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PRICE LINKAGE IN AN INTERDEPENDENT WORLD ECONOMY: PRICE RESPONSES TO EXCHANGE RATE AND ACTIVITY CHANGES

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The rate of inflation in major industrial countries has increased steadily from the late 1960's and spread dramatically throughout the world in the last several years. Given the persistence of inflation on a worldwide basis, it is natural to seek for explanations of inflation from an international point of view. Consequently, the transmission of inflation from one country to another has received increasing attention.[1] This paper analyzes the behavior of inflation in a country in a world of direct price linkages. Such an analysis is useful because it sheds some light on the question of how much the prices of other countries respond to a change in one country's exchange rate and unemployment rate.

The paper proceeds as follows. Section I specifies a model of the direct price linkages in a world economy. The model contains three sectoral equations for individual countries to explain the behavior of domestic prices, import prices, and changes in output levels. Section II discusses the estimated equations for twelve industrial countries (Australia, Austria, Belgium, Canada, Finland, Italy, Japan, Netherlands, Sweden, United Kingdom, United States, and West Germany). Then the model is tested by examining the results of dynamic simulations within the sample period. Section III provides some estimates of the multipliers on the own and cross-country inflation rates due to a change in an individual exchange rate and unemployment rate. In addition, the model

is used for assessing the contribution of actual changes in the exchange and unemployment rates to the rates of inflation during the period 1971-1973. The paper concludes in section IV with a summary of the main results.

I. A Model of International Price Linkages

Price behavior in most industrial countries reflects a variety of factors peculiar to the country in question. None of these countries, however, is isolated completely from the activity of the rest of the world. Thus, it is quite likely that some inflationary pressures originate abroad. In this broad sense, countries can be said to trade not only goods and services with each other but also inflations. Of course, countries differ significantly in their openness, and, thus, their propensities to import or export inflation are expected to differ markedly among countries.

In seeking explanations for international transmissions of inflation, three types of mechanisms can be distinguished: (a) direct, via prices of goods imported and wage rates, (b) indirect, via the changes in the aggregate demand working through the external account, and (c) indirect, via the change in the money supply induced by changes in international reserves. Although the latter two channels are considered to be of importance, we deal with only the direct mechanism of inflation transmission in this paper.[2]

Our model of direct price linkages is basically an extension of the Phillips model of price determination to a world of multiple countries trading with each other. It consists of equations determining

both domestic and import prices for each country. As shown below, the domestic price of each country is influenced not only by the unemployment rate and output at home, but also by the import price. Import prices of a given country are export prices of other countries to that country, adjusted for the variations of exchange rates. Through this direct relationship, domestic prices in the world are interdependent and therefore determined jointly. Thus, for example, an autonomous increase in the aggregate demand in any one country increases prices in the rest of the world.

The model estimated below can be considered the world consisting of n countries. For each country i, the domestic price of consumer goods is denoted by P_i, the wage rate by W_i, the domestic output level by Q_i, the import price by P_i^m, the unemployment rate by U_i, and the exchange rate defined as the number of U.S. dollars per unit of home currency i by E_i.

Formally, the two structural equations are specified to explain the domestic price and the money wage rate. It is hypothesized that the domestic price is determined by unit labor costs and the import price, whereas the money wage rate is influenced by the unemployment rate and the expected domestic price.[3] Due to lack of adequate quantitative information, the rate of change in the man-hours employed is assumed to be constant. Hence, they are written in a rate of change form:

$$\hat{P}_i = m_{0i} + m_{1i}\hat{W}_i - m_{2i}\hat{Q}_i + m_{3i}\hat{P}_i^m \qquad (1)$$

$$\hat{W}_i = n_{0i} + n_{1i}U_i^{-1} + n_{2i}\hat{P}_i^e \qquad (2)$$

A hat (^) over a variable indicates a proportional change of the variable, and P_i^e is expected price.

To show that the domestic price is determined by the unemployment rate, output and import price, after allowing for simultaneous interactions between price and wage rate, equations (1) and (2) are solved for $\hat{P}_i$ and $\hat{W}_i$. If the rate of change in actual domestic price is not equal to the rate of change in expected price, the unanticipated inflation calls for an adjustment in the expected inflation. Such an adjustment continues until both actual and expected inflation rates are equal. Imposing the equality of actual and expected inflations, $\hat{P}_i = \hat{P}_i^e$, in the solved reduced-form price equation, we obtain the equation to explain the price behavior in equilibrium, P_i^*:

$$\hat{P}_i^* = k_{0i} + k_{1i}U_i^{-1} - k_{2i}\hat{Q}_i + k_{3i}\hat{P}^m \qquad (3)$$

where $k_{0i} = (m_{0i}-m_{1i}n_{0i})/(1-m_{1i}n_{2i})$, $k_{1i} = m_{1i}n_{1i}/(1-m_{1i}n_{2i})$, and $k_{si} = m_{si}/(1-m_{1i}n_{2i})$ for $s = 2,3$. It is expected that k_{si} for $s = 1,2,3$ are positive, since m_{si} and n_{si} are positive, and $0 < m_{1i}n_{2i} < 1$, based on the available empirical evidence listed in Kwack ([22], p. 5).

The equality of actual and equilibrium prices may not hold at every point in time and adjustment toward such an equality takes some time because there are adjustment costs, pecuniary and nonpecuniary, associated with institutional rigidities and lack of accurate information. Therefore, it is assumed that the change in actual price is initiated by the changes in equilibrium prices in the current and previous periods. A particular form of the partial adjustment mechanism selected is the

form of a Koyck type, which seems a convenient starting point for empirical implementation. Incorporating the particular partial adjustment mechanism with (3), the following price equation is obtained:[4]

$$\hat{P}_i = \alpha_{0i} + \alpha_{1i}U_i^{-1} - \alpha_{2i}\hat{Q}_i + \alpha_{3i}\hat{P}^m_i + \alpha_{4i}\hat{P}_{i-1} \qquad (4)$$

where $\alpha_{1i} = k_{1i}\theta_i > 0$, $\alpha_{2i} = k_{2i}\theta_i > 0$, $\alpha_{3i} = k_{3i}\theta_i > 0$, $\alpha_{4i} = 1-\theta_i > 0$, and θ_i is the coefficient of adjustment.

Generally speaking, the import price of a country is influenced by the demand and supply of the imports. Thus, other things being equal, the domestic prices and levels of activity of both exporting and importing countries determined the import price. However, shifts in the supply schedule by the change in output levels may be taken as small, especially in the short run, perhaps due to the limited mobility of productive factors between the traded and nontraded goods sectors. Also, the substitutability in consumption between imports and domestic goods is assumed to be small in the short run. In this case, the import price can be hypothesized as being determined largely by the prices of tradables in exporting countries adjusted for changes in exchange rates and by the income of the importing country.[5] The prices of tradable and nontradable goods are linked within each country through competition in both production and consumption. This link ensures the price of nontradable goods to vary with the price of tradable goods over a longer period of time, and, perhaps, at the same rate of change. Based upon this relation, the domestic prices of tradables in exporting countries, which are a determinant of the import price, are assumed to be represented by their consumer prices.[6] Hence, we have the

following equation of the import price:

$$\hat{P}^m_i = \beta_{0i} + \beta_{1i}[\Sigma_j(a_{ij}\hat{P}_j + (a_{ij} - \delta_{ij})\hat{E}_j)/(1 + \delta_{ij}\hat{E}_j] + \beta_{2i}\hat{Q}_i \qquad (5)$$

where $a_{ii} = 0$, $1 \geq a_{ij} \geq 0$ for $i \neq j$ and $\Sigma_j a_{ij} = 1$, and δ_{ij} is a Kronecker delta having the property $\delta_{ij} = 1$ for $i=j$ and $\delta_{ij} = 0$ for $i \neq j$.

