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OPTIMUM INTEREST RATE FOR A COUNTRY UNDER A FLOATING EXCHANGE RATE SYSTEM

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By

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ABSTRACT

Analyzed are Phillips curves for the two exchange rate systems; fixed and floating exchange rate systems. Short- and long-run curves for both systems are compared and it is found that the country who prefers to inflate less than the world tends to adopt the floating exchange rate system. When we consider the interest-induced international capital flows, the Phillips curve for a country under the floating exchange rate system shifts down as the short-term interest rate increases. This is beneficial to the economy while the higher interest rate brings costs; interest payments to foreigners, and less economic growth if the long-term rate is raised accordingly. By equalizing the marginal benefit and marginal cost of the higher interest rate policy, we can find the optimum interest rate. Empirically, we found that the Japanese optimum rate was 14.1%, the long-term rate being kept constant. The cost of lower economic growth was prohibitive to allow the long-term rate to increase. The best we could suggest was to raise the short-term interest rate as high as possible until it reaches 14.1% while keeping the long-term rate intact.

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CHAPTER I

INTRODUCTION

The world-wide character of recent price and wage inflation has inevitably focused our attention on inflation as a problem of an open economy rather than that of a closed economy. Industrial countries have found internal stability threatened by inflationary forces from abroad. Dependency of one country on the other has become more intense than ever in many respects. Expansion in international trade and investment, growth of multinational enterprises and development of international banking facilities - all these have made national economies susceptible to external disturbances. A number of theoretical and empirical studies on the effects of foreign inflation upon the domestic economy have started to appear in professional journals.[1]

In order to understand the inflation problem, the Phillips curve discussion provides a good start. The Phillips curve trade-off relation has been a major research object since 1958, when Phillips laid the cornerstone for this type of analysis. Many empirical and theoretical studies of the Phillips curve have been made.[2] The era in which the theory of Phillips curve was developed enjoyed rather stable world rates of inflation and not much attention was given to the effects of foreign inflation upon the Phillips curve. The fixed exchange rate system worked well so that no attention was paid to the Phillips curve under the floating exchange rate system. Recent world-wide inflation and the slow shift in the international monetary system toward the floating exchange rate system has directed the economists' attention toward Phillips curves not only in a closed economy, but also in an open economy. How does the rate of foreign inflation affect the location and the shape of the Phillips curve? Are Phillips curves different for the two exchange rate regimes? Fried (1973) provided a framework to answer these questions from the view point of selecting the exchange rate system. Recognizing the importance of the Phillips curve for the discussion of international transmission of inflation, we plan to study the Phillips curve in an open economy in detail. Ultimately we need to study full mechanisms of the imported inflation as Turnovsky and Kaspura (1974) and others have.[3] We are, however, satisfied to look for further treatments of the Phillips curves in an open economy because these are the basis on which the imported inflation is studied.

In Chapter II, we extend the analysis developed by Fried. First, we review Fried's discussion and then we extend his analysis to include short- and long-run Phillips curves for a country under the fixed exchange rate system (a FIXER, hereafter), and for a country under the floating exchange rate system (a FLOATER, hereafter). Presented is the relationship of short- and long-run Phillips curves for a FIXER and a FLOATER. Qualifications to relate the optimum reserve and the optimum path from short- to long-run follow. The last section of this chapter discusses the Phillips curve for a FLOATER when we explicitly consider the income effects upon the balance of payments.

In Chapter III, we pay more attention to the floating exchange rate system since the world seems to be moving toward it. We introduce a new concept, an optimum interest rate. A high interest rate policy enables a FLOATER to shift the Phillips curve left and downward by inducing the international short-term capital inflows. This creates two opposing effects - teh downward shift of the curve, which is beneficial to the home country; and the higher interest rate, which involves some costs. Considering the benefit and the cost of the higher interest rate policy, we derive an optimum interest rate which allows the country to enjoy the maximum net benefit.

Chapter IV provides empirical applications. We study the wage price sector of the Japanese economy; we derive a hypothetical FLOATER's Phillips curve and the optimum interest rate.[4] We experimented the expected rates of inflation in estimated equations by indirect method.[5]

Chapter V summarizes the main results of the thesis. This chapter concludes the thesis by suggesting possible future studies with a remark on the limitations of the current study.

NOTES TO CHAPTER I

1. For theoretical works, see Shinkai (1973), Scarfe (1973), Fried (1973), Haberler (1974), Turnovsky and Kaspura (1974), Miller (1976). For empirical works, see OECD (1973), Pierce and Enzler (1974), Eatwell, Llewillyn, and Tarling (1974), and Ohtani (1975b).

2. See a recent survey article by Laidler and Parkin (1975).

3. See note 1 above.

4. 'Hypothetical' in the sence that we derive Phillips curves under the floating exchange rate system, assuming Japan is under it while she is actually not. We chose Japan because she has a large foreign sector including short-term capital flows and the author's familiarity with Japan.

5. See Chapter IV.

CHAPTER II

PHILLIPS CURVES IN AN OPEN ECONOMY UNDER FIXED AND FLOATING EXCHANGE RATE SYSTEMS

2.1. INTRODUCTION

Since Phillips (1958) published a study on the relationship between wage inflation and the rate of unemployment, there have been numerous theoretical and empirical contributions on the determination of wage rates; negative trade-off relationships have been found in various countries for post-war periods.[1] The rate of wage inflation is also found to be affected by factors other than the rate of unemployment. One of the most important factors is the rate of inflation, or the rate of consumer price inflation. While the rate of wage inflation depends upon the rate of consumer price inflation, the latter also depends upon the former. We are mainly concerned with this interaction process. It is very important to ask whether this interaction leads to a hyper-inflation or tends to converge at some constant level.

The interaction process is explained in terms of price expectation. A higher rate of inflation raises the expected rate of inflation. Changes in the expected rate of inflation have a direct effect upon the rate of wage inflation through the mass bargaining of labor unions. Changes in the expected rate of inflation also have an effect on the demand for labor. Demand for labor increases as producers expect higher inflation rates, and this drives up the wage inflation rate. Price expectations play an important role in this interaction process. They can be formed in various ways. Unfortunately there is no way of knowing *a priori* which specification is correct.[2] However, few will doubt the fact that the expectations are formed on the basis of past experience. In this chapter, we assume the simplest expectation formation: expectations are formed on the basis of the immediate past.[3]

Our purpose in this chapter is to clarify the interaction process and to propose an explicit treatment of the effects of foreign inflation upon Phillips curves in the short and long run for fixed and floating exchange rate systems. Analysis of the effects of foreign inflation on Phillips curves has been neglected. Fried (1973) first analyzed this connection and discussed Phillips curves for both exchange rate systems. However, his analysis does not include this interaction process. Although he considered the short- and long-run Phillips curves for the two exchange rate systems, his short- and long-run analysis is different from the conventional short- and long-run discussion with respect to Phillips curves.[4] We explicitly amend this and consider conventional short- and long-run Phillips curves available for the two exchange rate systems.

In section 2.2., we review Fried's analysis. The following section, 2.3., introduces a model of Phillips curves to show a wage-price interaction process. Section 2.4. discusses Phillips curves for a country under a floating exchange rate system based on the discussion in section 2.3. In section 2.5. we compare Phillips curves for a FIXER and a FLOATER. Section 2.6. provides qualifications for this comparison. The last section of this chapter extends the analysis of FLOATER's Phillips curve by considering income effects on the balance of payments.

2.2. FRIED'S MODEL

Fried (1973) provided a general analysis of exchange rate policy in response to inflation and unemployment for open economies. He showed that:

(1) a FIXER inflating less rapidly than the world will have a greater tendency to adopt a floating exchange rate than a FIXER inflating more rapidly.

(2) if nations can exert some influence on the rate of growth of international liquidity, the long-run world rate of inflation will be greater under a fixed exchange rate system than under a floating exchange rate system.

The analytical framework on which these conclusions are based is shown as follows. For a FIXER, import prices in home currency are exogenously given. If the foreign rate of inflation rises, the domestic rate of inflation will increase less than proportionately.[5] Changes in the rate of foreign inflation affect the balance of payments by changing the terms of trade. According to Fried,

> Given the level of the capital account, only if both foreign and domestic rates are the same will the balance of payments remain constant; if the domestic rate is greater (less) than the foreign rate then, through time, the price of domestically produced goods will rise (fall) relative to foreign-produced goods and, through substitution effects, lead to an *ever increasing* balance of payments deficit (surplus) on current account. The increasing deficit can, in the short run, be sustainted by the sale of international reserves but this could not be used indefinitely, and at some point the country must inflate less rapidly than the rest of the world until exchange reserves are again built up to satisfactory levels. A balance of payments surplus can be maintained only insofar as the country is able and willing to sterilize the inflow. Once the country has exhausted this possibility, the domestic inflation must become greater than the foreign rate until the domestic and foreign prices are again in line.
> (Fried, 1973, p. 45)

For a FLOATER, import prices in home currency are no longer exogenous but adjust to the domestic rate of inflation with continuous appreciation or depreciation of the foreign exchange rate. The inflation rates need to be equal to maintain the balance in the current account by keeping the relative prices of imports, exports, and non-tradables constant. The equality of domestic and foreign rates of inflation means that the trade-off for a FLOATER corresponds to the locus of constrained equilibrium trade-off points for a FIXER generated by altering the foreign rate of inflation.

Curves I, II, and III in Figure 2-1 show the short-run curves for a FIXER at given rates of foreign inflation measured in terms of home currency. Curves I, II, and III correspond with 0%, 1%, and 3% of foreign rates of inflation. If the foreign rate is 1%, then the short-run alternatives

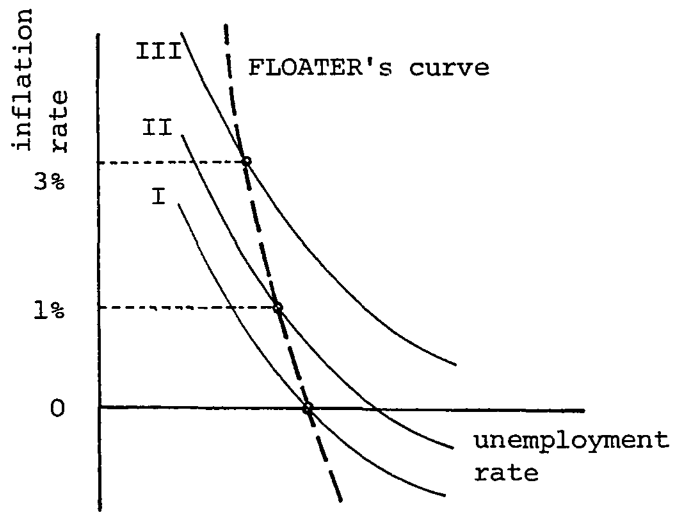


Figure 2-1

Fried's Diagram: FIXER vs. FLOATER

are described by curve II, so long as the possibility of running down or sterilizing international reserves countinues to exist. When those options are no longer available, the domestic rate of inflation must be in line with the foreign rate of inflation, 1%. The Phillips curve for a FLOATER is described by that combination of points where the domestic rate equals the foreign rate in home currency.

In the above discussion, Fried made two important assumptions:

(A-1) Expected and actual rates of inflation are equal.

(A-2) Income-induced effects on imports and exports offset one another.

As is remarked in note 4 of this chapter, 'long run' in the discussion of Phillips curves is characterized by correct price expectation. Hence, his analysis is for the long run. When the expected and actual rates differ (this case is more realistic), what can we say? We will answer this question in the next two sections. Assumption (A-2) is also somewhat peculiar; the ordinary assumption about imports and exports is such that imports depend upon income while exports are given exogenously. We alter (A-2) to this conventional assumption in section 2.7. Fried's conclusions based upon this framework are reviewed in section 2.5. when we compare a FIXER with a FLOATER.

2.3. WAGE-PRICE-INTERACTION MODEL

Consider the following two equation model:[6]

Wage Determination equation;

$$\dot{w} = f(u) + \alpha \, \dot{p}_{-1} \tag{1}$$

$$f'(u) < 0, \quad 0 < \alpha < 1.$$

Price Determination Equation;

$$\dot{p} = \beta(\dot{w} - \dot{q}) + \gamma \dot{p}_m \tag{2}$$

$$0 < \beta < 1, \quad 0 < \gamma < 1.$$

Symbols are:

$\dot{x}$	$\Delta x/x$, or proportional rate of change in x
w	money wage rate
u	unemployment rate
p	consumer price index
q	labor productivity
p_m	import price index in domestic currency unit
α, β, γ	constants

Determinants of the rate of wage inflation are the rate of unemployment and the rate of inflation of the previous periods. The rate of unemployment is an index of excess demand in the labor market. If the rate of unemployment is low, the excess demand for labor is high and the pressure for a wage increase is high. This relationship is shown in the function f(u) in (1). The second term in (1) is the expected rate of inflation, which is assumed to be equal to the inflation rate of the previous period. The coefficient α is positive and it is a parameter representing the bargaining power of labor unions. If labor unions are powerful enough to demand a wage increase greater than the expected rate of inflation, α is greater than one. In most of the empirical studies, however, this coefficient is less than one.[7]

If producers determine prices by a simple mark-up principle, and if major costs applied by this principle are labor and imported materials, we can roughly approximate the relationship by (2). The first term in (2) is the labor cost and the second term is the cost of imported materials. Lipsey and Parkin (1970) provided a justification for this approximation by introducing the identity

$$P \equiv WL + P_m M + CD + \Pi$$

where P market price of final output

W price per unit of labor

L quantity of labor used per unit of output

P_m price per unit of imported materials

M quantity of imports per unit of output

C price per unit of other unmeasured inputs per unit of output

D quantity of other unmeasured inputs per unit of output

Π profit per unit of output.

Assumptions are:

(1) M is constant.

(2) CD, unmeasured cost, is a constant fraction, μ, of measured cost.

(3) Firms aim at the constant proportionate unit mark-up, ν, and hence, aim for $\Pi = \nu P$.

(4) Firms' expectation of W, L and M are perfect so that we can use actual values in place of expected values.

With these assumptions we can transform the above equation to the *ex ante* price determination equation:

$$P = \frac{1 + \mu}{1 - \nu} (WL + P_m M).$$

Differentiate this equation with respect to time and divide both sides by P and we have:

$$\dot{P} = \frac{1 + \mu}{1 - \nu} \frac{WL}{P} (\dot{W} - \dot{L}) + \frac{1 + \mu}{1 - \nu} \frac{P_m M}{P_m} \dot{P}_m$$

where $\dot{L}$ is the rate of change of labor productivity. We rewrite this equation as in (2).

Substitute (1) into (2), and we have the following first order difference equation;

$$\dot{p} = \beta\ (f(u) - \dot{q}) + \alpha\beta\ \dot{p}_{-1} + \gamma\ \dot{p}_m\ .$$

This equation shows a family of short-run Phillips curves for a FIXER.[8] The rate of foreign inflation has an impact on the rate of domestic inflation by γ times the rate of foreign inflation if the rate of unemployment is kept constant.

A general solution for this equation is:

$$p_t = A_o\ (\alpha\beta)^t + \dot{p}^* \tag{4}$$

where A_o is determined by the initial condition and

$$\dot{p}^* = \frac{1}{1 - \alpha\beta} \cdot \{\beta\ (f(u) - \dot{q}) + \gamma\ p_m\}\ . \tag{5}$$

This equation shows a long-run Phillips curve for a FIXER. As long as $\alpha\beta$ is less than one, the rate of inflation converges at $\dot{p}^*$. Whether $\alpha\beta$ is less than one or not is an empirical question. We assume that $\alpha\beta$ is less than one in the following discussions.[9]

As is seen in (5), we have a family of long-run Phillips curves for a FIXER. The location of long-run Phillips curves depends upon the rate of foreign inflation and the rate of labor productivity increase. It is noted that a 1% increase in the rate of foreign inflation drives up the domestic rate of inflation by γ% in the short run and $\gamma/(1 - \alpha\beta)$% in the long run if the government authorities keep the rate of unemployment constant by domestic policies.

