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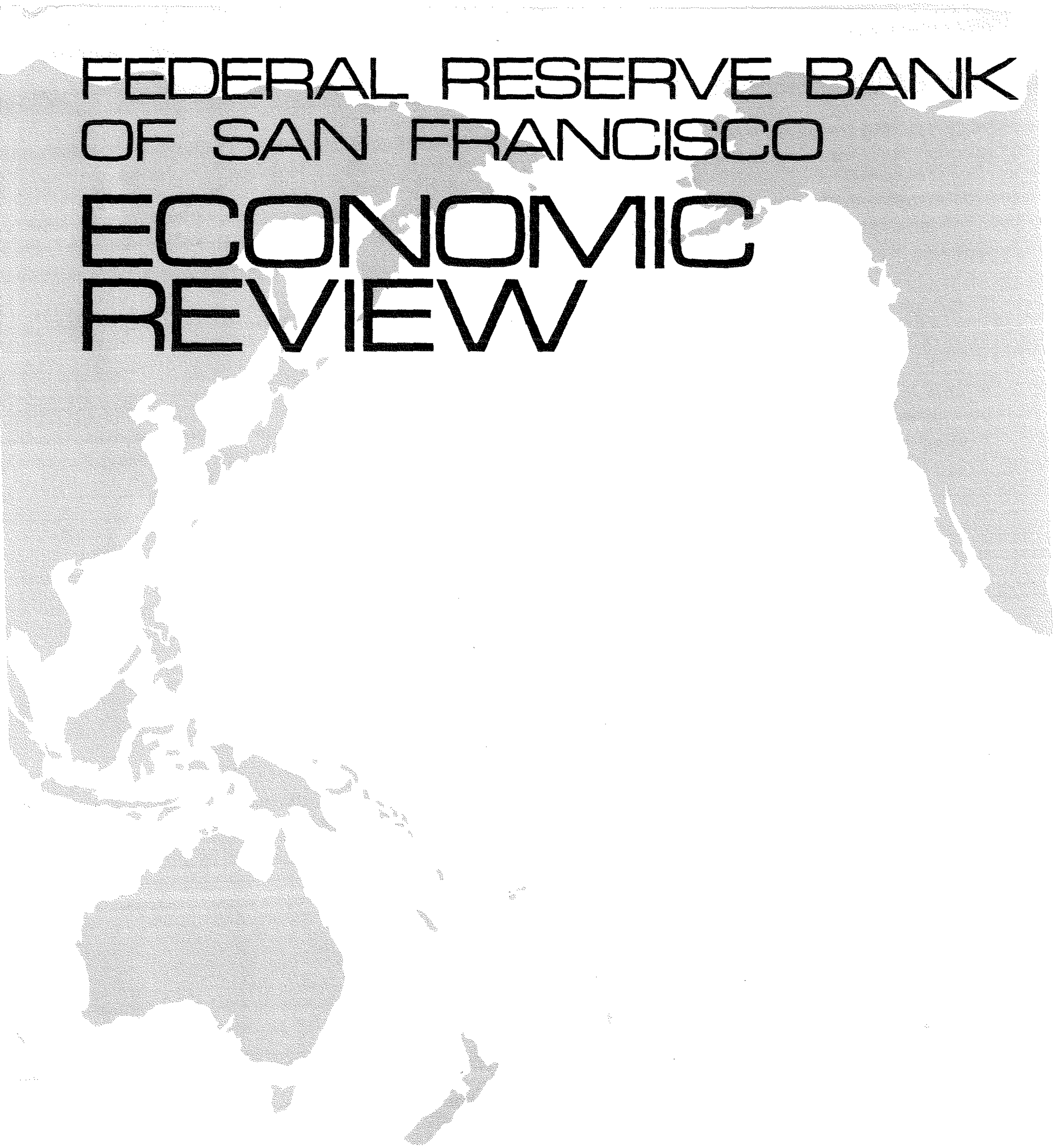

MONEY, INFLATION AND TRADE IN THE PACIFIC BASIN

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Inflation and Monetary Accommodation in the Pacific Basin

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This paper examines the inflation experience of eight Pacific Basin countries—the United States, Japan, Australia, South Korea, the Philippines, Malaysia, Taiwan, and Singapore—over the 1957–77 period. We will attempt to identify the causes of persistent inflation in each of these countries.

Note that we concentrate on explaining persistent inflation rather than simply short-term movements in particular prices. Over the last twelve years in the United States, and for a good deal longer in many other countries, price levels have climbed steadily, and at average rates that are high by historical standards. Furthermore, there is no sign of a slowdown in this phenomenon. World inflation has not been a temporary outbreak, confined to a few commodity prices, but a continuing process affecting all prices.

In the next section, we will argue that inflation can continue only if there are continuing increases in the money supply. Non-monetary factors can cause temporary movements in the price level, but if these are responsible for prolonged inflation, they must in some sense cause shifts in the rate of monetary expansion. According to our line of reasoning, then, identifying the reasons for accelerated money growth means identifying the reasons for increased inflation.

This approach is vital in formulating an anti-inflation policy. For if monetary expansion, and so inflation, has been an autonomous policy decision, then only tighter monetary policy will be able to stop inflation. If this were the case, price and wage hikes would moderate once monetary policy moderated. Another possibility, however, might be that monetary policy has been forced to accommodate large price or wage increases, or other disturbances. In this case, monetary tightening would subject the economy to the effects of these disruptions, with little near-term effect on inflation. A more effective policy in this case would be direct government action to slow price increases. The choice of policy therefore depends on whether monetary expansion is seen as the cause or effect of price changes.

This paper will investigate four factors which are said to affect money-supply growth: increasing wage demands, the OPEC oil price hike of 1973, government deficit spending, and the international transmission of inflation from abroad. We will consider whether these factors have indeed systematically caused money growth and inflation. The next section briefly discusses an economic theory of inflation which links the money supply and the price level. Section II presents Pacific Basin evidence for this link. Section III investigates the effects of the above four factors on money-supply growth, and Section IV provides a brief summary and discussion of these results.

