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Canadian Monetary Policy and Real and Nominal Exchange Rates [Revised]

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This study undertakes an analysis of the relationship between Canadian monetary policy and the movements of Canada's real and nominal exchange rates with respect to the United States and, less directly, with respect to the rest of the world.[1] It encompasses, extends and broadens a range of more narrowly-focused rigorous theoretical models that dealt with specific details relating the real exchange rate to utility functions in endowment models or relating expected changes in real exchange rates to real interest rate differentials in asset pricing models, and with specific individual sources of real exchange rate fluctuations in models with traded and non-traded goods or with productivity shocks and market frictions.[2]

[1]The theory and evidence presented here are extensions and refinements of material presented in the author's recent book, John E. Floyd, *Interest Rates, Exchange Rates and World Monetary Policy*, Springer, 2010.

[2]See, for example, William D. Lastrapes, "Sources of Fluctuations in Real and Nominal Exchange Rates," *Review of Economics and Statistics*, Vol. 74, No. 3, 1992, David Bachus and Gregor W. Smith, "Consumption and Real Exchange Rates in Dynamic Economies with Nontraded Goods," *Journal of International Economics*, Vol. 35, 1993, 297-316, Robert A. Amano and Simon Van Norden, "Terms of Trade and Real Exchange Rates: The Canadian Evidence," *Journal of International Money and Finance*, Vol. 14, No. 1, 1995, 83-104, Michael B. Devereux, "Real Exchange Rates and Macroeconomics: Evidence and Theory," *Canadian Journal of Economics*, Vol. 30, No. 4, 1997, 773-808, Pierre-Richard Agénor, "Capital Flows, External Shocks and the Real Exchange Rate," *Journal of International Money and Finance*, Vol. 17, No. 5, 1998, 713-740, and Yu Sheng and Xinpeng Xu, "Real Exchange Rate, Productivity and Labor Market Frictions," *Journal of International Money and Finance*, Vol. 30, No. 3, 2011, 587-603. For a tiny rigorous precursor of the model developed here, see Peter Neary, "Determinants of the Equilibrium Real Exchange Rate," *American Economic Review*, Vol. 78, No. 2, 1988, 210-215. And for a broader model applied to exchange rate policy in developing countries, see Sebastian Edwards, *Real Exchange Rates, Devaluation and Adjustment*, MIT Press, 1989.

Section I develops a broad-based theory to form the basis for subsequent empirical analysis that can reflect directly on the practical implementation of monetary policy in small open economies like Canada. The focus on Canada is useful because its economy is so closely connected to the large United States economy. The model suggests and incorporates a wide range of factors determining Canada's real exchange rates with respect to the United States and the world at large and outlines the effects of short-run and long-run monetary policy on nominal and real exchange rates. It finds some specific implications of real and nominal exchange rate shocks for the choice of a fixed as opposed to flexible exchange rate regime and for the conduct of monetary policy under flexible exchange rates. An important consideration arising within the theory is the possibility and implications of exchange rate overshooting.[3]

Implications of the theory are tested empirically in Section II. The major factor affecting Canada's real exchange rate with respect to the United States is found to be changes in the flow of capital into and out of Canada as compared to its southern neighbor. A lesser, but important factor is changes in world energy prices. The effects of Canadian and U.S. real income are those predicted by the Balassa-Samuelson hypothesis, with short-run employment effects operating in the opposite direction. And effects of world commodity prices and Canadian terms of trade changes turn out to be important as well. A very important empirical result is that monetary shocks, despite the possibility of overshooting, have no measurable effects on short-run real and nominal exchange rate changes, a fact that has important implications for interpreting the on-going conduct of monetary policy.

