The Link Between Money and Prices in an Open Economy: The Canadian Evidence from 1971 to 1980

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SINCE 1970, Canada ostensibly has followed a flexible exchange rate policy that should have allowed their monetary authorities to focus directly on controlling the Canadian inflation rate. Since 1975, the Canadian monetary authorities have been publicly committed to reducing inflation by a policy of gradually reducing the rate of monetary growth. Yet Canada has fared no better than the United States and other industrialized economies in controlling inflation during the 1970s. As table 1 shows, the average rate of Canadian money growth decreased from about 13 percent in 1971-75 to 8 percent in 1976-80, while the average rate of inflation remained unchanged at about 8½ percent in these two periods.

In this paper, we use a quantity theory framework to examine Canadian inflation over the past decade. In addition to assessing the impact of money growth on price changes, we test for the influence of other factors commonly believed to have contributed to Canadian inflation, for instance, the relative price of energy, Canadian wage-push and the rate of unemployment. Finally, we examine the influence of U.S. monetary growth and inflation on Canadian money growth and inflation. We find that Canadian inflation is largely explained by lagged Canadian money growth. Furthermore, we determine that Canadian monetary policy has not been independent from that of the United States: we find evidence of a link between Canadian and U.S. monetary growth in addition to a direct link between the U.S. and Canadian inflation rates.

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Table 1
Canadian Money Growth and Inflation

	Rate of money growth (M1)	Rate of inflation (GNP deflator)
1971	12.6%	3.2%
1972	14.2	5.0
1973	14.6	9.2
1974	9.5	15.3
1975	13.7	10.8
1976	8.1	9.5
1977	8.4	7.0
1978	10.4	6.4
1979	7.2	10.3
1980	6.4	10.6
1971-75	12.9	8.6
1976-80	8.0	8.7
1971-80	10.4	8.7

THE RELATIONSHIP BETWEEN MONEY AND PRICES: A GENERAL FRAMEWORK

One way to enhance our understanding of a complex system is to begin with a simple model of that system. Thus, it is instructive to consider first an economy in which market information is transmitted rapidly, and prices and wages adjust smoothly to maintain equilibrium continuously in all markets.

The Money-Price Link in a Frictionless Economy

In a smoothly operating, frictionless economy, the rate of change in prices would be determined largely by the rate of growth in the money stock. This can be derived from the well-known quantity theory of money. The quantity theory is usually written as:

(1) $MV = PY$,

where M is the stock of money, V is the velocity with which money circulates (the number of times money is used on average to finance final transactions), P is the price level and Y is the level of real income or output. According to the modern version of the quantity theory, V is a stable function of a few variables such as long-term income, interest rates and inflationary expectations.[1] If V is constant or changing at a steady rate and Y is growing at a steady rate, changes in P would be directly related to changes in M.[2] Expressed as rates of change, the quantity theory can be expressed as:

(2) $\dot{p} = \dot{m} + \dot{u}$,

where lowercase letters represent the values in natural logarithms and a dot indicates a first difference. Thus, p is the rate of change in the price level, $\dot{m}$ is the rate of change in the money stock and $\dot{u}$ is a residual term that represents the difference between the rate of change in velocity and that in output ($\dot{u} = \dot{v} - \dot{y}$).

If output and velocity grow at the same long-term rate, the average value of $\dot{u}$ would equal zero and the average rate of inflation per year would equal the rate of monetary growth. Deviations in velocity or output growth from their long-term trend values could cause the value of $\dot{u}$ to deviate temporarily from zero. To the extent that such changes are transitory, they only temporarily influence the rate of inflation.[3] In this sense, inflation is essentially a monetary phenomenon; that is, continuous growth in the money supply is necessary to sustain it.

In the above environment, factors such as increases in either real wages (brought about, say, by aggressive labor unions) or the relative price of energy could play only a limited role in explaining the rate of inflation. These factors could temporarily affect $\dot{u}$ (via their potential effect on full-employment output and velocity), but as long as there is no monetary accommodation—that is, as long as $\dot{m}$ is not influenced by these factors—their effect is likely to be short-lived.

Furthermore, in a frictionless economy, no special problem is created if the domestic rate of inflation differs from those in other countries. In such a case, the exchange rate could adjust continuously to reconcile differences between domestic and foreign rates of inflation.[4] For instance, if the domestic rate of inflation is 10 percent and the rate of inflation in the foreign economy is only 5 percent, the exchange rate—denoted as the number of units of the foreign currency that could be purchased by one unit of the domestic currency—would depreciate by 5 percent in each period and only this specific depreciation would keep the *relative* price of domestic and foreign goods the same.

The Effect of Frictions on the Money-Price Link

We do not live in a frictionless world. There are frictions in the adjustment process, for example, that arise from lags in the transmission of price information from one market to another and from inertia in the movement of wages and prices.[5] Given these information lags and temporary wage-price inflexibilities, the effect of monetary growth on inflation will not be reflected fully in one period; rather, it will be distributed over a number of periods.[6] Taking these lags into account, the relationship between money and prices can be modeled as

(3) $p = \dot{m} + \varepsilon$,

[1]See Milton Friedman, *A Theoretical Framework for Monetary Analysis* (National Bureau of Economic Research, 1971).

[2]Given smooth adjustment in our economy, long-term growth in real output would depend essentially on factors such as technological advance and population growth.

[3]For a discussion of the influence of nonmonetary factors such as a supply shock on the price level and the rate of price change, see Denis S. Karnosky, "The Link Between Money and Prices—1971-1976," this *Review* (June 1976), pp. 17-23.

[4]Real factors, such as changes in tastes, technology or the supplies of factors of production, also can affect the exchange rate.

[5]Information lags have been emphasized by Robert E. Lucas, "Expectations and the Neutrality of Money," *Journal of Economic Theory* (April 1972), pp. 103-24; "An Equilibrium Model of the Business Cycle," *Journal of Political Economy* (December 1975), pp. 1113-44. A recent explanation of wage-price stickiness is that, under conditions of uncertainty, transactions in markets with rapid price adjustments are costly, and therefore wages and prices may be changed infrequently to save these transaction costs. See Michael D. Bordo, "The Effects of Monetary Change on Relative Commodity Prices and the Role of Long-Term Contracts," *Journal of Political Economy* (December 1980), pp. 1088-1109.