I. Money and Inflation in Theory

Inflation is an increase in the money price of virtually all goods. Still, in any inflationary situation the prices of some goods will rise faster than others, and the prices of still others may even decline. These varying rates of change reflect the impact of such factors as changes in tastes, shifts of labor and capital among industries, and introduction of new productive techniques. While these phenomena can explain movements in some prices relative to others during an inflation, they cannot explain the inflation itself, the upward tendency in all prices.

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Economic theory distinguishes between factors such as these which affect relative prices, and those which affect the general price level. We can outline the reasoning behind this distinction, and give some flavor of the effect of money on prices, by discussing price determination in a very simple economy.

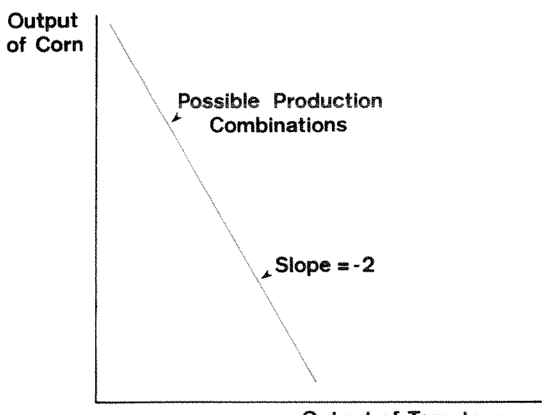
Consider an economy consisting of two commodities, corn and tomatoes, and a fixed amount of cash. Assume that land and water are plentiful enough so that labor is the only scarce factor in producing these commodities. Also, assume that one-hour of labor will produce two pounds of corn but only one pound of tomatoes.

In such an economy, possible outputs of the two commodities can be detailed by a production possibility curve as shown in Figure 1. This curve shows the maximum amount of corn that can be produced if tomato production is at a given level, and vice versa. The negative slope of this curve reflects the fact that tomato output can be increased only by drawing labor away from corn production, and so reducing corn output. Also, the slope of this curve is −2, which reflects the fact that one man-hour produces twice as many pounds of corn as of tomatoes.

Prices and outputs in the economy will reflect consumer tastes as well as these production conditions, with the end result that tomato prices will tend to be twice those of corn. Farmers know that they can increase tomato output by one pound only by decreasing corn output by two pounds, and they will be satisfied with this trade-off only if tomatoes yield twice the revenue of corn. Similarly, at this price consumers know that for every extra pound of tomatoes they purchase, they can purchase two less pounds of corn, and so they will adjust their consumption habits until they are satisfied with this trade-off.

Chart 1

Production Possibility Curve



At the same time, economic agents hold money because of the various conveniences it allows. They cannot increase consumption of both goods without decreasing their holdings of cash, and so decreasing their enjoyment of these conveniences, nor can they increase holdings of money without decreasing their consumption of goods. The money price of goods, then, indicates the purchasing power of money and so will tend to equal the value to agents of holding cash balances.

As we have said, outputs of corn and tomatoes will reflect consumers' desired consumption mix given the 2-to-1 trade between commodities. If the supply of tomatoes is increased above the usual level, the price of tomatoes will have to fall before consumers will be willing to purchase the increased amount. Furthermore, the output of tomatoes can be so increased only if that of corn falls. Though tomatoes are more plentiful than before, corn is more scarce, and consumers will be willing to pay higher prices to obtain these smaller amounts of corn. As the price of tomatoes falls, that of corn rises. Therefore the average price level, and so the purchasing power of money, need not change.

If production conditions and consumer tastes have not changed, prices and outputs will eventually move back to their old levels. However, even in the short run, when outputs are varying, the price level need not change since decreased tomato prices are offset by increased corn prices. Again, this is because output of one good can be changed only by changing output of the other good in the opposite direction.

This is not true of the money supply. For example, it takes no diversion of resources to change the denominations of currency.[1] Yet such redesignation will permanently change the supply of dollars. With an increased supply of dollars, money is less scarce at old prices, and consumers will attempt to spend some of their increased holdings by increasing purchases of commodities. This increased demand will bid up the prices of both goods, and so the price level will rise. Dollars are more plentiful, and thus the value or purchasing power of each dollar has fallen.

In the first example, corn becomes more scarce relative to tomatoes, but goods do not become more scarce relative to money, since labor shifts from producing one good to producing the other. Therefore the price level, which is the average money price of all goods, need not change. In the second example, demand and supply do not shift from one good to the other. Rather, the larger money supply increases the demand for both goods. This makes both more scarce relative to money, and the price level rises accordingly.

We have developed this analysis in a simple two-good economy, but the same basic points hold in the real world for any type of disturbance. Changes in tastes, techniques, and wages switch resources and expenditures from one good to another, ultimately causing some money prices to rise and others to fall. Only increases in total asset holdings can augment spending on all goods. Furthermore, only increases in the money supply can permanently augment spending without augmenting productive capacity.

Certain restrictive assumptions are made in our model. For example, it ignores changes in the capital stock and the supply of labor, or technological advances, which could change the "output" line in Figure 1. Also, changes in money demand and government policy are abstracted from. Such factors can cause short-term disturbances in the money-price relationship. However, as suggested in the model, continuing inflation must be accompanied by continuing growth of the money supply. Furthermore, changes in the money-supply growth rate will lead to changes in the rate of inflation.

II. Money and Inflation in Fact

The Pacific Basin countries have experienced prolonged inflation over the last two decades. Therefore, their experiences should provide some evidence of the link between money growth and inflation.

The correlation between the average rates of inflation and money growth across countries is .841 in the 1957–67 period (Table 1A) and .654 in the 1967–77 period (Table 1B)[2]. The former statistic is significant at the 1 percent level, while the latter is significant at the 5 percent level. In both sub-periods, then, there is statistically significant evidence of a relation between a country's rate of money supply growth and its inflation rate. Yet while the data show a strong relationship between inflation and money growth across countries, they do not indicate the strength of this relation within any given country. Nor do they determine whether money growth caused prices to rise, or vice versa.

Granger causality tests provide one way of testing for the direction of such causal effects between two variables.[3] This technique is used in most of the empirical analysis in this paper. It involves regressing one variable on its own past values and the past values of the other variable. The lagged values of "dependent" variable are included in order to detrend the series, and so reduce the probability of finding a relation between two variables which are not truly causally related, but which merely move up or down together over time.[4] (See the Appendix for further details on the Granger technique).

