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Real and Monetary Shocks to the Canadian Dollar: Do Canada and the U.S. Form an Optimal Currency Area?

by

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Abstract

There is widespread agreement that during the floating exchange rate period from 1970 to the present Canada's nominal and real exchange rates with respect to the United States have shown considerable volatility. It has been suggested that the volatility of the real exchange rate would be substantially reduced if the nominal exchange rate with the U.S. dollar were fixed, either through a permanent fixed exchange rate mechanism or the adoption of a common North American currency. In all discussions of the fixed verses floating exchange rate question, it is important to understand why real exchange rates are volatile. The sources of real exchange rate volatility are the focus of this paper. Our findings are that substantial asymmetric real shocks have occurred and were an important determinant of the real exchange rate but there is no evidence of real exchange rate effects of monetary shocks. Since our results indicate that the sources of exchange rate volatility are real, not monetary, they are unfavorable to the adoption by Canada of a common currency with the United States.

Classification codes: open economy macroeconomics, international monetary arrangements and institutions, financial aspects of economic integration.

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1 Introduction

There is widespread agreement that during the floating exchange rate period from 1970 to the present Canada's nominal and real exchange rates with respect to the United States have shown considerable volatility. As can be seen in Figure 1, the nominal and real exchange rates move closely together, differing by the modest and rather stable difference in the relative movements of the Canadian and U.S. price levels. It has been suggested that the volatility of the real exchange rate would be substantially reduced if the nominal exchange rate with the U.S. dollar were fixed, either through a permanent fixed exchange rate mechanism or the adoption of a common North American currency.[1] The suggestion has provoked considerable controversy.[2] In all discussions of the fixed verses floating exchange rate question, it is important to understand why real exchange rates are volatile. The sources of real exchange rate volatility are the focus of our paper.

The issue has important implications for the question of whether Canada and the United States form an optimum currency area.[3] This requires that that real shocks affect the two countries symmetrically so that the real exchange rate is unaffected. If asymmetric real shocks are an important determinant of the exchange rate, Canada and the U.S. do not form an optimal currency area.

Monetary shocks are also an important consideration. Asymmetric monetary shocks will directly affect a flexible nominal exchange rate. And the real exchange rate will then be dragged along in the short-run because of price level stickiness. But in the long-run the real exchange rate will return

[1] See Thomas J. Courchene and Richard G. Harris, *From Fixing to Monetary Union: Options for North American Currency Integration*, C.D. Howe Institute, 1999 and "North American Monetary Union: Analytical Principles and Guidelines," *North American Journal of Economics and Finance*, Vol. 11, No. 1, August 2000, 1–18, and Herbert G. Grubel, "The Case for the Amero: The Economics and Politics of a North American Monetary Union", *Critical Issues Bulletin*, The Fraser Institute, 1999 and "The Merit of Canada–U.S. Monetary Union", *North American Journal of Economics and Finance*, Vol. 11, No. 1, August 2000, 19–40.

[2] See, for example, John Crow, "Any Sense in a Canadian Dollar?" *PEAP Policy Study 99.1*, University of Toronto, 1999, David Laidler, "The Exchange Rate Regime and Canada's Monetary Order", *Working Paper 99-7*, Bank of Canada, 1999, and John Murray, "Why Canada Needs a Flexible Exchange Rate," *North American Journal of Economics and Finance*, Vol. 11, No. 1, August 2000, 41–60 [Originally *Bank of Canada Working Paper 99-12*, 1999].

[3] R.A. Mundell, "A Theory of Optimum Currency Areas," *American Economic Review*, Vol. 51, No. 4, September 1961, 657–665.

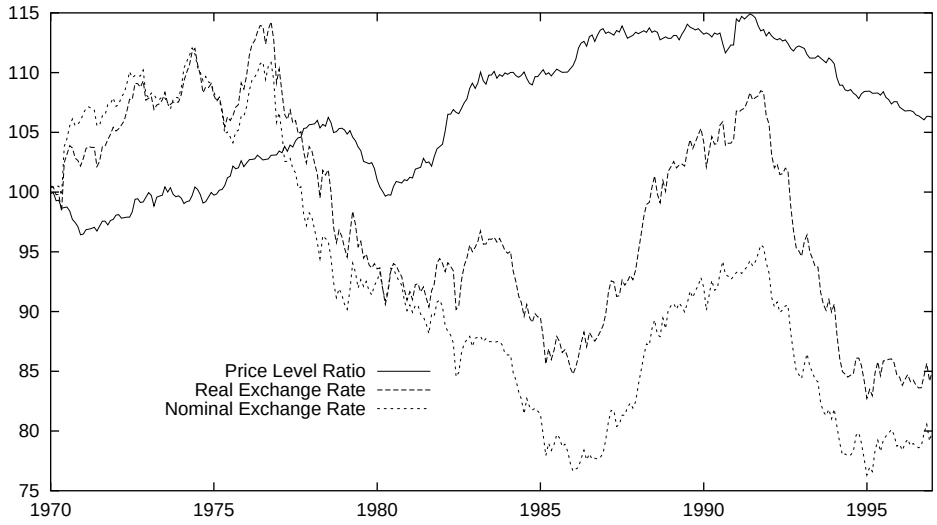

Figure 1: The ratio of the Canadian to the U.S. price level (solid line), the Canada/U.S. real exchange rate (dashed line) and the Canada/U.S nominal exchange rate defined as the U.S. dollar price of the Canadian dollar (dotted line), Indexes, 1963–66 = 100. Source: IMF/IFS.

to its original equilibrium level as the price level adjusts, along with the nominal exchange rate, to absorb the full effects of the asymmetric monetary shocks. Symmetric monetary shocks can also affect the real exchange rate in the short run under flexible nominal exchange rates if the degree of price level stickiness differs at home and abroad or the domestic and foreign economies respond to price stickiness in different ways. In the long-run, however, the two countries' price levels will move in the same proportion and neither real nor nominal exchange rates will be affected by symmetric monetary shocks.

Joining a common currency area and thereby permanently fixing the exchange rate will neutralize asymmetric monetary shocks and eliminate independent domestic monetary policy. Asymmetric shocks to the demand for or supply of money will simply cause offsetting movements in nominal money balances between the countries with no effects on their relative levels of output and prices. A fixed nominal exchange rate will not neutralize the effects of asymmetric real shocks, however, since the relative domestic/foreign price levels will then have to adjust to accommodate the movements in equilib-

rium real exchange rates. Such price level adjustments are always costly in the short run and sometimes costly in the long run and can be avoided by letting the nominal exchange rate adjust appropriately. Thus, whether fixing the exchange rate will bring an improvement will depend upon whether the shocks driving the real exchange rate are real or monetary and, of course, on the nature of the new common monetary regime.