[6]See, for example, the discussion by Keith M. Carlson, "The Lag from Money to Prices," this *Review* (October 1980), pp. 3-10.

where $\dot{\bar{m}}$ is some *weighted average of past monetary growth rates*—call it the long-term or trend rate of monetary growth—and ε is a *residual* term.

Several caveats, however, should be added to this simple representation of the lag between money and prices. First, theoretical analysis does not specify the pattern of weights that should be used in calculating the long-term monetary growth rate—it must be discovered empirically. Also, because these weights represent the lags between money and prices embedded in a particular policy regime and institutional setting, they will shift with significant changes in policy and institutions.[7] Second, ε represents the influence of all factors other than monetary growth. The effect of these factors also operates with lags and cannot be simply dismissed, at least theoretically, as a temporary deviation. Finally, in a nonfrictionless economy, the exchange rate need not change smoothly to offset exactly the difference between foreign and domestic inflation rates.[8] Thus, the economy generally will not be immune from the influence of inflation in the rest of the world.

DETERMINANTS OF CANADIAN INFLATION DURING 1971-80

The Role of Long-Term Monetary Growth

We begin by examining the influence of long-term monetary growth. As discussed above, the specific long-term monetary growth rate that best explains inflation must be estimated empirically. We found that, for the I/1971-IV/1980 period, a simple 12-quarter average of past growth rates of Canadian M1 provides an adequate measure of the long-term monetary growth rate for Canada.[9] The effect of long-term monetary growth, thus measured, on the quarterly rate of inflation in Canada is shown in regression equation 1 in table 2 and is illustrated in chart 1. The chart shows: (a) the actual rate of inflation measured by the quarter-to-quarter change in the GNP deflator over the period and (b) the rate of inflation predicted by the long-term monetary growth rate from equation 1 in table 2.

As chart 1 shows, the predicted rate traces quite well the sharp rise in the inflation rate up to 1974 and the gradual decline in the subsequent three years. The chart also shows that the inflation rate was much higher than the predicted rate in 1974 and, more recently, in 1979 and 1980.

To facilitate a comparison between the U.S. and Canadian inflation experience, chart 2 presents the actual and predicted rates of inflation in the United States using the same procedure as for the Canadian data (regression estimates for the United States are shown in equation 4, table 2).[10] As in the Canadian case, the simple 12-quarter average of M1 growth predicts inflation quite well. Note, however, that the predicted rate shown in the chart also includes the effect of price controls in the United States.

Nonmonetary Influences on Canadian Inflation

Having accounted for the direct impact of monetary growth on the Canadian inflation rate, we now consider certain nonmonetary factors that are potential causes of the residual inflation rate (the difference between the actual inflation rate and the rate predicted by long-term monetary growth). First, it is possible that the Canadian wage and price controls adopted at the end of 1975 and terminated in the third quarter of 1978 had some impact on Canadian inflation. If these controls were effective, the residual inflation rate

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[7]For instance, Robert E. Lucas, "Econometric Policy Evaluations," in Karl Brunner and Allan H. Meltzer (eds.), *The Phillips Curve and the Labour Market* (North Holland, 1976), has argued that the structure of the economy depends upon the conduct of policy.

[8]See Jacob Frankel, "The Collapse of Purchasing Power Parities During the 1970s," *European Economic Review* (February 1981), pp. 145-65.

[9]We regressed the rate of inflation on the simple average of past monetary growth rates, using three alternative definitions of money (M1, M1B and M2) and alternative averaging periods, differing by two-quarter intervals (2, 4, 6. . .). A 12-quarter average of M1 worked best in the sense of giving the lowest standard error of the regression. This procedure constrains the weights on past growth rates to be equal. To test this constraint, we estimated the following regression:

$$\dot{p}_t = a + \sum_{i=1}^{12} b_i \dot{m}_{t-i} + e.$$

In the above regression, the hypothesis that $b_1 = b_2 \ldots b_{12}$, could not be rejected at the conventional 5 percent level. Finally, note that we have not constrained the coefficient of $\dot{\bar{m}}$ ($\dot{\bar{m}}_t = \sum_{i=1}^{12} \dot{m}_{t-i}/12$) to be equal to unity.

[10]A 12-quarter average of M1 worked best for the U.S. data. The U.S. evidence also was consistent with the hypothesis that the weights on lagged monetary growth rates are all equal. In the U.S. regression, we also have included price-control and decontrol dummies as defined in Carlson's paper.

Note that the coefficient on $\dot{\bar{M}} > 1$ may reflect the impact of higher energy prices in the United States which are not captured explicitly in the U.S. equation. See Carlson, "The Lag from Money to Prices." This paper also provides estimates of the U.S. money-price relationship using Almon lags and including additional variables. Also see John A. Tatom, "Energy Prices and Short-Run Economic Performance," this *Review* (January, 1981), pp. 3-17.

Table 2

Estimates of the Money-Price Relationship in Canada and the United States: I/1971-IV/1980

	Equation	Constant	$\dot{m}$	DUMC	DUMA	$\dot{r}$	DW	$\bar{R}^2$	SE × 10^2
Canada	(1)	.003	.772				2.14*	.375*	.725*
		(.40)	(2.29)						
	(2)	−.007	1.205	−.005	.009		1.94	.525	.687
		(−1.35)	(5.90)	(−2.18)	(2.33)				
	(3)	−.008	1.119	−.005	.009	.190	2.33	.597	.641
		(−1.71)	(5.77)	(−2.05)	(2.65)	(2.50)			
United States	(4)	−.006	1.555	−.004	.008		1.88	.706	.316
		(−1.75)	(6.66)	(−3.38)	(4.09)				

NOTE: The dependent variable is $\dot{p}$ where p is the log of GNP deflator. $\dot{m} = (\sum_{i=1}^{12} \dot{m}_{t-i})/12$, where m is the log of M1. DUMC is the price control dummy (for Canada, equal to one over IV/1975-III/1978, zero elsewhere; for the United States, equal to one over III/1971-I/1974, zero elsewhere). DUMA is the dummy for the after-control period (for Canada, equal to one over IV/1978-III/1979, zero elsewhere; for the United States, equal to one over II/1974-IV/1974, zero elsewhere). r represents the log of an index of energy prices divided by the GNP deflator. $\bar{R}^2$ is the coefficient of determination corrected for degrees of freedom, SE is the regression standard error and DW is the Durbin-Watson statistic. (t-values are shown in parentheses.)