In the present context, the Granger causality technique specifies estimating the following equations:

$$(CPI)_t = \alpha + \sum_{j=1}^{8} \beta_j (MS)_{t-j} + \sum_{j=1}^{8} \gamma_j (CPI)_{t-j} + \epsilon_t , \quad (1)$$

and

$$(MS)_t = \alpha + \sum_{j=1}^{8} \beta_j (CPI)_{t-j} + \sum_{j=1}^{8} \gamma_j (MS)_{t-j} + \epsilon_t , \quad (2)$$

where $(CPI)_t$ is the CPI inflation rate in quarter t, $(MS)_t$ is the money supply growth rate at quarter t, ϵ_t is a random disturbance term, and the α's, β's, and γ's are coefficients to be estimated. Money growth can then be said to "cause" inflation if the β-coefficients in equation (1) are significantly different from zero and generally

Table 1
Inflation and Money Supply Growth

TABLE 1A
1958.I–1967.IV

	(1) Average CPI Inflation Rate (%)[1]	(2) Average Money Supply Growth Rate (%)[2]
Korea	12.03	23.01
Taiwan	4.62	19.25
Japan	4.34	16.82
Philippines	4.17	8.57
Australia	2.32	2.77
United States	1.75	3.44
Malaysia	0.55	2.19
Correlations between columns (1) and (2)		.841***

TABLE 1B
1968.I–1977.IV

	(1) Average CPI Inflation Rate (%)[1]	(2) Average Money Supply Growth Rate (%)[2]
Korea	13.29	33.26
Philippines	10.78	16.71
Japan	9.28	16.35
Australia	8.81	9.11
Taiwan	8.62	22.72
United States	6.22	5.96
Singapore	5.34	16.01
Malaysia	4.52	14.89
Correlations between columns (1) and (2)		.654**

** Significant at 5 percent level.
***Significant at 1 percent level.
(1) Geometric average rate of change in consumer price index.
(2) Geometric average rate of change in money supply.
Source: *International Financial Statistics*, International Monetary Fund.

positive. Such a result would concur with our conclusions in the preceding analytical section.

On the other hand, if disturbances in the real economy caused prices to rise, and eventually forced the money supply to increase, money growth would be "caused" by short-term inflation. In this case, the β-coefficients in equation (2) should be generally positive, so that inflation would "cause" money growth. Since equation (2) measures the response of the money supply to price-level disturbances, its estimation provides our first evidence on monetary accommodation of disturbances in the real economy.[5]

Equations (1) and (2) were estimated using unadjusted quarterly data with seasonal dummies for the period 1959:I to 1977:IV[6] (Tables 2 and 3). The hypothesis that $\beta_1 = ... = \beta_8 = 0$ in equations (1) and (2) can be tested by use of an F-statistic[7] (Column 8 of those tables). Significant F-values of these statistics indicate the respective coefficients are significantly different from zero.

These results generally suggest causality running from money growth to inflation. That is, the β vectors in equation (1) are generally positive and significantly different from zero at a much higher confidence level than the β vectors in equation (2). Furthermore, the long-run effects of money on prices are generally insignificantly different from one, as the quantity theory of money would suggest.[8] (Column 4 of Table 2) For most countries, then, money-supply growth apparently has had a systematic effect on inflation, with little or no reverse effect.

Two exceptions to these results are Japan and Korea. For Japan, the F-test for equation (1) is barely significant at the 10 percent level, while that for equation (2) is significant at the 5 percent level, and remains so under reformulations of this equation.[9] In other words, there is two-way "feedback" between money and prices. However, the values in equation (2) are generally negative. In this context, the results suggest that monetary policy in Japan reacted strongly to *counter* the effects of temporary price movements, rather than to *accommodate* them.[10]

For Korea, the F-statistic for equation (1) is significant at the 5 percent level, yet the cumulative effect of a change in money growth on the

Table 2

Effect of Lagged Money Supply Growth on Inflation

Estimates of $CPI_t = \alpha + \sum_{1}^{8} \beta_j (MS)_{t-j} + \sum_{1}^{8} \gamma_j (CPI)_{t-j} + \epsilon_t$[1]

	(1) α[3]	(2) $\Sigma\beta_j$	(3) $\Sigma\gamma_j$	(4) Long Run Effect of MS on CPI[4]	(5) R^2	(6) Durbin-Watson Statistic	(7) Standard Error of Equation[3]	(8) F Statistic for $\beta_1 = \ldots = \beta_8 = 0$
Australia	−0.17%	0.36	0.63	0.98 (−0.09)	0.68	1.97	3.09%	3.52***
Japan	−0.41%	0.20	0.60	0.50 (−0.84)	0.35	1.91	5.03%	1.77*
Korea	7.69%	0.04	0.33	0.07 (−1.80)*	0.20	1.99	12.10%	2.29**
Malaysia	−0.01%	0.14	0.59	0.34 (−2.28)**	0.66	1.90	3.48%	3.42***
Philippines	−1.39%	0.70	0.10	0.79 (−1.06)	0.51	2.01	7.61%	2.57**
Singapore[2]	−7.95%	0.70	0.62	1.81 (1.24)	0.71	2.28	6.40%	2.71**
Taiwan	−8.48%	0.66	0.37	1.04 (0.07)	0.22	1.98	13.82%	1.94*
United States	−0.15%	0.40	0.68	1.27 (1.05)	0.81	1.97	1.30%	2.93***

* Indicates significance at 10% level

** Indicates significance at 5% level

*** Indicates significance at 1% level

[1]Equation estimated with seasonal dummies, except in the case of Taiwan, for which the seasonal dummies increased the standard error of the equation. Period covered is 1959:I to 1977:IV.

[2]Period covered is 1966:I to 1977:IV. Because of the lower number of observations, the data were "mined" by taking the four most significant β and four most significant γ coefficients and re-estimating.

[3]Statistics are in annual rate-of-change terms.

[4]Defined as Column 2 divided by one minus Column 3. (See Appendix for an explanation). Figures in parentheses are the t-statistics for the hypothesis that this long-run effect equals one.

inflation rate is very small. This is surprising for a country which has averaged 12 percent inflation and 27 percent money growth annually over the past twenty years. Meanwhile, the effect of inflation on money growth is positive and marginally significant, indicating some monetary accommodation of price increase.