It is implicit in equation (5) that the aggregate foreign domestic price and exchange rate are defined, respectively, as averages of the domestic prices and exchange rates of exporting countries, weighted geometrically by their export value shares in the importing country. Recalling that the exchange rate of currency j, E_j, is measured by the number of U.S. dollars per unit of currency j, the term $(\Sigma_j(a_{ij}-\delta_{ij})\hat{E}_j)/(1+\delta_{ij}\hat{E}_j)$ is a rate of change of the exchange rate of currency i in home currency units. Thus, the term serves as a measure of the proportional change in its effective exchange rate. By hypothesis, the signs of both β_{1i} and β_{2i} are positive. The value of β_{1i} is expected to be close to unity, if the price elasticity of supply is very large relative to the price elasticity of import demand.[7] Also, the value of β_{2i} is likely to be higher when the importing country in question is larger, thereby affecting its import price to a greater extent.

Both the unemployment rate and the rate of change in the output level enter the domestic price equation (4) as exogenous variables. In order to isolate the transmission of inflation due to a change in the activity of a particular country, an equation is introduced in the model for the well-known mapping between unemployment and output, as shown by Okun [29]. Assuming that potential output grows at a constant

rate, the specification of Okun's relationship is approximated by:

$$\log Q_i = c_{0i}t - c_{1i}(U_i - U_i^0) \tag{6}$$

where t and U_i^0 are a linear time trend and the unemployment rate existing at the potential output level, respectively. The change in unemployment rate is derived by differentiating (6) with respect to time. It is given:

$$\Delta U_i = \gamma_{0i} - \gamma_{1j}\hat{Q}_i \tag{7}$$

where $\gamma_{0i} = c_{02}/c_{1i}$ and $\gamma_{1j} = 1/c_{1j}$. By assumption, it is expected that $\gamma_{0i} > 0$ and $\gamma_{1j} > 0$.

Equations (4), (5) and (7) are the basis for describing price behavior of an individual country in an interdependent world. Combining the three equations yields:

$$\hat{P}_i = \phi_i + \alpha_{1i}U_i^{-1} + \lambda_i\Delta U_i + \Sigma_j \mu_{ij}\hat{P}_j \tag{8}$$
$$+ \Sigma_j(\mu_{ij}-\sigma_{ij})\hat{E}_j/(1+\delta_{ij}\hat{E}_j) + \omega_i\hat{P}_{i-1}$$

where $\phi_i = \alpha_{0i} + \alpha_{1i} - \alpha_{2i}c_{0i} + \beta_{0i}\alpha_{3i}$, $\lambda_i = \alpha_{2i}c_{1i}$, $\mu_{ij} = \alpha_{3i}\beta_{1i}a_{ij}$, $\sigma_{ij} = \alpha_{3i}\beta_{1i}\delta_{ij}$, and $\omega_i = \alpha_{4i}$. Examining equation (8), it can be easily seen that the rate of inflation in country i depends not only on its own unemployment rate and exchange rate but also on the exchange rates and prices of all other countries. To simplify our exposition for qualitatively analyzing the effect of changes in foreign prices and exchange rates, the constant term, ϕ_i, is ignored. $\hat{E}_j$ is assumed to be small enough to approximate $1+\delta_{ij}\hat{E}_j$ by 1 and U_i^{-1} is linearized by $1-U_i$.

Thus, equation (8) is simplified to:

$$\hat{P}_i = \rho_i U_i + \Sigma_j \mu_{ij} \hat{P}_j + \Sigma_j (\mu_{ij} - \sigma_{ij}) \hat{E}_j + \omega_i \hat{P}_{i-1} \qquad (9)$$

where $\rho_i = -(\alpha_{1i} - \lambda_i)$. The signs of the parameters are $\rho_i < 0$, $\mu_{ij} > 0$, $\sigma_{ij} > 0$ and $\omega_i > 0$. The system of equation (8) for n countries can be written as follows:

$$\hat{P} = SU + R\hat{P} + [R - T]\hat{E} + L\hat{P}_{-1} \qquad (10)$$

where $\hat{P}$, U, and $\hat{E}$ are n dimensional vectors with elements $\hat{P}_i$, U_i, and $\hat{E}_i$, i=1,2,...n, respectively, and S, T and L are diagonal matrices, the elements of which are ρ_i, σ_{ii} and ω_i, respectively. The matrix R has the off-diagonal elements μ_{ij} and diagonal elements 0.

The effects on inflation in the countries in the system of a change in a predetermined variable can be described by the values of multipliers implied in (10). Since [I-R] possesses an inverse, the system can be solved for the vector of domestic price inflations, $\hat{P}$:

$$\hat{P} = [I-R]^{-1}SU + [I-R]^{-1}[R-T]\hat{E} + [I-R]^{-1}L\hat{P}_{-1} \qquad (11)$$

$[I-R]^{-1}S$ and $[I-R]^{-1}[R-T]$ are the impact or short-run multiplier matrices containing the elements of own and cross-country effects induced by a change in the unemployment rate or exchange rate of a country. Since R is a non-negative matrix, all elements of $[I-R]^{-1}$ are non-negative. Moreover, all elements of $[I-R]^{-1}$ and $[I-R]^{-1}[R-T]$ will not be decreased or will be increased when one element of R increases. This means that the own (diagonal) and cross-country (off-diagonal) effects are larger, the greater is the interdependence of the prices among countries. Also,

the own multiplier is necessarily larger than the cross-multipliers, because μ_{ij} are smaller than unity. So far, the vector of lagged inflations, $\hat{P}_{-1}$, is treated as exogenous. In a longer run, the lagged inflation variables, $\hat{P}_{-1}$, are considered as endogenous. The system is stable in the long run because each characteristic root of $[I-R]^{-1}L$ is less than one in absolute value.[8] Thus, the long-run equilibrium multiplier values of a change in U and $\hat{E}$ are $[I-R-L]^{-1}S$ and $[I-R-L]^{-1}[R-T]$, respectively. The matrix L is a diagonal matrix with positive elements, $0 \leq \omega_i < 1$. Thus, $[I-R-L]^{-1} > [I-R]^{-1}$, because R+L is a non-negative matrix which is greater than R. This proves that the long-run multipliers are greater than the corresponding short-run multipliers.

It has been shown that the effects of a change in the unemployment rate and exchange rate of a given country will result in changes in the inflation of all countries. Now, consider a special case where the initiating country i is small in the sense $a_{ji} = 0$ for country j. By definition, $a_{ji} = 0$ implies $\mu_{ji} = 0$ for all j, leading to the matrix $R = 0$. Therefore, there are no feedback effects through the induced changes in foreign domestic prices. Consequently, the effect on the inflation of the initiating country exclusively depends on the magnitudes of its own parameters, ρ_i, σ_{ii}, and ω_i. Moreover, introducing the condition $R = 0$ into equation (11), it can be proved that the multiplier values of a change in U_i and $\hat{E}_i$ in this special case are smaller than the values obtained in the case of induced cross-country effects, $R \neq 0$. This is so because $[I-R-L]^{-1} > [I-L]^{-1}$ for the long-run multipliers and $[I-R]^{-1} > I$ for the impact multipliers.

Table 1 summarizes the direction of the effects of a unit change in the unemployment rate and exchange rate of a particular country. Two points merit special attention. First, a reduction in the unemployment rate of a given country leads to a rise in the rate of inflation of all countries. The resulting increases in the inflation rates are greater in the case of the cross-country effects, $\mu_{ij} \neq 0$, than those expected when the country is small. The reason is that the induced increases in foreign prices cause the induced increases in import prices of all countries. Second, an appreciation of a currency against the U.S. dollar lowers that country's domestic price and raises the prices of the other countries including the United States. However, the reduction in own inflation is smaller when foreign prices also rise as is the case if $\mu_{ij} \neq 0$. This is because the rise in foreign domestic prices leads to a rise in the import price of the appreciating country, the effect of which constitutes an offsetting effect on the price in the appreciating country.