*Equation 1 is estimated using Cochrane-Orcutt adjustment with ρ = .357.

should be negative during the period of controls and positive immediately thereafter.[11] This pattern is suggested by chart 1 and is confirmed by equation 2 in table 2, where the price control dummy (DUMC) is significantly *negative* and the dummy variable for the one-year period following the end of controls (DUMA) is significantly *positive*.

Second, the relative rise of energy prices, which has been regarded as a significant factor in explaining U.S. inflation, could similarly have affected Canadian prices in the 1970s.[12] This hypothesis is supported by equation 3 in table 2, which shows that a four-quarter average of changes in relative energy prices has a significant positive effect on the Canadian inflation rate.[13]

A third explanation that invariably arises in inflation discussions is that the rising prices were caused, at least in part, by wage-push.[14] In Canada we found that the rate of monetary growth is not systematically related to (current or past) wage changes and, thus, there is no direct evidence that the Bank of Canada followed a policy of validating wage increases by accelerating the growth in money.[15] Even without monetary accommodation, wage-push elements may still have influenced the residual inflation rate, at least in the short run. This possibility also was rejected by the Canadian evidence, which shows that the rate of wage change (in the current and past three quarters) does

[11]For a further discussion of the Canadian experience with controls, see the articles by Michael Parkin and Jack Carr in Jack Carr et al., eds., *The Illusion of Wage and Price Control* (Vancouver: The Fraser Institute, 1976).

[12]Tatom, "Energy Prices and Short-Run Economic Performance."

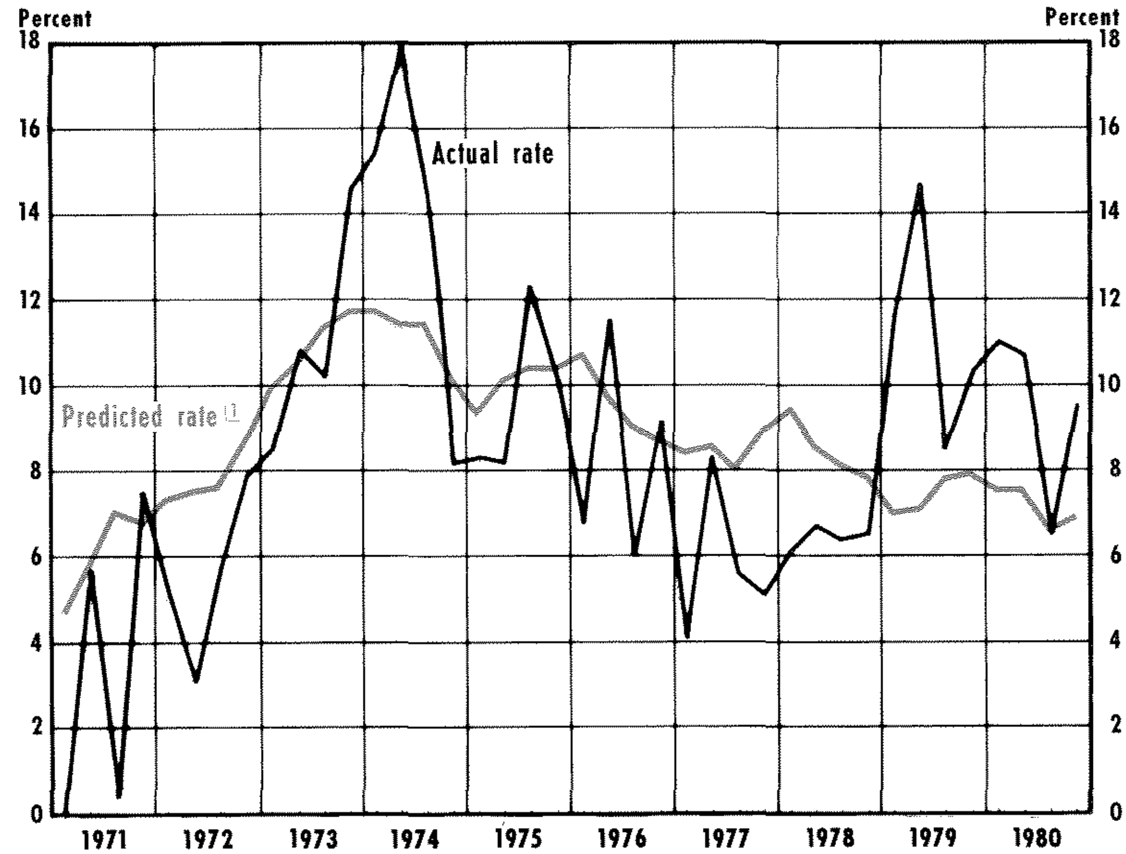
[13]Averages of relative energy prices for two, six and eight quarters also were considered, but the four-quarter average produced the strongest effect. The evidence also was consistent with the constraint (implicit in the simple four-quarter average) that the coefficients of current and three lagged energy-price terms were all equal.

[14]See Dallas S. Batten, "Inflation: The Cost-Push Myth," this *Review* (June/July 1981), pp. 20-26.

[15]Current and up to four lagged values of the rate of change in the wage index (hourly wage rate of manufacturing sector) were introduced in an autoregression of the rate of monetary growth (M1) containing four of its own lagged values. All wage terms were insignificant in this regression (estimated for the period I/1971-IV/1980). Also, see the evidence in Robert J. Gordon, "World Inflation and Monetary Accommodations in Eight Countries," *Brookings Papers on Economic Activity* (2:1977), pp. 409-68.