Even in these cases, there is some evidence of the effects discussed previously, and there are several possible explanations for the lack of stronger results.[11] Still, the effect of money growth on inflation appears surprisingly weak in Japan and Korea.

With these two exceptions, the results support our hypothesis that money-supply growth rates determine the underlying or continuing rate of inflation. The question then in explaining inflation becomes what caused monetary policy to act the way it did.

III. Evidence on Monetary Accommodation

What factors might stimulate money-supply growth and therefore lead to more rapid inflation? Certain disruptive shocks to the economy could perhaps have this effect, such as large com-

Table 3

Effect of Lagged Inflation on Money Growth

Estimates of

$$(MS)_t = \alpha + \sum_{1}^{8}\beta_j\,(CPI)_{t-j} + \sum_{1}^{8}\gamma_j\,(MS)_{t-j} + \epsilon_t{}^1$$

	(1) α^3	(2) $\Sigma\beta_j$	(3) $\Sigma\gamma_j$	(4) Long Run Effect of MS on CPI[4]	(5) $\bar{R}^2$	(6) Durbin–Watson Statistic	(7) Standard Error of Equation[3]	(8) F Statistic for $\beta_1=\ldots=\beta_8=0$
Australia	2.75%	0.28	0.37	0.45	0.79	1.93	8.69%	0.59
Japan	14.67%	−0.66	0.48	−1.29	0.91	1.93	8.67%	2.47**
Korea	37.64%	0.53	0.04	0.55	0.37	1.76	25.85%	2.05*
Malaysia	5.20%	0.34	0.32	0.51	0.26	2.00	15.94%	1.22
Philippines	7.05%	0.56	0.07	0.60	0.53	1.89	12.59%	1.77*
Singapore[2]	29.00%	−0.14	−0.68	−0.08	0.55	1.98	12.19%	1.01
Taiwan	27.65%	−0.11	−0.22	−0.09	0.59	1.95	19.22%	1.16
United States	2.03%	0.22	0.51	0.44	0.95	2.03	4.81%	1.17

* Indicates significance at 10 percent level.
** Indicates significance at 5 percent level.

[1]Equation estimated with seasonal dummies over the data period 1959:I to 1977:IV.
[2]Period covered is 1966:I to 1977:IV. (See footnote 2, Table 2.)
[3]Statistics expressed in annual rate-of-change terms.
[4]See Footnote 4, Table 2.

modity-price or wage increases. These increases act primarily on relative prices and the distribution of resources across industries, with little long-run effect on the price level. However, in the short run, resources can be slow to move among industries, and prices can be slow to adjust to reductions in demand. Therefore, the disruptive effects can cause temporary—but nevertheless painful—reductions in employment and output. To counter these effects, monetary authorities might seek a more expansionary monetary policy. In the long run this would lead to inflation, but the short-run gains could well make such moves desirable.[12]

Large commodity price increases, such as OPEC's quadrupling of oil prices in 1973, can also seriously strain an economy and so pressure monetary policy to provide accommodation. Similarly, large government deficits might be partially funded through money creation, in order to avoid disruptive changes in interest rates due to government borrowing needs.

Imported inflation could generate still another form of pressure. An expansionary monetary policy abroad, while causing foreign inflation, would also tend to stimulate domestic exports, and thus push the domestic-payments account into surplus. In the absence of complete exchange-rate adjustment, inflows of foreign assets due to the surplus might cause international reserves, and eventually the money supply, to increase domestically. Capital inflows and inflation would then continue until domestic prices were back in balance with prices of the country initially responsible for the inflation. Proponents of this view have attributed the world inflation and monetary expansion of the late 60's and early 70's to expansionary U.S. government policy during the Vietnam War era.

These four possible sources of pressure—wage push, commodity price increases, deficit spending, and foreign inflation—should have had a systematic effect on money growth rates if they were responsible for continued inflation. As before, we can use Granger causality tests to determine the effect these factors have had on money-supply growth.

A. Wage-push

If increasing wage settlements have consistently contributed to persistent inflation by forcing faster growth, then the rate of change of wages should statistically "cause" money growth, in much the same way that money growth was seen to cause inflation in the preceding section. On the other hand, if wage settlements have been merely a reaction to already existing inflation, then money growth should statistically "cause" wage increases.

To resolve this question, we can estimate the following models:

$$W_t = \alpha + \sum_{1}^{8} \beta_j (MS)_{t-j} + \sum_{1}^{8} \gamma_j (W)_{t-j} + \epsilon_t, \quad (3)$$

and

$$MS_t = \alpha + \sum_{1}^{8} \beta_j (W)_{t-j} + \sum_{1}^{8} \gamma_j (MS)_{t-j} + \epsilon_t \quad (4)$$

where W_t is the percentage rate of changes in wages at time t, MS_t is the percentage rate of change of the money supply, and other variables are the parameters ot the equation. If wage increases have "pushed" the money supply, then the β coefficients in equation (4) should be significantly different from zero and generally positive. If wage increases have been a response to monetary inflation, then the β coefficients in equation (3) should be significant and generally positive.

Equations (3) and (4) were estimated using quarterly data and seasonal dummies for the five countries for which data were available: Australia, Japan, Korea, the Philippines, and the U.S. The results of these estimations are summarized in Table 4 by the long-run effects of the independent variable, as defined in the Appendix, and the F-statistic for the hypothesis that $\beta_1 = \beta_2 = \ldots = \beta_8 = 0$ in either equation. Since available data covered different periods, critical F-values vary across countries. The 5 percent critical values of the F-statistic for each country are shown in parentheses following the name of each country.

Only in the case of Japan is there significant causality at the 5 percent level for equation (4). In that country, prior wage changes exert a strong but negative effect on money growth.