Table 1 - Direction of Multipliers

		No Cross-Feedback Effect, $\mu_{ji} = 0$		Cross-Feedback Effect, $\mu_{ji} \neq 0$	
		Impact	Long-Run	Impact	Long-Run
$\frac{\partial \hat{P}}{\partial U}$		S	$[I-L]^{-1}S=(s_i)$	$[I-R]^{-1}S=(s_i^*)$	$[I-R-L]^{-1}=(s_i^{**})$
	$\frac{\partial \hat{P}_i}{\partial U_i}$	ρ_i	$s_i > \rho_i(1+w_i)$	$s_i^* > \rho_i$	$s_i^{**} > s_i^*(1+w_i)$
	$\frac{\partial \hat{P}_j}{\partial U_i}$	0	0	$s_j^* > \mu_{ji}\rho_i$	$s_j^{**} > s_j^*(1+w_j)$
$\frac{\partial P}{\partial \hat{E}}$		[R-T]	$[I-L]^{-1}[R-T]=(r_i)$	$[I-R]^{-1}[R-T]=(r_i^*)$	$[I-R-L]^{-1}[R-T]=(r_i^{**})$
	$\frac{\partial \hat{P}_i}{\partial \hat{E}_i}$	$-\sigma_{ii}$	$r_i < -\sigma_{ii}(1+w_i)$	$r_i^* > -(\sigma_{ii} - \sum_{k\neq 1} \mu_{ik}\mu_{ki})$	$r_i^{**} < r_i^* - w_i\sigma_{ii}$
	$\frac{\partial \hat{P}_j}{\partial \hat{E}_i}$	0	0	$r_j^* < \mu_{ji}(1-\sigma_{ii}) + \sum_{k\neq i,j} \mu_{ik}\mu_{ki}$	$r_j^{**} > r_j^* + \mu_{ji}w_j$

The information on individual elements, s_i, r_i, s_i^*, r_i^*, s_i^{**}, and r_i^{**} are compared with the direction and magnitude obtained by the first-order Taylor approximations. Namely $[I-L]^{-1}$, $[I-R]^{-1}$ and $[I-R-L]^{-1}$ are compared with the values of [I+L], [I+R], and [I+R+L], respectively.

II. Estimation of Parameters

Three equations (4), (5) and (7) were estimated with annual data from 1957 through 1973 for each of the twelve countries: Australia, Austria, Belgium, Canada, Finland, Italy, Japan, Netherlands, Sweden, United Kingdom, United States and West Germany. (The sources of data are [19] and [40]). Except where necessary to obtain reasonable estimates, modifications of the equation specifications were not made. Also, ordinary least squares was employed, ignoring possible simultaneous equation bias. These two simplifications were adopted to avoid a flood of permutations and alternative specifications. Nevertheless, the estimates presented below are subject to the qualifications incurred from the use of ordinary least squares and the existence of some missing variables. In the tables that follow, the numbers in parentheses below the coefficient estimates are t-statistics, and $\bar{R}^2$, SEE, and DW stand for the coefficient of determination adjusted for degrees of freedom, the standard error of estimate, and the Durbin-Watson statistic, respectively.

Table 2 presents estimates of the price equations for each of the twelve countries. At first glance, most of the estimated equations are reasonable. Particularly, both the unemployment rate and import price have significant coefficients with the expected sign in all equations. This seems to confirm that the import price of a country, in addition to the unemployment rate, is an

Table 2 - Consumer Price Equations, 1957-1973

$$\log\left(\frac{P}{P(-1)}\right)_i = \alpha_{0i} + \alpha_{1i}\left(\frac{1}{U_i}\right) + \alpha_{2i}\log\left(\frac{Q}{Q(-1)}\right)_i + \alpha_{3i}\log\left(\frac{P^m}{P^m(-1)}\right)_i + \alpha_{4i}\left[\log\left(\frac{P}{P(-1)}\right)_i\right]_{-1} + \alpha_{5i}D_i$$

Country i	α_{0i}	α_{1i}	α_{2i}	α_{3i}	α_{4i}	α_{5i}	$\bar{R}^2$	SEE	DW
Australia[a/]	-0.016 (1.89)	0.041 (3.42)		0.409 (3.52)	0.576 (4.07)	0.130 (5.88)	0.877	0.007	2.488
Austria	0.004 (0.32)	0.108 (4.05)	-0.131 (1.25)	0.095 (1.20)			0.611	0.010	2.218
Belgium	-0.010 (1.84)	0.063 (3.38)		0.098 (3.72)	0.754 (6.44)		0.878	0.005	2.338
Canada	-0.021 (2.31)	0.111 (2.53)		0.347 (4.47)	0.857 (5.73)		0.806	0.007	1.659
Finland	-0.014 (0.52)	0.057 (1.58)		0.420 (4.51)	0.342 (1.98)		0.614	0.019	1.797
Italy	-0.004 (0.27)	0.146 (2.40)		0.194 (3.32)			0.592	0.016	2.009
Japan	0.050 (3.28)	0.023 (1.57)	-0.169 (3.44)	0.383 (7.60)			0.794	0.011	2.196
Netherlands[b/]	0.015 (0.93)	0.025 (1.48)		0.361 (2.54)		0.025 (1.75)	0.462	0.017	2.512
Sweden	0.034 (1.92)	0.038 (1.08)	-0.452 (2.15)	0.389 (3.42)			0.381	0.016	2.796
United Kingdom[c/]	0.007 (0.52)	0.062 (2.34)	-0.357 (3.01)	0.174 (3.07)		0.049 (5.04)	0.848	0.009	2.136
United States	-0.014 (2.02)	0.161 (4.92)	-0.125 (3.63)	0.195 (5.91)	0.399 (3.53)		0.898	0.005	2.202
West Germany	0.003 (0.32)	0.008 (1.70)		0.137 (2.75)	0.682 (3.29)		0.696	0.008	1.501

[a/] The sample period is from 1959 through 1973, and D_i is a dummy variable having 0.5 for 1973.

[b/] The unemployment rate enters with a lag of two years, and D_i is a dummy variable having 0.5 for 1970 and 1971, and 1 for 1972 and 1973.

[c/] The D_i variable is a dummy variable having 0.5 for 1969 and 1970, and 1 for 1971-1973.

important determinant of domestic prices.[9] This finding is consistent with past studies (see Ball and Duffey [2]) in which the import prices are shown to be significant in structural price equations in most industrial countries. The coefficient on U.S. unemployment rate is larger than those on most of the unemployment rates of other countries. This confirms the finding of previous studies (such as Kwack [22]) that U.S. trade-off between inflation and unemployment is worse than those abroad. The dummy variables in the equation for Netherlands and United Kingdom are designed to capture the policies of income restraint, whereas the dummy variable in the Australia equation is introduced to eliminate the observation for 1973[10]

When the equation results are closely inspected, however, there are some disturbing elements. The price equation for Canada is not satisfactory, in that the long-run coefficient on the import price, 2.42, is substantially higher than a priori expected maximum value of one and the estimate of 0.55 in TRACE reported in Bodkin [5]. But, the impact effect, 0.35, is close to TRACE's estimate of 0.45, indicating that the estimated equation can be used for short-analysis. In addition, the coefficient of U.K. import price, 0.18, seems to be low. Excluding Canada, the long-run coefficients of import prices are in the range from 0.10 to 0.96. For the six countries such as Australia, Belgium, Canada, Finland, United States and West Germany, the coefficients on the one-year lagged price variables are found to be significant. The implied coefficients of adjustment are between 0.15 and 0.65. The

estimates seem to be plausible, in view of the institutional rigidities as exemplified by escalator clauses and imperfect information.