Chart 1

The Actual Vs. Predicted Rate of Inflation in Canada



[1] The rate predicted by Canadian long-term monetary growth.

not exert a significant effect in the money-price regression.[16]

A fourth explanation, suggested by the Phillips curve theory, is that the residual rate of inflation may reflect the effect of excess supply or demand (in goods and/or labor markets) as measured by the unemployment rate.[17] This explanation also was tested and rejected: the effect of the unemployment rate (in the current and past three quarters) is insignificant when introduced in the regression containing the long-term monetary growth rate.[18]

HOW U.S. MONETARY GROWTH AND INFLATION CONTRIBUTED TO CANADIAN INFLATION

Monetary growth and inflation in the United States could have influenced the Canadian rate indirectly through their impact on Canadian monetary growth,

[16] We estimated the following regression equation:

$$\dot{p} = a_0 + a_1 \dot{\bar{m}} + a_2 DUMC + a_3 DUMA + a_4 \dot{\bar{r}} + \sum_{i=0}^{3} b_i \dot{w}_{t-i}$$

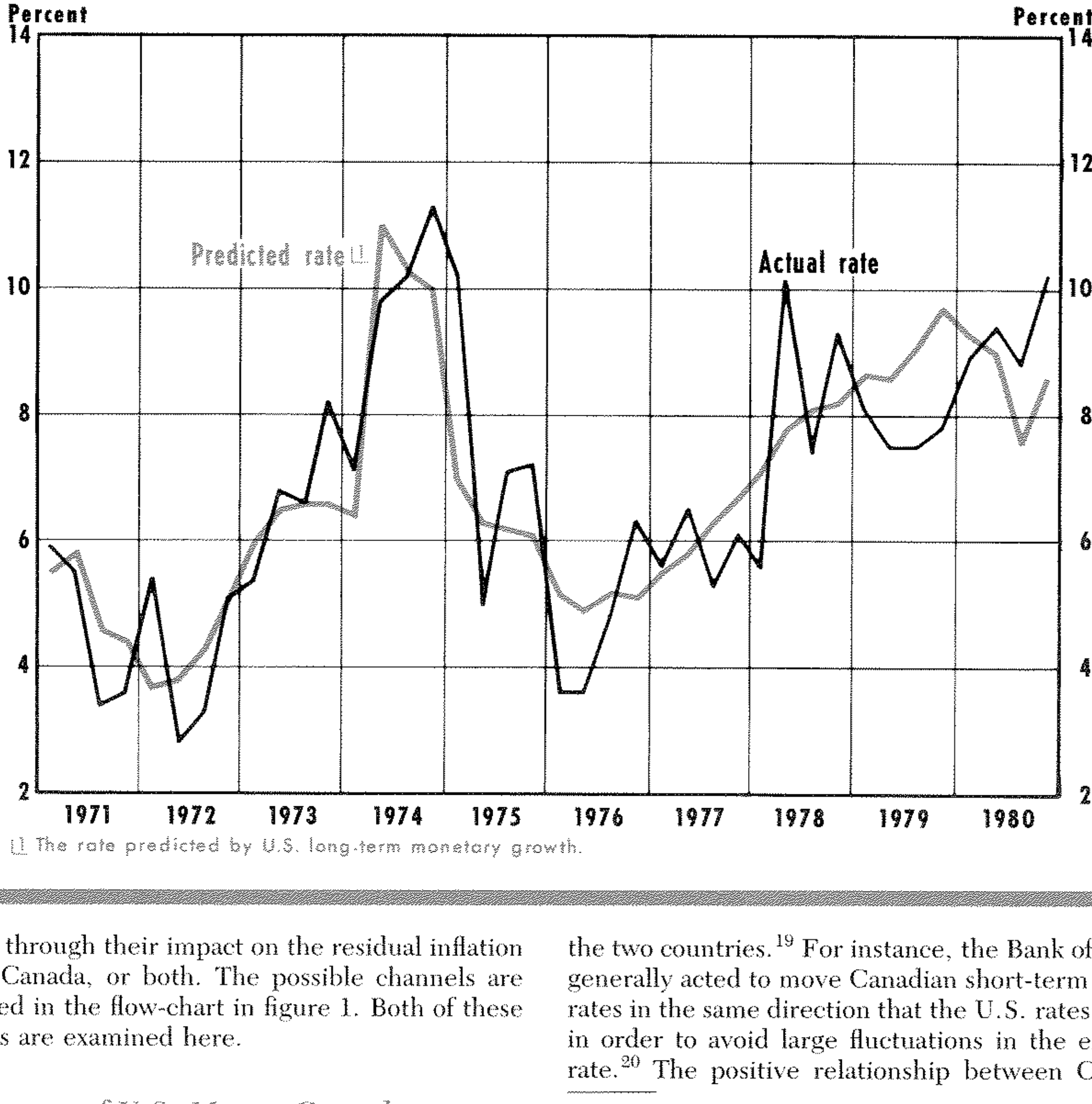
where w represents the log of the hourly wage rate in Canadian manufacturing, and other variables are as defined in table 1. In this regression, b_i's were insignificant individually as well as jointly. A four-quarter average of $\dot{w}$'s was tried, but its effect also was insignificant.

[17] In the standard version of the Phillips curve theory, a price-expectation term is added to the unemployment rate. See, for example, Rudiger Dornbusch and Stanley Fischer, *Macroeconomics*, 2nd ed. (McGraw-Hill, 1980). The above variant, in fact, represents a monetary-growth-augmented Phillips curve.

[18] As in the case of wage index, the coefficients of the current and three lagged values of the unemployment rate were insignificant both individually and jointly when added to the money-price regression (including control dummies and $\dot{\bar{r}}$). A four-quarter average of the unemployment rate also did not produce a significant effect.

Chart 2

The Actual Vs. Predicted Rate of Inflation in the United States



1 The rate predicted by U.S. long-term monetary growth.

directly through their impact on the residual inflation rate in Canada, or both. The possible channels are presented in the flow-chart in figure 1. Both of these channels are examined here.