Table 4

Relation Between Money Growth and Wage Increases

	(1) 5% Critical F–Statistic	(2) Long-run Effect of W on MS in Equation (4)[1]	(3) F-Statistic for Hypothesis that $\beta_1=\beta_2=\ldots=\beta_j=0$ in Equation (4)	(4) Long-run Effect of (MS) on (W) in Equation (3)[1]	(5) F-Statistic for Hypothesis that $\beta_1=\beta_2=\ldots\beta_1=0$ in Equation (3)
Australia	(2.19)	0.50	1.12	0.79	1.33
Japan	(2.11)	−12.03	2.64**	2.31	2.12**
Korea	(2.95)	−0.19	2.35	−6.38	1.86
Philippines	(2.19)	−0.10	.34	−0.02	.75
United States	(2.11)	.50	1.46	1.27	1.91*

* Significant at 10 percent level.

** Significant at 5 percent level.

[1] This statistic is defined as $\Sigma\beta_j/(1-\Sigma\gamma_j)$ for the appropriate regression equation. See Appendix for derivation.

Note: Periods covered are 1961:III to 1977:IV for Australia, 1957:I to 1977:IV for Japan, 1968:I to 1977:IV for Korea, 1961:IV to 1977:IV for the Philippines, and 1957:I to 1977:IV for the United States. Wage data are weekly earnings for Australia, monthly earnings for Japan and Korea, daily wage rate for the Philippines, and hourly earnings for the United States.

Again, it appears that policy reacts strongly in Japan to counter inflationary disturbances, rather than to accommodate them, as was suggested in the preceding section. In terms of the wage equation (3), the effect of lagged money growth on wages is significant, indicating mutual interdependence between Japanese money growth and wages.

For the other countries, none of the results are statistically significant. The F-statistic for the United States for equation (3) is nearly significant at the 5 percent level, and is larger than that for equation (4). There is no U.S. evidence of a positive causal effect from wages to money. Elsewhere, the smaller number of observations tends to preclude a powerful test of the hypotheses.

In order to correct for this, the data were "mined" by taking the four most significant lags for each set of variables in equations (3) and (4) and reestimating the equations. When this was done for Australia and Korea, the β values for equation (4) remained insignificant and negative, while those for equation (3) were significant at the 5 percent level and nearly so at the 1 percent level.[13] For the Philippines, the coefficients in both equations (3) and (4) became "significant" and positive, so that only this Philippines case provides any evidence of a systematic positive effect from wages to money. In general, no hard evidence was found of a systematic accommodation of wage-push factors—of a positive one-way effect from wage growth to money.

B. Oil price hike

The OPEC oil price increase provides a prominent example of the disruptive effects of commodity price changes on an economy. It is widely recognized that this factor exacerbated world inflation in the 1974-75 period—yet once again, the oil shock can be said to have caused continuing inflation only if money-supply growth accelerated to accommodate these effects. Furthermore, the United States and most other Pacific Basin countries experienced an acceleration in money-supply growth that peaked some four quarters before the oil price increase. It remains to be seen, then, whether the oil price hike contributed to subsequent inflation, or was itself (at least partly) a response to previous inflationary money-growth.

Because of its nature as a one-time shock, this phenomenon was examined with somewhat different techniques than those used elsewhere. Equations (1) and (2) were re-estimated including a dummy variable for the eight quarters following the oil price increase.[14] The "oil dummy" inserted in equation (1) shows the amount of *inflation* that is over and above that which could be predicted from the past behavior of money and prices. Similarly, the dummy in equation (2) shows the amount of *money growth* in excess of that predictable from the past behavior of money and prices.

For most countries, inflation was significantly higher following the oil shock than previous monetary growth could explain. (Table 5, Column 1) While the "inflation-effect" dummies are generally positive and significant, this is not true of the "money growth" dummies (Column 2). For no country is this dummy variable positive and significant; thus, the oil price hike apparently was not a source of significant monetary accommodation. Rather, the results are consistent with the view that the oil price hike was primarily a relative price change with only temporary effects on inflation.

C. Deficit financing—inflation tax

Deficit spending is frequently seen as one way in which the government causes inflation. Governments in underdeveloped countries are typically said to finance their expenditures by printing money, and so taxing through inflation, rather than by raising taxes directly. In developed countries, there is also political pressure to avoid tax hikes, but, as discussed earlier, deficits are most often blamed for inflation because the money supply is increased to prevent rising interest rates. If either of these descriptions are accurate, large government deficits should cause accelerations in money growth. Furthermore, there need be no causal effect running from money to deficits.

On the other hand, one might argue that deficits and money growth are inversely related. This could occur if monetary policy balanced or countered government deficits in a "fiscal-monetary mix". This could seem to imply two-way causality or feedback between money and deficits. Al-

Table 5

Effects of Oil Price Hike on Inflation and Money Growth

	On Inflation[1]	On Money Growth[1]
Australia	6.0%	6.8%
	(3.2)***	(1.2)
Japan	10.5%	6.2%
	(2.8)***	(0.9)
Korea	16.6%	11.4%
	(3.2)***	(1.0)
Malaysia	−3.3%	−23.1%
	(−1.2)	(−2.1)**
Philippines	−0.4%	−1.0%
	(−0.1)	(−0.1)
Singapore	10.7%	−6.7%
	(0.3)	(−0.2)
Taiwan	13.1%	12.9%
	(1.0)	(0.9)
United States	2.1%	−7.2%
	(2.3)**	(−2.2)**

** Significant at 5 percent level.

***Significant at 1 percent level.

Note: Column 1 represents "oil dummy" in equation (1) and column 2 represents "oil dummy" in equation (2).

[1]t-statistic in parentheses.

ternatively, if the money supply were exogenous, but increased subsequent tax receipts by stimulating income growth, money growth would have a negative effect (i.e., it would reduce the deficit) with no reverse effect from deficits to money.

Once more, we can formalize these hypotheses in terms of a simple causality model:

$$(DR)_t = \alpha + \sum_{1}^{8} \beta_j (MS)_{t-j} + \sum_{1}^{8} \gamma_j (DR)_{t-j} + \epsilon_t, \quad (5)$$

$$(MS)_t = \alpha + \sum_{1}^{8} \beta_j (DR)_{t-j} + \sum_{1}^{8} \gamma_j (MS)_{t-n} + \epsilon_t \quad (6)$$

where $(DR)_t$ is the deficit-to-GNP ratio in quarter t, and other variables are as defined before.[15] Thus, the inflation-tax hypothesis would specify that the β coefficients in (6) are positive and significant without specifying much about the β coefficient in (5). A fiscal-monetary mix argument would suggest the β coefficients in both (5) and (6) are predominantly negative and significant. Finally, the argument about exogenous monetary policy affecting taxes and thus the deficit would specify that β is negative and significant in (5) while probably zero in (6).