Table 3 contains the equations to explain the import prices as represented by the unit value indices in home currency units. P_i^x and F_i in the table are the weighted averages of the domestic prices in countries which export to country i and the effective rate for currency i, which are defined respectively in Table 4 and 5. The coefficients of the domestic prices abroad adjusted for the exchange rate variations, $P_i^x + F_i$, are between 0.4 and 1.2 for all countries with the exception of Austria, Italy, and the Netherlands. The coefficients for these three countries are close to 1.5, while these point estimates are not statistically different from one. On the whole, nevertheless, the coefficient estimates seem to overstate the extent to which foreign domestic prices are reflected in import prices. The dummy variable D_{-2} in the import price equations (except for Austria, Italy, Sweden, and the United States) accounts for the influence of the extraordinary upward surge of raw materials and oil prices that took place in the early 1970's. The output variables are found to be significant for the following six countries: Austria, Belgium, Japan, Sweden, United Kingdom and West Germany. Then our results indicate that import prices are not related to the income of the six remaining countries: Australia, Canada, Finland, Italy, Japan, Sweden, and the United States. This seems most likely to be puzzling because the United

Table 3 - Import Price Equations, 1957-1973

$$\log\left(\frac{P^m}{P^m_{(-1)}}\right)_i = \beta_{0i} + \beta_{1i}\left[\log\left(\frac{P^x}{P^x_{(-1)}}\right) + \log\left(\frac{F}{F_{(-1)}}\right)\right]_i + \beta_{2i}\log\left(\frac{Q}{Q_{(-1)}}\right)_i + \beta_{3i} D_{-2}$$

Country i	β_{0i}	β_{1i}	β_{2i}	β_{3i}	$\bar{R}^2$	SEE	DW
Australia	-0.014 (2.74)	0.831 (6.30)		0.012 (1.43)	0.708	0.012	2.213
Austria	-0.071 (3.80)	1.331 (3.46)	0.408 (1.53)		0.504	0.029	2.460
Belgium	-0.071 (2.89)	1.164 (1.83)	0.740 (2.66)	0.071 (2.24)	0.572	0.040	1.562
Canada	-0.006 (0.96)	0.681 (4.44)		0.021 (1.98)	0.670	0.014	1.871
Finland	-0.003 (0.19)	0.465 (3.83)		0.060 (1.86)	0.506	0.045	1.945
Italy	-0.054 (3.61)	1.539 (6.13)			0.696	0.041	2.039
Japan	-0.103 (3.99)	1.129 (2.31)	0.495 (3.02)	0.127 (3.87)	0.558	0.041	1.[illegible]
Netherlands	-0.032 (2.75)	1.481 (4.11)			0.498	0.025	1.946
Sweden	-0.033 (2.28)	0.816 (2.51)	0.368 (1.64)	0.034 (1.49)	0.613	0.024	2.460
United Kingdom	-0.048 (4.42)	0.833 (4.86)	0.778 (2.97)	0.057 (2.46)	0.853	0.027	2.331
United States	-0.031 (3.95)	1.231 (8.98)			0.833	0.020	2.168
West Germany[a/]	-0.038 (3.15)	0.853 (2.98)	0.219 (1.66)	0.386 (8.62)	0.824	0.019	0.941

D is a dummy variable reflecting structural shifts during 1970-1973 and has 0.5 for 1970 and 1971 and 1 for 1972 and 1973.

[a/] The dummy variable contains 0.5 for 1973 only.

Table 4- Foreign Export Prices In Each Currency Unit

$$\log\left(\frac{P^x}{P^x(-1)}\right)_i = \sum_j a_{ij} \log\left(\frac{P}{P(-1)}\right)_j$$

$\log\left(\frac{P^x}{P^x(-1)}\right)_{AS}$	0.0	0.004	0.008	0.053	0.006	0.026	0.222	0.018	0.025	0.261	0.292	0.085	$\log\left(\frac{P}{P(-1)}\right)_{AS}$
$\log\left(\frac{P^x}{P^x(-1)}\right)_{AU}$	0.000	0.0	0.026	0.003	0.008	0.098	0.014	0.043	0.047	0.090	0.034	0.637	$\log\left(\frac{P}{P(-1)}\right)_{AU}$
$\log\left(\frac{P^x}{P^x(-1)}\right)_{BL}$	0.005	0.005	0.0	0.021	0.005	0.068	0.027	0.234	0.027	0.096	0.123	0.389	$\log\left(\frac{P}{P(-1)}\right)_{BL}$
$\log\left(\frac{P^x}{P^x(-1)}\right)_{CA}$	0.010	0.003	0.005	0.0	0.001	0.013	0.068	0.007	0.009	0.066	0.785	0.033	$\log\left(\frac{P}{P(-1)}\right)_{CA}$
$\log\left(\frac{P^x}{P^x(-1)}\right)_{FI}$	0.004	0.025	0.026	0.007	0.0	0.033	0.030	0.057	0.284	0.211	0.055	0.267	$\log\left(\frac{P}{P(-1)}\right)_{FI}$
$\log\left(\frac{P^x}{P^x(-1)}\right)_{IT}$	0.011	0.039	0.072	0.028	0.007	0.0	0.026	0.098	0.029	0.080	0.174	0.437	$\log\left(\frac{P}{P(-1)}\right)_{IT}$
$\log\left(\frac{P^x}{P^x(-1)}\right)_{JA}$	0.193	0.002	0.010	0.104	0.001	0.016	0.0	0.010	0.010	0.041	0.534	0.070	$\log\left(\frac{P}{P(-1)}\right)_{JA}$
$\log\left(\frac{P^x}{P^x(-1)}\right)_{NE}$	0.006	0.008	0.212	0.021	0.009	0.063	0.032	0.0	0.029	0.089	0.158	0.373	$\log\left(\frac{P}{P(-1)}\right)_{NE}$
$\log\left(\frac{P^x}{P^x(-1)}\right)_{SW}$	0.003	0.030	0.051	0.011	0.091	0.045	0.032	0.073	0.0	0.227	0.114	0.325	$\log\left(\frac{P}{P(-1)}\right)_{SW}$
$\log\left(\frac{P^x}{P^x(-1)}\right)_{UK}$	0.054	0.022	0.045	0.134	0.045	0.059	0.057	0.102	0.100	0.0	0.229	0.156	$\log\left(\frac{P}{P(-1)}\right)_{UK}$
$\log\left(\frac{P^x}{P^x(-1)}\right)_{US}$	0.021	0.004	0.028	0.397	0.004	0.049	0.250	0.019	0.016	0.087	0.0	0.124	$\log\left(\frac{P}{P(-1)}\right)_{US}$
$\log\left(\frac{P^x}{P^x(-1)}\right)_{WG}$	0.008	0.039	0.170	0.017	0.013	0.189	0.036	0.260	0.045	0.071	0.152	0.0	$\log\left(\frac{P}{P(-1)}\right)_{WG}$

Note 1: The coefficients of matrix, a_{ij}, are average import value shares in 1971.

Note 2. The identification of countries is: AS(Australia), AU(Austria), BL(Belgium), CA(Canada), FI(Finland), IT(Italy), JA(Japan), NE(Netherlands), SW(Sweden), UK(United Kingdom), US(United States), and WG(West Germany).

Table 5 - Effective Exchange Rates in Domestic Currency Units

$$\log\left(\frac{F}{F(-1)}\right)_i = \sum_j a_{ij} \log\left(\frac{E}{E(-1)}\right)_j \;/\; \left(1 + \log\left(\frac{E}{E(-1)}\right)_i\right)$$