Figure 2-2 compares a family of short- and long-run Phillips curves for a FIXER. Suppose A is an initial point,

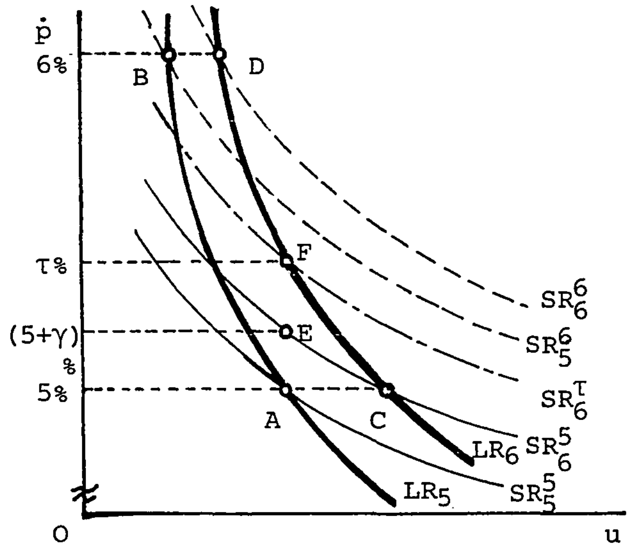


Figure 2-2

FIXER's Short- and Long-Run Phillips Curves

$$\tau = 5 + \frac{\gamma}{1 - \alpha\beta}$$

where $\dot{p} = \dot{p}_{-1} = \dot{p}_m = 5\%$. For a given $\dot{q}$, a short-run Phillips curve for a FIXER depends upon $\dot{p}_m$ and $\dot{p}_{-1}$ on its location while a long-run Phillips curve depends upon only $\dot{p}_m$. SR_5^5 and SR_6^5 are short-run Phillips curves for a FIXER at $\dot{p}_m = 5\%$ and 6% respectively when $\dot{p}_{-1}$ is 6%. Long-run Phillips curves for a FIXER when $\dot{p}_m$s are 5% and 6% are shown by LR_5 and LR_6 respectively. LR_5 is a locus of points where actual and expected rates of inflation are equal along short-run curves when the rate of foreign inflation is 5%, that is, SR_5^5, SR_5^6, and so on. Similarly LR_6 is a locus of points when actual and expected rates of inflation are equal along short-run curves when the rate of foreign inflation is 6%, that is, SR_5^6, SR_6^6, and so on. Impacts of a 1% increase in the rate of foreign inflation are shown by the distance AE for the short run and AF for the long run in Figure 2-2.

We reproduce a part of Figure 2-3 in Figure 2-3 to

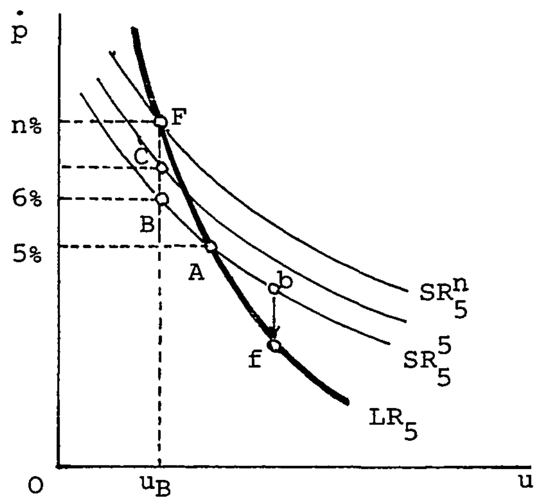


Figure 2-3

FIXER's Adjustment Process

discuss how the expected rate is adjusted to the actual rate. At point A, the actual and expected domestic rates and the foreign rate of inflation are all 5%. Suppose the government authorities prefer point B to point A and keep the unemployment rate at u_B by domestic policies. At point B the actual rate of inflation is 6% and the expected rate is 5%. As time passes people revise their expectations upward, for example, 6%, and thus a short-run Phillips curve shifts upward to SR_5^6. The economy, then, moves to point C. At C the actual rate is still higher than the expected rate and an adjustment to revise expectations keeps on going until the economy reaches to point F on LR_5. A short run curve which goes through point F, SR_5^n, is the curve when the expected rate is n%. The analysis is similar when the economy is at point b. Eventually the economy will be brought down to point f. This explains why long-run curves are steeper than short-run curves.

2.4. PHILLIPS CURVES FOR A FLOATER

Under a floating exchange rate system, the external imbalances are removed by the adjustment in the foreign exchange rates. If we assume that capital is immobile internationally and that the trade balance solely depends upon the terms of trade, the floating exchange rate system adjusts the exchange rate to keep the terms of trade constant. $\dot{p}_m$, the rate of foreign inflation in domestic currency, is actually a summation of $\dot{e}$ and $\dot{p}_f$, where $\dot{e}$ is the rate of change in the foreign exchange rate in foreign currency and $\dot{p}_f$ the rate of foreign inflation in foreign currency. When $\dot{p}_f$ changes, $\dot{p}_m$ can be kept constant by an offsetting adjustment in $\dot{e}$. In other words, the rate of foreign inflation in domestic currency is adjusted to equal the domestic rate of inflation to keep the terms of trade constant at any time. From the short- and long-run Phillips curves in the former section, therefore, we can derive the short- and long-run Phillips curves for a FLOATER, a country under a floating exchange rate system, by imposing a condition that $\dot{p} = \dot{p}_m$.

A short-run Phillips curve for a FLOATER is:

$$\dot{p} = \frac{\beta}{1 - \gamma} \cdot (f(u) - \dot{q}) + \frac{\alpha\beta}{1 - \gamma} \cdot \dot{p}_{-1} \cdot \qquad (6)$$

Locations of Phillips curves depend upon $\dot{p}_{-1}$ and $\dot{q}$. Figure 2-4 compares short-run Phillips curves for a FIXER and a FLOATER. Constancy of $\dot{q}$ is assumed. SR_0^5, SR_5^5, and SR_{10}^5 are short-run Phillips curves for a FIXER corresponding to

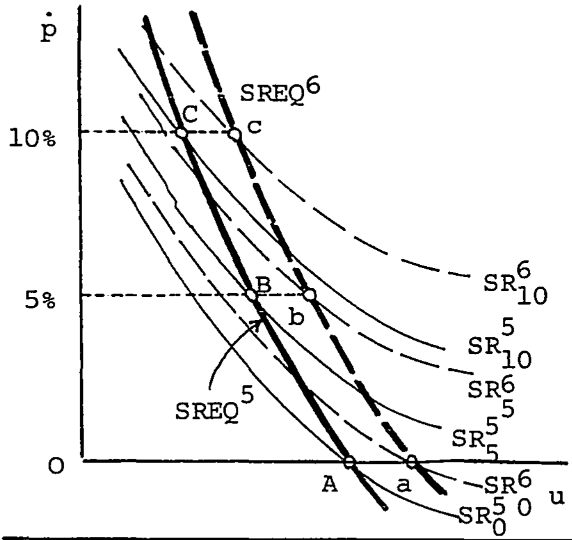


Figure 2-4

FLOATER's Short-Run Phillips Curves

$SREQ^i$ FLOATER's short-run Phillips curve when the expected rate of inflation is i%

$\dot{p}_m$ = 0%, 5%, and 10% respectively, when $\dot{p}_{-1}$ = 5%. $SREQ^5$ is a FLOATER's short-run Phillips curve when the expected rate is 5%. This is obtained by connecting points like A, B, and C where the rates of foreign and domestic inflation are the same. SR^6_0, SR^6_5, and SR^6_{10} are such curves for a FIXER when $\dot{p}_{-1}$ = 6%. By connecting points like a, b, anc c where the rates of foreign and domestic inflation are the same, we obtain another FLOATER's short-run Phillips curve, $SREQ^6$, with 6% expected rate of inflation. $SREQ^5$ is steeper than SR^5_5. This is explained as follows. Suppose a FIXER prefers a lower unemployment rate than point B; FIXER's economy is brought up to point D. At point D, the balance of payments is in deficit. A FLOATER cures this deficit by depreciating her home currency, thus reaching point E. Depreciation makes foreign goods more expensive in domestic currency. E is, thus, located above D. This explains why FLOATER's Phillips curves are steeper than FIXER's in the short run.

A long-run Phillips curve for a FLOATER is obtained by solving the difference equation (6) for $\dot{p}$:

$$\dot{p}_t = A_1 \left(\frac{\alpha\beta}{1 - \gamma}\right)^t + \dot{p}^{**} \tag{7}$$

where A_1 is determined by the initial condition and

$$\dot{p}^{**} = \frac{\beta}{1 - \alpha\beta - \gamma} \cdot (f(u) - \dot{q}) \ . \tag{8}$$

Equation (7) shows a long-run Phillips curve for a FLOATER. As long as $\alpha\beta + \gamma < 1$, the domestic rate of inflation converges at $\dot{p}^{**}$. The condition for convergence is more severe than the case for a FIXER; the FIXER's condition is $\alpha\beta < 1$. The more open the economy is, the more likely the domestic inflation becomes hyper-inflation in the long run. When $\alpha\beta + \gamma \geq 1$, the inflation rate becomes infinity as time passes. In other words, the Phillips curve becomes vertical at the natural rate of unemployment.[10] Thus, only one point at the natural rate of unemployment is practically available for the economy. Such natural rate is obtained by solving $f(u) - \dot{q} = 0$. When $\alpha\beta + \gamma < 1$, the inflation rate converges at $\dot{p}^{**}$. $\dot{p}^{**}$ can be obtained by another method by imposing $\dot{p} = \dot{p}_m$ in equation (4) and letting t become infinity.

In the following discussion, we assume $\alpha\beta + \gamma < 1$. Figure 2-5 shows the relationship among FLOATER's short- and long-run curves and FIXER's long-run curves. LREQ, a FLOATER's long-run curve, is obtained by connecting points at

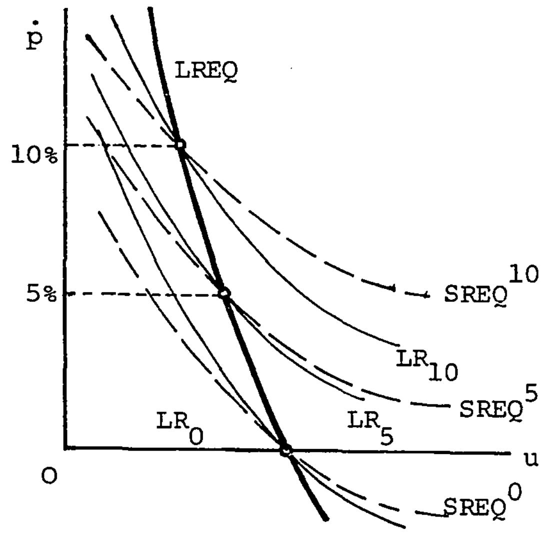


Figure 2-5

FLOATER's Long-Run Phillips Curve: LREQ

which expected and actual rates are the same along FLOATER's short-run Phillips curves. $SREQ^0$, $SREQ^5$, and $SREQ^{10}$ are FLOATER's short-run Phillips curves when expected rates of inflation are 0%, 5%, and 10% respectively. LREQ can be obtained by another method; by connecting such points that domestic and foreign rates of inflation are equal along FIXER's long run Phillips curves. LR_0, LR_5, and LR_{10} are FIXER's long run Phillips curves when foreign inflation rates are 0%, 5%, and 10% respectively.

The relation between SREQ and LREQ is shown in Figure 2-6. Suppose our economy is at point B. The actual rate is 6% while the expected 5% in the short run. As time passes, people revise their expectations upward, for example, 6%. Our economy is now at C along $SREQ^6$. At point C the actual rate is higher than the expected. Expectations will be revised upward. This adjustment continues until the economy reaches

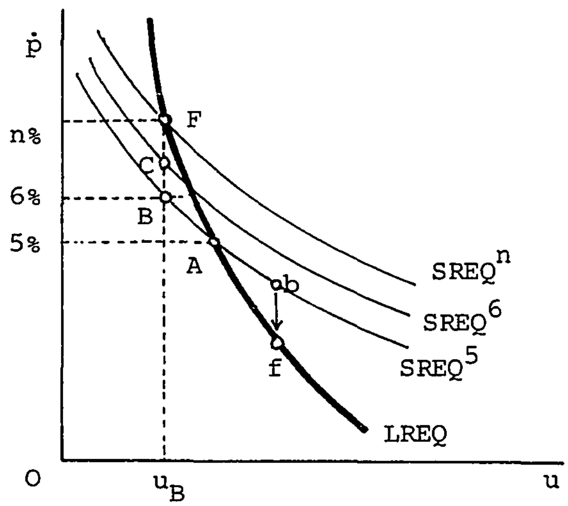


Figure 2-6

FLOATER's Adjustment Process

point F on LREQ. We can analyze similarly if we start from point b. Eventually our economy will be brought down to point f. This explains why LREQ is steeper than SREQs.

2.5. COMPARISON OF PHILLIPS CURVES FOR A FIXER AND A FLOATER

In this section we compare Phillips curves for two exchange rate regimes for short, long, and very long run by introducing disutility curves. Government authorities consider both inflation and unemployment undesirable. We assume that they can order the disutility attached to every combination of inflation and unemployment and thus have indifference curves which are concave to the origin. The distinction among short, long, and very long run is as follows. The expected rate of inflation is not adjusted in the short run, while it is adjusted and it becomes the actual rate in the long run. A FIXER can opt to sterilize or run down foreign exchange reserves in the short and long run. In the

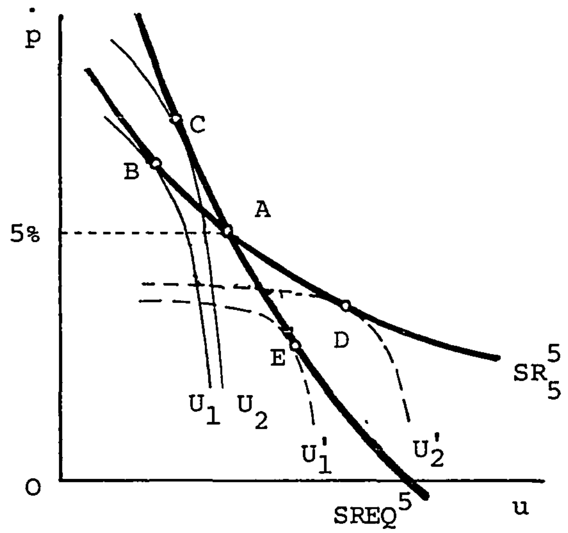


Figure 2-7

Short-Run Comparison: FIXER and FLOATER

very long run, however, a FIXER does not have this option. In such a state a FIXER is forced to maintain the balance of payments equilibrium by adjusting its inflation rate and income level.

SHORT RUN COMPARISON

Suppose that a short-run situation is such that both the expected rate and the foreign rate of inflation in foreign currency are 5%. A FIXER's Phillips curve is shown by SR_5^5 while a FLOATER's one by $SREQ^5$ in Figure 2-7. Any point along $SREQ^5$ is attainable by a FLOATER. The reason for this is as follows. Suppose A is not the desired point for a FLOATER in the short run in Figure 2-8. The FLOATER's government can employ domestic policies to control the rate of unemployment. Suppose such policy enables the economy to reach point B on SR_5^5, if there is no change in foreign exchange rates. A FLOATER, however, adjusts $\dot{p}_m$ to the rate

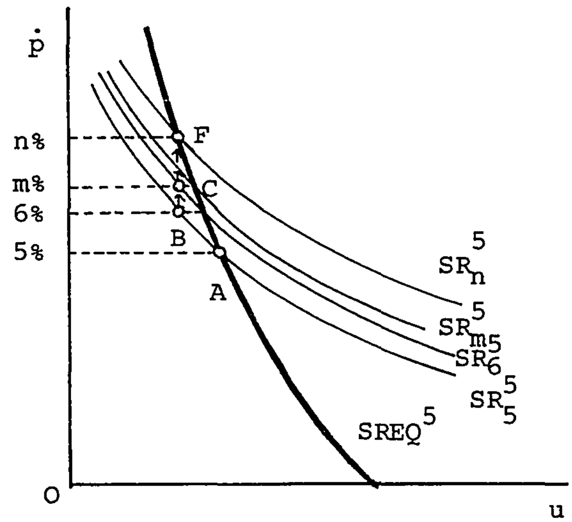


Figure 2-8

Effects of FLOATER's Policy To Change Unemployment Rate

of domestic inflation, 6% in this case, by automatic change in the foreign exchange rate. Due to this exchange rate adjustment, the short-run Phillips curve is now SR_6^5. The economy is now at C. We still have a gap between the foreign rate of inflation in domestic currency and the domestic rate. $\dot{p}_m$ is adjusted again to the domestic inflation rate by the exchange rate changes, thus shifting the short-run Phillips curve to SR_m^5. This process continues until the economy reaches point F. The process from points B to F is instantaneous so that we can see that the domestic policy change moves the economy along $SREQ^5$, that is, from A to F along $SREQ^5$.

