$$(29)\quad [(4-\lambda) - L - (1-\lambda)L^2]Y_t$$

$$= [\{(2-\lambda)-(1-\lambda)L^2\}a(L) - a'(L)L + \{\frac{1-\lambda}{2}\rho_1 L^2 + \frac{\lambda\rho_1 - 1+\lambda}{2}L + \frac{4-\lambda}{2}\}]\frac{\varepsilon_t}{1-\rho_1 L}$$

$$+ [\{(2-\lambda)-(1-\lambda)L^2\}b(L) - b'(L)L + \{(1-\lambda)(1+\frac{\rho_2}{2})L^2 + \frac{\lambda+\lambda\rho_2+1}{2}L - \frac{4-\lambda}{2}\}]\frac{\eta_t}{1-\rho_2 L}\ .$$

Then, in order to obtain the optimum monetary rule we have to set[5/]

$$(30)\quad \begin{aligned} &\{(2-\lambda) - (1-\lambda)L^2\}a(L) - a'(L)L = \theta_1(L)L \\ &\{(2-\lambda) - (1-\lambda)L^2\}b(L) - b'(L)L = \delta_1(L)L \end{aligned}$$

Since the optimum monetary rule has to minimize the variance for even as well as odd periods, we also get the following conditions:

$$(30')\quad \begin{aligned} &\{(1+\lambda) - \lambda L^2\}a'(L) - a(L)L = \theta_2(L)L \\ &\{(1+\lambda) - \lambda L^2\}b'(L) - b(L)L = \delta_2(L)L, \end{aligned}$$

Solving (30) and (30') simultaneously for $a(L)$, $a'(L)$, $b(L)$, and $b'(L)$, we have:

$$(31)\quad \begin{aligned} a(L) &= [\{(1+\lambda) - \lambda L^2\}\theta_1(L) + \theta_2(L)L]L\ /\ D \\ a'(L) &= [\{(2-\lambda) - (1-\lambda)L^2\}\theta_2(L) + \theta_1(L)L]L\ /\ D \\ b(L) &= [\{(1+\lambda) - \lambda L^2\}\delta_1(L) + \delta_2(L)L]L\ /\ D \\ b'(L) &= [\{(2-\lambda) - (1-\lambda)L^2\}\delta_2(L) + \delta_1(L)L]L\ /\ D \end{aligned}$$

where $D = (1-L^2)\{(2-\lambda)(1-\lambda) - \lambda(1-\lambda)L^2\}$.

Now from (29), it is clear that the optimum monetary policy specified by (31) leaves

$$(32)\quad Y_t = \frac{1}{2}\varepsilon_t + \frac{1}{2}\eta_t\ .$$

Then the variance of output is $\sigma_6^2 = \frac{1}{4}(\sigma_\varepsilon^2 + \sigma_\eta^2)$, which is independent of λ. Therefore, we conclude that unequal seasonal proportions of bargaining groups in the labor force are not a detriment of the stabilization policy, so long as the goal of the monetary authority is to minimize the variance of output.

We now turn to computing the variance of price under the optimal rule (31). Unfortunately, since the denominator of the generating function or z-transform of the weighting function has the zeros on the unit circle, the variance of the optimum money supply cannot be evaluated by residue calculus. Then from (3), it turns out that the variance of price cannot be evaluated either. However, the variance of "inflation rate" can be evaluated as follows.

First, from (3), (5), (31), and (32), we have for odd periods

$$(33)\quad P_t - P_{t-1} = M_t - M_{t-1} - (Y_t - Y_{t-1}) - (v_t - v_{t-1})$$
$$= \frac{B_1(L)}{A_1(L)}\varepsilon_t + \frac{B_2(L)}{A_2(L)}\eta_t .$$

Then the variance can be evaluated by

$$(34)\quad \sigma_6^2 = \sigma_\varepsilon^2 \oint \frac{B_1(z)B_1(z^{-1})}{A_1(z)A_1(z^{-1})z}\,dz + \sigma_\eta^2 \oint \frac{B_2(z)B_2(z^{-1})}{A_2(z)A_2(z^{-1})z}\,dz ,$$

where $\oint$ denotes the integral along the unit circle in the positive direction and can be computed by recursive formulas (see, e.g., Åstoröm (1970), Chap. 5). Let $I_1(\lambda,\rho_1)$, $I_2(\lambda,\rho_2)$ be the first and the second integral in (34). Since the variance for even periods σ_7^2 can be written as $\sigma_\varepsilon^2 I_1(1-\lambda,\rho_1) + \sigma_\eta^2 I_2(1-\lambda,\rho_2)$, the "total variance" becomes

$$(35)\quad \sigma_8^2 = \sigma_\varepsilon^2\{I_1(\lambda,\rho_1) + I_1(1-\lambda,\rho_1)\} + \sigma_\eta^2\{I_2(\lambda,\rho_1) + I_2(I-\lambda,\rho_2)\}.$$