In section 2 we set up the theoretical framework in which the influence of asymmetric real and monetary shocks can be analyzed and in section 3 we examine empirically the relative importance of asymmetric real versus monetary shocks in explaining movements in the Canada/U.S. exchange rate. Our findings are that substantial asymmetric real shocks have occurred and were an important determinant of the real exchange rate. This result confirms an earlier finding of Bayoumi and Eichengreen[4] that asymmetric real shocks hitting the U.S. and Canadian economies are responsible for a significant amount of the variation in the real exchange rate. We are unable to uncover any evidence that monetary shocks have had real exchange rate effects. The final section considers the policy implications of these empirical findings. Since our results indicate that the sources of exchange rate volatility are real, not monetary, they are unfavorable to the adoption by Canada of a common currency with the United States. They also explain the volatility of the real exchange rate in the floating rate period after 1970.

2 The Theoretical Framework

2.1 Real and Monetary Forces Affecting Exchange Rates

Canada's real exchange rate with respect to the United States can be defined as

$$Q = \frac{\Pi P}{P^*}, \tag{1}$$

where Q is the real exchange rate, Π is the nominal exchange rate, defined as the price of the Canadian dollar in terms of the U.S. dollar, P is a Canadian dollar price index of Canadian output and P^* is a U.S. dollar price index of U.S. output. Some rearrangement yields the alternative form

$$P = \frac{Q}{\Pi} P^*. \tag{2}$$

[4]Tamim Bayoumi and Barry Eichengreen, "One Money or Many? Analyzing the Prospects for Monetary Unification in Various Parts of the World", *Princeton Studies in International Finance*, No. 76, September 1994.

It is clear from this equation that regardless of how one models the structure of the economy a change in Q at any given level of P^* must be accompanied by a change in the same direction in either Π or P or both.

It is also clear from Figure 1 that Q and Π exhibit substantial parallel swings along a downward trend while the ratio of P to P^* remains comparatively stable. There are two possible ways to explain this pattern. A monetary shock explanation would envisage variations in the nominal exchange rate at given P^* resulting from portfolio shocks to the quantity of Canadian money demanded or supplied causing parallel movements in the real exchange rate because of rigidity of the nominal price level P. Were prices not rigid, these monetary shocks would cause inverse proportional changes in P and Π, leaving Q unchanged. Symmetric monetary shocks in the two countries would cause P and P^* to rise in the same proportion in the long-run leaving Q and Π unchanged although differential short-run price level rigidity in the two countries would cause the real and nominal exchange rates to change temporarily, possibly by different amounts, during the process of adjustment to long-run equilibrium.

A real shock explanation of the observed volatility of and positive correlation between the real and nominal exchange rates in the face of relative Canada/U.S. price level stability would have the long-run full-employment level of Q changing as a consequence of changes in the demand relative to supply of Canadian relative to U.S. output in world, including domestic, markets. The international relative price structure has shifted. At any given level of P^*, either Π or P or both must change in the same direction as Q. A change in the nominal exchange rate would thus insulate the Canadian price level from the asymmetric real shocks that changed the equilibrium level of the real exchange rate.

The appropriate policy response depends on which of these explanations holds true. If observed real and nominal exchange rate movements are caused by monetary shocks, institutions should be constructed to eliminate asymmetric effects of these shocks. A currency union or permanent fixed exchange rate arrangement would do the trick because any time there is an excess demand for money in Canada relative to the United States money balances will flow from the U.S. to Canada. Bank deposits would be transferred under a currency union while under a fixed exchange rate arrangement the Bank of Canada would be forced to increase the Canadian money supply relative to the money supply in the U.S. The Canadian monetary authority has to provide whatever supply of money the public demands at the fixed

exchange rate—otherwise, attempts to convert Canadian dollars into U.S. dollars or vice versa will drive the exchange rate off its peg.

If the observed real and nominal exchange rate movements are caused by asymmetric real shocks, the appropriate institutional response must allow the nominal exchange rate to adjust in response to long-run equilibrium movements in the real exchange rate while domestic monetary policy focuses on maintaining domestic price level stability. A system of flexible exchange rates would thus be the answer to the extent that it avoids costly domestic price level adjustments in the face of price stability in the United States.

In the case where both asymmetric real and monetary shocks are at work, the nominal exchange rate should be allowed to adjust to match movements in the long-run equilibrium real exchange rate and domestic monetary policy must focus on offsetting asymmetric shocks to the demand for Canadian relative to U.S. money balances while at the same time maintaining a trend level of domestic money growth consistent with an appropriate stable Canadian inflation rate.

Our task is to determine whether significant asymmetric real shocks have in fact occurred. The argument for a common North American currency arrangement would require that observed real exchange rate movements be primarily the result of monetary shocks.

2.2 More on Asymmetric Real Shocks

The Canadian and U.S. price levels can be defined as geometric weighted averages of the prices of a number aggregate output components—non-traded components in the two countries, denoted respectively by the subscripts nc and nu, a traded component involving goods exported in part by Canada to the U.S., denoted by the subscript xc, a traded component involving goods imported in some quantities by Canada from the U.S., denoted by the subscript mc, and separate traded components in each country involving goods entering into trade with third countries, denoted by the respective subscripts otc and otu.[5]

$$P = (P_{nc})^{\alpha} \left(\frac{P^*_{xc}}{\Pi}\right)^{\beta} \left(\frac{P^*_{mc}}{\Pi}\right)^{\gamma} \left(\frac{P^*_{otc}}{\Pi}\right)^{\delta} \tag{3}$$

$$P^* = (P^*_{nu})^{\alpha^*} (P^*_{mc})^{\beta^*} (P^*_{xc})^{\gamma^*} (P^*_{otu})^{\delta^*} \tag{4}$$

[5]We use the terms traded and non-traded components rather than traded and non-traded goods in recognition of the fact that in an open economy nearly every good has both non-traded and traded components—what distinguishes them are the proportions of non-traded components they contain.

where a $*$ superscript to a price variable indicates that it is measured in U.S. dollars and a $*$ superscript to a parameter indicates that it applies to the U.S. Note that the price of the Canadian export (import) component in (3) appears as the price of the U.S. import (export) component in (4). Although the prices of the components involved in trade by Canada and the U.S. with third countries, denoted respectively by the subscripts *otc* and *otu*, are measured in U.S. dollars, neither they nor the actual goods involved need be the same for both countries. Given that

$$\alpha + \beta + \gamma + \delta = \alpha^* + \beta^* + \gamma^* + \delta^* = 1,$$

substitution of equations (3) and (4) into (1) to yields

$$Q = \frac{\Pi P}{P^*} = \left[\frac{(\Pi P_{nc})^{\alpha}}{(P^*_{nu})^{\alpha^*}}\right]\left[\frac{(P^*_{xc})^{\beta-\gamma^*}}{(P^*_{mc})^{\beta^*-\gamma}}\right]\left[\frac{(P^*_{otc})^{\delta}}{(P^*_{otu})^{\delta^*}}\right]. \tag{5}$$

It is clear from the right-most term in (5) that a rise in the U.S. dollar prices of output components entering into trade between Canada and third countries countries relative to the U.S. dollar prices of U.S. output components that enter into trade with third countries will lead to an increase in Canada's real exchange rate with respect to the U.S.