Now we refer back to Figure 2-7. Two cases are distinguished:

<u>*Case 1*</u> *Higher Inflation Rate Than The World Rate Is Preferred*

Disutility curves in this case are shown by solid curves, U_1 and U_2. A FIXER in this case inflating more rapidly

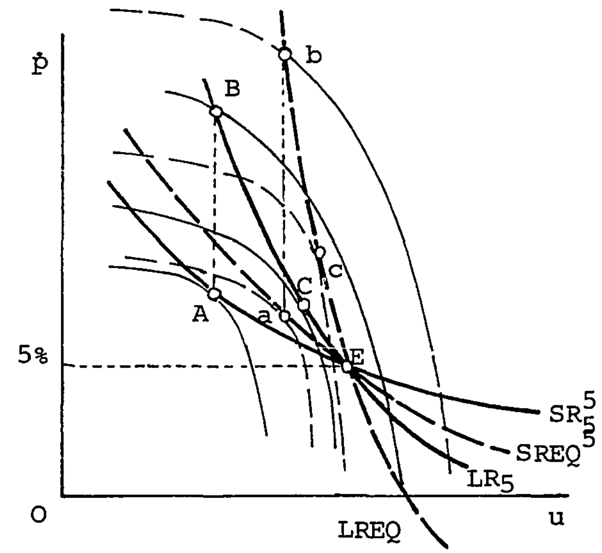


Figure 2-9

Long-Run Comparison: FIXER and FLOATER

- Higher inflation rate than the world is preferred.

than the world at point B. A FIXER attains the level of disutility, U_1, which is lower than the minimum level, U_2, a FLOATER can attain.

<u>Case 2</u> *Lower Inflation Rate Than The World Rate Is Preferred*

Disutility curves are shown by broken curves this time. A FIXER finds her optimum at point D and a FLOATER at point E. A FLOATER is in a better situation than a FIXER. From this we can conclude that a country, who prefers to inflate less than the world rate, tends to adopt a floating exchange rate system in the short run.

LONG AND VERY LONG RUN COMPARISON

To compare a FIXER with a FLOATER in the long and very long run, we again differentiate two cases:

<u>Case 1</u> *Higher Inflation Rate Than The World Rate Is Preferred*

A FIXER moves to point B in the long run if the government authorities keep the unemployment rate constant by domestic policies at the level preferred in the short run (Figure 2-9). A FIXER may prefer higher or lower rate than point B. The case in which they prefer a lower rate is shown at the tangency point, C, of a disutility curve and LR_5. A FIXER can move to C by attaining unemployment level, u_C, by domestic policies, as long as they have enough reserves to run down. If a FIXER cannot run down the reserves any longer, she is forced to inflate at the world rate; a FIXER is at E in the very long run. A FLOATER moves to b in the long run if the government authorities keep the unemployment rate constant by domestic policies at the level preferred in the short run. Whether b is better than B depends upon the disutility function. (In Figure 2-9, disutility functions are drawn such that B is better than b.) A FIXER (a FLOATER), however, will not let their economies move to B (b). A FIXER (a FLOATER) directs domestic policies to move her economies to C (c), where a disutility curve tangents to LR_5 (LREQ). Necessarily a FIXER is better off in this case. In the very long run, a FLOATER is at c while a FIXER is forced to be at E. A FLOATER is better off in the very long run.

<u>Case 2</u> *Lower Inflation Rate Than The World Rate Is Preferred*

In the long run, a FIXER is at B while a FLOATER is at b if they keep the unemployment level constant at the level preferred in the short run (Figure 2-10). Preferred

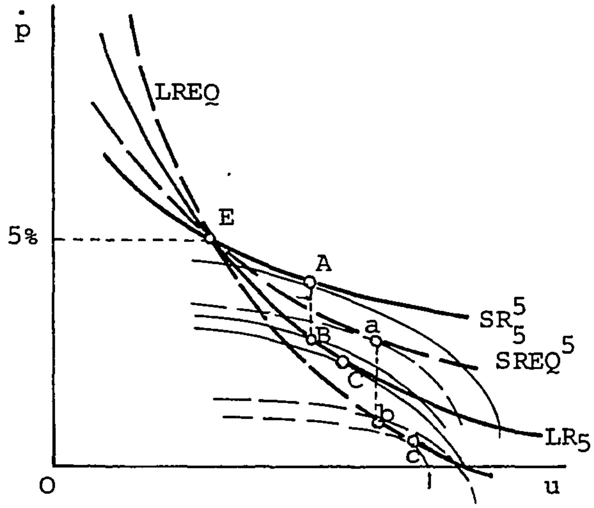


Figure 2-10

Long-Run Comparison: FIXER and FLOATER

- Lower inflation rate than the world is preferred.

points in the long run do not necessarily coincide with B and b. Such points are shown by C for a FIXER and c for a FLOATER. C is better than c whichever way we draw disutility curves. It is noted that a short-run choice is better than a long-run choice when a country (either a FIXER or a FLOATER) prefers a higher inflation rate than the world rate, while the opposite is true when a country prefers a lower rate than the world rate. This is because we started the discussion from short-run cases, assuming 5% expected rate of inflation. A FIXER is even worse in the very long run. A FIXER is forced to move to point E. As disutility curves show, point E is worse than point A (Figure 2-10).

2.6. QUALIFICATIONS FOR THE COMPARISON OF A FIXER WITH A FLOATER

In this section, we present some further thoughts on the comparison made in the last section. First, we mention the possibility for a FIXER to appreciate or depreciate her currency periodically. Second, we study how our comparison may change if we include the costs of foreign exchange reserve holding or borrowing. Third, we briefly consider the path of short to long and very long run. We give a thought on how 'optimum path' may be formed. We treat short-run cases only for first and second qualifications.

A FIXER's Periodic Exchange Rate Change

We compared a FIXER with a FLOATER in the last section, neglecting the possibility of periodic exchange rate changes. A FIXER has always an alternative to the policy of sterilizing or running down the reserves; that is, depreciation or appreciation of her currency. Appreciation (depreciation) causes a rapid deflation (inflation) for a short period of time as export and import prices adjust to the appreciation (depreciation). This implies that if appreciation (depreciation) is used consistently, then a fixed exchange rate system provides the same trade-off relationship, SREQ[5], as a floating exchange rate system. By combining periodic appreciation (depreciation) and sterilizing (running down) international reserves, however, can a FIXER attain a better position.

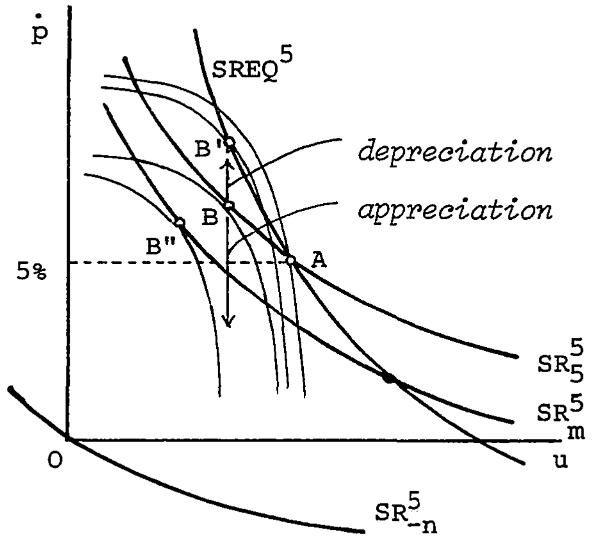


Figure 2-11

FIXER's Exchange Rate Policy

Figure 2-11 illustrate these points. Suppose a FIXER is initially at point B. She faces a deficit in the balance of payments because $\dot{p}_d$ is greater than $\dot{p}_m$. As long as she has enough reserves to run down, she can be remained at B. If she cannot run down the reserves any longer, she is forced to move to point A by domestic policies or to B' by depreciation. At point B', $\dot{p}_d$ equals $\dot{p}_m$, so that there exists no balance-of-payments problem. It depends upon the shape of disutility curves whether domestic policies are better than depreciation to cure the balance-of-payments problem. (Here, it is depicted that depreciation is better than domestic policies.) If a FIXER uses a policy of running down reserves and appreciation together, she can be at lower disutility curves (at point B"). At the extreme, a FIXER may be at the origin. It should be reminded that we can analyze as above because we assume away all the adjustment costs and political infeasibility. A country, who is shortsighted, may find an optimum point at some point like B", considering all the costs involved, but certainly attaining the origin involves too much costs to be the best.[11]

Costs of Reserve Accumulation and Borrowing

It always involves costs to move an economy from one point to the other on the Phillips curve; the cost of reallocation of capital and the costs due to additional uncertainty as to price changes and exchange rates, for instance. All these costs are applicable to both exchange rate systems. The cost of international reserve holding or borrowing, however, is only applicable to a FIXER since a FLOATER hardly needs the reserves. This cost difference works against a fixed exchange rate system when we compare two exchange rate systems. Figure 2-12 explains how a FIXER moves her economy to the optimum point. Disregarding the costs of adjustment except the costs incurred due to international reserves, we can argue as follows. Suppose our initial position is at point A. If there is no cost of borrowing (accumulating) international reserves, a FIXER will move to point B (in case she prefers to inflate more rapidly than the world - Figure 2-12 a) or to point b (in case she prefers to inflate less rapidly than the world - Figure 2-12 b). As the economy moves from A to C (a to c), the economy can attain lower disutility curves.

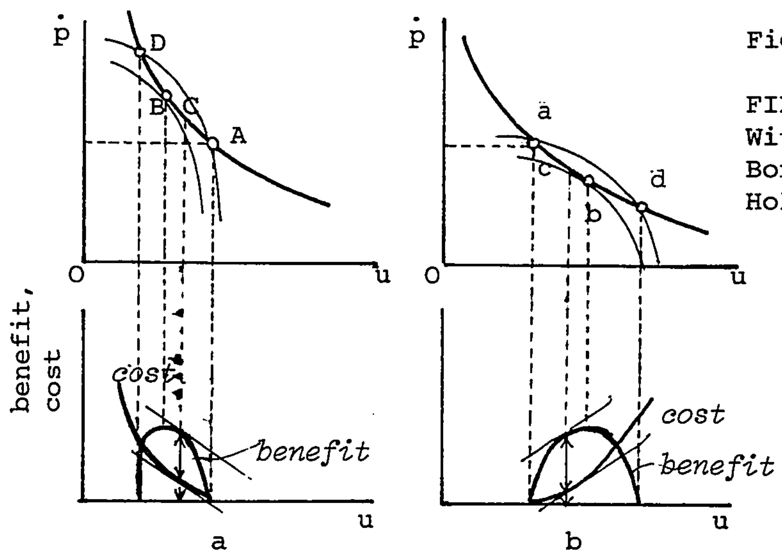


Figure 2-12

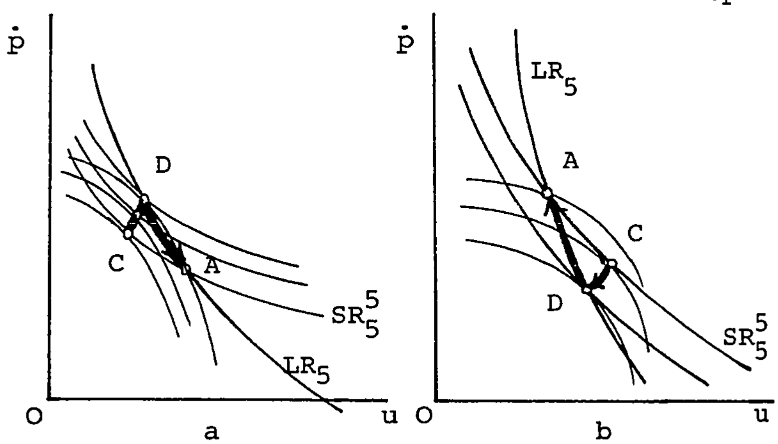
FIXER's Optimum Choice With Costs of Reserve Borrowing - a, and Reserve Holding - b

This is explained by benefit curves in lower diagrams in Figure 2-12. Highest benefits are reached at B and b. The amount of reserve borrowing and accumulation increases as the economy goes away from point A. Thus, the cost of international reserves is depicted as a monotonic function of the extent of divergence from point A in the lower diagrams of Figure 2-12. Now the question to a FIXER is to find a point to maximize the net benefit. Such points are determined by equalizing the marginal benefit and the marginal cost; C and c are such points. Point C (c) gives the optimum point for a FIXER. Corresponding with this point, there is an optimum level of reserve borrowing (accumulation).[12]

Thus, when we compare a FIXER with a FLOATER, favorability of a FIXER lessens even in the short run by this condideration.

Figure 2-13

Optimum Path



Optimum Path

So far we did not consider how an economy should move over time in order to minimize the total disutility. To make a discussion explicit, we assume that the foreign rate of inflation is 5% all the time; no adjustment costs incurred including the cost of reserves. An indifference curve tangents to LR_5 northwest of point A in Figure 2-13a. In the short run, a FIXER can attain the minimum disutility possible at point C. As time passes, people's expectation changes, thus shifting short-run curves upward. By domestic policies, government authorities can attain tangency points throughout. Thus, the economy will be brought up to point D. From D, the economy needs to be brought down to A eventually. Whether this path, C-D-A, is better than just staying at A all the time is an open question. This mainly depends upon how the economy weights present welfare and future welfare.

Figure 2-13b shows a special case where it is always better to pursue different rates of inflation than the world rate.

2.7. A FLOATER'S PHILLIPS CURVE WITH INCOME EFFECTS ON THE BALANCE OF PAYMENTS

In this section we introduce the effects of the unemployment rate on the balance of payments in deriving FLOATER's Phillips curves. The assumption of international capital immobility still holds so that the balance of trade is the balance of payments. Fried (1973) assumed that income-induced effects on imports and exports offset one another. We change this assumption to the ordinary assumption that imports increase as income increases while exports are given exogenously. The unemployment rate is inversely related with income. Hence, the above assumption implies that imports increase as the unemployment rate decreases while exports do not change. Thus, the effect of reducing (increasing) the unemployment rate is to create a balance-of-payments deficit (surplus).

Figure 2-14 explains the derivation of a FLOATER's curve when we include this income effects on the balance of payments. We derive only short-run Phillips curves since a long-run Phillips curve with income effects follows similarly. The expected rate of inflation is 5% and the balance of payments is in equilibrium at point A. SR_5^5 and SR_{10}^5 are FIXER's short-run Phillips curves when the foreign rate of inflation is 5% and 10%. $SREQ^5$ is the FLOATER's

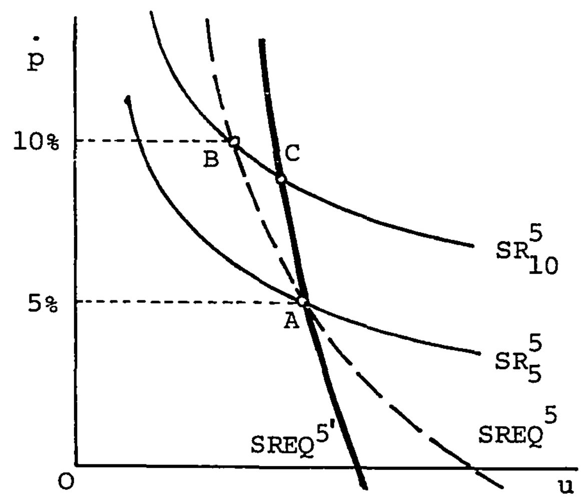


Figure 2-14

FLOATER's Short-Run Phillips Curve: Income Effects Present

Phillips curve we derived in section 2.4. It is a locus connecting points A and B where the domestic and foreign rates are equal. While the terms of trade are the same, income level is higher at B than A, or the unemployment rate is lower at B than at A. Since imports increase as income rises while exports do not change, a country faces a deficit at point B. The domestic rate of inflation needs to be less than 10% and the unemployment needs to be greater than at point B. At some point like C we can attain a balance of payment equilibrium. By tracing points like C on FIXER's curves, we can draw a FLOATER's curve with income effects on the balance of payments. This curve is shown by $SREQ^{5'}$, which is necessarily steeper than $SREQ^5$. Thus, our conclusions in section 2.5. are enforced when we explicitly consider income effects.