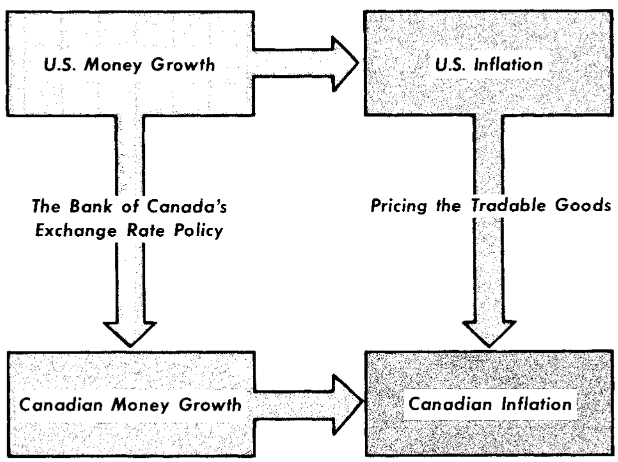
The Impact of U.S. Money Growth on Canadian Money Growth

During the 1970s, despite the nominal existence of a flexible exchange rate system, the Bank of Canada often has attempted to control the movement of the Canadian-U.S. dollar exchange rate. This exchange rate intervention may have established a link between the Canadian and U.S. monetary growth. Because the Bank engages in interest-rate control to implement monetary policy, Canadian money growth is likely to be linked to U.S. money growth via interest rates in the two countries.[19] For instance, the Bank of Canada generally acted to move Canadian short-term interest rates in the same direction that the U.S. rates moved, in order to avoid large fluctuations in the exchange rate.[20] The positive relationship between Canadian

[19]Since 1975 the Bank of Canada began announcing target ranges for the growth of M1. However, it has continued to use the control of short-term interest rates as the policy instrument in the short run. For a further discussion of the Bank of Canada's approach to monetary policy, see Thomas J. Courchene, "On Defining and Controlling Money," *Canadian Journal of Economics* (November 1979), pp. 604-15.

[20]The relationship between the Canadian-U.S. interest rate differential and the exchange rate could be either positive or negative depending on whether the interest rate differential represents differences between expected inflation rates or real interest rates in the two countries. For a further discussion of the relationship between the exchange rate and interest rates, see Dallas S. Batten, "Foreign Exchange Market: The Dollar in 1980," this *Review* (April 1981), pp. 22-30.

Figure 1
The Transmission of U.S. Money Growth to Canadian Inflation



and U.S. interest rates arising from this policy also is likely to imply a positive correlation between rates of monetary growth in the two countries.[21]

To explore whether Canadian money growth is systematically related to U.S. money growth, we regressed the monetary growth rate in Canada on current and lagged values of the U.S. monetary growth rate. The results show a statistically significant, synchronous relationship between the rates of growth in Canadian M1 and U.S. M1A.[22] Thus, the Bank of Canada's exchange rate policy appears to have established a link between U.S. and Canadian money growth. This link opens up a channel through which U.S. money growth can influence Canadian inflation.[23]

The effect of operating through this channel is illustrated in chart 3. In this chart, we show both the actual rate of long-term Canadian monetary growth and the rate induced by U.S. monetary growth because of Canadian exchange-rate intervention.[24] The difference between the two rates can be viewed as the result of Canadian monetary policy actions not related to exchange market intervention.

Two interesting points emerge from this chart. First, the portion of Canadian money growth induced by U.S. money growth has been sizable and relatively stable throughout the period (it has varied between 4.2 and 6.1 percent per year). Second, the residual growth rate, as represented by the gap between the actual and the U.S.-induced rates, rose sharply in the early 1970s but has been declining gradually since the mid-1970s. Thus, the Bank of Canada's anti-inflation policy adopted in 1975 appears to be effectively reducing the nonintervention portion of Canadian money growth, while having little impact on the contribution of foreign exchange market intervention to money growth.

The Impact of U.S. Inflation on Canadian Inflation

The Canadian rate of inflation also may be directly related to the U.S. inflation rate because of price linkages between Canadian and U.S. tradable goods. According to one hypothesis about these price linkages—called the "law of one price"—the Canadian price for goods produced both in the United States and Canada is the same as the U.S. price adjusted for the exchange rate. According to this hypothesis, the Canadian rate of inflation would depend on the U.S. rate of inflation adjusted for changes in the exchange rate.[25] It should be pointed out that even if Canadian money growth were held constant and there were no intervention in the exchange market, an increase in the U.S.

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[21]The direction of the relationship between monetary growth and the rate of interest in each country also would depend on whether interest rate changes reflect changes in expected inflation or real interest rates. We assume that the direction of this relationship is the same in both Canada and the United States.

[22]The estimated regression equation is:

$$\dot{m}_t^{ca} = .012 + .894\,\dot{m}_t^{US}$$
$$(1.96) \quad (2.40)$$

$$DW = 1.98,\ R^2 = .13,\ SE = .0164$$

where m^{ca} and m^{US} represent the logs of Canadian M1 and U.S. M1A. Up to four lagged values of $\dot{m}^{US}$ also were introduced in the regression but their effect was found to be insignificant at the 5 percent level. Using M1 as an alternative measure of the U.S. money supply, the results of the above tests were similar, but the effect of U.S. M1 on Canadian M1 was weaker than U.S. M1A. (Using U.S. M1 instead of U.S. M1A, the coefficient of $\dot{m}_t^{US}$ was equal to .666 in the above regression, with a t-value of 1.74.)

[23]Of course, the synchronous relationship between Canadian and U.S. money growth does not, by itself, imply anything about the direction of causation. We assume, however, that U.S. monetary policy actions are independent of Canadian monetary policy.