Again both $I_1(\lambda,\rho_1) + I_1(1-\lambda,\rho_1)$, and $I_2(\lambda,\rho_2) + I_2(1-\lambda,\rho_2)$ are symmetric around $\lambda = \frac{1}{2}$, but as illustrated in figure 1 and figure 2, only the former assumes the minimum at $\frac{1}{2}$.[6/] Therefore, equal seasonal proportions of bargaining groups in the labor force may not be most desirable from the point of view of stable inflation rate, if the variance of nominal disturbances σ_η^2 is larger than that of real disturbances σ_ε^2. It is clear that the optimum distribution of wage settlements depends on their relative magnitude as well as the values of ρ_1 and ρ_2. On the other hand, extremely concentrated seasonal pattern of bargaining is again undesirable because it amplifies the disturbance on the supply side.

Next, let R_t and R_{t+1} be the real wage at time t and t+1. Then R_t can be written as

$$(36)\quad R_t = \frac{1}{2}(P_{t-1} + {}_{t-1}P_t) - P_t = -\frac{1}{2}(P_t - P_{t-1}) - \frac{1}{2}(P_t - {}_{t-1}P_t).$$

Noting that ${}_{t-1}M_t = M_t$, $u_t - {}_{t-1}u_t = \varepsilon_t$, and $v_t - {}_{t-1}v_t = \eta_t$, we get from (3) and (33)

$$(37)\quad P_t - {}_{t-1}P_t = -\frac{1}{2}\varepsilon_t - \frac{1}{2}\eta_t.$$

Continue to assume that t is odd, and substitute from (33). Then it is seen that R_t is represented as

$$(38)\quad R_t = -\frac{B_1(L) - A_1(L)}{2A_1(L)}\varepsilon_t - \frac{B_2(L) - A_2(L)}{2A_2(L)}\eta_t$$

On the other hand, R_{t+1} can be written as

$$(39)\quad R_{t+1} = \frac{1}{2}(P_{t-1} + {}_{t-1}P_t) - P_{t+1} = -(P_{t+1} - P_t) + R_t.$$

Replacing λ with $1-\lambda$ in (33), and substituting into (39), we have

$$(40)\quad R_{t+1} = \frac{C_1(L)}{A_1(L)}\varepsilon_{t+1} + \frac{C_2(L)}{A_2(L)}\eta_{t+1}.$$

Now, paralleling our calculation in (33) and (34), we can evaluate their variances. More precisely, let us denote the sum of residues associated with covariance generating functions

$\frac{B_1(L) - A_1(L)}{2A_1(L)}$, $\frac{B_2(L) - A_2(L)}{2A_2(L)}$, $\frac{C_1(L)}{A_1(L)}$ and $\frac{C_2(L)}{A_2(L)}$ as $I_3(\lambda,\rho_1)$, $I_4(\lambda,\rho_4)$, $I_5(\lambda,\rho_1)$, and $I_6(\lambda,\rho_2)$, respectively.[7/] It should be noted that $I_3(\lambda,\rho_1) + I_3(1-\lambda,\rho_1),\ldots\ldots$ are symmetric around $\frac{1}{2}$, but that $I_3(\lambda,\rho_1) + I_5(\lambda,\rho_1),\ldots\ldots$ are not. Although in general these integrals can be evaluated only by numerical methods, completing the square gives

$$\text{(41)}\quad \begin{aligned} &I_3(0,\rho_1) + I_5(0,\rho_1) > I_3(1,\rho_1) + I_5(1,\rho_1) \\ &I_4(0,\rho_2) + I_6(0,\rho_2) > I_4(1,\rho_2) + I_6(1,\rho_2), \end{aligned}$$