An increase in Canada's terms of trade with respect to the U.S. will also lead to a rise in the Canada/U.S. real exchange rate when components entering into export from Canada to the U.S. are a bigger fraction Canadian output than they are of U.S. output, and components entering into export from the U.S. to Canada are a bigger fraction of U.S. output than they are of Canadian output. The requirement is that each country's production be skewed towards the goods it exports.[6]

Finally, Canada's real exchange rate with respect to the U.S. will increase in response to a rise in the U.S. dollar price of Canadian non-traded output components relative to U.S. non-traded output components. This could result from a shift in the tastes of Canadian residents for goods produced primarily with home labour and home-generated services, or from a shift of U.S. residents' tastes in the opposite direction. One source of such shifts in tastes would be changes in public-sector production and distribution of services that use primarily non-traded inputs. Also, an increase in the real

[6]This terms of trade effect on the real exchange rate would disappear if Canada and the U.S. produced the same output mix and be reversed if each country's production is skewed towards the things it imports. Trade would then occur only as a result of differences in the preferences of the two countries' residents for the other country's goods.

exchange rate could result from a greater rate of technological progress in Canadian production of traded components relative to non-traded components. Resources would have to be shifted from the non-traded sector to the traded sector, reducing the supply of non-traded components and increasing their price. Similarly, a greater rate of technological progress in the production of U.S. traded components relative to non-traded components would lower the Canada/U.S. real exchange rate.

An important factor that will affect the relative prices of non-traded components in Canada vs. the U.S. is the allocation of world investment to the two countries. Suppose, for example, that world investors come to regard Canada as a better place to invest than before. This might arise because new technology permits the exploitation of certain natural resources that could previously not be utilized. Or it might arise on account of changes in Canadian government policy. The result will be an increase in the level of investment in Canada accompanied by an equivalent inflow of capital. If the additional investment uses only traded components, imports will automatically increase relative to exports by an amount equal to the increase in investment and the real exchange rate will be unaffected. More likely, however, the additional Canadian investment will utilize at least some non-traded inputs and thereby represent an increased demand for the non-traded component of Canadian output. The price of that component will thus increase relative to the prices of traded components and, other things equal, to the price of the non-traded components of U.S. output. The resulting rise in the Canada/U.S. real exchange rate will shift world demand off Canadian goods and thereby increase Canadian imports relative to exports sufficiently to match the increased net capital inflow. Net capital inflows and the Canada/U.S. real exchange rate will be positively related, assuming that net inflows of capital into the U.S. do not also change. By the same argument, an increased allocation of world investment to the United States will, other things equal, cause the Canada/U.S. real exchange rate to fall, provided of course that the additional investment in the U.S. utilizes at least some non-traded productive factors in that country. Accordingly, we would expect that, other things equal, the bigger the net capital inflow relative to GDP in Canada as compared to the United States, the higher will be the Canada/U.S. real exchange rate.

Income growth in Canada relative to the United States is an indication of greater growth of both capital (human and physical) and technology and is not necessarily a reliable indicator of differences in technological change

between the two countries. And even if it were, technological change can affect both the non-traded and traded components of output and could thus affect the real exchange rate in either direction. Over different short time intervals, we could thus expect to observe either positive or negative effects of Canadian relative to U.S. real income growth on Canada's real exchange rate with respect to the U.S. The Balassa-Samuelson hypothesis predicts that over long periods technological change has a bigger impact on the production of traded components than non-traded components of output, since the latter are largely labour intensive services. Accordingly, a greater long-term trend rate of growth in Canada as compared to the U.S. should have a positive effect on the Canada/U.S. real exchange rate in the absence of differential trends in the the ratios of productivity change in non-traded relative to traded components of output in the two countries.[7]

2.3 More on Monetary Shocks

Monetary shocks take the form of increases or decreases in the demand for money relative to the supply. Under conditions of complete price flexibility and full employment, they can have no effect on the real exchange rate. Equilibrium desired money holdings are reestablished entirely through changes in the price level. The nominal exchange rate adjusts to reflect changes in the relative values of Canadian and U.S. currency, measured by the inverses of the respective countries' price levels, with the real exchange rate being unaffected. Monetary shocks are thus of interest here only to the extent that prices are slow to adjust to eliminate underlying monetary disequilibria.

The argument can proceed with reference to the conditions for equality of the demand and supply of money in Canada and the United States

$$M = P\ L(r + E_p, Y, \Phi_m) \tag{6}$$

$$M^* = P^* L(r^* + E_{p^*}, Y^*, \Phi_m^*) \tag{7}$$

where M denotes the nominal money stock, Φ_m is a demand-for-money shift variable, r denotes the real interest rate, Y is real income and E_p, and E_{p^*} are the expected percentage rates of change of P and P^*. An additional condition is also required for overall portfolio equilibrium, namely

$$r = r^* + \rho - E_q, \tag{8}$$

[7] Bela Balassa, "The Purchasing Power Parity Doctrine: A Reappraisal," *Journal of Political Economy*, Vol. 72, No. 6, December 1964, 584–96, and P. A. Samuelson, "Theoretical Notes on Trade Problems," *Review of Economics and Statistics*, Vol. 46, No. 2, May 1964, 145–54.

where ρ is the risk premium on Canadian assets and E_q is the expected rate of change in the real exchange rate. Canadian real interest rates will be bid up or down in relation to U.S. real interest rates until world wealthholders' desired mix of Canadian and U.S. assets in portfolios equals the existing mix.

The nature of price stickiness is conditioned by equations (3) and (4), which could be substituted into (6) and (7). Price stickiness would be expected to occur in Canada only with respect to non-traded output components since the prices of traded components are fixed in the rest of the world. The situation is more complicated for the U.S., which is big enough to influence the prices of a wide variety of the traded components she produces.

Suppose that there is a positive asymmetric shock to the demand for Canadian money balances relative to the supply and that the prices of Canadian non-traded components of output cannot change in the short-run. To maintain portfolio equilibrium Canadian residents will attempt to sell assets to obtain the desired increase in their cash balances. Since the sale must be to foreign residents an incipient balance of payments surplus will arise, leading to a nominal appreciation of the Canadian dollar in terms of the U.S. dollar. This will lower the prices of the traded components of Canadian output and bring about the necessary fall in the Canadian price level. If real output and real interest rates remain unchanged the Canadian price level will fall in proportion to the increase in desired money holdings. The Canadian dollar must appreciate in a greater proportion than the fall in the price level. To see this, take the differential of (3) holding all nominal prices constant and convert the resulting expression to relative changes to obtain

$$\frac{dP}{P} = -(1-\alpha)\,\frac{d\Pi}{\Pi}$$

which, when output and the real interest rate do not change, implies

$$\frac{d\Pi}{\Pi} = -\frac{1}{1-\alpha}\,\frac{dP}{P} = \frac{d\Phi_m}{\Phi_m} - \frac{dM}{M}.$$

Since in the long-run after prices have fully adjusted P must fall in proportion to the exogenous rise in excess demand for money, and α is less than unity, the nominal exchange rate will overshoot its long-run equilibrium. And since Π rises in greater proportion than P falls in the short-run, the real exchange rate must temporarily rise in response to the asymmetric monetary shock.