Section III brings the theory and evidence together to reach an understanding as to how monetary policy in a country like Canada should be conducted. Given the evidence that can be extracted as to what the Bank of Canada is in fact doing, the general conclusion emerges that it is doing things correctly by indirectly following virtually an identical policy to that in the United States using what seems to be an orderly markets approach. Although the United States authorities purport to operate on real interest rates and thereby on domestic investment, that option is not available to a small country like Canada embedded in a world capital market. But control

[3]For an interesting discussion of this issue, see Mathias Hoffman, Jens Sondergaard and Niklas J. Westelius, "The Timing and Magnitude of Exchange Rate Overshooting," *Deutsche Bundesbank Discussion Paper 28*, 2007.

of overnight borrowing rates in Canada nevertheless provides a good method of influencing the expected domestic inflation rate, which is crucially important for policy. And it also enables the Bank to change the profitability of and thereby induce gradual adjustments of bank reserves with eventual effects on the stock of base money. While nominal exchange rate adjustments, and associated short-run real exchange rate changes turn out to be an important monetary policy instrument for a small-open-economy like Canada, potentially observable direct short-term pressure by the Bank of Canada on the exchange rate through base money stock adjustments is desirable only in situations of major world crises like the one recently experienced or under circumstances where the Canadian inflation rate for some reason has continually deviated substantially from an appropriate level. The empirical evidence uncovered here makes it possible to arrive at a rough estimate of how far the Bank of Canada would have to change the nominal and real exchange rates, under the critical circumstances above, to move the unemployment rate in a desired direction by one percent, with the real exchange rate returning to its long-run equilibrium level as inflation expectations and wages and prices eventually adjust. An obvious related conclusion is that the Bank of Canada should not announce, or claim credit for, any short-run real and nominal exchange rate changes that economic conditions require it to engineer.[4]

I: The Theory of Real Exchange Rate Determination

The real exchange rate is the relative price of domestic output in terms of foreign output and can be expressed as

$$Q = \frac{\Pi P}{\tilde{P}} \tag{1}$$

where Q is the real exchange rate, Π is the nominal exchange rate defined as the foreign currency price of domestic currency, P is the domestic price level and $\tilde{P}$ is the foreign price level. At a given level of the real exchange rate, the nominal exchange rate will be inversely related to the ratio of the domestic over the foreign price level—that is, by the extent of past domestic relative to foreign price inflation. The domestic and foreign price levels can

[4]For a careful non-technical analysis of the role played by the exchange rate in Bank of Canada policy, see Christopher Ragan, "The Exchange Rate and Canadian Inflation Targeting," *Bank of Canada Working Paper 2005-34*, November 2005.

be expressed as geometrically weighted averages of the prices of the traded and non-traded components of the domestic and foreign outputs:

$$P = P_N^{\theta} P_T^{1-\theta} \tag{2}$$

and

$$\tilde{P} = \tilde{P}_N^{\tilde{\theta}} \tilde{P}_T^{1-\tilde{\theta}} \tag{3}$$

where $1 > \theta > 0$ and $1 > \tilde{\theta} > 0$ are the fractions of domestic and foreign output represented by non-traded components. Here it is assumed that all goods have traded and non-traded components. Even the classic non-traded good, haircuts, has traded components because hair stylists will be using clippers, chairs and other things that can be imported from abroad. And the classic traded good, wheat, will have cost components representing domestic labour required to arrange storage, transport and sale. Substituting these two equations into (1), we obtain

$$\begin{aligned} Q &= \frac{\Pi\, P_N^{\theta} P_T^{1-\theta}}{\tilde{P}_N^{\tilde{\theta}} \tilde{P}_T^{1-\tilde{\theta}}} = \frac{\Pi\, P_N^{\theta} (\tilde{P}_{T_D}/\Pi)^{1-\theta}}{\tilde{P}_N^{\tilde{\theta}} \tilde{P}_T^{1-\tilde{\theta}}} \\ &= \frac{(\Pi/\Pi^{1-\theta})\, P_N^{\theta} \tilde{P}_{T_D}^{1-\theta}}{\tilde{P}_N^{\tilde{\theta}} \tilde{P}_T^{1-\tilde{\theta}}} = \left[\frac{(\Pi P_N)^{\theta}}{\tilde{P}_N^{\tilde{\theta}}}\right] \left[\frac{\tilde{P}_{T_D}^{1-\theta}}{\tilde{P}_T^{1-\tilde{\theta}}}\right] \end{aligned} \tag{4}$$

where $\tilde{P}_{T_D}$ is the foreign currency price of the domestic traded componont of output. The real exchange rate of Canada with respect to the United States will thus depend on the ratio of the prices of the non-traded components of Canadian output to the prices of the non-traded components of U.S. output and on the prices of the Canadian traded output components relative to the prices of the U.S. traded output components.