for all ρ_1 and ρ_2 such that $|\rho_1|<1$, and $|\rho_2|<1$. Since the "total variance" of real wage for those who are involved in wage negotiations at even periods is equal to $\{I_3(\lambda,\rho_1) + I_5(\lambda,\rho_1)\}\sigma_\varepsilon^2 + \{I_4(\lambda,\rho_2) + I_6(\lambda,\rho_2)\}\sigma_\eta^2$, that for those who are involved in wage negotiations at odd periods is equal to $\{I_3(1-\lambda,\rho_1) + I_5(1-\lambda,\rho_1)\}\sigma_\varepsilon^2 + \{I_4(1-\lambda,\rho_2) + I_6(1-\lambda,\rho_2)\}\sigma_\eta^2$. Now suppose that most wage negotiation occurs at even periods. Then λ approaches to 1 and the results in (41) mean that the "total variance" of real wage is smaller for those who are involved in wage negotiations during even periods. It should be noted that in the definition of these integrals we assumed that λ is the proportion of workers whose wage increments are negotiated at even periods.

Furthermore, as an alternative of "total variance" defined above, we can evaluate the variance of (geometric) mean of real wage $R_t + R_{t+1}$. Again straightforward calculation shows that for all ρ_1 and ρ_2 such that

$|\rho_1| < 1$, and $|\rho_2| < 1$, this variance is smaller for those who are involved in wage negotiations during even periods. These results imply that in general the variance of real wage is smaller for those who are involved in wage negotiations in the period when the nominal wage of a large proportions of workers are settled. As before, if workers are risk-averse, this means that it is advantageous to be involved in wage negotiation in these periods. In conclusion, our model with annual wage rounds shows that there exists an incentive for such an extremely concentrated seasonal pattern of bargaining as observed in Japan to emerge.

V. Concluding Remarks

This paper extends the theory of long-term contract to consider the implications of uneven year-to-year and quarter-to-quarter distributions of wage settlements. As the analysis shows, the monetary authority can attain the minimum output variation by means of feedback rule. However, these feedback rules do not attain the minimum price variation automatically. In fact the variance of price level as well as inflation rate depends on the distribution of wage settlements, and in the model with multi-year contracts this variance assumes the minimum under the uniform distribution of wage settlements. In this sense an uneven distribution of wage increments can be thought of as an additional source of instability.

This paper also argues that an extremely concentrated pattern of bargaining makes money partly neutral. Suppose that in the model with multi-year contracts the proportion of workers involved in wage negotiations during, say even periods approaches to unity. Since the monetary policy is wholly anticipated by the public and was already incorporated in the recent wage determination, the first term of equation (2) does not cause any quantity adjustments, while the second term which represents the effects of the inertia in the nominal wage is institutionally zero. Thus the temporary supply curve reduces to the Lucas supply function in odd periods, and the behavior of real output becomes invariant to the monetary policy. In other words, the monetary policy aiming at the stability of output causes large price variations in odd periods.

The most interesting result in our paper is that this neutrality is not the consequence of an exogenously given distribution of wage settlements, but endogenously reconstructed by the risk-aversive public through changing their timing of bargaining. It is advantageous for agents to negotiate wage changes during the priods in which a large proportion of workers are involved in wage negotiations, because the variation of real wage is smaller if the nominal wage is determined during thse periods. Therefore, these exists an incentive for the concentrated pattern of bargaining to emerge. If the authority, as is assumed in Fischer (1977), aims at minimizing output variations, the economy goes to the undesirable equilibria which are accompanied by large price variations. However, Lucas's critique to the Ashenfelter-Fischer-Pencavel model is not the end of the story. As was pointed out in Section III, if the authority takes into account the public's risk-aversion, then at least theoretically it can attain the minimum variations of both output and prices.

In the model with annual wage rounds presented in Section IV, we assumed another "stickiness" in the wage determination because the nominal wage is partially indexed to the past price changes. In effect this additional "stickiness" prevents the variance of inflation rate from going to infinity, even under the extremely concentrated pattern of bargaining. Generally speaking, the model in Section II is of relatively simple structure, and capable of simple interpretation. On the other hand, the model in Section IV is more complicated but realistic and it serves as the basis to explain the formation of Japan's "spring wage offensive." Of course, there are various institutional reasons without which such concentrated pattern of bargaining would not have emerged. However, according to our analysis, this tendency seems to have been backed by the macroeconomic mechanisms.