Government-deficit data were available for Australia, Japan, Korea, Philippines and the United States. As Table 6 makes clear, only for the U.S. is there any sign of a positive effect of deficit spending on money growth. However, the F-statistics for the U.S. are insignificant for both equations (5) and (6). Allowing for shorter lags from deficits to money improves the U.S. F-statistic somewhat, but it is still not significant.

Where the F-statistics are significant, they indicate a negative effect of the deficit on money growth, which is apparently consistent with a policy-mix argument. This is the case with Australia, Japan, and Korea. For the Philippines, the signs of the coefficients and the magnitude of the F-statistics are most consistent with the exogenous-money argument, although the small number of observations precludes any definite conclusions. In summary, then, there is little evidence from these five countries of a positive impact of deficit financing on money growth, which means that the inflation tax has not been consistently important in explaining inflation.

D. Imported inflation

Even if a country is not affected by domestic wage increases or government deficits, developments of this type abroad can lead to inflows of funds and domestic monetary expansion. Several observers have cited this scenario in blaming world inflation on the effects of American deficit spending, transmitted abroad under a fixed exchange-rate system.[16] Once again, if such arguments are correct, foreign inflation or monetary-expansion rates should affect domestic money growth.

Rather than attempt to construct a relevant "world inflation" or "world money supply" series,[17] we tested these hypotheses using U.S. money-supply growth and inflation rates as explanatory variables. That is, the following equations were estimated:

$$(MS)_t = \alpha + \sum_1^8 \beta_j (MSU)_{t-j} + \sum_1^8 \gamma_j (MS)_{t-j} + \epsilon_t \quad (7)$$

$$(MS)_t = \alpha + \sum_1^8 \beta_j (CPIU)_{t-j} + \sum_1^8 \gamma_j (MS)_{t-j} + \epsilon_t \quad (8)$$

where $(MS)_t$ is domestic money-supply growth at t, $(MSU)_t$ is U.S. money-supply growth at t, and $(CPIU)_t$ is U.S. inflation at t.

Under the imported-inflation hypothesis, if U.S. money-supply growth exerts immediate effects on domestic money, then the β values in equation (7) should be positive and significantly different from zero. However, because of the lags from U.S. money to U.S. prices, and from U.S. prices to domestic money, eight-quarter lags may be insufficient to capture these effects. In this case, the β values in equation (8) would be more

Table 6

Relation Between Deficits and Money Growth
Estimates of Equations (5) & (6)

	(1) 5% Critical F-Stat.	(2) Long-run Effect of $(DR)_t$ on $(MS)_t$[1]	(3) F-Statistic for Hypothesis that $\beta_1=\beta_2=\ldots\beta_8=0$ in Equation (6)	(4) Long run-Effect of $(MS)_t$ on $(DR)_t$[1]	(5) F-Statistic for Hypothesis that $\beta_1=\beta_2=\ldots\beta_8=0$ in Equation (5)
Australia	(2.36)	−0.05	1.99*	−1.68	2.08*
Japan	(2.11)	−0.74	2.33**	−1.85	1.95*
Korea	(2.18)	−0.11	3.02***	3.64	0.64
Philippines	(3.44)	−0.44	0.54	−1.55	1.83
United States	(2.11)	0.43	1.61	0.01	1.63

* Significant at 10 percent level.
** Significant at 5 percent level.
***Significant at 1 percent level.

Note: Periods covered are 1965:I to 1977:IV for Australia, 1957:I to 1977:III for Japan, 1960:I to 1976:IV for Korea, 1969:I to 1977:IV for the Philippines, and 1957:I to 1977:IV for the United States.

[1]See footnote 1, Table 4.

likely to capture the effect, since they have dropped one source of lag in the process.

Equations (7) and (8) were estimated with unadjusted quarterly data and seasonal dummies over the period 1957:I to 1977:IV for the seven countries other than the U.S. in our study.[18] F-statistics were then computed for the hypotheses that $\beta_1 = \beta_2 = \ldots = \beta_8 = 0$ in these equations.

Table 7 suggests that U.S. price and money developments are not very helpful in explaining money-supply growth in Pacific Basin countries. While the β values are generally positive, for the most part they are not statistically significant. Therefore, they provide little indication of a causal effect of U.S. inflation on domestic money growth.

When longer lags were tried in equation (7), they did not change the results. Also, when Japanese money growth was substituted for U.S. money growth, no causal effects emerged. American inflation did show an effect on Malaysian money growth, but it is not clear how much meaning we can attach to this isolated case.

In summarizing, we have found little evidence in this section of systematic monetary accommodation. It might be objected that the techniques employed were biased toward finding no causality, since the tests involved the significance of a whole vector of coefficients. Yet it's not clear how meaningful are one or two significant lagged coefficients, since the theories do not suggest, say, that wages affect money growth at the third- and sixth-quarter lag. Rather, the monetary-accomodation hypotheses suggest that certain factors have some effect on money growth. The F-tests employed here showed the general explanatory power of past values of changes in the "independent" variables, which seems to be the proper way to test the accommodation hypotheses. Furthermore, mining the data by re-estimating the equations with only the most significant lags did not change our conclusions in most cases.[19]

Finally, any objections that would be made to the estimation procedure used here would apply equally to the procedure used in the preceding section. Yet that section generally supported our analysis of the effect of money-supply growth on inflation, while the present section showed very few systematic effects of commonly discussed "inflationary" disturbances on money growth.

IV. Summary and Conclusions

This study has found the existence of a fairly strong "causal" relation between the money supply and prices, but little causal effect on money-supply growth from the factors most commonly ascribed as underlying causes of inflation. The evidence presented here suggests that such factors as wage demands, deficit spending, and imported inflation did not, individually, sys-

Table 7

Effects of U.S. Money and Prices on Domestic Money

	F-Statistics for Hypothesis that $\beta_1=\beta_2=\ldots=\beta_8=0$ in	
	Equation (7)	Equation (8)
Australia	1.46	1.23
Japan	0.32	0.80
Korea	1.04	1.40
Malaysia	1.14	2.29**
Philippines	1.40	0.43
Singapore	0.83	0.37
Taiwan	1.67	0.82

** Significant at 5 percent level.

tematically affect the money supply in the countries studied, and therefore cannot be considered sources of continued inflation.