It is clear from the above that we can expect Canada's real exchange rate with respect to the U.S. to rise when the prices of commodities and energy rise in international markets, relative to the prices of other goods, because production of these commodities represents a higher proportion of Canadian output than United States output. More broadly, we would expect that a rise in Canada's terms of trade with respect to the rest of the world relative to the U.S terms of trade with the rest of the world would also lead to an increase in the real exchange rate. And, according to the Balassa-Samuelson hypothesis,

we would also expect the real exchange rate to rise in response to an increase in domestic relative to foreign full-employment income.[5] As income rises so do real wages and the relative increase in real wages increases the cost of producing the non-traded components of output relative to the cost of producing foreign non-traded output components. A further obvious factor causing the real exchange rate to rise will be shifts of demand of domestic residents from goods with low non-traded components to those with high non-traded components. While shifts of this sort will be extremely difficult to measure, one obvious measurable factor might be the share of government expenditure in domestic output since there are obvious political pressures on government to channel its spending as directly as possible to domestic residents.

Finally, we can expect that a decision of international investors, in response to new technological developments, to increase their investment in Canada relative to their investment in United States will produce an increased demand for the non-traded components of Canadian as compared to U.S. output, requiring a higher relative price of Canadian output to achieve equilibrium. This rise in the real exchange rate will have to reduce the current account surplus, or increase the current account deficit, sufficiently to offset the increased net capital inflow. This follows from the fact that domestic income, denoted by Y, can be divided into the components

$$Y = C + I + B_T + DSB \tag{5}$$

where C is total private plus government expenditure on consumption, I is total private plus government expenditure on investment, B_T is the balance of trade in goods and services excluding the services of capital, and DSB is the debt service balance which equals total income from foreign employed capital owned by domestic residents minus total income from domestically employed capital owned by foreigners. Subtraction of total consumption and investment from both sides produces the expression

$$Y - C - I = B_T + DSB \tag{6}$$

[5]B. Balassa, "The Purchasing Power Parity Doctrine: A Reappraisal," *Journal of Political Economy*, Vol. 72, No. 6, 1964, 584-96, and Paul A. Samuelson, "Theoretical Notes on Trade Problems," *Review of Economics and Statistics*, Vol. 46, No. 2, 1964, 145-154.

which reduces to

$$S - I = CAB \tag{7}$$

where $S = Y - C$ is the level of savings and $CAB = B_T + DSB$ is the current account balance. These conditions are true by definition when the variables are the actual values and represent the condition of output-market equilibrium—the equality of aggregate demand and supply—when the variables are the desired magnitudes. For equilibrium to occur, the real exchange rate, and perhaps also the level of income and thereby savings must adjust to ensure that the above equality holds. The role of real exchange rate adjustment becomes obvious when we recognize that the current account balance can be expressed

$$CAB = B_T(Q, Y, \tilde{Y}) + DSB \tag{8}$$

where $\tilde{Y}$ is the level of foreign income, $\partial CAB/\partial Q < 0$, $\partial Y/\partial Q < 0$ and $\partial \tilde{Y}/\partial Q > 0$. This expression can be written equivalently as