Even if all labor contracts run for three periods instead of two periods, the same conclusion can be obtained; it is advantageous to negotiate wage changes during the periods in which a large proportion of workers are involved in wage negotiations.; Next to these periods the neutrality of money appears. Now, consider the case in which two-periods contracts and three-periods contracts coexist. Suppose that the largest number of wage settlements occur at $t = 6n$, $6n+6$, $6n+12, \ldots\ldots$ Then, again it is advantageous to negotiate wages during these periods. This time, however, there remain considerable number of wage settlements in such periods as $6n+2$, $6n+3$, $6n+4$, $6n+8$, $6n+9$, $6n+10, \ldots\ldots$ Therefore, even if our model is still applicable to this situation, its implications will be weaken. In the late 1940's and early 1950's much attention was paid in the United States for "pattern bargaining," which is defined as the negotiation of labor contracts by reference to the "key bargaining" (see, e.g., Seltzer (1951), Eckstein and Wilson (1962), and MacGuire and Rapping (1968)). Our analysis partly explains why "key bargaining" was thought of as a standard for the timing as well as amount of wage increases in pattern bargaining. However, the advantage associated with setting the nominal wage in the period when a large proportion of workers are involved in wage negotiations has not caused a sailient "bunching" of wage settlements because the intervals between settlements are variable and not exactly equal to, say two years in the United States. In fact the conformity with the terms of a key bargaining has been decreasing since the 1950's.

As for the Japan's experience, our model provides at least the following two testable hypotheses: (i) Price variations are larger in fall than in spring. (ii) Price variations have been increased along with the prevalence of "spring wage offensive." These are not pursued here, but are interesting problems for future research.

Appendix

In this appendix, the exact form of the lag polinomials and integrals used in Section IV will be given.

$$\theta_1(L) = \frac{\rho_1(1-\lambda)}{2}L^2 + \frac{\lambda\rho_1+\lambda-1}{2}L - \frac{4\rho_1+\lambda}{2}$$

$$\delta_1(L) = -\frac{\rho_2(1-\lambda)}{2}L^2 - \frac{2\rho_2+1-\lambda-\lambda\rho_2}{2}L + \frac{4\rho_2-\lambda-2\lambda\rho_2}{2}$$

$$\theta_2(L) = \frac{\rho_1\lambda}{2}L^2 + \frac{\rho_1-\lambda\rho_1-\lambda}{2}L - \frac{4\rho_1+1-\lambda}{2}$$

$$\delta_2(L) = -\frac{\rho_2\lambda}{2}L^2 - \frac{\rho_2+\lambda+\lambda\rho_2}{2}L + \frac{2\rho_2-1+\lambda+2\lambda\rho_2}{2}$$

$$A_1(L) = 2\{\lambda(1-\lambda)L^2 - (2-\lambda)(1+\lambda)\}(1-\rho_1 L)$$

$$B_1(L) = -(1-\lambda)\lambda\rho_1 L^3 + (1-\lambda)\{\lambda(1+2\rho_1) - 2\rho_1\}L^2 + (1+\lambda)\{-(2-\lambda)(2+\rho_1)$$
$$+ 2(1+2\rho_1)\}L + (2-\lambda)(1+\lambda)$$

$$A_2(L) = 2\{\lambda(1-\lambda)L^2 - (2-\lambda)(1+\lambda)\}(1-\rho_2 L)$$

$$B_2(L) = -\lambda(1-\lambda)\rho_2 L^3 + (1-\lambda)\{\lambda(1+2\rho_2) + 2\rho_2\}L^2 + (1+\lambda)\{-(2-\lambda)(2+\rho_2) + 2\}L$$
$$+ (2-\lambda)(1+\lambda)$$

$$C_1(L) = \rho_1(1-\lambda)L^3 + (1-\lambda)(1+\rho_1\lambda)L^2 - (2-\lambda)(1+3\rho_1-\lambda-\lambda\rho_1)L - (2-\lambda)(1+\lambda)$$

$$C_2(L) = -\rho_2(1-\lambda)L^3 + (1-\lambda)(1-\lambda\rho_2+2\rho_2)L^2 - (2-\lambda)(1-\lambda-\rho_2-\lambda\rho_2)L - (2-\lambda)(1+\lambda)$$

$$I_3(0,\rho_1) = \frac{1}{4}\left\{\frac{\rho_1^2}{4} + \frac{(1+\rho_1^2)^2}{4} + \frac{(\rho_1-2)^2(1+\rho_1)}{4(1-\rho_1)}\right\}$$