NOTES TO CHAPTER II

1. A recent survey article by Laidler and Parkin (1975) covered this subject very well. Phillips (1958), Klein and Ball (1959), Dicks-Mireaux and Dow (1959), Lipsey (1960), Dicks-Mireaux (1961), and Ball (1962) for the United Kingdom, Samuelson and Solow (1960), Bathia (1961), and Perry (1964) for the United States, and Watanabe (1966), Toyoda (1972), Minami and Ono (1972, 1973), and Spitäller (1972) for Japan - all found the inverse relationship between the rate of wage change and the unemployment rate. Theoretically, Lucas and Rapping (1969), Alchian (1960), Mortensen (1970), and Phelps (1970) contributed greatly.

2. A recent good survey on this subject is found in Danes (1973) and Carlson and Parkin (1975).

3. Toyoda (1972) actually found that this holds true in case of Japan. He followed the method employed by Solow (1969) and found that the expectation is formed on the basis of the most immediate past experience. In other words, $\lambda = 1$ case explains the wage equation best of all, where λ is the speed of adjustment in the adaptive expectation scheme. The adaptive expectation scheme is formally expressed as

$$\dot{p}^e = \lambda \dot{p} + (1 - \lambda) \dot{p}^e_{-1}$$

   where $\dot{p}^e$ and $\dot{p}$ are the expected and actual rates of inflation. For a detailed discussion, see Chapter IV.

4. Our "long run" concept is rather special from the viewpoint of other economics fields like economic growth theory. In the field of expectation, it is common to use the "long run" to mean the expected rate rate of inflation equals the actual rate. In other words, the inflation is correctly expected all the time. Friedman (1968) argued that in the short run there can be a discrepancy between the expected and the actual, but not in the long run. After the discrepancy has been fully adjusted, the only relevant magnitudes are "real", so that there exists no such trade-off relation as the Phillips curve. Solow (1969) argued that there exists a trade-off relation even in the long run. We use the words short- and long-run in this context in the following.

5. This is because the substantial component of the price index is composed of goods and services that are only traded domestically.

6. The two equation model is most commonly used to estimate the price sector. See, for instance, Dicks-Mireaux (1961) and Lipsey and Parkin (1970).

7. 0.476 by Toyoda (1972) and 0.40 by Watanabe (1966) just to take a few instances.

8. The original Phillips curve relation is between the rate of wage inflation and the unemployment rate. A 'modified' Phillips curve shows the relation between the rate of consumer price inflation and the rate of unemployment. By Phillips curve we mean this modified Phillips curve.

9. = 1 assumption can be interpreted as the case for Friedman-Phelps accelerationins hypothesis. See Toyoda (1972).

10. Originally the natural rate of unemployment is defined as the unemployment rate which gives the zero rate of wage inflation. In other words, the natural rate of unemployment is given by the point where the Phillips curve in the original sense cuts the unemployment rate axis in the wage inflation unemployment trade-off graph. However, we are referring to the modified Phillips curve in this context and the natural rate of unemployment refers to the unemployment rate where the modified Phillips curve cuts the unemployment rate axis.

11. When we talk about the cost and benefit, we think about a minor change in the economy so that we do not have to include many associated costs.

12. This opens up a new approach to the optimum reserve, although we need more detailed discussion of the evaluation of the benefit and cost.

CHAPTER III

OPTIMUM INTEREST RATE

3.1. INTRODUCTION

In the last chapter, we explored short- and long-run Phillips curves for a FIXER and a FLOATER. Further, we considered the effects of income level upon FLOATER's Phillips curves.

In this chapter, we look for another extension possibility; we relax the assumption of international capital immobility. Short-term capital moves from one country to the other according to the international difference of nominal short-term interest rates. We discuss the effectiveness of raising a nominal short-term interest rate on affecting the location of FLOATER's curves. We consider benefits and costs of a higher nominal short-term interest rate and derive an optimum interest rate. In particular, it is shown that:

(1) A FLOATER can shift down her Phillips curve by raising a nominal short-term interest rate.

(2) Shifting the Phillips curve is beneficial to the economy.

(3) A higher nominal short-term interest rate causes some costs upon the domestic economy; higher interest payments to foreign countries and loss of national income.[1]

(4) A FLOATER can find an optimum interest rate, which maximizes her net benefit.

In section 3.2., we present our standpoint on the theory of international capital movements. Section 3.3. introduces a formal model to derive a FLOATER's Phillips curve when capital is internationally mobile. Section 3.4. considers benefits of higher interest rate policy while section 3.5. treats costs of this policy. Section 3.6. concludes this chapter by introducing a new concept of an optimum interest rate.

3.2. INTEREST RATE AND CAPITAL ACCOUNT

The theory of capital flows is not well formalized as of today because the decision to make foreign investments involves many random factors. According to Leamer and Stern (1970);

> The desire to hold a security will be a function of the expected rate of return, not the market rate. This expected return is determined subjectively by the investors and involves a decision that may be quite short lived. This will make theoretical and empirical research on capital flows difficult. Moreover, the difficulty exists in the impact of institutions and institutional changes in capital flows.
> (Leamer and Stern, 1970, p.76)

There are in fact many sophisticated approaches to capital flows.[2] Since our main concern is not on the cause of capital flows, we ask ourselves: "If capital is responsive to the interest rate changes at all, then what can we say?" The capital account of the balance of payments has certain items; items independent from and items dependent upon domestic interest rate policy. Direct investments, foreign aid, and speculative capital movements are independent. Other items are influenced by domestic interest rate policy. We are concerned with this portion of capital account.

As long as foreign investors see foreign exchange rate stability in the near future, they, interested in how much interest they can repatriate, use nominal rates to assess the expected rate of return.[3] Real interest rate matters only if they plan to purchase goods produced in a host country in the future. But the former case dominates. Moreover, the nominal rate equals the real rate in the short run since the expected rate of inflation is exogenously given in the short run. We consider, therefore, that short term capital moves due to international differences of nominal short term interest rates.

Let us write the capital account equation as:

$$BK = \psi(i_s - \bar{i}_s), \quad \psi' < 0$$

where BK, i_s, and $\bar{i}_s$ are net capital inflow, new nominal short term interest rate, and old nominal short term rate respectively. $\bar{i}_s$ is also an exogenously given foreign short term interest rate. BK is an increasing function of a nominal interest rate difference of domestic and foreign countries, or a difference of new and old domestic interest rates.

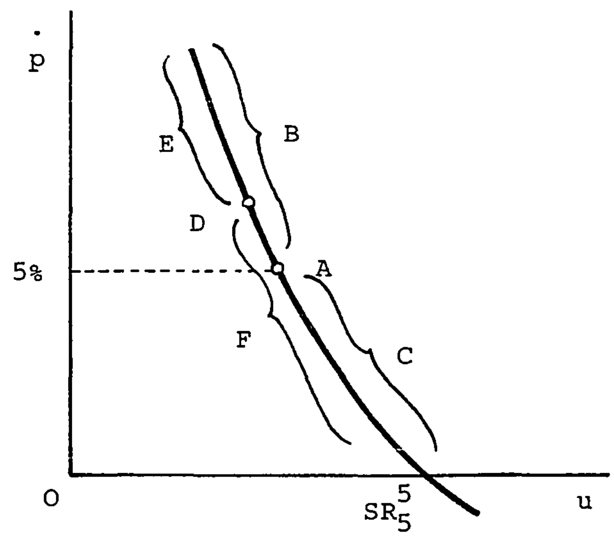


Figure 3-1

Balance-of-Payments Equilibria and Interest Rates

3.3. FLOATER'S PHILLIPS CURVE WHEN CAPITAL IS MOBILE

In this section we derive a FLOATER's Phillips curve from FIXER's curves, assuming international capital mobility. In Figure 3-1, one of FIXER's curves is drawn. Suppose the foreign rate of inflation and the domestic rate of inflation are both 5%. The expected rate of inflation is 5% throughout this chapter. Our economy is, therefore, at point A in Figure 3-1. FIXER's curves shift according to the rate of foreign inflation as discussed in the last chapter. A foreign inflation rate is 5% in the case drawn here. Suppose initially the rates of interest of domestic and foreign countries are the same. The balance of capital, BK, and the balance of trade, BT, are both zero, initially. BT is negative in zone B and positive in zone C (Figure 3-1). Suppose that the domestic short-term interest rate is raised. Point A no longer guarantees the equilibrium in the balance

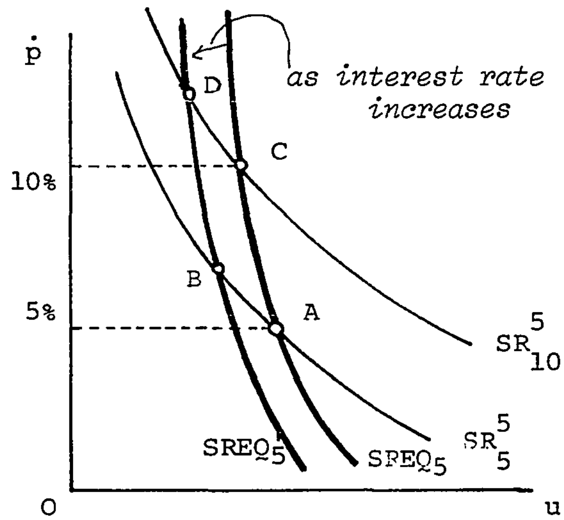


Figure 3-2

Effect of Interest Rate Changes on FLOATER's Short-Run Phillips Curve

of payments, BP. At point A, BK is positve while BT is zero. Domestic price level should go up to create negative BT, which in turn will offset positive BK; point D is the point where negative BT exactly offsets positive BK to have the BP equilibrium.

We derived a FLOATER's curve from many FIXER's curves by connecting the points of the balance-of-payments equilibrium. $SREQ_5$ in Figure 3-2 shows a FLOATER's curve derived by connecting such points with no change in a short-term interest rate (See section 2.4.). When a nominal short-term interest rate increases, the points to connect to derive a FLOATER's curve are located northwest of the points to connect to derive $SREQ_5$. By connecting these new points, we find a new FLOATER's Phillips curve, $SREQ_5'$, which is closer to the origin.

Formally, a simple FLOATER model is as follows:

A MODEL

. Phillips curve trade-off relation

$$\dot{p}_d = f(u) + \alpha(\dot{p}_f + \dot{e}) \tag{1}$$

. Domestic policy effect upon u

$$u = g(G, i_l - \overline{\dot{p}_d^e}) \tag{2}$$

. Balance of trade

$$BT = -\beta_0(1 + \dot{p}_d - \dot{p}_f - \dot{e}) + \beta_1 u \tag{3}$$

. Balance of capital

$$BK = \gamma(i_s - \bar{i}_s) \tag{4}$$

. Balance of payments equilibrium

$$BT + BK = 0 \tag{5}$$

. Relation between short- and long-term interest rates

$$i_l = \delta(i_s - \bar{i}_s) + \bar{i}_l \qquad \begin{array}{l} \delta = 0 \text{ for } |i_s - \bar{i}_s| < \varepsilon \\ \delta = \delta_o \text{ for } |i_s - \bar{i}_s| > \varepsilon. \end{array} \tag{6}$$

SYMBOLS

$\dot{p}_d$	domestic rate of inflation
u	unemployment rate
$\dot{p}_f$	foreign rate of inflation in foreign currency
$\dot{e}$	rate of change in foreign exchange rate
G	government expenditure
i_l	current nominal long-term interest rate

$\overline{\dot{p}}_d^e$ expected rate of inflation

BT balance of trade

BK balance of capital

i_s current nominal short-term interest rate

$\overline{i}_s$ initial nominal short-term interest rate

$\overline{i}_1$ initial nominal long-term interest rate

ε limit of divergence from the initial rate of nominal short-term interest rate not to affect the long-term rate

The first equation shows a Phillips curve trade-off relation in an open economy. The second term of this equation indicates the degree of impact of foreign inflation; 1% increase in the foreign rate of inflation affects the domestic rate of inflation by α%, which is less than one, at a constant unemployment level.

The second equation specifies how G, government expenditure, and $i_1 - \overline{\dot{p}}_d^e$, the real long-term interest rate, affect the rate of unemployment.[5] They can affect income level, thus affecting the level of employment. The rate of inflation is influenced accordingly. More specifically, the real long-term interest rate affects the level of investment, which in turn affects the level of income and the level of unemployment. Thus, the unemployment rate is a function of the government expenditure and the real long-term interest rate.[6]

Equation (3) is a balance-of-trade equation. BT, the balance of trade, is assumed to be a function of the terms of trade and the unemployment rate. We express the terms of trade as P_d/P_m where P_d is the export price and P_m the import price in domestic currency. P_m equals $P_f.E$ where P_f is the import price in foreign currency and E the exchange rate. Assuming $P_d/P_m = 1$ initially, the new terms of trade is expressed as $1 + \dot{p}_d - \dot{p}_f - \dot{e}$. If this is greater (less) than one, BT tends to be in deficit (surplus). An increase in u affects BT favorably since it lowers imports while it does not affect exports.

Equation (4) is a balance-of-capital equation. BK depends upon the international difference of nominal short-term interest rates. If the domestic rate is higher (lower) than the foreign rate, BK tends to be in surplus (deficit).

Equation (5) makes this model one of a FLOATER. Through the adjustment in the foreign exchange rate, the balance of payments is kept in equilibrium.

Equation (6) shows the relation between short- and long-term interest rates. This function is illustrated in Figure 3-3. It is assumed that the long-term interest rate is unaffected by the change in the short-term rate as long as the change is less than ε% in absolute value. Once the short-term rate differs from the foreign rate more than ε%, there exists a direct relation between the short- and long-term rates.

From (3), (4), and (5), we obtain

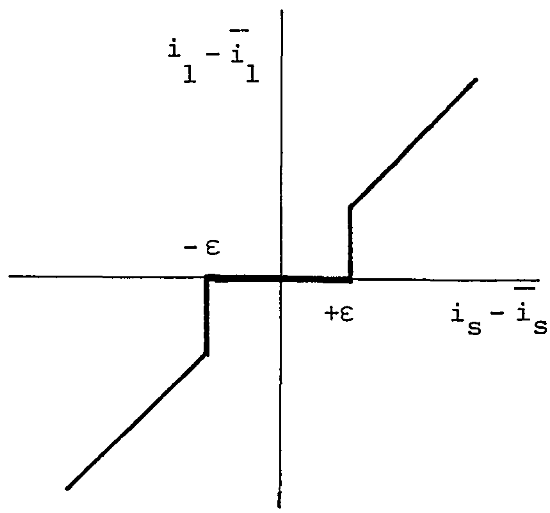


Figure 3-3

Relation Between Short- and Long-Term Interest Rates

$$\dot{p}_f + \dot{e} = -\frac{\beta_1 u + \gamma(i_s - \bar{i}_s)}{\beta_0} + p_d + 1 \quad . \tag{7}$$

This shows the relation of domestic and foreign rates of inflation and the unemployment rate to keep a balance-of-payments equilibrium. A change in nominal short-term interest rates affects this relation.

Substitute (7) into (1);

$$\dot{p}_d = \frac{1}{1-\alpha} f(u) - \frac{\alpha}{(1-\alpha)\beta_0}\left[\beta_1 u + \gamma(i_s - \bar{i}_s)\right] + \beta_0 \, . \tag{8}$$

Equation (8) implies that when the short-term interest rate increases, $\dot{p}_d$ decreases. For the case that the domestic interest rate and foreign interest rate are the same, substitute $i_s - \bar{i}_s = 0$ in (8), and we have:

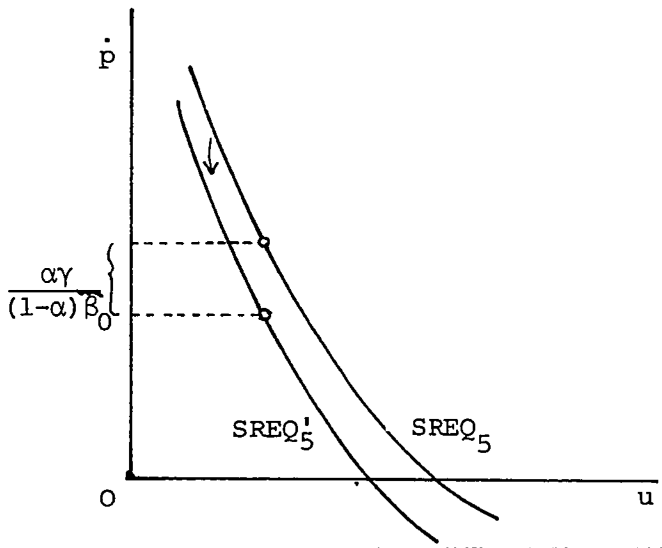


Figure 3-4

Shift of FLOATER's Short-Run Phillips Curve Due To 1% Increase in Interest Rate

$$\dot{p}_d = \frac{1}{1-\alpha} f(u) - \frac{\alpha\beta_1 + \beta_0}{(1-\alpha)\beta_0} u = \phi(u) \tag{9}$$

This curve is shown by SREQ$_5$ in Figure 3-4. $\dot{p}_d$ is expressed as a function of u; namely, $\phi(u)$. Suppose that the international difference of nominal interest rates is 1%. This shifts down the curve by $\frac{\alpha\gamma}{(1-\alpha)\beta_0}$ %.[7] A new curve is shown by SREQ$'_5$ in Figure 3-4. How should we evaluate this shift of the curve? We answer this question in the next section.