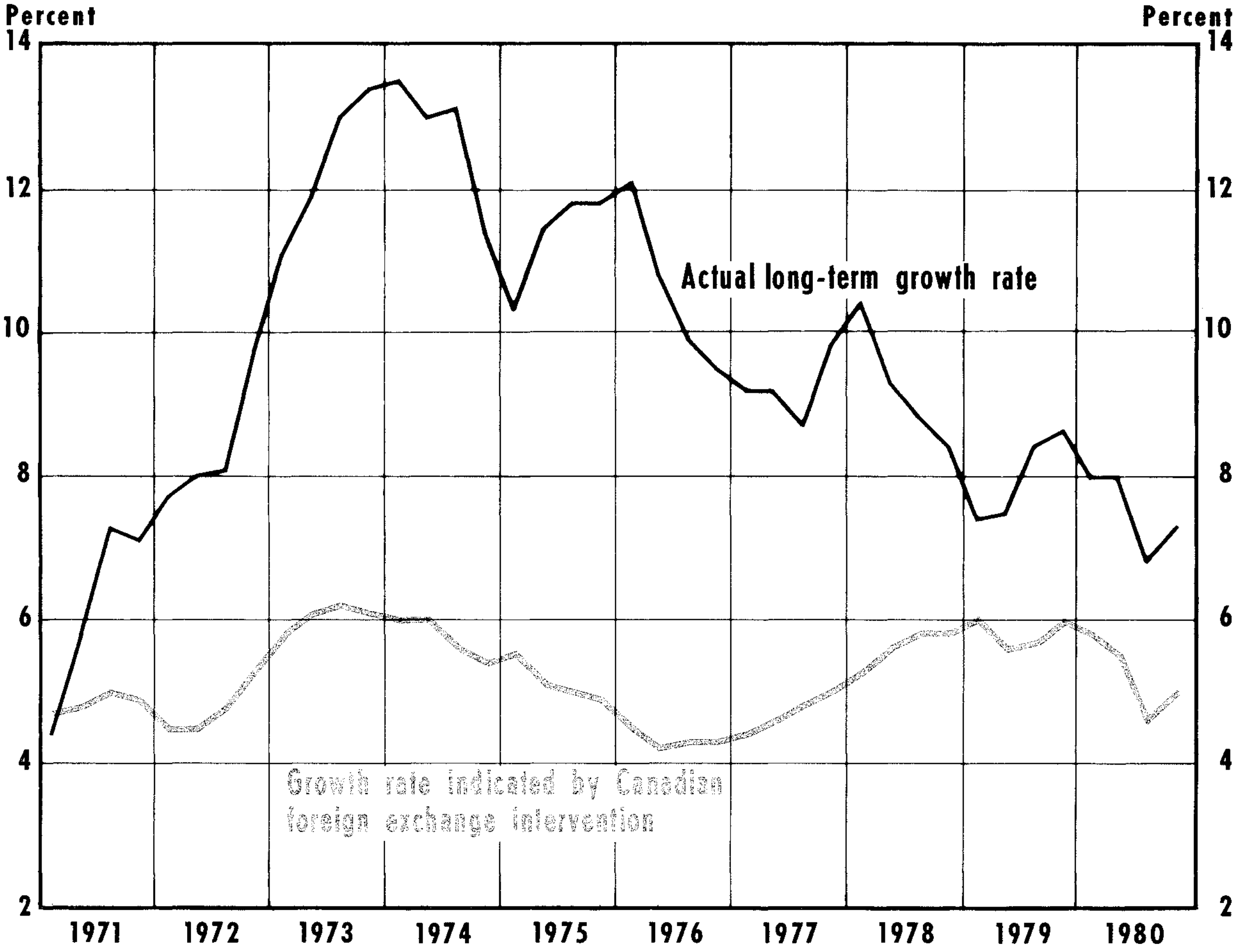
[24]Using the regression equation relating $\dot{m}^{ca}$ to $\dot{m}^{US}$ in footnote 22 and averaging over 12 quarters, the long-term monetary growth in Canada equals:

$$\bar{\dot{m}}^{ca} = .012 + .894\,\bar{\dot{m}}^{US} + u,$$

where u is the 12-quarter average of the residual error in the regression equation in footnote 22. From the above equation, we estimate the amount of Canadian long-term monetary growth induced by U.S. long-term growth to be equal to $.894\,\bar{\dot{m}}^{US}$.

[25]For individual tradable goods, the law implies that the rate of change in the Canadian price would equal the rate of change in the U.S. price, plus the rate of appreciation of the U.S. dollar. The relationship between inflation rates in the two countries, however, would be generally weaker because: (a) some nontraded goods would be included in each country's aggregate price index and (b) the weights used in the aggregate index may be different for the two countries.

Chart 3
The Contribution of U.S. Long-Term Monetary Growth to Canadian Long-Term Monetary Growth



inflation rate need not be accompanied by an equal depreciation of the U.S. dollar in the short run. U.S. inflation, therefore, could *temporarily* affect the residual rate of inflation in Canada.[26]

The simple version of the law of one price is based on the assumptions that the costs of making price changes and undertaking arbitrage are negligible, the goods produced in the two countries are identical in all respects and perfect competition prevails. If one or more of these assumptions do not hold, the price relationship implied by the law of one price could be significantly altered.[27] For instance, if prices are costly to change, domestic prices may not respond to those changes in foreign prices and the exchange rate that are perceived to be transitory.[28] This modification of the law of one price suggests that Canadian price changes

[26]In terms of the quantity theory framework, the above effect implies that U.S. inflation can temporarily influence the rate of growth in velocity and/or output in Canada. Such an impact is possible in open-economy models which allow for capital mobility and/or distinguish between traded and nontraded goods. For a discussion of monetary adjustment in open-economy models, see Rudiger Dornbusch, *Open Economy Macroeconomics* (Basic Books, 1980).

[27]For empirical evidence on the depatures from the law of one price, see Irving B. Kravis and Robert E. Lipsey, "Price Behaviour in the Light of Balance of Payments Theories," *Journal of International Economics* (2:1978), pp. 193-246.

[28]The costs of making price changes would include not only administrative and labeling costs, but also the costs associated with advertising price changes, adverse reaction from customers and uncertainty about the response of competitors.