If people can correctly forecast the future nominal exchange rate or are aware that the upward real exchange rate adjustment is temporary, they will expect the real exchange rate to depreciate in the future with the result that E_q will become negative. A temporary rise in Canadian real interest rates will then occur, reducing the quantity of money demanded and moderating the degree of exchange rate overshooting.

One might want to assume that, due to pricing to market, the domestic prices of the traded components are insensitive to movements in the exchange rate with the result that the domestic price level cannot decrease at all in the short run.[8] In this case the only possible mechanism of adjustment apart from a decline in domestic output is a rise in Canadian real interest rates resulting from an expectation that the rise in the real exchange rate will be reversed in the future.[9]

Whatever one assumes about the nature and degree of overshooting, movements of the real exchange rate resulting from monetary shocks must eventually be reversed. Ultimately the price level must fall in response to an appreciation of the real exchange rate resulting from an excess demand for money or rise in response to a depreciation of the real exchange rate resulting from an excess supply of money. Thus, if observed movements of the Canada/U.S. real exchange rate were the result of monetary shocks we would expect the Canadian price level to subsequently move relative to the U.S. price level in the opposite direction to the real exchange rate. And if domestic prices of traded-components of output respond to changes in the nominal exchange rate we should expect the real exchange rate and the Canadian price level to be negatively correlated in the current period. An absence of evidence of a current and/or lagged inverse response of the Canadian price level to observed movements in the Canada/U.S. real exchange rate would suggest that monetary shocks were not the major cause of these real exchange rate movements and that asymmetric real shocks must therefore have been at work.

The process of price adjustment will also typically involve deviations of output around the full-employment level. The price level ultimately rises or falls because depreciation or appreciation of the real exchange rate shifts

[8]For a discussion of this issue, see Michael B. Devereux, "Real Exchange Rates and Macroeconomics: Evidence and Theory," *Canadian Journal of Economics*, Vol. 30, No. 4a, November 1997, 773–807.

[9]This is essentially the overshooting argument put forward by Rudiger Dornbusch in "The Theory of Flexible Exchange Rates and Macroeconomic Policy," *Scandinavian Journal of Economics*, Vol. 78, No. 2, May 1976, 255–75.

world demand towards or away from domestic goods. When prices are sticky, domestic output and employment will respond in the short run with the associated market pressures being passed on to wages and prices in the long run. Accordingly, if observed Canada/U.S. real exchange rate movements are the result of monetary shocks we would expect to find a current or lagged inverse response of output and employment to movements in the real exchange rate. Failure to find such an association would indicate that monetary shocks are not the primary determinant of the observed real exchange rate movements.

In addition, a positive association of Canada/U.S. real interest rate differentials with the real exchange rate should also appear in the data if market participants correctly anticipate the overshooting nature of the movements in the Canada/U.S. real exchange rate.

Finally, consider in more detail the sources of monetary shocks. Changes in the supply of money will result from changes in the public's desired holdings of currency in relation to deposits or the commercial banking system's desired reserve/deposit ratio, provided that the central bank does not make offsetting changes in the supply of base money. Or the central bank could directly impose changes in the money supply by changing base money. Changes in the demand for money could result from changes in inflationary expectations, E_p in (6), or expectations about future movements in the real exchange rate, which would appear as a component of domestic interest rates in equation (8), or from currency substitution on the part of holders of domestic and foreign monetary reserves.[10] Changes in investors' evaluation of the risk of holding Canadian vs. U.S. assets, indicated by ρ in (8), would also lead to changes in interest rates and the quantity of money demanded in Canada relative to the United States.

[10]To accommodate currency substitution we would need to include each country's interest rate as an argument in the other country's demand function for money, although the Canadian interest rate would have a zero coefficient in the U.S. demand for money because of the small size of the Canadian relative to the U.S. economy.

3 The Evidence

We begin with a search for evidence that monetary shocks are the prime cause of observed exchange rate movements.

3.1 A Search in Vain for Evidence of Monetary Shocks

If the major movements of Canada's real exchange rate with respect to the U.S. dollar were due to monetary causes, and if the domestic prices of at least some traded components are not rigid in the face of nominal exchange rate changes, we should observe, as noted above, a negative correlation between the real exchange rate and the Canadian price level, given the price level in the United States. The relationship depends only on the representation of the domestic price level as a weighted average of the prices of non-traded and traded components and not at all on the way the exchange rate is modelled. The negative relationship occurs because an excess money supply shock in Canada, for example, will cause the Canadian dollar to depreciate leading to a rise in the prices of domestic traded components and the domestic price level. As long as non-traded goods prices are rigid the real exchange rate will fall.

Even if the Canadian price level is completely inflexible because of pricing to market we would expect that monetary induced depreciation of the real exchange rate would lead to an increase in domestic output and employment. A a negative relationship between the real exchange rate and output and employment (positive relationship between the real exchange rate and unemployment) should therefore be evident in the data.

Finally, if the trade balance is not immediately responsive to money shock induced real exchange rate changes and both traded and non-traded price level components are rigid, the only avenue of adjustment is a realization by asset holders that the movement of the real exchange rate is so large that it must eventually reverse itself. In this case we would expect a positive association between money shock induced real exchange rate movements and the Canada/U.S. interest rate differential.

The evidence is presented in Table 1. Despite the dictates of economic theory, it is inappropriate to regress the ratio of the Canadian to the U.S. price level on the real exchange rate or to regress the Canadian price level on the real exchange rate and the U.S. price level. Since the real exchange rate equals the ratio of price levels multiplied by the nominal exchange rate, errors in the measurement of the price levels would show

Table 1: OLS Analysis of the Effects of Canada/U.S. Real Exchange Rate Movements on Economic Conditions in Canada Relative to the U.S.: Jan. 1972 to Dec. 1998

Independent Variables	Dependent Variable				
	CPICA	CPICA/CPIUS	IPRODRAT	UEMPDIFF	INTDIFF
CONSTANT	11.28***	96.08***	-.001	1.787**	-11.54
	(4.91)	(44.33)	(-.036)	(2.147)	(-.762)
NEXCAUS	.095***	.007			
	(5.05)	(.25)			
REXCAUS			.0002	-.015**	.104***
			(.70)	(-2.24)	(8.49)
CPIUS	1.296***				
	(22.31)				
TREND	-.080***	.03***	.00004	-.0009	.0047***
	(-4.46)	(8.83)	(-1.563)	(-1.20)	(3.72)
R^2	.99	.42	.02	.02	.20
Std. Error	2.50	3.73	.0346	.852	1.56
Signif. of F	.00000	.00000	.01996	.08261	.00000
DW	.01	.01	.13	.09	.23
DF (t)	-.85	-.05	-3.334*	-2.59	-4.46***
Aug. DF (t)	-1.76	-1.15	-3.343*	-3.19*	-3.12*
Lags	14	16	14	9	8

Notes: CPICA and CPIUS are the Canadian and U.S. consumer price indexes, NEXCAUS and REXCAUS are Canada's nominal and real exchange rates with respect to the U.S, IPRODRAT is the ratio of Canadian to U.S. industrial production, UEMPDIFF is the difference between the Canadian and U.S. unemployment rates and INTDIFF is the difference between the Canadian and U.S. 90-day commercial paper rates. The figures in parentheses are t-ratios. The number of lags for the augmented Dickey-Fuller test is the optimum chosen by *SHAZAM*. The superscripts ***, ** and * denote statistical significance at the 1, 5 and 10 percent levels, respectively.