3.4. BENEFIT FROM HIGHER INTEREST RATE

If we know the exact shape of the disutility function of the economy, a shift of the Phillips curve can be evaluated easily by a change in this disutility. Of course, measuring disutilities may be problematical. However, we can measure, for instance, disutility changes by the change in unemployment

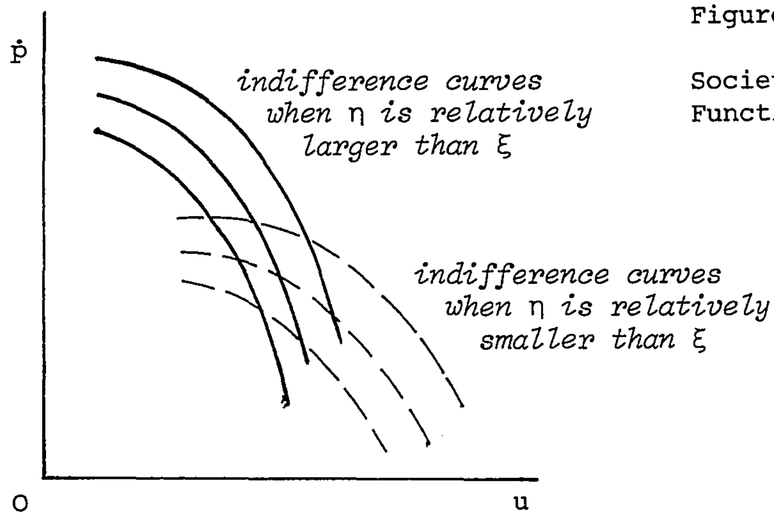


Figure 3-5

Society's Preference Function

rates at some constant inflation rate, as long as we know the exact shape of the disutility function. A change in unemployment rates, then, can be transferred to dollar terms.

We may assume a seemingly agreeable disutility function like the following;

$$D = \eta u^2 + \xi p_d^2 \tag{10}$$

where η and ξ show the society's preference for the combination of unemployment rate and inflation rate. When η is relatively larger than ξ, the disutility function looks like the solid curves in Figure 3-5; unemployment is a more severe problem than inflation. On the other hand, when η is relatively smaller than ξ, the disutility function looks like the broken curves; inflation is a more severe problem than unemployment.

A tangency point of the disutility function and the

Phillips curve is found by solving the minimization problem;

minimize D

subject to

$$\dot{p}_d = \phi(u) - \frac{\alpha\gamma}{(1-\alpha)\beta_0}(i_s - \bar{i}_s)$$

Substitute (10) into D;

$$D = \eta u^2 + \left[\frac{\xi}{(1-\alpha)^2}\phi^2(u) - \frac{2\alpha\gamma}{\beta_0}(i_s - \bar{i}_s)\phi(u) + \frac{\alpha^2\gamma^2}{\beta_0^2}(i_s - \bar{i}_s)^2\right]. \qquad (11)$$

Suppose, for the sake of exposition, that ϕ is a simple linear function of u;

$$\phi(u) = a - bu \qquad (12)$$

where a and b are positive constants. Substitute (12) into (11);

$$D = \left[\eta + \frac{\xi b^2}{(1-\alpha)^2}\right]u^2 - \frac{\xi}{(1-\alpha)^2}\left[2ab - \frac{2\alpha\gamma b}{\beta_0}(i_s - \bar{i}_s)\right] u + \frac{\xi}{(1-\alpha)^2}\left[a^2 - \frac{2\alpha\gamma a}{\beta_0}(i_s - \bar{i}_s) + \frac{\alpha^2\gamma^2}{\beta_0^2}(i_s - \bar{i}_s)\right]. \qquad (13)$$

Differentiate (13) with respect to u;

$$\frac{dD}{du} = 2\left[\eta + \frac{\xi b^2}{(1-\alpha)^2}\right]u - \frac{2\xi}{(1-\alpha)^2}\left[ab - \frac{\alpha\gamma b}{\beta_0}(i_s - \bar{i}_s)\right]. \qquad (14)$$

Set (14) equal to zero, and solve for u;

$$u^* = \frac{\xi\beta_0 ab + 2\alpha\gamma b(i_s - \bar{i}_s)}{\beta_0\eta(1 - \alpha)^2 + \xi b^2} \tag{15}$$

where * implies 'optimum'. By changing the rate of short term interest, i_s, we can have different u*s. Substituting back u* to (8), we get p*. A combination of p* and u* is the choice of the economy. Substituting these values into the disutility function, (10), we can calculate the disutility changes due to the short-term interest rate changes.[8]

Disutility depends upon the short-term interest rate and all the parameters; α, β_0, γ, η, ξ, a and b. If we can express this disutility in dollar terms, we have no difficulty in assessing the benefit. In the following, we evaluate the benefit by the gains in employment rather than the changes in disutility.

3.5. COST OF HIGHER INTEREST RATE

In the former section, we discussed the benefits of higher interest policy. A higher rate of short-term interest induces, however, some costs; larger interest payments to foreigners and costs of recessionary impacts of higher interest rates.

Fried argued that the use of interest rate policy to control the level of inflation and unemployment is not viable in the long run. Assuming that the capital flows are responsive, but not infinitely elastic with respect to the nominal rate of interest and that price expectations of investors are such that the expected and actual rates of inflation are equal, he discussed as follows:

> Assume the government decides to increase the domestic rate of inflation above the foreign rate while keeping the real rate of interest fixed. Initially this may lead to either a surplus or deficit in the balance of payments; The current account will tend toward deficit due to an increase in the relative price of domestically produced goods while the capital account will tend toward surplus as the nominal in the rest of the world. However, the surplus on capital account is a once and for all increase due to the increase in inflation, whereas the increase in inflation causes an ever increasing current account deficit. Consequently, even if the existence of capital flows permitted a nation to avoid the balance of payments constraint in the short run, it would be ineffective in the intermediate to longer term if the real rate of interest is to remain constant. Furthermore changes in the real rate of interest will have an effect on the actual capital stock and hence on income and growth. At some point the cost in terms of income lost (or, in the case of a decreasing real rate of interest, of forgone current consumption) outweigh the gains associated with the desired inflation and unemployment levels, thus leading the government authorities to return to the world rate of inflation. (Fried, 1973, p.47)

This is true as long as nominal rate differences are concerned. Even in this case, however, it is worthwhile to look at the short run benefits. Although a higher real interest rate imposes some costs on the domestic economy, it is hardly right to stop the analysis by saying that the cost is enormous so that the government authorities should return to the world rate of inflation. We need to analyze what these costs are. Fried said that changes in the real rate of interest will have an effect on the actual capital stock and hence on income and growth. What we have in mind is the policy like "operation twist", where the short-term rate is changed to attract the foreign capital while the long-term interest rate is kept constant to maintain the current domestic production level.[9] First, we consider a case that the "operation twist" is successful. Second, we consider a case that the "operation twist" is unsuccessful; a case that the long-term is affected by changes in the short-term rate.

Case 1 SUCCESSFUL OPERATION TWIST

The main cost in this case is the increased flow of interest payments needed to service the greater volume of foreign held liabilities. Gray (1964), and Willett and Forte (1969) tried to find this cost. Gray argued that the marginal cost of induced international capital movements depends upon volume of funds attracted, new short-term rate, volume of liabilities held prior to the change of interest rates, difference between the old and new average rates of return per annum, and time needed for the new averate rate to be achieved (Gray, 1964, p.190). The marginal cost of induced international capital movements, or the additional cost of the last unit of foreign capital, is formulated as:

$$C/K = (K\ i_s + F\ (i_s - \bar{i}_s))\ /\ K \qquad (16)$$

where C increase in interest payments per annum made to foreigners

K volume of induced capital movements

F	volume of short term liabilities held prior to the rate increase
i_s	average rate of return paid on newly attracted funds
$\bar{i}_s$	old average rate of return paid to the short term liabilities held before the rate increase.

Willett and Forte incorporated the portfolio growth in this context. They argued that one must add the explicit or implicit interest cost on the change in newly attracted capital flows as well as the change in the interest cost on flows which would have occurred anyway. Their basic conclusion is that there will be a flow of international capital even in the absence of international differences of the interest rates. Capital movements increase as time passes even when the rate of interest stays the same. They call this effect "portfolio growth". Since we are interested in the short run, we can safely neglect the portfolio growth effects on the international capital allocation. The total cost for inducing capital for a year, TC, is given by

$$TC = BK.i_s + F.(i_s - \bar{i}_s) \quad . \tag{17}$$

BK, the volume of induced capital movements, is a function of international differences of short-term interest rates.

$$BK = \gamma(i_s - \bar{i}_s) \qquad \gamma > 0 \tag{18}$$

Substituting (17) into (16),

$$TC = \gamma(i_s - \bar{i}_s)\ i_s + F\ (i_s - \bar{i}_s). \tag{19}$$

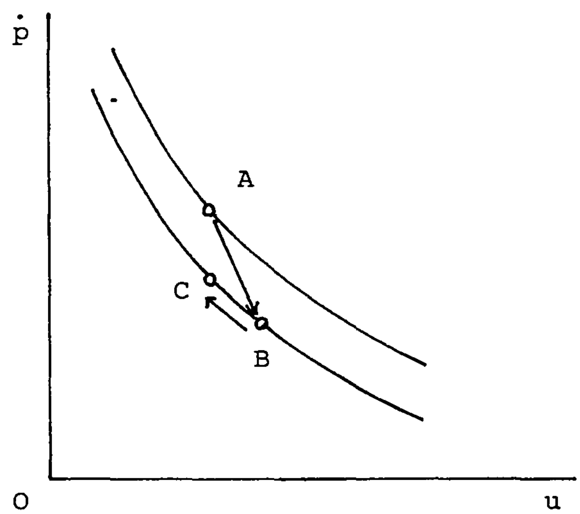


Figure 3-6

Effects of Higher Long-Term Interest Rate

CASE II UNSUCCESSFUL OPERATION TWIST

When the operation twist is unsuccessful, a long-term interest rate is raised by the increase in a short-term rate. A higher long-term interest rate will cause adjustment costs. A higher rate of short-term interest causes the shift of the Phillips curve as is shown in Figure 3-6. As a long-term interest rate is affected, the economy will be brought down to point B instead of point C. To bring back our economy to point C, the government needs to expand government expenditure. This adjustment involves some costs and can be considered as an increasing function of a difference of the new and old long-term interest rate.

$$C_a = \zeta(i_1 - \bar{i}_1) \qquad \zeta > 0 \tag{20}$$

where C_a is the adjustment cost, and ζ is a constant coefficient.[10] Total cost, TCII, will be the summation of the cost derived in case I and this adjustment cost.

$$TCII = TC + C_a$$

$$= \gamma(i_s - \bar{i}_s)i_s + F(i_s - \bar{i}_s) + \zeta(i_1 - \bar{i}_1)$$

$$= \gamma(i_s - \bar{i}_s)i_s + (F + \zeta\delta_0)(i_s - \bar{i}_s) \qquad (21)$$

3.6. OPTIMUM INTEREST RATE

Based upon the arguments of section 3.5. and 3.6., we will formulate an optimum interest rate in this section. As we derived in section 3.4., the general disutility function is hard to handle. Since we simply wish to expose the new idea of an optimum interest rate in the following, we replace the general disutility function to a much simpler one.

$$D = \eta p_d \text{ for a given } u^* \qquad (22)$$

where D is the level of disutility. The disutility function, (22), suggests a very strict assumption. $u = u^*$ is the only possible unemployment rate desired for the domestic economy. Home country prefers u^* to any other level of unemployment rate. Indifference curves are actually kinked curves like D_0, D_1, D_2, and D_3 in Figure 3-7. The reduction in the rate of inflation due to the n% increase in the interest rate is given by

$$n\alpha\gamma/(1 - \alpha)\beta_0.$$

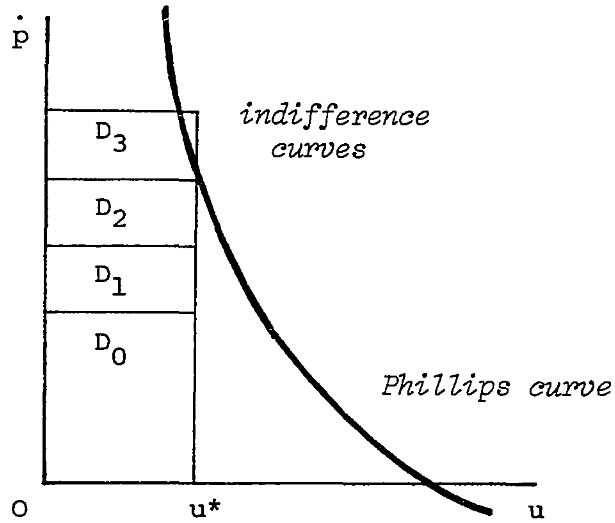


Figure 3-7

Special Indifference Curves

The total gain from the n% higher interest rate policy is

$$\eta n\alpha\gamma/(1-\alpha)\beta_0.$$

Thus, the marginal gain, MB, or the gain by increasing the interest rate one per cent more is given by

$$MB = \eta\alpha\gamma/(1-\alpha)\beta_0. \tag{23}$$

MB is, thus, constant.

To evaluate the cost of a higher short-term interest rate, we need to differentiate the following two cases.

CASE I SUCCESSFUL OPERATION TWIST

The total cost for inducing foreign capital in this case is given by (19);

$$TC = \gamma(i_s - \bar{i}_s)i_s + F(i_s - \bar{i}_s). \tag{19}$$

Rearranging this equation in terms of the difference of new and old interest rates and letting n represent such a difference,

$$TC = \gamma n(n - \bar{i}_s) + Fn.$$

The marginal cost of raising the short-term interest rate by one per cent is obtained by differentiating the above equation with respect to n;

$$MC = \frac{dTC}{dn} = 2\gamma n - \gamma \bar{i}_s + F. \qquad (24)$$

Comparing marginal benefit (MB) and marginal cost (MC), we can now formulate an optimum rate of interest. An optimum difference of new and old interest rates is found where MB = MC. Necessary and sufficient condition for the existence of an optimum rate of interest is:

$$\gamma i_s + F \leq \eta\alpha\gamma/(1 - \alpha)\beta_0. \qquad (25)$$

An optimum difference, n*, is:

$$n^* = \frac{1}{2\gamma}\left[\frac{\eta\alpha\beta}{(1 - \alpha)\beta_0} + \gamma i_s - F\right]. \qquad (26)$$

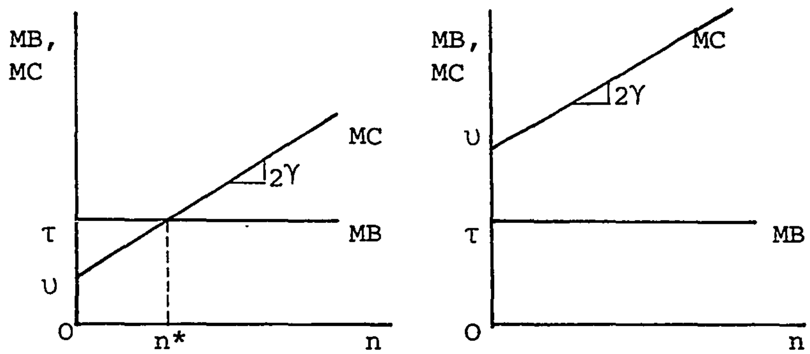
An optimum interest rate is $i_s^* = \bar{i}_s + n^*$. Thus,

$$i_s^* = \frac{1}{2\gamma}\left[\frac{\eta\alpha\beta}{(1 - \alpha)\beta_0} + 3\gamma i_s - F\right]. \qquad (27)$$

This optimum interest rate is greater if η and γ are larger and if β_0 and F are smaller.

Figure 3-8

Optimum Interest Rate:
Successful Operation Twist



$\tau = \eta\alpha\gamma/(1-\alpha)\beta_0$

$\upsilon = F - \gamma\bar{i}_s$

The optimum interest rate difference and the necessary and sufficient condition are illustrated in Figure 3-8.