Table 3
The Influence of U.S. Inflation in the Canadian Money-Price Relationship

	(1)	(2)	(3)	(4)
Constant	−.007 (−1.45)	−.012 (−2.28)	−.020 (−2.73)	−.026 (−3.81)
$\dot{m}^{ca}$	1.107 (5.68)	1.015 (5.31)	.994 (5.29)	.997 (5.43)
DUMC	−.004 (−1.81)	−.003 (−1.07)	−.001 (−.56)	
DUMA	.010 (2.72)	.007 (2.00)	.005 (1.38)	
$\dot{r}$	.214 (2.67)	.085 (.87)	.078 (.81)	
$\dot{p}^{US}+\dot{e}$	−.062 (−.96)			
$\dot{p}^{US}$		.474 (1.78)		
$\dot{e}$		−.140 (−1.92)	.141 (−1.98)	
$\hat{\dot{p}}^{US}$			.933 (2.35)	1.33 (4.40)
$\dot{p}^{US}-\hat{\dot{p}}^{US}$			.272 (.93)	
DW	2.39	2.37	2.42	1.90
R^2	.608	.653	.677	.579
SE × 10^2	.642	.613	.601	.638

NOTE: The dependent variable is $\dot{p}^{ca}$. e is the log of the exchange rate (Can. $/U.S. $). $\hat{\dot{p}}^{US} = -.006 + 1.555\,\dot{m}^{US}$, represents the fitted value of $\dot{p}^{US}$ from equation 4, table 2 (without the control dummies). Other variables are defined in table 2. (t-values in parentheses.)

are related to *long-term* movements in U.S. prices and the exchange rate.

To explore the direct link between the U.S. and Canadian inflation, we experimented with a number of tests. First, we added the exchange-rate-adjusted U.S. inflation ($\dot{p}^{US} + \dot{e}$, where e is the logarithm of the price of the U.S. dollar in Canadian dollars) to the money-price regression including price-control dummies and the relative energy price. As shown in equation 1, table 3, the effect of this variable is insignificant.[29] Next, we included the U.S. inflation rate ($\dot{p}^{US}$) and the exchange rate change ($\dot{e}$) as separate variables in the regression equation. In this test (see equation 2, table 3), while the U.S. inflation rate has a positive effect, the effect of the exchange-rate change is negative (both variables are significant at the 10 percent level, though not at the 5 percent level).[30] We are, thus, unable to find a consistent effect of the exchange rate on Canadian inflation. One explanation of this is that the exchange rate exhibited little or no time trend during the flexible exchange rate period.[31] Its movements, therefore, could have been considered transitory and largely disregarded in the adjustment of Canadian prices.

Finally, to examine the possibility that transitory and trend changes in U.S. prices may exert different effects on Canadian inflation, we divided the U.S. inflation rate in two parts: (a) the rate predicted by long-term U.S. money growth ($\hat{\dot{p}}^{US}$) and (b) the residual rate ($\dot{p}^{US} - \hat{\dot{p}}^{US}$). Each part was entered in the regression equation separately. As shown in equation 3, table 3, this test produced the interesting result that, although the effect of the U.S. monetary-induced trend rate of inflation is positive and significant, the effect of the residual rate is insignificant. It is also interesting to note that the effect of both price-control dummies as well as that of the relative energy price is insignificant in this regression.[32] In equation 4, table 3, we present the regression equation that emerges when

[29]Up to three lagged values of the exchange-rate-adjusted U.S. inflation also were added to the regression, but their effects remained insignificant.

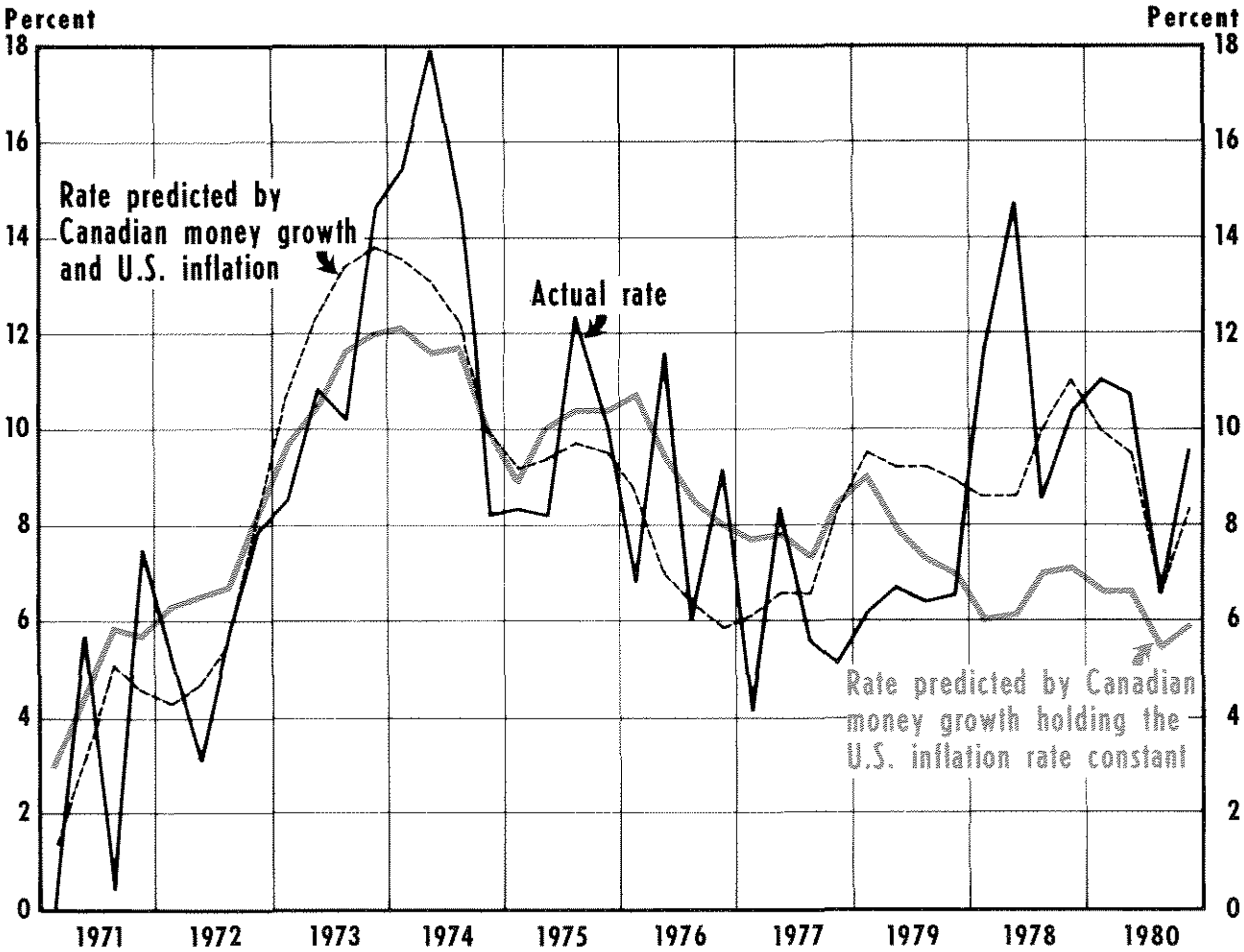
[30]Again, up to three lagged values of both $\dot{p}^{US}$ and $\dot{e}$ were introduced in the regression, but none of these terms produced a significant effect. A four-quarter average of $\dot{e}$ was tried, but this variable also had an insignificant influence.