$$S - I - DSB = B_T(Q, Y, \tilde{Y}) \tag{9}$$

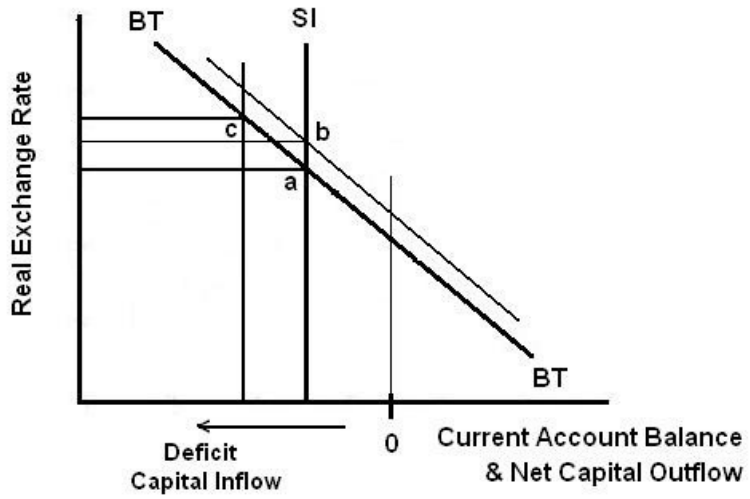
or as

$$I - S + DSB = -B_T(Q, Y, \tilde{Y}) \tag{10}$$

which states simply that the net capital inflow plus debt service balance must be equal to the negative of the balance of trade in goods and services. When capital flows in, a rise in the real exchange rate will be required to increase imports relative to exports and thereby decrease the balance of trade surplus or increase the balance of trade deficit to create a flow of goods into the country equal to the inflow flow of ownership claims to capital. An increase in domestic income will increase imports at any given real exchange rate, reducing the balance of trade, and an increase in foreign income will raise exports, increasing it. This will, of course, require corresponding adjustments of savings relative to investment, given the general equilibrum nature of the adjustment process.

Under full-employment conditions, an appropriate graphical presentation of the above simultaneous relationship is presented in the figure below.

Figure 1: Real Exchange Rate Determination



The vertical SI line gives the excess of savings over investment at the current level of full-employment income and the B_T curve gives the response of the real exchange rate to changes in the full-employment net capital inflow. An increase in domestic investment relative to savings shifts SI to the left causing the real exchange rate to rise and the current account surplus (deficit) to decline (increase) as the equilibrium moves from point **a** to point **c**. An increase in commoditiy or oil prices in the Canadian case, or an increase in that country's terms of trade holding the U.S. situation unchanged, will cause the B_T curve to shift upward to the right moving the equilibrium from point **a** to point **b**. An upward shift of B_T will also occur in response to an increase in Canadian full-employment real income holding income abroad constant.

The question immediately arises as to the validity of the assumption that the SI line is vertical. It would seem reasonable to expect that a change in the real exchange rate would have effects on the net capital inflow in both directions. The fact that the relative price of Canadian in terms of world output increases with a rise in the real exchange rate can be reasonably expected to make additional in investment in Canada profitable. At the same time, however, the effect of the rise in the real exchange rate on the

wealth of Canadian holders of domestic-employed capital will probably result in some increase in domestic savings. The fact that investment and savings move in the same direction makes the combined effect on the slope of the SI curve unclear. Given our lack of knowledge about the magnitudes of the opposing effects, the best alternative would seem to be to continue assuming that the SI line is vertical, recognizing that some bias in our results in one direction or the other may be present.

Short-run transitory changes in income and employment will affect the two curves in opposite directions. An increase in output and employment, holding the full-employment level of income unchanged, will result in an increased supply of domestic goods in world markets, causing the B_T curve to shift downward to the left. At the same time, the public's recognition that the increase in income is transitory will cause savings to increase as consumption is maintained at its inter-temporally optimal level, causing the SI line to shift to the right. The real exchange rate will decline and the current account balance will increase.

Letting domestic consumption and investment be functions of the real interest rate and domestic income, the domestic aggregate real goods market condition becomes

$$Y = G_D(\tilde{r} + \rho, Y, \Phi_D) + B_T(Q, Y, \tilde{Y}, \Phi_B) + DSB \tag{11}$$

where the function $G_D()$ is domestic private plus public aggregate demand for goods and services with $\tilde{r}$ being the world real interest rate and ρ the risk premium on domestic-employed capital and Φ_D and Φ_B are shift variables.

Full equilibrium, of course, also requires conditions of asset equilibrium. For a small open economy like the Canadian one operating in a world capital market, asset equilibrium can be expressed by a single equation, the demand function for real money balances, with a risk premium or discount on Canadian employed assets encorporated, along with the expected rate of inflation, in the interest rate variable. With the nominal money supply on the left side, this equation becomes

$$\begin{aligned} M &= P\, L(\tilde{r} + \rho + E_p, Y, \Phi_M) \\ &= P_N^{\theta}(\tilde{P}_T/\Pi)^{1-\theta}\, L(\tilde{r} + \rho + E_p, Y, \Phi_M) \end{aligned} \tag{12}$$

where M is the nominal money stock, the Canadian real interest rate is $\tilde{r} + \rho$ and E_p is the expected rate of Canadian inflation, making $\tilde{r} + \rho + E_p$

the domestic nominal interest rate. And the function $L(\tilde{r}+\rho+E_p, Y, \Phi_M)$ is the demand function for domestic real money balances with Φ_M being another shift variable.