$$\begin{bmatrix} \log(\frac{F}{F(-1)})_{AS} \\ \log(\frac{F}{F(-1)})_{AU} \\ \log(\frac{F}{F(-1)})_{BL} \\ \log(\frac{F}{F(-1)})_{CA} \\ \log(\frac{F}{F(-1)})_{FI} \\ \log(\frac{F}{F(-1)})_{IT} \\ \log(\frac{F}{F(-1)})_{JA} \\ \log(\frac{F}{F(-1)})_{NE} \\ \log(\frac{F}{F(-1)})_{SW} \\ \log(\frac{F}{F(-1)})_{UK} \\ \log(\frac{F}{F(-1)})_{US} \\ \log(\frac{F}{F(-1)})_{WG} \end{bmatrix} = \begin{bmatrix} -1.0 & 0.004 & 0.008 & 0.053 & 0.006 & 0.026 & 0.222 & 0.018 & 0.025 & 0.261 & 0.292 & 0.085 \\ 0.000 & -1.0 & 0.026 & 0.003 & 0.008 & 0.098 & 0.014 & 0.043 & 0.047 & 0.090 & 0.034 & 0.637 \\ 0.005 & 0.005 & -1.0 & 0.021 & 0.005 & 0.068 & 0.027 & 0.234 & 0.027 & 0.096 & 0.123 & 0.389 \\ 0.010 & 0.003 & 0.005 & -1.0 & 0.001 & 0.013 & 0.068 & 0.007 & 0.009 & 0.066 & 0.785 & 0.033 \\ 0.004 & 0.025 & 0.026 & 0.007 & -1.0 & 0.033 & 0.030 & 0.057 & 0.284 & 0.211 & 0.055 & 0.267 \\ 0.011 & 0.039 & 0.072 & 0.028 & 0.007 & -1.0 & 0.026 & 0.098 & 0.029 & 0.080 & 0.174 & 0.437 \\ 0.193 & 0.002 & 0.010 & 0.104 & 0.001 & 0.016 & -1.0 & 0.010 & 0.010 & 0.051 & 0.534 & 0.070 \\ 0.006 & 0.008 & 0.212 & 0.021 & 0.009 & 0.063 & 0.032 & -1.0 & 0.029 & 0.089 & 0.158 & 0.373 \\ 0.003 & 0.030 & 0.051 & 0.011 & 0.091 & 0.045 & 0.032 & 0.073 & -1.0 & 0.227 & 0.114 & 0.325 \\ 0.051 & 0.022 & 0.045 & 0.134 & 0.045 & 0.059 & 0.057 & 0.102 & 0.100 & -1.0 & 0.229 & 0.156 \\ 0.021 & 0.004 & 0.028 & 0.397 & 0.004 & 0.049 & 0.250 & 0.019 & 0.016 & 0.087 & -1.0 & 0.124 \\ 0.008 & 0.039 & 0.170 & 0.017 & 0.013 & 0.189 & 0.036 & 0.260 & 0.045 & 0.071 & 0.152 & -1.0 \end{bmatrix} \begin{bmatrix} \log(\frac{E}{E(-1)})_{AS} \\ \log(\frac{E}{E(-1)})_{AU} \\ \log(\frac{E}{E(-1)})_{BL} \\ \log(\frac{E}{E(-1)})_{CA} \\ \log(\frac{E}{E(-1)})_{FI} \\ \log(\frac{E}{E(-1)})_{IT} \\ \log(\frac{E}{E(-1)})_{JA} \\ \log(\frac{E}{E(-1)})_{NE} \\ \log(\frac{E}{E(-1)})_{SW} \\ \log(\frac{E}{E(-1)})_{UK} \\ \log(\frac{E}{E(-1)})_{US} \\ \log(\frac{E}{E(-1)})_{WG} \end{bmatrix}$$

Note 1: The coefficients of matrix, a_{ij}, for $i \neq j$ are average import value shares in 1971.

e 2: The identification of countries is: AS(Australia), AU ;tria), BL(Belgium), CA(Canada), FI(Finland), IT(Italy), JA(Japan), NE(Netherlands), SW(Sweden), UK(United Kingdom), US(United States), and WG(West Germany).

States and Sweden, for example, are considered to be a large and small country, respectively. The results are only tentative, because no explicit differentiation between tradable and nontradable prices is made. Nevertheless, our empirical results may make the impacts of a change in output levels overstated, although very small.

Table 6 presents the results obtained for the unemployment rate equations. First-order Almon distributed lags on real output are introduced to allow for the possible effects of changes in the real output in the past. The coefficients of current and previous real output levels are negative for all the twelve countries, indicating that the Okun's relationship holds. The long-run change of the unemployment rate with respect to real output is indicated by the sum of the distributed lag coefficients of current and lagged real outputs. As expected, the sum of the coefficients varies substantially across countries, ranging form -2.5 for Japan to -47.0 for Canada. Needless to say, the estimate for Japan appears to be unrealistic and suggests that the Okun specification needs to be modified. In the case of the United States, the sum of the coefficients, -31, is in agreement with the estimate of Friedman and Wachter [13], -29, based on quarterly data for 1954I-1970IV. The constant terms are significant and positive for all countries. Consequently, the explanation of potential output by a time trend is a reasonable first-order approximation.

Table 6 - Okun's Law Equations, 1957-1973

$$\Delta U_i = \gamma_{0i} + \sum_{k=0}^{4} \gamma_{1+k,i} \log\left(\frac{Q(-k)}{Q(-k-1)}\right)_i$$

Country i	γ_{0i}	γ_{1i}	γ_{2i}	γ_{3i}	γ_{4i}	γ_{5i}	$\bar{R}^2$	SEE	DW
Australia[a/]	0.496 (3.32)	-10.269 (4.76)					0.607	0.397	2.100
Austria	0.511 (2.01)	-6.288 (2.95)	-4.192 (2.95)	-2.096 (2.95)			0.325	0.311	1.084
Belgium	1.386 (4.66)	-13.96 (5.23)	-10.47 (5.23)	-6.980 (5.23)	-3.490 (5.23)		0.622	0.487	0.835
Canada	2.308 (3.66)	-20.04 (3.60)	-13.36 (3.60)	-6.679 (3.60)			0.428	0.745	1.793
Finland[a/]	1.046 (3.81)	-15.09 (4.44)					0.572	0.457	2.009
Italy	0.646 (1.36)	-5.726 (2.21)	-4.295 (2.21)	-2.863 (2.21)	-1.432 (2.21)		0.195	0.609	0.683
Japan	0.296 (1.97)	-1.298 (2.20)	-0.865 (2.20)	-0.433 (2.20)			0.194	0.163	2.118
Netherlands	1.120 (2.61)	-7.387 (2.44)	-4.925 (2.44)	-2.462 (2.44)			0.236	0.472	1.187
Sweden	0.550 (5.32)	-10.113 (5.81)					0.672	0.191	1.839
United Kingdom	1.417 (4.11)	-15.31 (4.00)	-12.24 (4.00)	-9.183 (4.00)	-6.122 (4.00)	-3.061 (4.00)	0.484	0.383	1.380
United States	1.311 (3.68)	-12.36 (4.09)	-9.273 (4.09)	-6.182 (4.09)	-3.091 (4.09)		0.496	0.712	2.374
West Germany	0.962 (3.57)	-9.876 (4.49)	-6.584 (4.49)	-3.292 (4.49)			0.545	0.403	1.866

[a/] e sample period is from 1959 through 1973.

Even though each individual equation is acceptable, there is no a priori assurance that the system of all equations performs satisfactorily as a whole. If the system does not track price behavior reasonably well, it may not be adequate for policy simulations. A test of this is based on summary statistics derived from the within sample dynamic simulation from 1957 through 1973. The mean bias and root mean square error statistics for individual equations are given in Table 7. The statistics of mean bias show that the errors generated from the simulation are not severely cumulative and tend to offset each other over time. Judging from the values of the root mean square error, the import price and output equations for Italy and Japan seem to perform poorly relative to other equations. Perhaps, the poor performance of these two equations is associated with the fact that the low coefficients of real output in the unemployment rate equations generate cyclical behaviors of import and consumer prices that differ substantially from the actual movements. Thus, the analysis of the simualtion exercises in the following section need to be interpreted with caution. Given this caveat, however, the test statistics seem to indicate that the model is able to trace the actual behavior of the rates of change in consumer and import prices and in output.

III. Simulation Results: Effects of Exchange Rate and Unemployment Rate Changes

Different types of dynamic simulations can be conducted to observe the behavior of inflation for all countries in response to

TABLE 7
Prediction Error statistics of the Dynamic Simulations, 1957 - 1973
(in fraction)

	MEAN BIAS			ROOT MEAN SQUARE ERROR		
Country	Consumer Price	Import Price	Output	Consumer Price	Import Price	Output
Australia	0.0053	0.0007	0.0097	0.0105	0.0093	0.0365
Austria	0.0002	0.0047	0.0024	0.0110	0.0280	0.0471
Belgium	0.0022	0.0028	0.0009	0.0066	0.0400	0.0353
Canada	0.0012	0.0007	0.0010	0.0101	0.0157	0.0429
Finland	0.0013	0.0006	0.0115	0.0266	0.0417	0.0383
Italy	-0.0004	0.0001	0.0021	0.0144	0.0418	0.0854
Japan	0.0016	0.0030	0.0027	0.0167	0.0754	0.1600
Netherlands	0.0001	0.0033	0.0021	0.0201	0.0299	0.0581
Sweden	0.0006	0.0014	0.0000	0.0130	0.0262	0.0170
United Kingdom	-0.0009	0.0046	0.0041	0.0094	0.0303	0.0246
United States	0.0010	0.0019	0.0025	0.0090	0.0214	0.0700
West Germany	0.0043	0.0007	0.0007	0.0113	0.0228	0.0504

a shock given to a particular exogenous variable. In each simulation, all other exogenous variables are kept at their actual values. Thus, the differences between the shocked and the control solution is the estimates of the own-and cross-country multipliers discussed in the previous section. In the following, the model will be simulated over the period 1968-1973 to derive the multipliers of a unit change in the exchange rate and unemployment rate of each country in the system. After having done those simulations, two additional simulations will be performed to ascertain how much of actual inflation rates during the period 1971-1973 has been associated with actual changes in the exchange rates and unemployment rates. The model is non-linear and simultaneous; consequently, the estimates derived from simulations depend on the initial conditions and the size of shocks.