CASE II UNSUCCESSFUL OPERATION TWIST

The total cost for this case is shown by (21);

$$TCII = \gamma(i_s - \bar{i}_s)i_s + (F + \zeta\delta_0)(i_s - \bar{i}_s). \tag{21}$$

Rearranging this equation in terms of the difference of new and old interest rates, n,

$$TCII = \gamma n(n - \bar{i}_s) + n(F + \zeta\delta_0).$$

The marginal cost of raising the short-term interest rate by one per cent is obtained by differentiating the above equation with respect to n;

$$MCII = \frac{dTCII}{d\ n} = 2\gamma n + F + \zeta\delta_0 - \gamma\bar{i}_s. \tag{28}$$

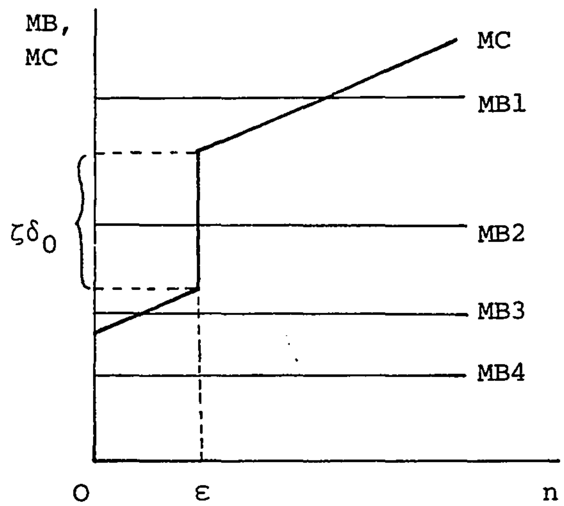


Figure 3-9

Optimum Interest Rate: Unsuccessful Operation Twist

Being the marginal benefit the same as in case I, an optimum n, or n*, is found by the rule MB = MC (MCII);

$$n^* = \frac{1}{2\gamma}\left[\frac{\eta\alpha\gamma}{(1-\alpha)\beta_0} + \gamma\bar{i}_s - F - \zeta\delta_0\right]. \qquad (29)$$

An optimum interest rate is, thus,

$$i_s{}^* = \frac{1}{2\gamma}\left[\frac{\eta\alpha\gamma}{(1-\alpha)\beta_0} + 3\gamma\bar{i}_s - F - \zeta\delta_0\right]. \qquad (30)$$

Figure 3-10 illustrates new possibilities. Four possible cases are shown by drawing different marginal benefit curves; MB3 and MB4 correspond with the former case while MB1 and MB2 correspond with new possible optimum interest rates. The possibility of $\bar{i}_s + \varepsilon$ being the optimum interest rate becomes greater than the possibility in the former case.

NOTES TO CHAPTER III

1. This is because there exists a positive link between short- and long-term interest rates and a higher long-term interest rate dampens investment, thus lessening national income through multiplier process.

2. Portfolio selection approach by Miller and Whitman (1970), for instance.

3. McKinnon discussed this in the case of Korea; "The incentives to move funds into Korea in one form or another had become enormous. The higher *nominal* domestic interest rate looked like high *real* rates to foreigners, who had the option of repatriating short-term investments at a stabel foreign exchange parity." (McKinnon, 1973, p.163)
When the new short-term rate does not change much from the old rate, the expectations of investors are quite stable in the short run; they expect that there will be no foreign exchange risk and domestic and foreign inflation rates will not change much.

4. If we consider income effects upon the balance of payments as in section 2.7., and if we regard A being the overall balance point, point C indicates less than 10%. See Figure 2-14.

5. Since we are analyzing the short-run case, we assumed the expected rate of inflation is given. Thus we put a bar over p_d^e to denote an exogenous variable.

6. In a typical Keynesian system, income is determined by
$$Y = C + I + G + X,$$
where Y, C, I, and X are income, consumption, investment, government expenditure, and export respectively (all in real terms).

7. Substitute $i_s - \bar{i}_s = 1$ in equation (8). Compare this substituted equation with equation (9).

8. Unless actual parameter values are given, the calculation is quite complicated. We will use more simplified indifference curves in later discussions.

9. "Operation Twist" was experimented by the United States in 1961. It met with only limited success.

10. This assumption is made just for simplicity.

CHAPTER IV

EMPIRICAL EVIDENCE

4.1. INTRODUCTION

In the last two chapters, we presented simple models of Phillips curves. We discussed short- and long-run Phillips curves for a FIXER and a FLOATER. Further, we argued that there might exist an optimum interest rate for a FLOATER. Since the models presented in Chapters II and III are simplified for expository purposes, they seem inappropriate for direct application to empirical studies. We present a refined model to explain the Japanese wage-price sector. We chose Japan for this empirical study for the period, 1952 to 1973.[1]

In section 4.2., we survey current price movements in Japan and discuss some characteristics of the Japanese economy. In section 4.3., we present an econometric model which features such characteristics. The results of empirical study are reported in section 4.4. Section 4.5. concludes this chapter by suggesting a possible optimum interest rate based upon our estimates of the wage-price sector.

4.2. CURRENT PRICE MOVEMENT IN JAPAN

During the two decades of 1950s and 1960s, there was a considerable discrepancy in the movements of wholesale price indeces and consumer price indeces; the former was stable, while the latter increased rapidly. The average annual growth rate for wholesale price indeces was .5% and that for consumer price indeces was 3.9% for the period. In 1970s, however, we observed different patterns; both indeces were growing very rapidly. The average annual growth rate for wholesale price indeces was 8.4% and that of consumer price indeces was 11.6% for the period, 1970 to 1975. These high inflation rates are mainly due to high inflation rates of imported materials. The price of imported materials was stable during 1950s and 1960s, but suddenly it increased at 19.8% per annum in 1970s. Wholesale price, consumer price, and import price indeces are compared in Figure 4-1. We showed two import price indeces. The import price indeces for raw materials and the import price indeces for final goods. The latter seemed to lead consumer price indeces until 1970.

Wholesale price indeces can be divided into two categories; wholesale price indeces for the high productivity sector and those for the low productivity sector. The high productivity sector (HPS, hereafter) includes large-scale manufacturers, while the low productivity sector (LPS, hereafter) includes small-scale manufacturers and an agricultural sector.[2] Until 1970s, wholesale price indeces

Figure 4-1 Wholesale Price Movements

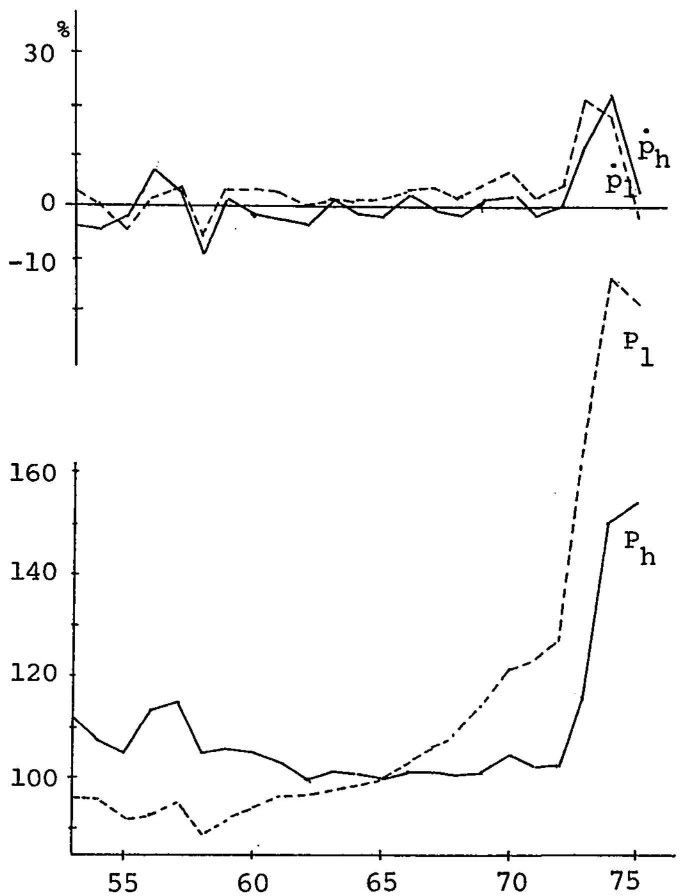
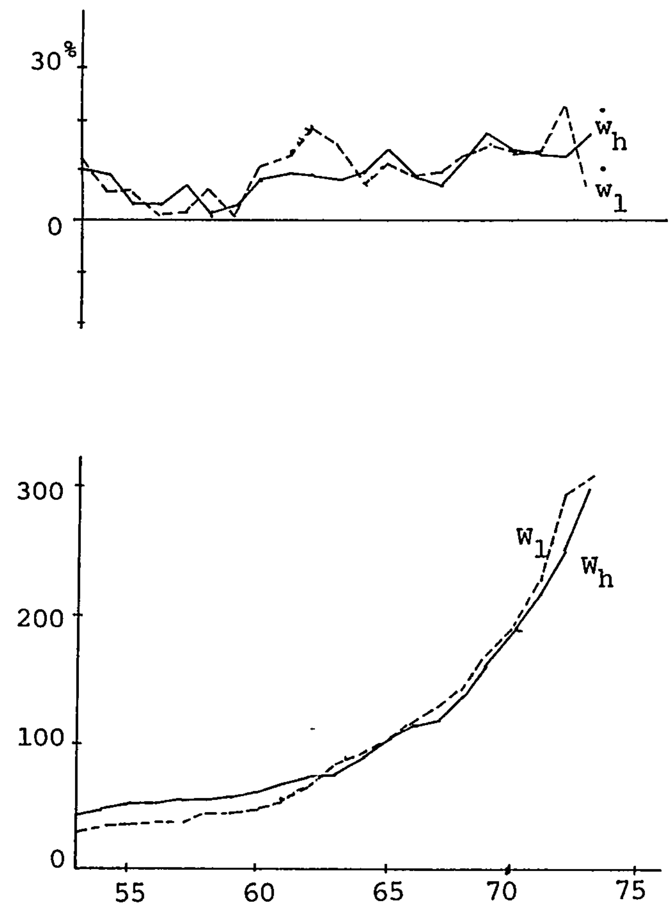


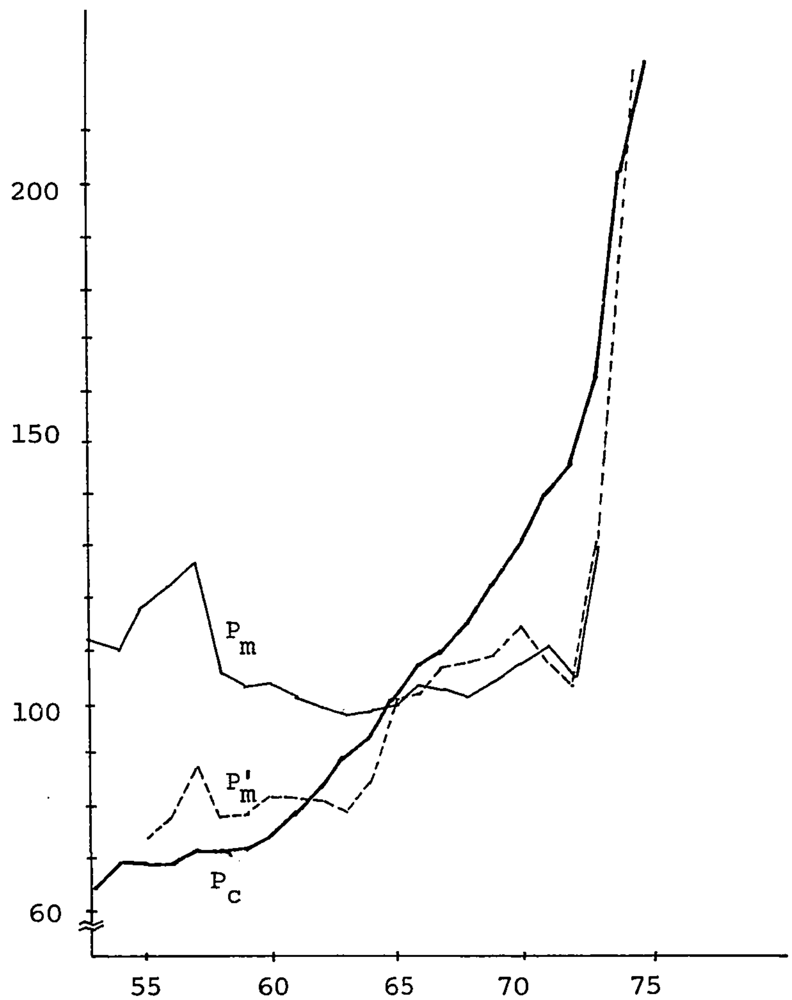
Figure 4-2 Wage Movements



P and W are wholesale price and wage rate.
Lowercase letter with · over it shows the rate of change.
Subscripts h and l are HPS and LPS.

Figure 4-3

Price Movements



P_c consumer price index

P_m price index for imported raw material

P'_m price index for imported finished goods for HPS showed a declining trend; those for LPS showed a rising trend. Because two opposing forces offset each other, the overall wholesale price indeces were considerably stable. This trend continued until 1972 (Figure 4-2). Because of the extreme foreign inflation, every price index showed a rapid increase after 1972. Yet, a slight delay was observed in wholesale price indeces for HPS.

We also observed a lead and lag in the wage rates for HPS and LPS. As we see in Figure 4-3, there was no significant difference in the rate of change in the wage rates between HPS and LPS until 1960. After 1960, however, the rate of change in the wage rates for LPS was much higher than that for HPS. We used to observe a great difference in the wage rates between HPS and LPS, but the difference has shrunk very rapidly since 1960.

4.3. A MODEL

As we saw the current price movements in Japan in section 4.2., there existed considerable gaps between HPS and LPS: wholesale price indeces for HPS was stable, while those for LPS showed a rapid increase; wage rates differed greatly between HPS and LPS. Recently these gaps shrunk to some extent because of the interaction between two sectors. This feature of the Japanese economy is called "dual structure".[3] The interaction between HPS and LPS must be considered in capturing the entire picture of the price movements in Japan. We also observed the close relationships among consumer price indeces, wholesale price indeces for LPS, and imported final goods price indeces. We introduce these features in the following model.[4]

A MODEL

$$\dot{w}_h = \phi_1(\overset{-}{\dot{u}}, \overset{+}{\dot{p}^e_c}, \overset{-}{\dot{\pi}}) \tag{1}$$

$$\dot{w}_l = \phi_2(\overset{-}{\dot{u}}, \overset{+}{\dot{w}^e_h}, \overset{+}{\dot{p}^e_c}) \tag{2}$$

$$\dot{p}_h = \phi_3(\overset{+}{\dot{w}_h}, \overset{-}{\dot{q}_h}, \overset{+}{\dot{p}_m}) \tag{3}$$

$$\dot{p}_l = \phi_4(\overset{+}{\dot{w}_l}, \overset{-}{\dot{q}_l}, \overset{+}{\dot{p}_m}, \overset{+}{\dot{p}_h}) \tag{4}$$

$$\dot{p}_c = \phi_5(\overset{+}{\dot{p}_l}, \overset{+}{\dot{p}'_m}) \tag{5}$$

$$\dot{w}^e_h = \phi_6(\overset{+}{\dot{w}_{h-1}}, \overset{+}{\dot{w}_{h-2}}, \text{etc.}) \tag{6}$$

$$\dot{p}^e_c = \phi_7(\overset{+}{\dot{p}_{c-1}}, \overset{+}{\dot{p}_{c-2}}, \text{etc.}) \tag{7}$$

The symbols, + and -, are signs of the first derivative of each variable.

SYMBOLS

Endogenous variables:

$\dot{w}_h$, $\dot{w}_l$ percentage changes in wages of HPS and LPS, respectively

$\dot{p}_h$, $\dot{p}_l$ percentage changes in wholesale prices of HPS and LPS, respectively

$\dot{p}_c$	percentage change in consumer prices
$\dot{w}_h^e$	expected rate of change in wages of HPS
$\dot{p}_c^e$	expected rate of consumer price inflation

Lagged endogenous variables:

$\dot{w}_{h_{-t}}$	percentage change in wages of HPS, t year lagged
$\dot{p}_{c_{-t}}$	percentage change in consumer prices, t year lagged

Exogenous variables:

u	unemployment rate
$\dot{\Pi}$	percentage change in profit rates of HPS
$\dot{q}_h$, $\dot{q}_l$	percentage changes in labor productivity of HPS and LPS, respectively
$\dot{p}_m$	percentage change in the price of imported raw materials
$\dot{p}_m'$	percentage change in the price of imported final goods.