If none of these factors have been consistent causes of inflation, why have the Pacific Basin countries experienced monetary expansion and inflation? One explanation that is consistent with our results (although obviously not proven) is that monetary policy has been truly discretionary, designed to manipulate the ups and downs of the business cycle. Unfortunately, a meaningful test of this hypothesis would involve an analysis of policy objectives that is far outside the scope of this paper. For now, we have found no evidence that the money supply has been led to expand in response to certain commonly-mentioned sources of inflationary pressure.

Appendix[20]

This Appendix explains the methodology of Granger causality used in most of the empirical results in the text. A general model that can be written for two time series x_t and y_t is

$$x_t = \alpha + \sum_{o}^{\infty} \beta_j y_{t-j} + \sum_{1}^{\infty} \gamma_j x_{t-j} + \epsilon_t \quad (A.1)$$

$$y_t = \quad + \sum_{o}^{\infty} \mu_j x_{t-j} + \sum_{1}^{8} \eta_j y_{t-j} + u_t, \quad (A.2)$$

where ϵ_t and u_t are white-noise processes. In this model, y_t can be said to cause x_t if the β vector is non-zero, since in this case the y series will affect the determination of the x_t. Similarly, x_t causes y_t if the μ vector is non-zero.

However, consistent estimates of (A.1) and (A.2) cannot be obtained since if β_o and μ_o are non-zero, estimation will be subject to simultaneous-equation bias. In order to correct for this problem, we can substitute (A.1) for x_t in (A.2), and solve for y_t, and substitute (A.2) for y_t in (A.1), and then solve for x_t. This yields:

$$x_t = \frac{\alpha}{(1-\beta_o\mu_o)} + \sum_{1}^{\infty} \frac{\beta_j + \beta_o\eta_j}{(1-\beta_o\mu_o)} y_{t-j} + \sum_{1}^{\infty} \frac{\gamma_j + \beta_o\mu_j}{1-\beta_o\mu_o} x_{t-j} + \frac{\epsilon_t + \beta_o\mu_t}{1-\beta_o\mu_o}$$

$$\equiv a + \sum_{1}^{\infty} b_j y_{t-j} + \sum_{1}^{\infty} c_j x_{t-j} + e_t, \quad (A.1')$$

and

$$y_t = \frac{\delta}{1-\beta_o\mu_o} + \sum_{1}^{\infty} \frac{\mu_j + \mu_o\gamma_j}{1-\beta_o\mu_o} x_{t-j} + \sum_{1}^{\infty} \frac{\eta_j + \mu_o\beta_j}{1-\beta_o\mu_o} y_{t-j} + \frac{\mu_t + \mu_o\epsilon_t}{1-\beta_o\mu_o}$$

$$\equiv d + \sum_{1}^{\infty} n_j y_{t-j} + f_t, \quad (A.2')$$

where e_t, f_t are white-noise random processes. In this formulation all right-hand side variables are independent of e_t, f_t and so these equations can be consistently estimated.

Furthermore, if the β vector in (A.1) is zero, then the b vector in (A.1′) is zero, while if $\mu = 0$ in (A.2), $m = 0$ in (A.2′). Thus, causality can be tested by running equations (A.1′) and (A.2′) with suitably truncated lags. This is the procedure taken in the text.

The text estimates such equations in the form

$$x_t = a + \sum_{1}^{8} b_j y_{t-j} + \sum_{1}^{8} c_j x_{t-j} + e_t \quad (A.1'')$$

$$y_t = d + \sum_{1}^{8} m_j x_{t-j} + \sum_{1}^{n} n_j y_{t-j} + f_t. \quad (A.2'')$$

Now suppose $b_1 = b_2 = \ldots = b_8 = 0$ in (A.1″). Then this equation becomes

$$x_t = a + \sum_{1}^{8} c_j x_{t-j} + g_t. \quad (A.3)$$

It can then be shown that under this hypothesis, if SSR_u is the sum of squared residuals from the estimation of (A.1″), and if SSR_c is that from (A.3), then

$$\mathcal{J}. = \frac{(SSR_c - SSR_u)/8}{(SSR_u)/(n-17)} \quad (A.4)$$

is distributed F with 8 and n-17 degrees of freedom, where n is the number of observations. 8 is the number of constraints placed on the b vector ($b_1 = b_2 = \ldots = b_8 = 0$), and 17 is the number of coefficients estimated in (A.1″). If three seasonal dummies were included, the 17 would change to 20.

The statistic defined in (A.4) can thus be used to test the hypothesis that $b_1 = b_2 = \ldots = b_8 = 0$. An equivalent test holds for $m_1 = m_2 = \ldots = m_8 = 0$ in (A.2″).

In the equations in Section 3, for example, the data run from 1957:I to 1977:IV, 84 quarters. One observation is lost in computing percentage changes, and 8 more are lost in lagging the right-hand side variables. Thus, the equation is fitted over the period 1959:II to 1977:IV, a 75-quarter period. Subtracting 17 coefficients and 3 seasonal dummies leaves 55 degrees of freedom in equations (1) and (2). The F-statistics in Section 3, then, have 8 and 55 degrees of freedom. The degrees of freedom for the other tests follow similarly.

The long-run effect of x_t on y_t (or vice versa) can be defined as the change in the "steady-state" value of $y_t(x_t)$ due to a change in the "steady state" value of $x_t(y_t)$. In (A.2″), if x_t is held at a value $\bar{x}$ indefinitely, then y_t will tend to a value $\bar{y}$ such that

$$\bar{y} = d + \sum_1^8 m_j\bar{x} + \sum_1^8 n_j\bar{y}$$

or

$$\bar{y} = \frac{d}{1-\sum_1^8 n_j} + \frac{\sum_1^8 m_j}{1-\sum_1^8 n_j}\bar{x}$$

In other words, $\sum_1^8 m_j/(1-\sum_1^8 n_j)$ is the change in the long-run value of y_t due to a sustained change in x_t. A similar formula gives the long-run effect of y_t on x_t. These formulae are used in computing the long-run values used in the text.