The model is simulated with a sustained increase of a 1 percent in the exchange rate of each country, one country at a time. The multiplier values for domestic and import prices of all countries are computed by comparing the solution with the control solution. The own- and cross-country multipliers for domestic prices are summarized in a matrix form, as given in Table 8.

Although the table contains a wealth of information, only some general conclusions can be drawn because of limited space. The reductions in the domestic prices of the countries which

TABLE 8 - THE EFFECTS OF A 1% APPRECIATION IN THE DOLLAR PRICE OF AN INITIATING COUNTRY"S CURRENCY ON FOREIGN CONSUMER PRICE INFLATION

(in percent)

Initiating Country \ Receiving Country	Australia	Austria	Belgium	Canada	Finland	Italy	Japan	Nether-lands	Sweden	U.K.	U.S.	West Germany	Off-Diagonal Row-Sum
Australia													
Impact	-0.32	0.0	0.0	0.0	0.0	0.0	0.06	0.0	0.0	0.01	0.01	0.0	0.09
Long-Run	-0.67	0.0	0.0	0.01	0.0	0.0	0.02	0.0	0.0	0.0	0.01	0.0	0.04
Austria													
Impact	0.0	-0.12	0.0	0.0	0.01	0.01	0.0	0.01	0.01	0.0	0.0	0.0	0.04
Long-Run	0.01	-0.10	0.0	0.01	0.01	0.01	0.0	0.01	0.01	0.0	0.0	0.01	0.07
Belgium													
Impact	0.01	0.01	-0.11	0.0	0.01	0.03	0.01	0.11	0.02	0.01	0.01	0.02	0.24
Long-Run	0.02	0.01	-0.34	0.02	0.01	0.02	0.01	0.07	0.02	0.01	0.01	0.04	0.24
Canada													
Impact	0.03	0.0	0.0	-0.21	0.0	0.01	0.06	0.02	0.01	0.02	0.08	0.0	0.23
Long-Run	0.02	0.0	0.01	-0.92	0.0	0.0	0.01	0.01	0.0	0.0	0.03	0.01	0.09
Finland													
Impact	0.0	0.0	0.0	0.0	-0.30	0.0	0.0	0.0	0.02	0.01	0.0	0.0	0.03
Long-Run	0.01	0.0	0.0	0.0	-0.28	0.0	0.0	0.0	0.02	0.01	0.0	0.0	0.04
Italy													
Impact	0.01	0.01	0.01	0.0	0.01	-0.29	0.01	0.03	0.01	0.01	0.01	0.02	0.13
Long-Run	0.03	0.01	0.03	0.03	0.01	-0.31	0.01	0.03	0.02	0.01	0.02	0.04	0.24
Japan													
Impact	0.05	0.0	0.0	0.02	0.01	0.0	-0.40	0.02	0.01	0.01	0.04	0.01	0.16
Long-Run	0.13	0.0	0.01	0.11	0.01	0.01	-0.33	0.02	0.01	0.01	0.09	0.01	0.41
Netherlands													
Impact	0.01	0.01	0.01	0.0	0.01	-0.01	0.01	-0.52	0.02	0.01	0.0	0.02	0.09
Long-Run	0.02	0.01	0.05	0.01	0.01	0.0	0.01	-0.43	0.02	0.01	0.01	0.04	0.19
Sweden													
Impact	0.01	0.01	0.0	0.0	0.06	0.01	0.01	0.01	-0.29	0.01	0.0	0.0	0.12
Long-Run	0.02	0.0	0.01	0.01	0.06	0.01	0.01	0.02	-0.28	0.01	0.01	0.01	0.17
United Kingdom													
Impact	0.08	0.01	0.01	0.02	0.05	0.02	0.03	0.05	0.06	-0.19	0.02	0.01	0.36
Long-Run	0.18	0.01	0.04	0.09	0.06	0.03	0.05	0.05	0.07	-0.15	0.05	0.03	0.66
United States*													
Impact	0.09	0.01	0.01	0.14	0.08	0.08	0.18	0.08	0.02	0.06	-0.21	0.02	0.77
Long-Run	0.17	0.0	0.05	0.55	0.03	0.12	0.16	0.06	0.04	0.06	-0.29	0.04	1.28
West Germany													
Impact	0.04	0.08	0.05	0.01	0.07	0.13	0.04	0.19	0.10	0.03	0.03	-0.10	0.77
Long-Run	0.08	0.05	0.13	0.07	0.07	0.11	0.05	0.15	0.08	0.03	0.06	-0.25	0.88
Off-Diagonal Column Sum	0.33	0.14	0.09	0.19	0.31	0.28	0.41	0.52	0.28	0.18	0.20	0.10	
	0.69	0.09	0.33	0.91	0.27	0.31	0.33	0.42	0.29	0.15	0.29	0.23	

Notes: *In the United States' case the dollar is appreciated by a 1% against all of the other countries' currencies.

1. The Off-Diagonal Row Sum is the effect of the initiating country's rate on foreign consumer prices.
2. The Off-Diagonal Column Sum is the effect of foreign countries' rates on the consumer price of the receiving country.
3. The Diagonal is the effect of the initiating country's rate on its own consumer price.
4. The Impact effect is the effect of a change in the initiating country's rate at the end of the first year following the change and the Long-Run is the effect after the sixth year.

appreciate their currency values vary from one country to another, as shown by the diagonal elements of the matrix. On the average, a 1 percent appreciation reduces the prices by about 0.26 percent in the first year after the policy change and by about 0.36 percent after six years. Thus, the effect on own domestic inflation is substantial. As revealed in the off-diagonal elements, a currency appreciation is accompanied by induced increases in the prices of other countries, although not by an appreciable amount initially. But, the cross-country effects tend to become greater gradually as time passes on, because of the lagged adjustments. Since all the cross-effects are not found to be zero, the inflationary pressure from a change of a currency value can be transmitted abroad.

The sum of the off-diagonal row elements represents the extent to which the prices of receiving countries are influenced. According to the numerical values, the changes in the values of U.S. dollar and German DM are expected to have appreciable impacts on the prices of other countries. On the other hand, the sum of the off-diagonal column elements is a measure of the vulnerability of a country's domestic price to changes in the external currency values. Canada, Australia and the Netherlands, for example, belong to the class of the highly dependence.

As noted earlier, prices are also affected by the changes in unemployment rates originating at home abroad, not only through changing the inverse of unemployment rates but also through changing the rate of growth in output levels. The multipliers to reveal these influences are also computed by simulations. Table 9 comprises the own-and cross-effects on the domestic prices of all countries of a 1 percent increase in the unemployment rate of each country. As expected, the domestic price of a country tends to fall appreciably in the long run, as a result of the simulated increase in its own unemployment rate. As shown by the diagonal elements, the long run effect is the decline in the domestic prices by approximately 0.24 percent, on the average. The responses in the first year are mixed, however, depending on whether the positive effect attributable to the induced decrease in the output level as described by the Okun equation outweights the negative effect of the increased unemployment itself.