Sources: *CANSIM* and *CITIBANK* for unemployment and interest rates, and *IMF/IFS* for the remaining series.

up on both sides of the regression equation, leading to a positive bias in the estimated response of the price level ratio to real exchange rate shocks. Fortunately, since the real and nominal exchange rates are highly correlated and the nominal exchange rate is measured without error, we can use the nominal exchange rate as a proxy for the real exchange in the leftmost two regressions in the table. We would expect the nominal exchange rate to have a negative sign. In the case where the Canadian price level is regressed on the nominal exchange rate and the U.S. price level, the nominal exchange rate is statistically significant with the wrong sign. When the ratio of the Canadian to the U.S. price level is used as the dependent variable, the nominal exchange rate has the wrong sign but is statistically insignificant. Neither of these regression equations can pass a Dickey-Fuller cointegration test.[11] The real exchange rate is significant with the expected sign in explaining the interest rate differential. There is no significant simple statistical relationship between the real exchange rate and the ratio of Canadian to U.S. industrial production. The relationship between the real exchange rate and the difference between the Canadian and U.S. unemployment rate is significant with the wrong sign and the regression cannot clearly pass a Dickey-Fuller cointegration test.

The positive relationship that exists between the Canada/U.S. interest rate differential and the real exchange rate lends some credibility to the possibility that monetary shocks are being adjusted to by expected reversals of the resulting real exchange rate movements and that they therefore lead to changes in the same direction in Canadian relative to U.S. interest rates. The other regression results in Table 1 indicate no appropriately signed contemporaneous relationships between observed real exchange rate movements and Canadian/U.S. price levels, Canadian/U.S industrial production, or the excess of the Canadian over the U.S. unemployment rate.

Though the trade balance and output may be unaffected in the immediate run and the price level may be rigid in the short run, it is reasonable to expect that these variables will eventually adjust. Accordingly, Granger causality tests were conducted to determine whether there are lagged responses to observed real exchange rate movements of the Canadian price level, industrial production and employment relative to the comparable U.S. variables.

[11] When we use the real exchange rate instead of its proxy the coefficients still have the wrong signs and are more statistically significant. The result would thus be more favorable to our conclusions.

Table 2: Granger Causality Tests of the Effects of Canada/U.S. Real Exchange Rate Movements on Economic Conditions in Canada Relative to the U.S.: Jan. 1972 to Dec. 1998

Independent Variables	Dependent Variable		
	CPICA/CPIUS	IPRODRAT	UEMPDIFF
CONSTANT	.840***	.005***	.078
	(4.40)	(3.05)	(1.44)
NEXCAUS	.063		
	(.204)		
REXCAUS		.002	.003
		(.770)	(.03)
24 Leads	.036	.0021	-.067
	(.178)	(1.10)	(-1.09)
Signif. of F	.993	.0000	.538
24 Lags	-.094	-.002	.0447
	(-.462)	(-1.23)	(.722)
Signif. of F	.701	.904	.914
R^2	.15	.41	.33
Std. Error	3.26	.030	.80
Signif. of F	.6789	.00000	.0026
DW	.0406	.1917	.1179
DF (t)	-1.75	-3.97*	-2.64
Aug. DF (t)	-1.75	-3.72*	-2.64
Lags	0	1	0

Notes:
The variables are detrended versions of those defined in the notes to Table 1. The figures in parentheses are t-ratios. The number of lags for the augmented Dickey-Fuller test is the optimum chosen by *SHAZAM*. The superscripts ***, ** and * denote statistical significance at the 1, 5 and 10 percent levels, respectively.

Sources: See Table 1.

The results of these tests are shown in Table 2. Again, for the reasons previously noted, the nominal exchange rate is used as a proxy for the real exchange rate in the left-most regression. There is no evidence of a lagged effect of exchange rate changes on the ratio of the price level in Canada to the price level in the U.S. The regression is insignificant and the residuals are non-stationary. The regression in the center column indicates that the ratio of industrial production in Canada to that in the U.S. leads the observed movements in the real exchange rate and that the leads had a positive though statistically insignificant sign. The twenty-four leads as a group were highly significant and the residuals of the regression appear stationary. The twenty-four lags were insignificant as a group. This would suggest that movements in Canadian relative to U.S. industrial production led rather than lagged behind the observed movements in the real exchange rate—that changes in industrial production caused rather than were caused by the real exchange rate changes. The regression in the third column indicates no difference in timing in the relationship between differences in the Canadian and U.S. unemployment rate and the real exchange rate. The regression is statistically significant but none of the variables by themselves are, suggesting the presence of collinearity between the leading and lagging variables. The regression residuals are not stationary at the 10 percent level of significance.

The fact that no lagged response of either Canadian industrial production or the Canadian price level to movements in real exchange rates is found makes it unlikely that the positive coefficients of the interest rate differential in Table 1 indicate that the shocks to the real exchange rate were monetary. To believe that the observed real exchange rate movements and interest rate differentials were caused by monetary shocks we would have to believe that prices and output never adjust, even in the long run, but agents nevertheless expect adjustment to occur.

The question arises as to why we observe a significant positive simple correlation between the Canada/U.S. interest rate differential and the real exchange rate. Some might argue that the interest rate differential thereby reflects money supply shocks. The problem with this argument is that no other consequences of monetary shocks are present. In section 3.3 we test the proposition that money supply shocks directly affect the real exchange rate. The empirical evidence there does not support that proposition. We conclude that there is no evidence that observed changes in the Canada/U.S. real exchange rate were caused by monetary shocks.

3.2 Evidence of Asymmetric Real Shocks

The theoretical analysis above suggests that we might expect the Canada/U.S. real exchange rate to be positively affected by an improvement of the bilateral Canada/U.S. terms of trade. The well-known Van-Norden-Bank-of-Canada-Royal-Bank regressions[12] use a commodity price index net of energy and an oil price index, both in U.S. dollars and deflated by the U.S. implicit GDP deflator, instead of the terms of trade. This suggests that we should include those variables to see if they contribute something additional to the terms of trade variable, as might be expected if they reflect the relative prices of Canadian vs. U.S. goods traded with third countries. Here we deflate these U.S. dollar based indexes by the index of U.S. traded goods prices (taken as an unweighted average of export and import prices) instead of by the implicit GDP deflator, which contains a much larger fraction of non-traded components. Our theory suggests that we should deflate the commodity price series by prices of traded good components because we want to examine the effects of relative traded goods price changes on the real exchange rate, leaving the effects of non-traded goods prices to other variables in our regression equation.