Finally, from equation (1) the nominal exchange rate must be equal to

$$\Pi = \frac{Q\tilde{P}}{P}\,. \tag{13}$$

Equations (11) and (12) and (13) form the complete model relevant for the anaysis that follows.

The domestic authorities have two basic options. They can either fix the exchange rate or let it float. Let us begin by assuming that Canada adopts a fixed exchange rate with respect to the U.S. dollar. Under conditions of price flexibility and full-employment, where $Y = Y_f$ and $Q = Q_f$, the real goods market equilibrium equation (11) becomes purely descriptive and, given the fixed level of Π, the equilibrium price level is determined by equation (13) as

$$P = \frac{Q_f\tilde{P}}{\bar{\Pi}}$$

where $\bar{\Pi}$ is the fixed U.S. dollar price of the Canadian dollar. The Canadian price level will rise and fall through time with the full-employment real exchange rate level. As will be established in the empirical work below, Canada's real exchange rate with respect to the U.S. has varied very substantially over the years making a fixed exchange rate system a poor choice. Given the fixed levels of output and prices, the asset equilibrium equation (12) simply determines the nominal money stock the authorities must maintain in order to validate the fixed exchange rate—this level of domestic liquidity can be maintained by appropriate open market operations in domestic securities together with purchases and sales of U.S. dollar reserves in the open market.

Turning now to the short-run situation where the domestic price level cannot adjust, we impose on the model the additional assumption that $P = \bar{P}$. Equation (13) now produces the short-run equilibrium level of the real exchange rate

$$Q = \frac{\bar{\Pi}\,\bar{P}}{\tilde{P}}$$

which will not vary in response to changes in its full-employment equilibrium level. This real exchange rate level plugs into the output-flow equilibrium equation (11) to produce the short-run equilibrium level of Y which, when substituted into the asset stock equilibrium equation (13) again generates the level of liquidity that the Canadian authorities must supply to maintain the fixed exchange rate.

Clearly, an independent Canadian monetary policy is not possible. But the domestic authorities could still bring about appropriate variations in the level of domestic output and employment by a properly constructed fiscal policy that shifts Φ_D and can also make economically inefficient variations in the level of output through tariff and trade policies that shift Φ_D. Note also that changes in the full-employment equilibrium level of the real exchange rate will create deviations of Q from Q_f. To the extent that Q_f falls relative to Q, domestic exports will decline relative to imports, reducing the level of Y in the goods market equilibrium equation (11). The very substantial effects of changes in the full-employment equilibrium real exchange through time that will be shown empirically below will have major short-run effects on output and employment in the process of generating the substantial long-run effects on the Canadian price level. This makes the argument against adopting a fixed exchange rate with respect to the U.S. dollar even stronger.[6]

Suppose alternatively what is in fact the case—that Canada allows the dollar to float freely in international markets. Under conditions of price flexibility and full employment, the imposition of $Y = Y_f$ in the asset equilibrium equation (12) generates an equilibrium real stock of money M/P. The domestic authorities can now fully control the price level by variations in the nominal money supply. That equilibrium level of prices, together with the full-employment equilibrium level of the real exchange rate, generates the equilibrium nominal exchange rate

$$\Pi = \frac{Q_f \tilde{P}}{P} .$$

The major variations in Q_f through time will now simply result in proportional variations of Π with the Canadian price level being fully under the

[6]For a broad discussion of the merits of a flexible exchange in the Canadian case see John Murray, "Why Canada Needs a Flexible Exchange Rate," *North American Journal of Economics and Finance*, Vol. 11, No. 1, 2000, 41-60.

control of the domestic authorities. As in the fixed exchange rate case the real goods market flow equilibrium equation (11) becomes purely definitional.

Now let us impose short-run rigidity of the Canadian price level, making for the moment an assumption that there is pricing to market—that is, that the Canadian prices of traded goods are fixed independently of movements in the exchange rate.[7] When we plug this fixed price level into the asset equilibrium equation (12) we obtain the following relationship between the nominal money supply and output.

$$M = \bar{P}\, L(\tilde{r} + \rho + E_p, Y, \Phi_M)$$

The short-run equilibrium level of output will respond positively to changes in the money supply, and negatively to positive shifts in the demand for liquidity. When we plug this level of output into the goods market equation, that equation generates the short-run equilibrium level of the real exchange rate which, when plugged into equation (13), produces the equilibrium level of the nominal exchange rate.