$$I_4(0,\rho_2) = \frac{1}{4}\left\{\frac{\rho_2^2}{4} + \left(\frac{\rho_2^2}{2} - \rho_2 - \frac{1}{2}\right)^2 + \left(\frac{\rho_2^3}{2} - \rho_2^2 - \frac{\rho_2}{2} + 1\right)^2\Big/(1 - \rho_2^2)\right\}$$

$$I_5(0,\rho_1) = \frac{1}{4}\left\{\frac{\rho_1^2}{4} + \frac{1}{4}(1+\rho_1^2)^2 + \left(-\frac{\rho_1^3}{2} + \frac{5}{2}\rho_1 + 1\right)^2 + \left(-\frac{\rho_1^4}{2} + \frac{5}{2}\rho_1^2 + \rho_1 + 1\right)^2/(1-\rho_1^2)\right\}$$

$$I_6(0,\rho_2) = \frac{1}{4}\left\{\frac{\rho_2^2}{4} + \left(-\rho_2 + \frac{\rho_2^2}{2} - \frac{1}{2}\right)^2 + \left(\frac{\rho_2^3}{2} - \rho_2^2 - \frac{3}{2}\rho_2 + 1\right)^2 + \left(\frac{\rho_2^4}{2} - \rho_2^3 - \frac{3}{2}\rho_2^2 + \rho_2 + 1\right)^2 \Big/ (1-\rho_1^2)\right\}.$$

$$I_3(1,\rho_1) = \frac{1+3\rho_1^2}{4(1-\rho_1^2)} \quad , \qquad I_4(1,\rho_2) = \frac{1}{4} \quad ,$$

$$I_5(1,\rho_1) = \frac{1+3\rho_1^2}{4(1-\rho_1^2)} \quad , \qquad I_6(1,\rho_2) = \frac{1}{4} \quad .$$

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Notes

1) See Gray (1978) and Blanchard (1979) for the approaches in which the nature of contracts is subject to the policy environment.

2) Each variable in the model should be interpreted as a deviation from a deterministic trend. For example, we assume that $\alpha = 0$ in ${}_{t-i}W_t = \alpha + {}_{t-i}P_t$, i=1, 2, to obtain (1).

3) We attached the subscript "i" ($1 \leq i \leq 8$), as σ_i^2, in order to identify eight variances that appear in the following.

4) The second derivative of "total variance" is positive.

5) The exact forms of lag polinomials that appear in this section are given in Appendix.

6) Figure 1 and 2 are drawn for $\rho_1 = .5$ and $\rho_2 = .5$.

7) The exact forms of $I_j(0,\rho_k)$, $3 \leq j \leq 6$, k=1, 2 are also given in Appendix.

Table 1

The Distribution of Wage Settlements in Japan

1960 - 1978

Size of Establishments (# of workers)	Year	First Quarter	Second Quarter	Third Quarter	Fourth Quarter
	1960	18.3	33.1	21.0	25.6
	1965	9.6	62.1	11.4	16.9
Total	1970	8.8	66.8	17.8	6.6
	1975	2.8	76.2	11.0	10.1
	1978	3.8	81.2	9.4	5.6
	1960	15.1	54.8	16.3	13.8
500	1965	3.4	63.2	13.3	20.1
or	1970	1.7	72.2	22.3	3.8
more	1975	1.4	79.8	8.9	9.9
	1978	1.0	85.5	9.7	3.7
	1960	18.5	33.5	20.0	28.0
100	1965	8.8	66.9	9.2	15.1
~	1970	8.2	69.9	14.7	2.2
499	1975	3.7	73.9	12.1	10.4
	1978	1.7	81.1	13.0	4.2
	1960	19.5	27.9	23.7	28.9
30	1965	21.7	51.3	12.2	14.9
~	1970	22.5	52.3	14.4	10.8
99	1975	5.1	70.4	14.6	9.9
	1978	4.8	73.8	15.9	5.5

Ministry of Labor : Monthly Labor Statistics.