Finally, applying seasonal filters to seasonally adjust the data before estimating equations (A.1″) and (A.2″) can be shown to introduce spurious causality. However, adding seasonal dummies to these equations using unadjusted data can be shown to subtract seasonal means from the data without filtering it, and so without distorting the causality relationships. The latter procedure is therefore taken in the text.

FOOTNOTES

1. Obviously, money creation does divert some resources temporarily, but it does so in small amounts compared to the value of the currency printed. Furthermore, a permanent increase in the money supply can be accomplished by only a temporary use of the printing presses.

Alternatively, continually increasing supplies of one good would require continual drains of more and more resources away from the other goods. However, the money supply can be continually increased using the same amounts of resources.

2. The money supply series used in these and the other tables is that given in **International Financial Statistics**, as published by the International Monetary Fund. This series differs very slightly from the Federal Reserve's M_1 definition, but corresponds to Japanese M_1 as published by the Bank of Japan. Singapore came into existence in 1966 and so is excluded from Table 1.

3. For a full exposition of this technique, see Christopher Sims, "Money, Income, and Causality," **American Economic Review**, September, 1972.

4. For example, there is no economic reason to suppose that, say, the population and the price level should be causally related. Yet because both have increased over time, a regression of the price level on population alone would almost surely show significantly positive coefficients. These would reflect the spurious correlation in the trends of the two series. However, including lagged values of the price level in the regression would capture the trend in the price level and therefore tend to eliminate the significance of the population coefficients.

If one variable truly causes another, then the former should be able to explain changes in the latter's trend. The Granger technique seeks to determine whether this is the case.

5. Notice that the β vector in (2) need not show a central bank's reaction function to inflation. If the inflation were originally caused by monetary expansion, and the central bank thus reacts to the effects of its own prior actions, such behavior will show up in the γ coefficients in equation (2). The β coefficients in (2) are more likely to show the monetary response to temporary price disturbances.

6. For Taiwan, the seasonal dummies did not improve the fit of equation (1). They were therefore not used in the result shown for Taiwan in Table 3.

7. For an explanation of this test, see Franklin Fisher, "Test of Equality between Sets of Coefficients in Linear Regressions," Section 3.1, **Econometrica**, March 1970.

8. This long-run effect is derived in the Appendix.

The Quantity Theory is the traditional theory of the effect of the money supply on prices. For a review of it, see Milton Friedman, "The Quantity Theory of Money: A Restatement," in his **Studies in the Quantity Theory of Money.**

9. When the four most significant lags of each set of variables are retained in Equations (1) and (2), and these equations are re-estimated, the vectors in both equations become significant, with the β's in equation (2) still having negative sum.

When such reformulations were done for other countries, however, the one-way causality from money to prices became more prominent. Japan appears to be the exception here.

Also, running equation (1) over subperiods of the 1957-77 period tends to improve the fit of inflation regressed on money, suggesting that changes in coefficients over time were more important for Japan than other countries.

10. These results are in accord with other studies which have found a strong counter-inflationary bias in Japanese monetary policy in order to maintain external balance. On this subject, see Charles Pigott's article in this **Review,** as well as R. Komiya and S. Suzuki, "Inflation in Japan," in **World Inflation,** L. Krause and W. Salant (eds.), Brookings Institution, 1977.

11. One such explanation is that money growth rates and inflation did not vary much over the sample period for these countries, so that equation (1) had little variation to measure. A measure of the variation of a variable is the ratio of its standard deviation to its average value. This ratio gives the variation in the variable **relative to trend.** When this "detrended variation" variable was computed for each country and compared to the size of the F-statistic in Table 3 for that country, the resulting Spearman rank correlation coefficient was 0.95, which is significant at the 1 percent level. In other words, countries with significant variation in money-supply growth rates tended to show stronger effects of money growth on inflation.

We can rationalize this in terms of our theory as follows. Changes in the money growth rate alter the underlying rate of inflation. If a country's money growth rate does not vary much, then its underlying rate of inflation will not vary much. The variations in the inflation rate that do occur will then be more likely the temporary effects of relative price changes, or random factors, which are less likely to be affected by the money supply. The effect of money-supply growth on inflation will then naturally be statistically weaker in these cases, since money growth rates are useful in explaining movements in inflation trends, and few of these have occurred. It is instructive to note that the two countries with the weakest effect in Table 2, Japan and Taiwan, also show the least variation in money-supply growth relative to trend.

12. For another discussion of monetary accommodation, and for references to the various expanations of inflation, see Robert J. Gordon, "World Inflation and Monetary Accommodation in Eight Countries," **Brookings Papers on Economic Activity,** 1977:2.

13. More precisely, these values would be significant at this level if we had run the equation without use of prior information. The fact that we used results from a previous estimate for this sample reduces the significance of the results somewhat.

14. The oil embargo and quadrupling of prices occurred in the 4th quarter of 1973. The dummy period used was 1974:I to 1975:IV.

15. The ratio of deficit to GNP—rather than the deficit itself—was used in order to induce stationerity in (i.e., to detrend) the government deficit series. The deficit series is in nominal terms and so will be non-stationary during a period of rising prices. Dividing by nominal GNP will produce a variable which need not automatically increase over time when prices do.

16. For references on this argument, see Robert J. Gordon, **op. cit.**

17. This is not to minimize the relevance of such series. However, there is reason to believe that different countries are more affected by some trading partners than others. However, a world money-supply series gives a fixed weight to each country that may be disproportionate to its effect on a particular Pacific Basin country.

While the U.S. money series does the same, by giving 100 percent to the U.S., it nevertheless helps us concentrate on the hypothesis that U.S. money growth spawned world inflation, as postulated in what Gordon calls the "international monetarist" hypothesis.

18. The sample period for Singapore runs from 1966:I to 1977:IV.

19. Nor do the causality conclusions change when inflation rates are substituted for money-growth rates in equations (3)-(8). The author will supply results of these other tests on request.

20. Larry Butler has developed this derivation of the causality technique.