Clearly, when the exchange rate is flexible the Canadian authorities are able to conduct a counter-cyclical monetary policy. Moreover, as can be seen from the goods market equation (11) combined with the fact that the level of domestic output and employment is determined by the condition of asset equilibrium, fiscal or tariff produced shifts in Φ_D or Φ_T will lead to sufficient opposite changes in Q to neutralize any effect on income and employment.

The above result that monetary policy works only under flexible exchange rates and fiscal policy only under fixed exchange rates goes back to the path-breaking work of Fleming and Mundell.[8]

A difficulty in the flexible exchange rate case is the possibility of exchange rate overshooting if the Canadian authorities operate directly on the monetary aggregates. A monetary expansion results in the attempt by asset holders to re-balance their portfolios by exchanging money holdings for non-monetary assets. This causes the nominal and real exchange rates to

[7] C. Betts and Michael B. Devereux, "Exchange Rate Dynamics in a Model of Pricing to Market," *Journal of International Economics*, Vol. 50, No. 1, 2000, 215-44

[8] J. M. Fleming, Domestic Policies under Fixed and Flexible Exchange Rates, *International Monetary Fund Staff Papers* 9, 1962, 369-379 and R. A. Mundell, Capital Mobility and Stabilization Under Fixed and Flexible Exchange Rates, *Canadian Journal of Economics and Political Science*, Vol. 29, No. 4, 1963, 475-485.

devalue and thereby leads to an expansion of exports relative to imports and domestic output and employment sufficient to increase demand for money holdings to equal the new higher stock of nominal money balances. This can be seen from the asset equilibrium equation (12). An increase in M on the left side of that equation must be matched by and equal increase in the right side for asset market equilibrium to be maintained. Since output prices cannot change in the short-run, the fall in Π will reduce the real exchange rate and shift world demand onto domestic output, causing Y to increase by an amount which, together with any exchange rate induced rise in the domestic price level, will increase the right side of the equation to equal the increase in the left side. The problem is that it takes time for the balance of trade and the level of real income to respond to a fall in the real exchange rate. Until an output response can take place the fall in the nominal exchange rate which, under the pricing-to-market assumption above holding all nominal prices constant, has no effecton the right-hand side of (12) so there is no equilibrating mechanism—the nominal and real exchange rates will have no equilibium levels. When we relax the assumption of pricing to market and assume that

$$P = P_N^{\theta}(\tilde{P}_T/\Pi)^{1-\theta}\,,$$

a devaluation of the nominal exchange rate causes a rise in the in the domestic prices of at least some of the traded components of output. Taking the logarithm of equation (12) under these circumstances where output prices, the real and nominal interest rates and real output are constant, we obtain

$$\begin{aligned} log(M) &= \theta\, log(P_N) + (1-\theta)[log(\tilde{P}_T) - log(\Pi) + log(L(\tilde{r} + E_p, Y)) \\ &= -(1-\theta)\, log(\Pi) \end{aligned} \tag{14}$$

which can be rewritten as

$$log(\Pi) = -\frac{1}{1-\theta}\, log(M)\,. \tag{15}$$

Taking the total differential of the above expression yields

$$\frac{d\Pi}{\Pi} = -\frac{1}{1-\theta}\,\frac{dM}{M}\,. \tag{16}$$

Under the reasonable assumption that one-third of domestic output consists of traded components that vary in price with changes in the nominal exchange rate, a one percent increase in the nominal money supply will cause the

nominal exchange rate to fall by three percent. But this now ignores the fact that it will take at least some finite period of time for the domestic currency prices of the traded components of output to adjust to the exchange rate change. In the days during which these prices remain unchanged the nominal exchange rate may fall much further, with the only equilibrating mechanism being a speculative one arising from knowledge that there has to be a lower limit to its the long-run equilibrium level. The expectation that the real exchange rate will eventually rise back to its full-employment level implies that the price of domestically employed capital will rise relative to the price of capital employed abroad, signifying a real capital gain. This will cause the price of domestically employed capital to rise relative to its cost of production, lowering the domestic real interest rate which can then be expressed as