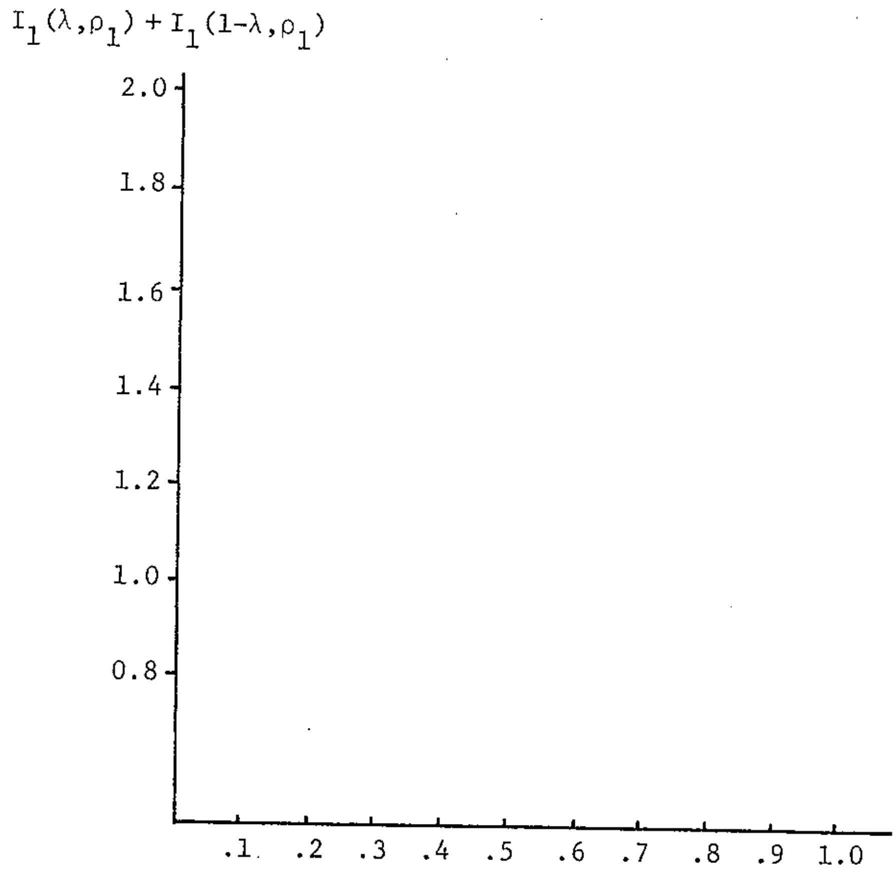
$I_1(\lambda,\rho_1) + I_1(1-\lambda,\rho_1)$
2.0
1.8
1.6
1.4
1.2
1.0
0.8
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0

Fig. 1

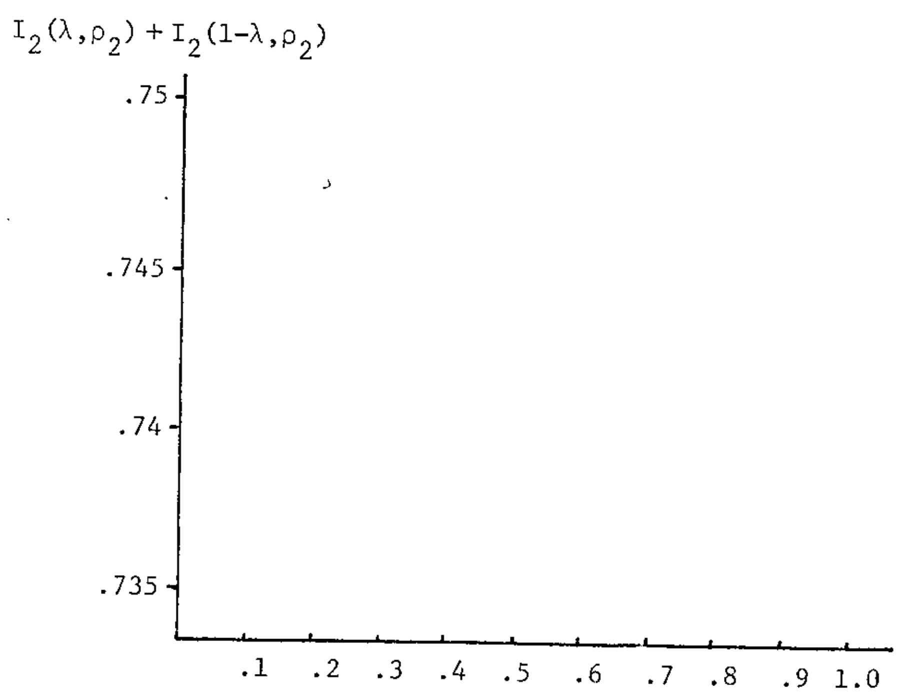
$I_2(\lambda,\rho_2) + I_2(1-\lambda,\rho_2)$
.75
.745
.74
.735
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0

Fig. 2