The cross-effects, particularly in the long run, appear to be large and negative, as given by the off-diagonal elements. This suggests that the inflationary pressure generated by the increased activity in a country produces inflationary pressures in other countries. While the cross-effects of a change in unemployment rates could be exaggerated, as indicated in the previous section, the cross-effects are found to be definitely sharper and larger than those resulting from currency

TABLE 9

The Effects of a 1% Increase in the Unemployment Rate of an Initiating Country on Foreign Consumer Price Inflation

(in percent)

Initiating Country	Receiving Country	Australia	Austria	Belgium	Canada	Finland	Italy	Japan	Nether-lands	Sweden	U.K.	U.S.	West Germany	Off-Diagonal Row - Sum
Australia														
Impact		-1.10	0.0	0.0	0.01	0.0	0.01	-0.09	-0.01	0.0	-0.01	-0.01	0.0	-0.14
Long-Run		-1.85	0.0	-0.01	-0.06	-0.01	-0.01	-0.17	-0.02	-0.01	-0.02	-0.04	-0.01	-0.36
Austria														
Impact		0.0	0.51	0.0	0.0	0.0	0.01	0.0	0.0	0.01	0.0	0.0	0.0	0.02
Long-Run		-0.01	-2.54	-0.01	-0.01	-0.02	-0.04	-0.01	-0.02	-0.03	-0.01	-0.01	-0.03	-0.20
Belgium														
Impact		-0.02	-0.01	-0.78	-0.01	-0.01	-0.03	-0.02	-0.10	-0.03	-0.01	-0.01	-0.02	-0.27
Long-Run		-0.03	-0.01	-1.44	-0.03	-0.03	-0.05	-0.02	-0.19	-0.04	-0.02	-0.03	-0.09	-0.54
Canada														
Impact		-0.01	0.0	0.0	-0.41	0.0	-0.01	-0.03	-0.01	0.0	-0.01	-0.04	0.0	-0.11
Long-Run		-0.12	0.0	-0.02	-1.38	-0.01	-0.03	-0.12	-0.05	-0.02	-0.04	-0.22	-0.02	-0.65
Finland														
Impact		0.0	0.0	0.0	0.0	-0.29	0.0	0.0	0.0	-0.01	0.0	0.0	0.0	-0.01
Long-Run		-0.01	0.0	0.0	0.0	-1.12	0.0	0.0	-0.01	-0.03	-0.01	0.0	-0.01	-0.07
Italy														
Impact		-0.01	-0.01	-0.01	-0.01	-0.01	-0.93	-0.01	-0.04	-0.02	-0.01	-0.01	-0.02	-0.16
Long-Run		-0.04	-0.02	-0.04	-0.04	-0.02	-0.94	-0.02	-0.05	-0.03	-0.01	-0.03	-0.07	-0.37
Japan														
Impact		-0.22	-0.01	-0.02	-0.08	-0.02	-0.04	-2.52	-0.07	-0.04	-0.03	-0.17	-0.02	-0.72
Long-Run		-0.18	0.0	-0.02	-0.16	-0.01	-0.02	-0.88	-0.03	-0.02	-0.02	-0.11	-0.02	-0.59
Netherlands														
Impact		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Long-Run		-0.02	-0.01	-0.06	-0.01	-0.02	-0.03	-0.01	-0.62	-0.02	-0.01	-0.01	-0.06	-0.26
Sweden														
Impact		0.02	0.02	0.01	0.0	0.11	0.02	0.0	0.04	2.43	0.03	0.01	0.01	0.29
Long-Run		-0.02	-0.01	-0.01	-0.01	-0.06	-0.01	-0.01	-0.02	-0.69	-0.01	-0.01	-0.01	-0.18
United Kingdom														
Impact		0.06	0.01	0.01	0.01	0.03	0.02	0.01	0.04	0.05	0.74	0.02	0.01	0.27
Long-Run		-0.11	-0.01	-0.03	-0.06	-0.03	-0.02	-0.03	-0.04	-0.04	-0.49	-0.03	-0.02	-0.42
United States														
Impact		0.0	0.0	0.0	0.01	0.0	0.0	0.01	0.0	0.0	0.0	0.04	0.0	0.02
Long-Run		-0.32	-0.01	-0.08	-0.80	-0.04	-0.09	-0.32	-0.14	-0.07	-0.06	-1.12	-0.08	-2.01
West Germany														
Impact		-0.03	-0.03	-0.03	-0.02	-0.04	-0.08	-0.04	-0.12	-0.07	-0.02	-0.03	-0.53	-0.53
Long-Run		-0.14	-0.11	-0.21	-0.11	-0.13	-0.18	-0.08	-0.29	-0.15	-0.04	-0.10	-1.23	-1.54
Off-Diagonal Column Sum		-0.21	-0.05	-0.04	-0.11	0.08	-0.12	-0.17	-0.27	-0.11	-0.06	-0.24	-0.04	
		-1.00	-0.18	-0.49	-1.29	-0.38	-0.48	-0.79	-0.86	-0.46	-0.25	-0.59	-0.42	

Note: 1. The Off-Diagonal Row Sum is the effect of the initiating country's activity on foreign consumer prices. 2. The Off-Diagonal Column Sum is the effect of foreign countries' activities on the consumer price in the receiving country. 3. The Diagonal is the effect of the initiating country's activity on its own consumer price. 4. The Impact effect is the effect of a change in the initiating country's activity at the end of the first year following the change, and the Long-Run is the effect after the sixth year.

appreciations. The sum of the off-diagonal row elements and of the off-diagonal column elements is also given in Table 9. As expected, the changes in the U.S. and German activity do affect the inflation in other countries to a great extent, whereas the inflation in Canada and Japan seems to be highly influenced by foreign activity.

One of the interesting conclusions emerging from the discussion on economic policy in an interdependent world is that the achievement of the policy targets of a country is less costly if policy decisions take into account the interactions with other countries.[11] We calculate the effects of changes in the exchange rate and unemployment rate of a country upon its own inflation through their impact abroad. This calculation serves to see how important the repercussions of interdependence can be. The results are given in Table 10. As discussed in the previous section, the feedback effect of a currency appreciation tends to offset the initial negative effect on the inflation of the appreciating country, whereas the feedback effect of a rise in the unemployment rate reinforces the price-dampening effect of a higher unemployment rate. In addition, the estimates reveal that the feedback effect is greater, the larger the country's share in world trade. Although the feedback effects on the whole are smaller than expected, the presence of such repercussion effects suggests that in order to achieve policy targets, it is necessary to take into account the interdependence of national rates of inflation.

Table 10

The Size of Feedback Effects on Domestic Inflation

(in percent)

	A 1% Exchange Rate of Appreciation		A 1% Rise in Rate of Unemployment	
	Impact	Long-Run	Impact	Long-Run
Australia	0.01	0.0	-0.01	-0.04
Austria	0.0	0.0	0.0	0.0
Belgium	0.0	0.1	-0.01	-0.03
Canada	0.02	0.05	-0.01	-0.12
Finland	0.01	0.0	-0.01	0.0
Italy	0.0	0.01	0.0	-0.01
Japan	0.02	0.03	-0.06	-0.05
Netherlands	0.01	0.02	0.0	-0.02
Sweden	0.01	0.01	0.0	0.0
United Kingdom	0.0	0.01	0.0	-0.01
United States	0.03	0.11	0.0	-0.15
West Germany	0.01	0.03	-0.01	-0.05

1. Feedback effects are defined as the effects estimated with no changes in the consumer price and unemployment rates of all other countries minus the effects with the changes as reported in Tables 8 and 9.

2. Negative sign means the addition to the negative effect, while a plus sign indicates the offsetting of the negative effect.