$$r \;=\; \tilde{r} + \rho - E_q \,. \tag{17}$$

Equation (14) must then be modified, becoming

$$\begin{aligned} log(M) \;=\; & \theta\, log(P_N) + (1-\theta)[log(\tilde{P}_T) - log(\Pi)] \\ & + \eta\,(\tilde{r} + \rho \;-\; E_q \;+\; E_p) \;+\; \epsilon\; log(Y)\,, \end{aligned} \tag{18}$$

where the interest rate variable and its components are not expressed in logarithms and E_q is the expected rate of change in the real exchange rate, $\epsilon > 0$ is the income elasticity of demand, and $\eta < 0$ the interest semi-elasticity of demand, for real money balances. An increase in E_q lowers the domestic real and nominal interest rates, increasing the right side of the equation and thereby requiring a smaller decline in the real and nominal exchange rates to produce equilibrium.[9]

Quite apart from overshooting exchange rate effects of money supply shocks, there are also good reasons to believe that potential overshooting exchange rate effects of shocks to the demand for money will occur from time to time. During the period between late-1962 and early-1970 when Canada was on a fixed exchange rate and, for reasons noted above, the supply of money was endogenous, the standard deviations of the month-to-month percentage changes in the monetary base, M1 and M2 were 2.4, 3.6 and 2.6, suggesting substantial short-run exchange rate effects had Canadian liquidity growth

[9]For the original formulation of this this equilibrating mechanism, see Rudiger Dornbusch, "Expectations and Exchange Rate Dynamics," *Journal of Political Economy*, Vol. 84, No. 6, 1976, 1161-76.

been held constant and the dollar allowed to float. This presence of money demand shocks rules out money growth rules as a policy focus. Indeed, given the presence of exchange rate overshooting pressures resulting from demand for money shocks, a central background feature of Bank of Canada policy must be the maintenance of orderly markets—the accusation of permitting or creating market instability is a central banker's nightmare. The standard way to ensure orderly markets is to continually adjust base money growth and credit provision to the banking system to prevent short-period exchange rate movements from jumping sharply from day to day outside the normal trading range. The problem with this approach, of course, is that the Bank will end up financing all major changes in the domestic demand for liquidity with the result that it will finance any changes in the expected rate of inflation. Any major independent influence by the Bank on domestic output and employment and, in the longer run, inflation will necessarily involve significant pressure on the nominal exchange rate. The problem is that when the Bank induces changes in the market value of the Canadian dollar it loses sight of the equilibrium level of that exchange rate.

Contrary to popular opinion, it is unreasonable to expect the Bank of Canada to be able to manipulate the domestic real interest rate. Normal adjustments of the nominal money supply will induce a relatively small relative change in the world demand for domestic assets and it is thus difficult to imagine that ρ, the underlying risk premium on domestically employed real capital, will be significantly affected. Even though it has no control over the underlying levels of domestic real interest rates relevant for investment decisions, however, there are two reasons why it makes good sense for the Bank of Canada to announce targets for, and exercise control over, the interest rate at which it will lend reserves to the domestic banking system. First, setting a target for the overnight lending rate helps establish public awareness of the Bank's commitment to its inflation target. It is extremely important that the public have an appropriate expected inflation rate because by following an orderly markets monetary policy that keeps the nominal exchange rate from jumping sharply outside normal trading ranges the Bank can end up financing that expected inflation rate. Second, by controlling the rate at which it will lend to the banking system and at which the commercial banks will be able to borrow from each other, the Bank of Canada can affect the profitability to commercial banks of expanding their reserves and deposits and thereby exercise an element of direct influence on money supply growth