Another implication of our theory is that the greater the capital inflow from the rest of the world into Canada as compared to the U.S., the greater the upward pressure should be on the Canada/U.S. real exchange rate. Accordingly, we include as an independent variable the negative of the Canadian balance of trade in goods and services other than the services of capital as a percentage of GDP minus the negative of the U.S. balance of trade in goods and services other than capital services as a percentage of that country's GDP.

We would also expect that government expenditure tends to be devoted more than private expenditure to the purchase of non-traded components. This suggests that government consumption expenditure as a percentage of GDP in Canada minus the corresponding variable in the United States might have a positive effect on the Canada/U.S. real exchange rate. We also include the ratio of Canadian to U.S. GDP as an independent variable to capture possible differences in the effects of economic growth in the two countries, with no presumption as to an expected sign.

The results are shown in Table 3. The bilateral terms of trade variable

[12]See "Drivers of the Canadian Dollar and Policy Implications," *Current Analysis*, Vol. 2, No. 9 (August 1998), Royal Bank of Canada. This work was based on research at the Bank of Canada by Simon Van-Norden.

Table 3: OLS Analysis of the Effects of Real Factors on the Canada/U.S. Real Exchange Rate: 1972/Q1 to 1998/Q4

Independent Variable	Dependent Variable: Real Exchange Rate (1)	(2)
CONSTANT	-32.30	-82.70***
	(-.739)	(-3.12)
PCOMXEN	.085***	.114***
	(3.61)	(9.67)
POIL	.078***	.083***
	(3.14)	(3.40)
TOTCAUS	.242**	.226**
	2.42	(2.26)
DIFFNTAB	2.12***	1.91***
	(6.68)	(6.73)
RGDPRAT	821.8**	1235.4***
	(2.16)	(4.939)
DIFFGOV	-1.02	
	(-1.44)	
R^2	.841	.837
Std. Error	4.67	4.69
DW	.304	.305

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Table 3 (Continued)

Notes:

PCOMXEN = index of commodity prices net of energy in U.S. dollars deflated by an unweighted U.S. dollar index of U.S. export and import prices; TOTCAUS = bilateral Canada/U.S. terms of trade (Fisher's ideal index); DIFFNTAB = difference between the negative of the Canadian balance of trade in goods and services excluding the services of capital and the corresponding U.S. series; RGDPRAT = ratio of Canadian to U.S. real GNP; DIFFGOV = the excess of government consumption as a percentage of GDP in Canada over the same variable in the U.S. The figures in parentheses are t-ratios. The superscripts ***, ** and * denote statistical significance at the 1, 5 and 10 percent levels, respectively.

Sources: See Table 1.

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and the difference between the negatives of the trade balances as percentages of GDP have the correct signs and are statistically significant, the latter variable highly so. The difference in the percentages of government consumption to GDP in the two countries is insignificant with the opposite sign to what we would expect. The second regression omits this variable. The index of commodity prices excluding energy is also significant as is the oil price variable. The ratio of Canadian to U.S. GDP is statistically significant with a positive sign.

Not unexpectedly, the low Durbin-Watson statistics provide strong evidence of misspecification. Nevertheless, Johanson cointegration tests clearly indicate that cointegration is present.[13] Given the necessary omission of variables reflecting the differential effects of technological change on the non-traded and traded components of output in the two countries, and the consequent serial correlation in the residuals, we can have little confidence in the magnitudes of the regression coefficients. The best we can say is that the effects seem to go in the right direction. The results clearly indicate that asymmetric real shocks had an important influence on the Canada/U.S. real exchange rate. This reenforces the empirical results of Bayoumi and Eichengreen who, using a different methodology, found a negative correlation of -0.47 between supply disturbances in Canada and the United States.[14]

[13]The null hypothesis that no cointegrating vectors are present vs. one or more can be rejected at the 1 percent level.

[14]See Bayoumi and Eichengreen, *op. cit.* They also found a negative correlation between supply disturbances in Mexico and the U.S. of -0.59 and concluded that

Table 4: OLS Analysis of the Effects of Unanticipated Money Supply Shocks on Canada/U.S. Real Exchange Rate: 1972/Q1 to 1998/Q4

Independent Variable	Dependent Variable: Real Exchange Rate (1)	(2)
CONSTANT	-88.58***	-83.47***
	(-3.31)	(-3.07)
PCOMXEN	.116***	.114***
	(9.83)	(9.48)
POIL	.076***	.083***
	(3.12)	(3.37)
TOTCAUS	.247***	.225***
	(2.47)	(2.23)
DIFFNTAB	1.85***	1.90***
	(6.52)	(6.64)
RGDPRAT	1268.2***	1242.8***
	(5.06)	(4.84)
Unanticipated Canadian M1 Shocks	-14.98	
	(-0.53)	
Unanticipated U.S. M1 Shocks	102.68	
	(1.69)	
Unanticipated Canadian M2 Shocks		-17.8
		(-0.24)
Unanticipated U.S. M2 Shocks		-40.58
		(-0.49)
R^2	.842	.838
Std. Error	4.67	4.73
DW	.336	.304

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"It would appear that the NAFTA countries are are affected by very different supply conditions." (p. 25).

Table 4 (Continued)

Notes:

The unanticipated money shocks are the residuals from regressions of the logarithms of the money stock series on themselves lagged 8 periods and the logarithm of real GDP lagged 8 periods. The other variables are defined in the notes to Table 1. The figures in parentheses are t-ratios and *** denotes statistical significance at the 1 percent level.

Sources: See Table 1.

3.3 More Evidence About Unanticipated Money Supply Shocks

Our earlier evidence indicates that monetary shocks were clearly not a major factor driving the observed movements in the Canada/U.S. real exchange rate and that real shocks clearly were. The results thus far, however, cannot dispute the assertion that monetary shocks had some influence. Some additional evidence on the effects of monetary shocks can be obtained by adding unanticipated Canadian and U.S. money supply shocks to our regression (2) in Table 3. The results are presented in Table 4. Two alternative measures of the money supply were used—M1 and M2. The unanticipated shocks are the residuals from a regression of the logarithm of the money supply aggregate on itself lagged from one to eight quarters and on one to eight quarter lags of the logarithm of nominal GDP. If exogenous Bank of Canada money supply management were a factor affecting real exchange rates we would expect negative signs on the Canadian money supply shock variables. Correspondingly, we would expect positive coefficients for the U.S. unanticipated money supply shocks. Although three of the four signs were correct, none of these variables are statistically significant. This adds further support to the proposition that the observed movements in the real exchange rate were driven by asymmetric real shocks.