Finally, simulation experiments are made for the years 1971-1973 under the assumption that either exchange rates or unemployment rates during the three years are identical to those prevailing in 1970. The results are presented in Table 10.[12] In the countries whose currencies are effectively appreciated, domestic prices decrease as the result of the appreciations. For instance, the inflation rates in Japan and West Germany were lower by about 2.3 and 0.7 percent on annual average basis than they would have been predicted in the absence of such currency appreciations. These reductions are substantial; they amounts to one-third and one-fifth of the predicted inflation rates, respectively. Symmetrically, those countries that experience the effective depreciations of currency values have more inflation. For example, the U.S. dollar was effectively depreciated by about 5 percent per year. Accordingly, an annual increase in U.S. price of about 1.4 percent can be attributed to the devaluation. As shown in the table, the devaluation-induced rise is one-third of the predicted inflation rate, which estimate is of the same order of magnitude as implied in Kwack [22]. On this ground, the U.S. devaluation can be regarded as an

TABLE 11

The Response of Consumer Price Inflation to the Changes in the Exchange Rate and Unemployment Rate During 1971 - 1973

(in percent)

Country	EXCHANGE RATE EFFECT			UNEMPLOYMENT RATE EFFECT		
	Effective Exchange Rate Change[1]	Consumer Price Change[2]	Relative Magnitude[3]	Unemployment Rate Change[4]	Consumer Price Change[2]	Relative Magnitude[3]
Australia	-3.697	-1.289	0.215	0.533	-1.370	0.233
Austria	-1.293	-0.207	0.038	-0.533	1.037	0.189
Belgium	-1.077	-0.210	0.045	0.467	-0.603	0.133
Canada	-0.047	-0.020	0.005	0.200	-0.397	0.097
Finland	2.753	0.703	0.110	0.433	-0.817	0.129
Italy	3.490	0.973	0.185	0.233	-0.473	0.091
Japan	-5.830	-2.330	0.341	0.100	-0.483	0.071
Netherlands	-1.960	-1.073	0.182	1.267	-0.573	0.098
Sweden	-0.080	-0.027	0.005	0.567	-0.480	0.083
United Kingdom	4.437	0.637	0.078	0.733	-0.933	0.121
United States	5.113	1.363	0.282	0.567	-0.777	0.175
West Germany	-4.670	-0.720	0.173	0.333	-0.623	0.152

1. The average effective exchange rate change of a country's currency from 1971 through 1973. The effective appreciation of the U.S. dollar is equivalent to the depreciation of all the other currencies. 2. The average change of consumer price inflation due to the change in exchange rate (unemployment rate). 3. The ratio of the change in consumer price inflation induced by the exchange rate (unemployment rate) change to the inflation predicted with the actual exchange rate, in fraction. 4. The average change in unemployment rate from 1971 through 1973.

absolute

important factor for generating inflationary pressure in the U.S. economy.

Since the depreciation of a currency means the appreciation of other currencies, it is not clear whether a currency depreciation would call forth a worldwide inflation. If domestic prices of all countries possess their characteristics of downward inflexibility, the currency depreciation drives up prices. Insofar as the downward rigidity in prices were the case, the exchange rate changes made in the early 1970's can be said to be one of the factors for the presend widely spread inflation.

As shown in the table, unemployment rates in all countries except for Austria have been increased, in the range from 0.3 percent to 1.2 percent annual average during the three years. As expect from our finding that a rise in the unemployment rate of a country leads to decreases in the prices of all countries, the increases in unemployment rates would have produced a decline in domestic prices between about 0.4 and 1.3 percent annually.

Although very informative, our analysis based on the simulations does not certainly deal with all the events that may be regarded as causes of sharply accelerated worldwide inflation during these three years. Increases in petroleum and material prices and upward shifts of natural unemployment rates due to change in demographic and related factors could be examples of other contributing factors.[13] The monetary expansions in the world, either passively or actively, can be said to be associated with the inflation in a

sense that the persistent inflation over a long period of time is incompatible with the absence of excessive monetary expansions.

IV. Conclusions

This paper attempts to provide a framework for the analysis of price behavior and inflation in an interdependent world. It must be repeated that the model is limited in scope and much remains to be done; sectoral specifications can be improved for individual countries, and real demand and monetary sectors could be incorporated to get more comprehensive conclusions. Nevertheless, the simulation results of the model are useful in increasing our understanding of a phenomenon that has not previously been examined in great detail - the international transmission aspects of inflation.

The major conclusion emerging from this study is that a rise in the import price of a country not only shifts the trade-off relation between inflation and unemployment but also affects inversely the relations in other countries. Independent of the effects through changing aggregate demand and monetary stocks, consequently, the changes in external currency values and activities are transmitted to the rest of the world. For a given change in the domestic prices of a country, greater foreign price responsiveness is found when the initiating country is more open and has larger trade relations with other countries. Our results seem to suggest that the capability of a country to manage its own inflation may become strengthened,

if national policy-makers do take into account the degree of the interdependence of prices among countries.

Our results indicate that a currency depreciation contributes to domestic inflation. That is what is expected when a currency value is depreciated without being accompanied by an appropriate reduction in domestic absorption. If there is worldwide downward rigidity in prices, it seems highly likely that a currency depreciation of an important trading country will give rise to pressures toward a worldwide inflation.

Our analysis is carried out in a preliminary way by the use of an aggregative model. Consequently, little attention is paid to differences in rates of inflation between tradable and nontradable goods. A promising avenue for further investigation would require an explicit distinction between the two types of goods within a model covering worldwide activity and financial transactions, such as the Project LINK model. In the meanwhile, we have shed some light on the interdependence among the economies of industrial nations.

Footnotes

*The author is an economist, Division of International Finance, of the Board of Governors of the Federal Reserve System. The views expressed do not necessarily represent those of the Federal Reserve System. The author benefited from the comments of Peter Clark, Dick Berner, John Helliwell, Howard Howe, and Guy Stevens. He is also indebted to the stimulus provided by Gary Fromm, Lawrence Klein and Thomas Willett, and to Sam Parrillo and Ken Pannell for research assistance. An earlier version of this paper was presented at the NBER Conference on Research in Income and Wealth--"Price Behavior: 1965-1974" held on November 21-23, 1974 in Washington, D.C.

[1]While a fuller discussion and reconciliation of some works in the area of international transmission of inflation can be found in Sweeney and Willett [35], an example of the works in this area is found in Haberler [17]. Johnson and Klein [2], and Hickman [18] attempted to quantitatively examine the interdependence of activities among countries in the world, using a LINK model.

[2]The transmission channels are spelled out in detail in Sweeney and Willett [35]. Also see Turnovsky and Kaspura [39] for a thorough discussion on imported inflation in a small country, and Johnson [20], Laider [25], and Parkin [30] for a monetarist view.

[3]These hypotheses are used in some models in the LINK system. No import prices are included in the works of Gordon [15] and Perry [32] and the wage-price sectors in most U.S. and Canadian models in Eckstein [10].

[4]This specification was applied in Kwack [23] to explain both U.S. prices and wage rates during 1959I - 1972IV. The specification seems to be quite satisfactory, regardless of whether the money stock and government spending are added. Equation (3) was used in Kwack [22].

[5]This is a limiting case of the general specification discussed above that is derived from solving the demand and supply equations, as applied by Amano [1] to explain export price behavior in industrial countries. While the special form was used here for simplicity, further investigations will be undertaken to examine whether or not the general form reduces specification errors involved in the special form.

[6]This assumption is restrictive as discussed by Balassa [3] because of the difference between the movement of consumer prices (in which prices of nontraded goods are also reflected) and tradable goods prices. However, this assumption simplifies a great deal by enabling us to avoid constructing a complicated sub-sector to show how the two prices are determined.

[7]Branson ([6], p.21) showed that $0 \leq \beta_{1i} = \theta_j/(\theta_j-\varepsilon_i) \leq 1$, where ε_i = own price elasticity of ith import demand and θ_j = own price elasticity of jth supply.

[8]See Goldberger ([14], pp. 373-378) for a mathematical proof of the stability conditions and discussion on multipliers in general.

[9]Clark [7] found the import price to be marginally important in explaining the U.S. GNP deflator, when it was used with the money stock and government expenditures. As noted before, Kwack [23] found that the coefficients on the import price variable were stable and significant in explaining U.S. deflators for consumption expenditures even in the presence of the money stock. The import prices were important in explaining U.S. and aggregate foreign CPI behavior, shown by Kwack [22].

[10]Braun [4] provided a broad survey of some issues of incomes policy and discussed actual implementations of incomes policy in industrial countries. One interesting point emerging from his survey is that incomes policies were frequently employed in connection with changes in currency values.

[11]See Cooper [8] for the policy choice of a country in an interdependent world through capital mobility. Duesenberry [9] pointed out the importance of external factors even in the United States, which external sector was regarded as relatively small.

[12]Exchange rates and unemployment rates are treated as exogenously determined, ignoring the activity effect of inflation that is likely to be present in a general equilibrium framework.

[13]Nordhaus [28] investigated how energy requirements will be satisfied and energy prices will affect prices of goods, and Popkin [31] discussed the impact on the U.S. price level of increasing prices of raw material commodities in the world.

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