<u>WAGE DETERMINATION</u>

One explanatory variable for the percentage change in the wages of HPS and LPS is the rate of unemployment. The unemployment rate is one of indeces to show the labor demand situation. As u increases (decreases), it becomes harder (easier) for labor unions to bargain wage hikes. Thus, the signs of the first derivatives with respect to u in (1) and (2) are negative. The expected rate of consumer price inflation works similarly; the higher the rate, the greater the demand for a wage hike of labor unions.

We add $\dot{\pi}$ as an independent variable for HPS and $\dot{w}_h^e$ for LPS because each factor characterizes each sector. Labor unions in HPS see $\dot{\pi}$ as a sign of companies's ability to pay and demands a higher wage hike when $\dot{\pi}$ is higher; companies also allow such a wage hike when $\dot{\pi}$ is higher. Labor unions in LPS base their demand for a wage hike on their expectations of percentage changes of HPS's wage rates, rather than on the companies' ability to pay.

DETERMINATION OF PRICE

Wholesale prices are determined more or less by a mark-up principle; the price is the costs incurred for production times some mark-up rate. Wages and imported raw materials have direct influences on wholesale prices; the higher these costs, the higher the rate of change in wholesale prices. Labor productivity also influences wholesale prices; the higher the productivity, the lower the rate of change in wholesale prices. The inclusion of the rate of change in wholesale prices of HPS is due to the fact that LPS purchases important inputs such as steel from HPS.

The rate of change in consumer price indeces is determined from the rates of change in the wholesale prices of LPS and the prices of imported final consumption goods. We treat this equation as a behavioral equation because retailers determine the price for final consumption goods based on wholesale prices. There involves some decision making process in this regard.

PRICE EXPECTATION

The expected rate of inflation is formed by past experiences. There are basically two approaches in treating this expectation problem; the 'direct' and the 'indirect'.[5] The 'direct' method uses direct information for expectations, survey data for business men's expectations for instance, and regresses this against other variables (lagged or unlagged). The 'indirect' method uses some kind of lag structures and runs a regression of a certain equation which includes price expectation variables and takes the best fit result, thus finding the best lag structure.

Typical lag structures used for the 'direct' and 'indirect' methods are adaptive expectation hypothesis, extrapolative expectation hypothesis, and Almon lag expectation hypothesis.

The adaptive expectation hypothesis is stated as:

$$\dot{p}^e - \dot{p}^e_{-1} = \lambda(\dot{p} - \dot{p}^e_{-1}) \qquad 0 < \lambda < 1.$$

Expectation is revised by a fraction, λ, of the last period's forecast error, that is, the discrepancy between the current observed value and the previous expected value.[6]

The extrapolative hypothesis is:

$$\dot{p}^e = \delta_0\dot{p} + \delta_1(\dot{p} - \dot{p}_{-1})$$

The expected rate equals the summation of the actual rate of inflation times some constant, δ_0, and some fraction, δ_1, of the actual trend.[7] If δ_1 is positive, it is expected that the trend of the actual rate of inflation continues. The trend is extrapolated. If δ_1 is negative, a change in the trend is expected.

The Almon lag expectation hypothesis is expressed as:

$$\dot{p} = \beta_0\dot{p} + \beta_1\dot{p}_{-1} + \beta_2\dot{p}_{-2} + \cdots + \beta_s\dot{p}_{-s}$$

where we postulated a lagged effect up to s periods.[8] Almon's method rules out the direct attempt to estimate all $(s+1)\beta$'s and uses instead the assumption that the β's can be approximated by some function

$$\beta_z \simeq f(z).$$

Weierstrass's theorem makes the approximation possible over the whole interval by a polynomial of suitable degree.[9] Thus,

$$f(z) \simeq \alpha_0 + \alpha_1 z + \cdots + \alpha_r z^r.$$

By specifying the degree of polynomial and the lag period, we estimate α's first, and then β's by substituting the values of α's.

Problems with the adaptive and the Almon lag specifications are that they imply systematic underestimation if there exists a trend in price changes.

4.4. EMPIRICAL RESULTS

To estimate the simultaneous equation system, we did it in two steps. First, we estimated endogenous variables. that is, $\dot{w}_h$, $\dot{w}_l$, $\dot{p}_h$, and $\dot{p}_l$, by using the variables, u, $\hat{\dot{q}}_h$, $\dot{q}_l$, and $\dot{p}_m$. Secondly, we used these estimated values, $\hat{\dot{w}}_h$, $\hat{w}_l$, $\hat{p}_h$, $\hat{p}_l$, to estimate each equation in the system. The expected rates of inflation, $\dot{w}_h^e$ and $\dot{p}_c^e$, are estimated in this stage to test three expectation hypotheses. Data and data sources are discussed in the Appendix A.

RESULTS

Wage Equation for HPS:

$$\dot{w}_h = \underset{(7.69)}{12.46} - \underset{(-3.56)}{2.25}\, u + \underset{(1.39)}{0.21}\, \dot{p}_c^e + \underset{(2.56)}{0.48}\, \hat{\dot{p}}_h \qquad (8)$$

$$R^2 = 0.66 \qquad DW = 1.81$$

The numbers in parentheses are t-ratios. $\bar{R}^2$ is the multiple correlation coefficient adjusted for the degree of freedom. DW is the Durbin-Watson statistics. Three different lag structures were estimated for this equation. The results are shown in Appendix B. Almon specification explains poorly compared with others. We do observe little difference between the adaptive expectation hypothesis and those of the extrapolative specification. As we use $\bar{R}^2$ as a criterion, the extrapolative hypothesis with $\delta_1 = 1$ explains best of all.[10] The result of wage equation with this specification is reported above. We included $\dot{p}_h$ and $\dot{q}_h$

together for the first experiment because they are proxies for the profit rate in HPS. Unfortunately the results were not significant, thus dropping $\dot{q}_h$. The coefficient of $\dot{p}_h$ is quite significant and large. This explains that firms can allow the wage rate to increase just half the rate of the product price inflation rate. The expected rate of inflation affects the wage determination for HPS slightly.

Wage Equation for LPS:

$$\underset{}{\dot{w}_1} = \underset{(3.38)}{12.02} - \underset{(-1.83)}{2.16\, u} + \underset{(1.29)}{0.27}\, \dot{w}_h^e \qquad (9)$$

$$\bar{R}^2 = 0.26 \qquad DW = 2.08$$

Demand pressures, represented by u, in the labor market for LPS affects the wage determination less than it does for HPS. The expected rate of the wage inflation in HPS is formed from the past experience and the best lag structure was found to be the extrapolative expectation specification with $\delta_1 = 1.0$ for this equation. δ_0 was assumed to be one for the entire estimation. Appendix C shows the results of three expectation hypotheses. This expected rate plays an important role in the wage determination in LPS. The expected rate of consumer price inflation did not explain the equation significantly, thus we dropped it for the estimation.

<u>Wholesale Price Equation for HPS</u>:

$$\dot{p}_h = \underset{(-0.16)}{-0.31} + \underset{(0.62)}{0.13}\ \hat{\dot{w}}_h - \underset{(-0.87)}{0.09}\ \dot{q}_h + \underset{(2.75)}{0.36}\ \dot{p}_m \tag{10}$$

$$\bar{R}^2 = 0.63 \quad DW = 2.75$$

The HPS wholesale price inflation rate is determined mainly by the imported raw material price inflation rate. The next most important factor is the wage inflation rate of its own sector. The labor productivity change affects the wholesale price inflation rate just 9%.

<u>Wholesale Price Equation for LPS</u>:

$$\dot{p}_l = \underset{(-0.60)}{-1.12} + \underset{(1.93)}{0.31}\ \hat{\dot{w}}_l + \underset{(6.00)}{1.31}\ \hat{\dot{p}}_h \tag{11}$$

$$\bar{R}^2 = 0.65 \quad DW = 1.41$$

It is interesting to observe that the price formation of the HPS affects the price formation of the LPS quite significantly. A 1% increase in the HPS wholesale price inflation rate leads to a 1.31% increase in the LPS wholesale price inflation rate. The wage inflation rate is also a very important factor. The labor productivity wasincluded in the first trial estimation equation to be no significant variable.

<u>Consumer Price Equation</u>:

$$\dot{p}_c = \underset{(4.41)}{0.69}\ \hat{\dot{p}}_l + \underset{(1.12)}{0.16}\ \dot{p}'_m \tag{12}$$

$$\bar{R}^2 = 0.35 \quad DW = 1.04$$

We tried to include the wholesale price inflation rate of the HPS in this equation to find an insignificant result. The wholesale price inflation rate of the LPS is, however, quite dominant in the determination of the consumer price inflation rate.

Equations (8) to (12) are structual equations. Expressing all the endogenous variables solely by exogenous variables, we can have a reduced form. First, we regard $\dot{p}_c^e$ and $\dot{w}_h^e$ as exogenous, or different from the actual values, $\dot{p}_c$ and $\dot{w}_h$. In other words, we want to derive the reduced form for the short run.

$$\begin{bmatrix} \dot{w}_h \\ \dot{w}_l \\ \dot{p}_h \\ \dot{p}_l \\ \dot{p}_c \end{bmatrix} = \begin{bmatrix} 13.13 & -2.40 & -0.05 & 0.18 & 0.00 & 0.00 & 0.22 \\ 12.02 & -2.16 & 0.00 & 0.00 & 0.00 & 0.27 & 0.00 \\ 1.40 & -0.31 & -0.10 & 0.38 & 0.00 & 0.00 & 0.03 \\ 4.44 & -1.08 & -0.13 & 0.50 & 0.00 & 0.08 & 0.04 \\ 3.06 & -0.75 & -0.09 & 0.35 & 0.16 & 0.06 & 0.03 \end{bmatrix} \begin{bmatrix} 1 \\ u \\ \dot{q}_h \\ \dot{p}_m \\ \dot{p}'_m \\ \dot{w}_h \\ \dot{p}_c \end{bmatrix} \tag{13}$$

As long as the structural parameters are concerned, we argued correctly that the demand pressure in labor market, represented by u, affects more in the LPS than in the HPS. Looking at the estimates in the above reduced form, however, we can no longer assert this. In fact, the demand pressure has stronger effects upon the determination of the wage rate in the HPS than in the LPS.

The last row of the above reduced form matrix gives the modified Phillips curve, or the relationship between the consumer price inflation rate and the unemployment rate;

$$\dot{p}_c = 3.06 - 0.75\ u - 0.09\ \dot{q}_h + 0.35\ \dot{p}_m + 0.16\ \dot{p}'_m + 0.06\ \dot{w}^e_h + 0.03\ \dot{p}^e_c. \tag{14}$$

This modified Phillips curve depends upon many factors. The rates of change of import prices of the raw and finished final goods and the expected rates of consumer price inflation and the wage inflation rate of the HPS shift the curve directly; the Phillips curve shifts upward when one of these increases. The rate of change of the labor productivity in the HPS affects the Phillips curve adversely; an increase in the rate shifts the Phillips curve downward.

In order to obtain the Phillips curve for 1973, we substitute the data for $\dot{q}_h$, $\dot{p}_m$, $\dot{w}^e_h$, and $\dot{p}^e_c$; -16.51, -2.92, 13.43, and 5.80, respectively. The last row of the above matrix now reads;

$$\dot{p}_c = 5.99 - 0.75\ u + 0.35\ \dot{p}_m. \tag{15}$$

We further substitute $\dot{p}_m = 18.75$ and we obtain the short-run Phillips curve for a FIXER for 1973;

$$\dot{p}_c = 12.62 - 0.76\ u. \tag{16}$$

Letting $\dot{p}_c = \dot{p}_m$ in (15), we obtain the short-run Phillips curve for a FLOATER for 1973;

$$\dot{p}_c = 9.21 - 1.15\ u. \tag{17}$$

Next, let us put $\dot{p}_c^e = \dot{p}_c$ and $\dot{w}_h^e = \dot{w}_h$; the expected rates are correctly realized. In the long-run steady state, the equality of the expected rate and the actual rate holds. In this steady state, the reduced form equations now become;

$$\begin{bmatrix} \dot{w}_h \\ \dot{w}_l \\ \dot{p}_h \\ \dot{p}_l \\ \dot{p}_c \end{bmatrix} = \begin{bmatrix} 14.00 & -2.60 & -0.07 & 0.26 & 0.04 \\ 15.92 & -3.21 & -0.03 & 0.12 & 0.03 \\ 1.47 & -0.41 & -0.10 & 0.40 & 0.01 \\ 5.75 & -1.53 & -0.14 & 0.65 & 0.04 \\ 3.98 & -0.93 & -0.09 & 0.38 & 0.17 \end{bmatrix} \begin{bmatrix} 1 \\ u \\ \dot{q}_h \\ \dot{p}_m \\ \dot{p}'_m \end{bmatrix}. \tag{18}$$

The last row of the above shows the negative relationship between the consumer price inflation rate and the unemployment rate. Substituting the actual values for $\dot{q}_h$ and $\dot{p}_m$, we have;

$$\dot{p}_c = 5.96 - 0.93\ u + 0.38\ \dot{p}_m. \tag{19}$$

Substituting $\dot{p}_m = 18.75$, we get the long-run Phillips curve for a FIXER for 1973;

$$\dot{p}_c = 13.09 - 0.93\ u. \tag{20}$$

Letting $\dot{p}_c = \dot{p}_m$ in equation (20), we obtain the long-run Phillips curve for a FLOATER;

$$\dot{p}_c = 9.61 - 1.5\ u. \tag{21}$$

4.5. OPTIMUM INTEREST RATE

In the last section, we found the short-run Phillips curve for a FLOATER. Based upon this resul, we derive an optimum interest rate for a FLOATER in this section. We need to know the elasicity of the trade balance with respect to the terms of trade and the interest sensitivity of the short-term capital flows. Amano and others (1973) did an extensive econometric study on the Japanese balance of payments sector. We borrow some of their estimated results for calculating the optimum interest rate.

Amano and others reported that;

1. A 10% evaluation leads to 10% of export worsening in the balance of trade for a quarter.
2. A 1% increase in the domestic call rate leads to 320 million dollars to 5 million dollars short-term capital flows for a quarter.

Suppose the maximum value, 320 million dollars, of capital flows in when the call rate is raised by 1%. In 1973, the short-term capital net debit amounted to 12.8 billion dollars. The cost of increasing n% in the call rate is calculated as;

$$TC = 12.8\ n\ (n + \bar{i}_s) + 128\ n \qquad (22)$$

where $\bar{i}_s$ is the current call rate and n the difference between the new and current rates.[11] The total cost, TC, is in million dollars. This total cost refers to the case when the "operation twist" is successful.

The unsuccessful "operation twist" creates the cost different from the equation (22). In order to assess the cost in this case, we need to know the relation between the short- and long-term interest rates. Our specification of the relation is such that the long-term rate is unaffected if the change of the short-term rate is small enough. The relation is formally expressed as;

$$\Delta i_l = \xi \Delta i_s \qquad \begin{array}{l} \xi = 0 \text{ for } \Delta i_s < \varepsilon \\ \xi = \xi_0 \text{ for } \Delta i_s > \varepsilon \end{array} \qquad (23)$$

where Δi_l and Δi_s are changes in the long- and short-term interest rates respectively. Although the "operation twist" is a policy control by the government, economic forces make it operative or inoperative. We wish to find the value ε, where the border of the operative "operation twist" lies. We looked back the data to 1971 and used the quarterly data to see this effect. The official discount rate was used for the long-term interest rate and the call rate for the short-term interest rate. The data are reported in the Appendix D.

The methodology we employed to estimate this special function is as follows. Suppose the actual data for Δi_s are 0.5, 1.0, 0.2, 0.4, 0.3, and 0.8. In order to see the certain value for ε is more likely than the other, we change the data for Δi_s. Suppose the values for ε we want to test are 0.4 and 0.8. We change the data for Δi_s as

0.5, 1.0, 0.0, 0.4, 0.0, and 0.8 for $\varepsilon = 0.4$ and 0.0, 1.0, 0.0, 0.0, 0.0, and 0.8 for $\varepsilon = 0.8$. We have, thus, two sets of data for Δi_s. For each set, we run a regression and we compare the results. The ε which gives the better result is more likely to be the real ε.

The regression results are summarized in Table 4-1 below. $\varepsilon = 0.3$ explains best of all if we take $\bar{R}^2$ as a criterion. An n% change in the short-term interest rate affects the long-term rate positively by 0.517n% when the short-term rate changes more than 0.3%.