4 Policy Conclusions

The fundamental conclusion of our analysis is that movements in the Canada/U.S. real and nominal exchange rates reflect asymmetric real and not monetary shocks. To summarize, it can be seen in Figure 1 that a monetary explanation of the observed real exchange rate movements since 1970 is impossible unless one assumes protracted long-term price level rigidity. Canada's real exchange rate fell by about 30% between 1977 and 1985. Had this been due to monetary factors, correcting upward adjustments of the domestic price level to bring the real exchange rate back to its unchanged equilibrium level would surely have begun to occur within a couple of years—let alone eight. Then the country's real exchange rate increased by about 20% between 1986 and 1991. Again, had this real exchange rate movement been a disequilibrium response to negative monetary shocks, a fall in the price level that would reestablish the initial and equilibrium real exchange rate would surely be underway within five years. From 1991 to 1995 the real exchange rate fell around 20% and again there is no evidence of correcting movements in the Canadian price level. On the other hand, these substantial correlated real and nominal exchange rate swings are easily explained, as our regression results show, by asymmetric real factors, with the Bank of Canada following monetary policies that maintained the domestic price level very stable relative to the U.S. price level.

There are a number of implications of this basic conclusion.

4.1 Dealing With Exchange Rate Volatility

Flood and Rose[15] quote from Friedman[16]

> ... instability of exchange rates is a symptom of instability in the underlying economic structure ... a flexible exchange rate need not be an unstable exchange rate. If it is, it is primarily because there is underlying instability in the economic conditions ...

and conclude that[17]

[15]Robert P. Flood and Andrew K. Rose, "Understanding Exchange Rate Volatility without the Contrivance of Macroeconomics," Discussion Paper 1944. London: Centre for Economic Policy Research, 1998.

[16]Milton Friedman, "The Case for Flexible Exchange Rates," in *Essays in Positive Economics*, University of Chicago Press, 1953, p. 158.

[17]Flood and Rose, *op. cit.*, p. 3.

> . . . simply put, to a first approximation countries with fixed exchange rates have less volatile exchange rates than floating countries, but macro-economies that are equally volatile. This stylized fact is inconsistent with theories that model both the exchange rate and the exchange rate regime as manifestations of underlying economic shocks. Unsurprisingly, such theories have performed poorly when applied to the data. Neither the exchange rate nor the exchange rate regime seems to reflect observable economic shocks.

Flood and Rose present convincing evidence that macro-economic policy is similar in fixed and floating exchange rate regimes and that floating regimes exhibit substantially more volatility than fixed regimes. Indeed as Stockman notes, this fact in conjunction with the similarity in the behavior of output, employment and prices under the two types of regime has been a puzzle for research.[18] Nevertheless, from the facts, Flood and Rose are incorrect in their conclusion that "neither exchange rate regime seems to reflect observable economic shocks". The evidence we present in this paper for the Canada-U.S. exchange rate clearly shows that the movements in the real exchange rate reflect to a large extent real economic shocks. The real exchange rate is volatile because there is volatility in real economic conditions. The volatility is not due to volatility in macroeconomic policy or speculative shocks to the demand for money but rather to volatility in asymmetric real forces hitting the economy.

Why are real exchange rates more volatile under floating than fixed-rate regimes? Or, to put it differently, why would there be more volatility of real shocks when a country has a floating exchange rate than when it follows a fixed exchange rate regime? We would argue that the choice of exchange rate regime by a country is not exogenous. When asymmetric real forces become more volatile and a fixed exchange rate therefore becomes more difficult to manage, countries will tend to adopt floating exchange rate regimes, as Canada did during much of the Bretton-Woods period.

We explain the current volatility of the Canadian dollar as the result of volatile real economic forces. During the past five years, for example, the

[18] Alan C. Stockman, "Choosing An Exchange-Rate System", *Journal of Banking and Finance*, Vol. 23, No. 10, October 1999, 1483–98. See also M. Baxter and Alan C. Stockman, "Business Cycles and the Exchange Rate Regime: Some International Evidence," *Journal of Monetary Economics*, Vol. 23, No. 3, 1989, 377–400, and Robert P. Flood and Andrew K. Rose, "Fixing Exchange Rates: A Virtual Quest for Fundamentals," *Journal of Monetary Economics*, Vol. 36, No. 1, 3–38, December 1995.

Asian crises led to a fall in the demand for Canadian export goods which, along with the fall in oil prices and commodity and minerals prices in general, resulted in a decline in Canada's equilibrium real exchange rate. These movements did not result from shocks to the demand for domestic money arising from speculation against Canadian assets or future movements in the Canadian dollar, but rather from ongoing changes in the international relative price structure.

4.2 When Should a Common Currency be Adopted?

Courchene and Harris[19] have advocated the eventual adoption of a common currency between Canada and the U.S. They believe that if Canada had adopted a common currency with the U.S. in 1988 the subsequent decline in the Canadian standard of living relative to the U.S. would not have occurred to the extent that it did.

> Since that time, pre-tax personal income per capita in Canada has fallen relative to that in the United States, magnified by Canadian exchange rate depreciation, which suggests there has been a significant fall in Canadians' average standard of living relative to that of Americans.

But real forces affect the economy independently of the exchange rate regime.[20] Under fixed exchange rates the adjustment that would otherwise occur in the exchange rate will instead be channelled into myriad of individual prices and ultimately a change in the general price level, with the same final effect on real economic well-being, and the same equilibrium real exchange rate, in both regimes.

Suppose that Canada had adopted the U.S. dollar back in 1988. When real shocks such as the fall in the prices of commodities hit the Canadian economy, a large number of individual prices and wages in Canada would have had to adjust, leading to a decline in the price level in Canada relative to the United States. If prices and wages were not fully flexible in the short-run, Canada would have experienced an increase in unemployment. As a result of both its terms of trade and employment effects, the fall in Canadian export

[19] Thomas J. Courchene and Richard G. Harris, *From Fixing to Monetary Union ...* .

[20] Harris and Courchene believe that policy makers are better able to monitor real sources of declines in standard of living under fixed exchange rate regimes. However, there is no good policy tool to negate the effects of negative real shocks under any exchange rate regime.

prices would have adversely affected the standard of living in Canada. Our conclusion that the real exchange rate has primarily reflected asymmetric real forces means that a common currency would not have protected Canada against the undesirable effects of these negative real shocks and, to the extent that unemployment effects resulted, would have even made them worse.

Additionally, Mundell outlined two conditions for regions to form an optimum currency area.[21] If Canada and the U.S. meet these conditions they should adopt the same currency. The first condition is that real shocks affecting the two regions be symmetric. In the case at hand, this means that the equilibrium Canada/U.S. real exchange rate should be constant. As noted above, most of the over 30% fall in the Canadian dollar since 1975 represents a fall in the real exchange rate—asymmetric real shocks have unquestionably hit the Canadian economy. Our empirical results are consistent with the findings of Bayoumi and Eichengreen[22] that asymmetric real shocks hitting the U.S. and Canadian economies are responsible for explaining a significant amount of the variation in the real exchange rate. The first condition is therefore not satisfied. The second condition is that there be free mobility of labour between the regions. Since the Canada-U.S. border clearly imposes significant barriers to labour market mobility, this condition for the two countries being an optimum currency area is also not met.