[31]From II/1970 to IV/1980, the exchange rate changed by only 12 percent. The U.S. aggregate price level changed by 102 percent over the same period.

[32]As these variables are correlated with the U.S. inflation rate, it is difficult to disentangle their separate influences on Canadian inflation. For example, the correlation coefficient between $\dot{p}^{US}$ and $\dot{r}$ is .655, between $\dot{P}^{US}$ and DUMC is −.237 and between $\dot{p}^{US}$ and DUMA is .198.

Chart 4

The Contribution of Monetary-Induced U.S. Inflation to Canadian Inflation



we exclude the dummy variables, the relative energy price and the exchange rate. In this equation, the Canadian inflation rate is explained by only two factors: (1) the long-term rate of money growth in Canada and (2) the U.S. monetary-induced or trend inflation rate.

The Canadian rate of inflation predicted by regression equation 4 in table 3 is shown in chart 4. To illustrate the role of U.S. inflation in the Canadian price equation, the chart also shows the Canadian inflation rate that would have been predicted by Canadian money growth if the U.S. inflation rate had remained constant throughout the period.[33] The difference between the two predicted rates can be interpreted as the contribution of the (money-growth-related) U.S. inflation rate to the rate of inflation in Canada. As the chart illustrates, while the U.S. influence (as operating through the U.S. inflation rate) has tended to lower the predicted rate of inflation in Canada during the early 1970s and in the control period, it has added to the predicted rate during the 1973-74 period and, more recently, in the post-control period.[34]

It was noted earlier that the Canadian rate of inflation has stayed well above the rate predicted by the

[33]The U.S. inflation rate is set constant at its quarterly average for the 1971-80 period (equal to .017 when expressed as a fraction per quarter). Under this assumption, the Canadian inflation rate is predicted by the equation: $\dot{p}^{ca} = -.003 + .997\ \dot{m}^{ca}$.

[34]It is interesting to note that because of lags between U.S. money growth and inflation, the effect of monetary-induced U.S. inflation on Canadian inflation in 1973-74 and the post-control period has, in fact, been produced by rapid U.S. money growth prior to these periods.

Canadian long-term monetary growth in 1979 and 1980. Chart 4 shows that this difference can be explained for most of the period by taking into account the effect of the monetary-induced U.S. rate of inflation. As can be seen from the chart, although there are large deviations in the first two quarters of 1978, the predicted inflation rate (based on both Canadian money growth and U.S. trend inflation rate) tracks the actual inflation rate quite well in the remainder of the 1979-80 period.

The above discussion of the impact of U.S. money growth and inflation on the rate of inflation in Canada has highlighted two channels through which the effect of U.S. money growth is transmitted to Canadian inflation. As illustrated in figure 1, U.S. money growth influences inflation in Canada via: (1) Canadian money growth and (2) U.S. inflation. The first channel operates because of the Bank of Canada's policy of intervening in the exchange market. It is interesting to point out that this policy also may have strengthened the second channel. For instance, if the Bank of Canada had not attempted to influence the exchange rate and followed an independent monetary policy, the exchange rate may have shown a pronounced trend which may have offset, at least in part, the effect of monetary-induced U.S. inflation on Canadian inflation.

SUMMARY AND CONCLUSIONS

This article has examined the role of a number of factors in determining the rate of Canadian inflation over the last decade. The evidence shows that long-term monetary growth—as measured by the average rate of growth of Canadian M1 over the past 12 quarters—is a key determinant of Canadian inflation. Furthermore, after taking into account the effect of long-term Canadian monetary growth, factors such as wage-push and unemployment did not exert a significant effect on Canada's inflation rate.

The article also has examined the transmission of inflation from the United States to Canada. It finds that long-term U.S. monetary growth—also measured by a 12-quarter average of past money growth rates—contributed significantly to Canadian inflation in two distinct ways: (1) U.S. monetary growth directly affected Canadian monetary growth, and (2) the monetary-induced portion of U.S. inflation—the part of the inflation rate explained by long-term U.S. monetary growth—directly affected Canadian inflation (holding constant the effect of Canadian monetary growth). The link between U.S. and Canadian monetary growth arises, in our view, from the Bank of Canada's policy of not allowing the exchange rate to fluctuate freely. Indeed, it is possible that this policy of exchange rate management also may have strengthened the direct link between U.S. and Canadian inflation.

Recently, monetarism has been criticized in Canada because the Bank of Canada, while apparently successful in reducing the rate of growth of Canadian M1, has been unable to significantly reduce inflation. This article suggests that Canada's difficulties in controlling inflation can be explained, at least in part, by taking into account the effect of U.S. long-term monetary growth on Canadian inflation.