Table 4-1

Regression Results: Relation Between Short- and Long-Term Interest Rates

ε	ξ_0	$\bar{R}^2$	DW
0.1	0.5158	0.8254	1.851
0.2	0.5160	0.8257	1.892
0.3	0.5166	0.8266	1.840
0.4	0.5180	0.8261	1.918
0.5	0.5138	0.8055	1.968

Baba and others recently published a book titled "Pilot Model SP-17 for Short Term Forecasing" (Baba and et al., 1976). According to their analysis, a 0.25% decrease in the official discount rate, or the long-term interest rate, induces 442 billion yen, 1435 million dollars, reduction in the real gross national expenditure for a year.

We regard this reduction in GNE as the cost of the higher interest rate policy. An n% increase in the short-term interest rate increases the long-term rate by 0.517n% and this, in turn, reduces GNE by 0.517n × 1435 / 0.25 = 2968n million dollars. Hence, the total cost to include this cost is;

$$
\begin{aligned}
TCII &= TC + 2968\ n \\
&= 12.8\ n\ (n + \bar{i}_s) + 3096\ n \qquad (24)
\end{aligned}
$$

where TC is from (22).

To evaluate the benefit of the higher interest rate policy, we need to look at the shift of the Phillips curve due to the increase in the interest rate. The improvement of 320 million dollars in the capital balance can be offset by the equal amount of the deficit in the trade balance. To achieve this, the home currency needs to be appreciated by 0.22%. This is because, in 1973, 10% of the export value was 3,626 million dollars. In terms of $\dot{p}_c$ and $\dot{p}_m$ relation, we need to let

$$\dot{p}_c = \dot{p}_m + 0.22.$$

Assuming the linearity, an n% increase in the call rate forces us to put

$$\dot{p}_c = \dot{p}_m + 0.22\ n$$

to derive the new FLOATER's curve after the n% increase in the interest rate. Substituting this into (15), we find;

$$\dot{p}_C = 9.22 - 1.15\ u - 0.12\ n. \tag{25}$$

This is the FLOATER's short-run Phillips curve when the short-term interest rate is raised by n%. Rewriting (25) as;

$$u = 8.02 - 0.10\ n - 0.87\ \dot{p}_C. \tag{26}$$

We now know that the effect of the n% change of the short-term interest rate upon u is 0.1. The n% short-term interest rate increase decreases u by 0.1n%. We approximate the benefit of decreasing the unemployment rate by (GNE × reduction in the unemployment rate). 0.1% of GNE in 1973 is 373 million dollars. Thus, the total benefit from the n% higher interest rate policy is;

$$TB = 373\ n. \tag{27}$$

OPTIMUM INTEREST RATE

To discuss the optimum interest rate we differentiate two cases; one, successful "operation twist", and the other, unsuccessful "operation twist". For two cases, the marginal benefit, MB, is the same. Differentiate (27), and;

$$MB = 373 \tag{28}$$

The optimum interest rate is obtained by equalizing the marginal benefit and the marginal cost. The marginal costs, MC, become different for the two cases.

CASE I SUCCESSFUL OPERATION TWIST

The short-term interest rate currently being 9%, the total cost is now obtained by substituting 9% for $\bar{i}_s$ in (22);

$$TC = 12.8\ n^2 + 243\ n \qquad (28)$$

The marginal cost, MC, is found by differentiating (28) with respect to n;

$$MC = 25.6\ n + 243 \qquad (29)$$

Letting MB = MC, we solve for n;

$$n^* = 5.1$$

The optimum interest rate is 5.1% higher than the current rate, that is, 14.1%. This is optimum as long as we can keep the long-term rate unchanged. As we explored earlier, however, the past experience showed that economic forces relate the short-term and long-term rates once the short-term rate changes more than 0.3%. Thus, we need to discuss what the optimum interest rate will be if this constraint is present.

CASE II UNSUCCESSFUL OPERATION TWIST

When the long-term rate is raised by the increase in the short-term rate, we encounter some additional costs. Equation (24) indicates the cost in this case. Substituting 9% for $\bar{i}_s$ in (24);

$$TCII = 12.8\ n^2 + 3111\ n \qquad (30)$$

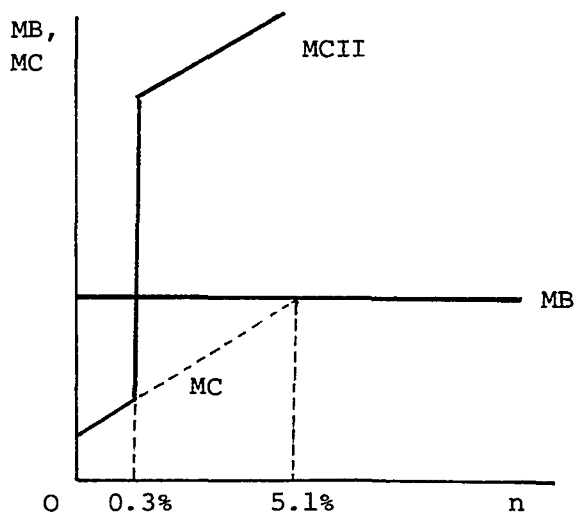


Figure 4-4

Optimum Interest Rate Change

The marginal cost, MCII, is found by differentiating (30) with respect to n;

$$MCII = 25.6\ n + 3111. \tag{31}$$

This marginal cost, MCII, applies when the long-term rate is affected by the change in the short-term interest rate. As we found earlier, if the short-term rate change is less than 0.3%, the marginal cost which applies is not (31) but (29). MCII applies when n is greater than 0.3%. When n is less than 0.3%, the marginal benefit is always smaller than the marginal cost. Hence, the optimum is found when n = 0.3%. The optimum interest rate is, thus, 9.3%. This is illustrated in Figure 4-4.

NOTES TO CHAPTER IV

1. We chose Japan because she has a large foreign sector including short-term capital flows and the author's familiarity with Japan.

2. See Minami and Ono (1973) for this distinction.

3. This view was originally expressed by Ohkawa and Minami and Ono (1973) rebuilt the model for empirical verification. Ohtani (1975a) also proposed this kind of model as a prototype model for the Japanese economy.

4. This model is similar to those by Minami and Ono (1973) and Ohtani (1975a).

5. See Turnovsky and Wachter (1972) for 'direct' method, and Abe et al. for 'indirect' method (1975).

6. The adaptive expectation model is equivalant to the statement that $\dot{p}^e_{t+1}$ is a weighted average of $\dot{p}_t$, $\dot{p}_{t-1}$, $\dot{p}_{t-2}$, and so on with weights $\lambda, \lambda(1-\lambda)$, $\lambda(1-\lambda)^2$, and so on. The weights attatched to the past rates of inflation decay geometrically with remoteness in the past; they add up to one. If λ is close to zero, the weights decay rapidly; if λ is one, only the last period's rate counts. See Solow (1969), Phelps (1968), and Toyoda (1970).

7. In the following, δ_0 is assumed to be one.

8. See Almon (1965), Johnston (1972), and Abe et al. (1975).

9. The degree of polynomial is r in the following equation.

10. δ_0 is one.

11. The first item of (22) is the interest payments to the current capital inflow. The second item is the additional payments to the borrowed capital in the past.

CHAPTER V

CONCLUSION

We have, thus, presented the Phillips curve analysis in an open economy (Chapter II), introduced the new concept of the optimum interest rate (Chapter III), and empirically found the optimum rate (Chapter IV). We started our discussion by presenting the analytical framework employed by Fried (1973) and extended his analysis in many ways. We discussed the short- and long-run Phillips curves for a FIXER and a FLOATER and considered the income effects upon them. Qualifications followed and they included a new view of the optimum reserve accumulation or borrowing and the optimum path from short to long run. Fried's conclusion, which states that a FIXER inflating less rapidly than the world has a greater tendency to become a FLOATER, was enforced when we extended his analysis to the conventional long-run analysis and the analysis with the income effects.

When we take the interest induced international capital flows into consideration, we can extend further to the discussion of the optimum interest rate. A FLOATER can shift down her Phillips curve by raising a short-term interest rate. Shifting the curve down is beneficial while the higher rate brings some costs to the economy. The benefit and costs being functions of the short-term interest rate, we can maximize the net benefit at some interest rate. We call such an interest rate the optimum interest rate.

Followed was the empirical research of the wage-price sector of Japan. We estimated a common model and found a FIXER's short-run Phillips curve. By applying the theory we developed, we obtained the other three Phillips curves indirectly. Based upon the FLOATER's short-run curve thus obtained, we calculated the cost and benefit of a higher short-term interest rate policy. The benefit was obtained by the calculation of the implicit increase of the national income by the reduction of unemployment due to the higher interest rate. The cost is just the interest payments to foreigners if the long-term interest rate is kept constant. If the long-term rate is affected, the higher long-term rate dampens the growth of the economy. Thus, we differentiated two cases and found the optimum short-term interest rate for each case. For the successful "operation twist" case, where the long-term rate is unaffected, the optimum interest rate was 14.1% in 1973. For the unsuccessful "operation twist" case, where the long-term rate cannot be separated from the short-term rate, we found that the cost of the higher long-term rate was enormous so that there existed no optimum rate for the range where the long-term rate was affected. To see at what rate the long-term rate begins to be affected, we experimented regressions on the relation between the short- and long-term interest rates to find that the long-term rate began to be affected at 0.3%. Assuming this held true in 1973, the best we could do was to raise the rate to 9.3% (9% being the current rate). It should be reminded that the short- and long-term interest rates relation was based upon the past experiences of Japan, not necessarily the experience of the "operation twist". Hence, the estimated value tends to be underestimated.

Several things can be done in our future research. The optimum reserve accumulation or borrowing and the optimum path discussion need more refinement. Costs and benefits of the higher interest rate policy may include other things and they need to be quantified satisfactorily. Concerned with the estimation of Phillips curves, what we did was to estimate a FIXER's short-run Phillips curve first; the other three curves were calculated accordingly next. In the future it might be possible to estimate a FLOATER's curve directly since many countries are presently experiencing the floating exchange rate system. More importantly it is necessary to build a macro-econometric model, of which the wage-price sector is just a part. We need to simulate the full effects of policy changes in such a model and then we can find the optimum interest rate by our own estimates.

APPENDIX A

DATA AND DATA SOURCES

Yearly data from 1953 to 1974 were used for the estimation of the wage-price sector of Japanese economy.

Data sources are:

P_h	wholesale price index for HPS	*Bukka Shisū Nenpō* (*Price Index Annal*), The Bank of Japan
P_l	wholesale price index for LPS	"
P_c	consumer price index	"
P_m	price index of imported raw materials	*Nihon Keizai Shihyō* (*Japanese Economic Indicator*), Economic Planning Agency
P'_m	price index of imported final goods	"
W_h	wage index for HPS	*Maitsuki Kinrō Tōkei Yōran*, Ministry of Labor
W_l	wage index for HPS	"
Q_h	labor productivity in HPS	*Kikan Seisansei Shisū*, Nihon Seisansei Honbu
Q_l	labor productivity in LPS	"
u	unemployment rate	*Nihon Keizai Shihyō* (*Japanese Economic Indicator*), Economic Planning Agency.

We used *Kōgyō Tōkei Hyō* to adjust the data for HPS and LPS. All the variables except u are changed to the rates of change. Such rates are denoted by the lower-case letters with ˙ over them.

APPENDIX B

ESTIMATED RESULTS OF A WAGE EQUATION FOR A HIGH PRODUCTIVITY SECTOR

1. Adaptive Expectation Hypothesis

λ	constant	u	$\dot{p}_c^e$	$\dot{p}_h$	$\bar{R}^2$	DW
0.2	9.57 (3.18)	-2.68 (-4.84)	1.07 (1.60)	0.30 (1.64)	0.66	2.04
0.4	11.38 (4.91)	-2.44 (-4.15)	0.55 (1.32)	0.36 (1.98)	0.66	1.97
0.6	11.95 (5.47)	-2.39 (-3.87)	0.39 (1.13)	0.40 (2.17)	0.65	1.93
0.8	12.12 (5.77)	-2.37 (-3.74)	0.34 (1.09)	0.42 (2.28)	0.64	1.88
1.0	12.08 (6.05)	-2.32 (-3.67)	0.33 (1.21)	0.44 (2.38)	0.65	1.89

2. Extrapolative Expectation Hypothesis

δ	constant	u	$\dot{p}_c^e$	$\dot{p}_h$	$\bar{R}^2$	DW
1.0	12.46 (7.69)	-2.25 (-3.56)	0.21 (1.39)	0.48 (2.56)	0.66	1.81
0.5	12.15 (6.82)	-2.25 (-3.54)	0.28 (1.39)	0.47 (2.53)	0.66	1.85
-0.5	13.03 (6.51)	-2.55 (-4.14)	0.19 (0.62)	0.40 (2.11)	0.63	1.93
-1.0	14.04 (8.45)	-2.65 (-4.43)	-0.00 (-0.02)	0.40 (2.06)	0.61	1.84

3. Alomon Lag Hypothesis

lag	constant	u	$\dot{p}_c^e$	$\dot{p}_h$	$\bar{R}^2$	DW
3	11.44	-2.23	0.17	0.37	0.64	1.92
	(4.33)	(-3.21)	(1.09)	(1.98)		
4	13.07	-2.79	0.08	0.38	0.52	1.81
	(2.70)	(-1.54)	(0.44)	(0.99)		
5	11.13	-2.39	0.15	0.35	0.63	1.81
	(2.79)	(-1.67)	(1.09)	(1.47)		
6	12.55	-3.26	0.12	0.26	0.64	1.95
	(2.97)	(-1.90)	(0.95)	(0.95)		

APPENDIX C

ESTIMATED RESULTS OF A WAGE EQUATION FOR A LOW PRODUCTIVITY SECTOR

1. Adaptive Expectation Hypothesis

λ	constant	u	$\dot{w}_h^e$	$\bar{R}^2$	DW
0.2	15.52 (2.12)	-2.79 (-2.30)	0.01 (0.01)	0.19	2.07
0.4	13.13 (2.20)	-2.52 (-1.97)	0.23 (0.44)	0.20	2.04
0.6	11.50 (2.08)	-2.26 (-1.75)	0.35 (0.81)	0.22	2.03
0.8	10.69 (2.07)	-2.10 (-1.66)	0.41 (1.06)	0.24	2.04
1.0	10.50 (2.18)	-2.04 (-1.63)	0.41 (1.19)	0.25	2.05

2. Extrapolative Expectation Hypothesis

δ	constant	u	$\dot{w}_h^e$	$\bar{R}^2$	DW
1.0	12.02 (3.38)	-2.16 (-1.82)	0.27 (1.29)	0.26	2.08
0.5	11.11 (2.71)	-2.06 (-1.70)	0.35 (1.30)	0.26	2.07
-0.5	12.04 (2.33)	-2.33 (-1.84)	0.30 (0.77)	0.21	2.08
-1.0	14.70 (3.30)	-2.71 (-2.24)	0.07 (0.21)	0.19	2.09

3. Almon Lag Hypothesis

lag	constant	u	$\dot{w}_h^e$	$\bar{R}^2$	DW
3	10.98	-2.07	0.15	0.21	2.05
	(1.71)	(-1.42)	(0.77)		
4	11.00	-2.74	0.18	0.25	1.67
	(4.48)	(-1.12)	(1.03)		
5	18.56	-3.85	-0.04	0.08	2.20
	(1.88)	(-1.34)	(-0.23)		
6	18.43	-3.21	-0.05	0.03	2.16
	(1.82)	(-1.04)	(-0.31)		

APPENDIX D

DATA OF SHORT- AND LONG-TERM INTEREST RATES

		Official Discount Rate	Average Call Money Rate
1971	I	5.750	7.333
	II	5.583	6.583
	III	5.250	6.250
	IV	5.083	5.500
1972	I	4.750	5.083
	II	4.583	4.815
	III	4.250	4.465
	IV	4.250	4.487
1973	I	4.250	5.189
	II	5.333	6.129
	III	6.667	7.882
	IV	7.667	9.443
1974	I	9.000	12.077
	II	9.000	12.173
	III	9.000	13.037
	IV	9.000	12.869
1975	I	9.000	12.865
	II	8.333	11.267
	III	7.667	10.453
	IV	6.500	8.101
1976	I	6.500	7.094
	II	6.500	6.801

Data Source: *Japanese Economic Indicator* (*Nihon Keizai Shihyo*), Economic Planning Agency.

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