Therefore, none of Mundell's conditions for an optimum currency area between Canada and the United States exist. Our results do not favor the adoption by Canada of a common currency with the United States.

[21] R.A. Mundell, *op. cit.*

[22] *op. cit.*.

Appendix: Estimated Price-Level Effects of Fixing the Exchange Rate

We can make a rough calculation of the price level and inflation rate changes that would have been imposed by fixing the exchange rate with respect to the U.S. dollar from 1957 to the present. Let us make the assumption that the equilibrium real exchange rate is a five-year moving average of the observed real exchange rate, as shown in the top panel of Figure 2. This assumes that all deviations of the observed real exchange rate from this moving average representation were due to monetary shocks that would have been neutralized under a fixed exchange rate by endogenous money supply adjustments. The moving average of the observed real exchange rate series represents the real shocks that would have been absorbed by the price level in lieu of nominal exchange rate adjustments.

In the middle panel of Figure 2 we calculate the equilibrium Canadian price level that would have resulted from these real exchange rate movements imposed on equation (2) under conditions in which the U.S. price level took its observed values. The simulated Canadian price level increases much less than the actual price level over the period, reflecting the downward trend in the real exchange rate. While this might be interpreted as good for the country, a significant decline in the price level would have occurred after 1991. This downward adjustment would have been much greater than the mere reduction in the inflation rate imposed by the Bank of Canada's low inflation policy, which was met with considerable criticism in some quarters.[23]

Even the reduced upward trend of the price level would have come at a cost, however, as indicated by the simulated inflation rate relative to the actual rate shown in the bottom panel of Figure 2. The swings in the inflation rate under a fixed exchange rate would have been more substantial than the ones actually experienced. The equilibrium inflation rate would have dropped from 12% to 4% and then shot back up to 10% in the period 1973 to 1980, fallen back down to 2% by the mid 1980s, shot up again to 8% by 1990 and then dropped to negative levels after 1991 where it would have remained until the present. These are the kinds of inflation rate adjustments that governments will quickly abandon fixed exchange rates to prevent.

We concede, of course, that the estimates in the bottom two panels of Figure 2 are rough calculations. The situation could be made more favorable

[23]See, for example, Pierre Fortin, "Presidential Address: The Great Canadian Slump", *Canadian Journal of Economics*, Vol. 29, No. 4, November 1996, 761–87.

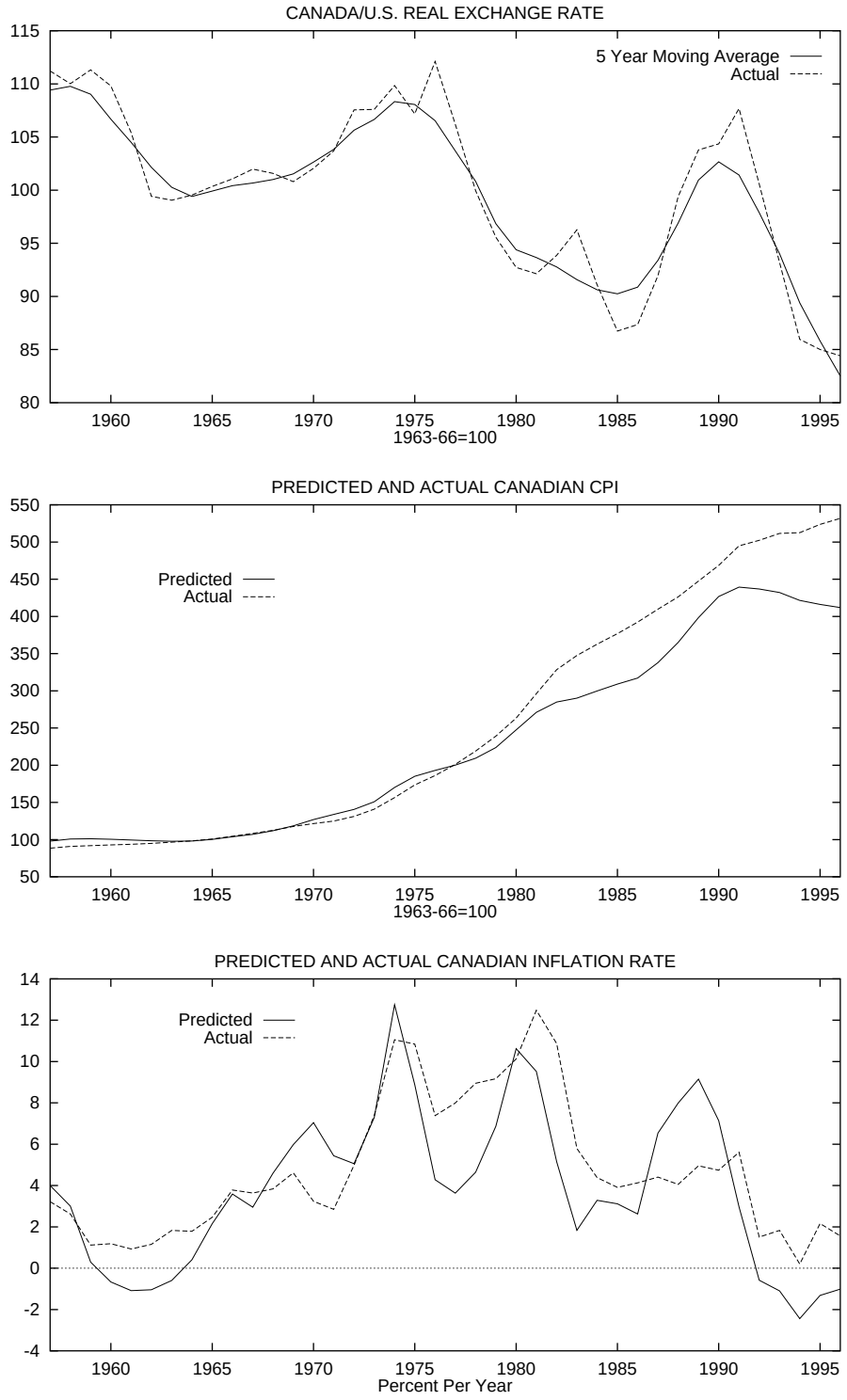

Figure 2: Actual and five-year centered moving average Canada/U.S. real exchange rate, and simulated Canadian price level and inflation rate under a fixed exchange rate as compared to the actual price level and inflation rate. Source: IMF/IFS.

to the adoption of a fixed exchange rate by taking a 10-year instead of 5-year moving average. But our empirical results do not even justify the degree of smoothing implied by a 5-year moving average. We can find no evidence that any significant portion of the observed real exchange rate movements were due to monetary shocks and would therefore have been eliminated by fixing the nominal exchange rate.

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