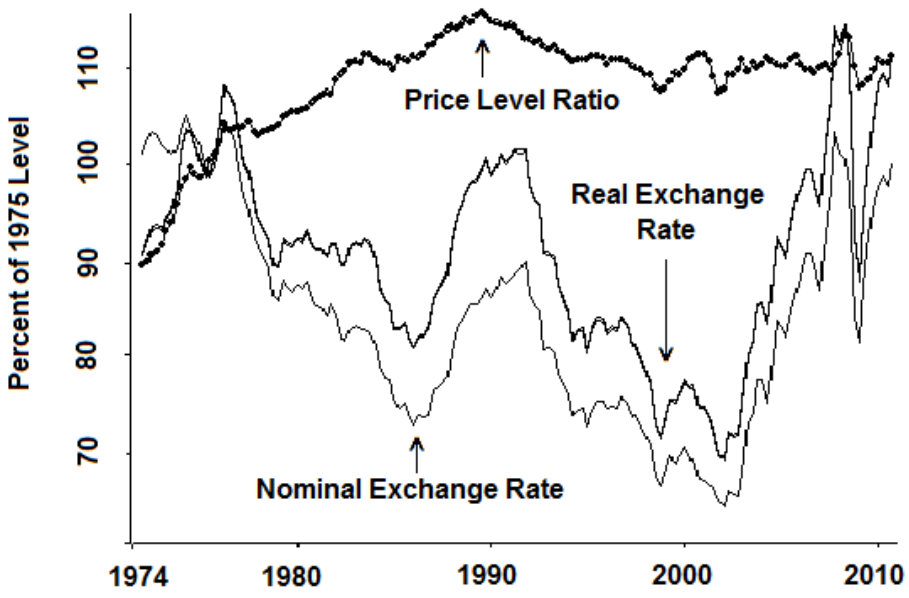
followed by hopefully gradual nominal and real exchange rate changes in the appropriate direction.

In the long-run, of course, the expansion of output and employment resulting from the devaluation of the Canadian dollar and fall in the real exchange rate that will inevitably result from increased domestic monetary expansion will lead to upward pressure on and increases in the Canadian price level that will reduce domestic output and raise the real exchange rate back to their full-employment levels.

II: The Empirical Evidence

The time paths of Canada's real and nominal exchange rates with respect to the United States and the ratio of the Canadian over the U.S. price levels are shown in Figure 2 below, with all three variables indexed to the base of 1974 = 100.

Figure 2: Canadian Real and Nominal Exchange Rates and Price Level Ratio with Respect to the U.S.



Canada's real exchange rate fell by about 25 percent between the late-1970s and the mid-to-late-1980s and then rose by about 20 percent by the early-1990s. Then after falling about 30 percent by the early years of the 21st century it rose back above its 1974 level by the end of 2010. The Canadian price level rose relative to the United States price level by about 20 percent in the 16 years between 1974 and 1990 and then this ratio declined a bit less than 5 percent by the year 2000 and was trend-less thereafter. The relatively smooth behaviour of the price level ratio as compared to the real exchange rate resulted in a pattern of nominal exchange movements pretty-much in step with those of the real exchange rate. There is no doubt that the movements of Canada's real and nominal exchange rates with respect to the United States were very substantial.

The above theoretical analysis suggests that an empirical investigation of the factors determining Canadian long-run equilibrium exchange rates should begin by regressing the logarithm of Canada's real exchange rate with respect to the United States on the following variables.[10]

1) The logarithm of the prices of commodities excluding energy in U.S. dollars divided by an equally weighted average of the U.S. dollar prices of U.S. exports and imports.

2) The logarithm of energy prices in U.S. dollars divided by an equally weighted average of the U.S. dollar prices of U.S. exports and imports.

3) The logarithm of Canada's terms of trade with respect to the rest of the world divided by the U.S. terms of trade with respect to the rest of the world.

4) Canadian government consumption expenditure as a percentage of GDP minus U.S. government consumption expenditure as a percentage of that country's GDP. The use of government consumption rather than total expenditure focuses on a portion of government activity that would seem more likely to concentrate on the use of domestic labor and non-traded resources.

5) The logarithm of Canadian real GDP.

6) The logarithm of United States GDP.

7) The percentage of the Canadian labour force employed.

8) The percentage of the United States labour force employed.

[10]The sources of the data on these variables are discussed in the Appendix attached to the end of this paper.

9) The net capital inflow into Canada plus the debt service balance as a percentage of Canadian GDP minus the net capital inflow into the U.S. plus that country's debt service balance as a percentage of U.S. GDP, where the net capital flows plus the debt service balances are estimated as the negative of the country's balances of trade in goods and services.

In the earlier published work, the terms of trade variable, government consumption variable and the two GDP variables turned out to be statistically insignificant and were dropped, and no attempt was made to investigate any long-run implications of the employment rate variables. The regression result below extends that regression to the period from 1974Q1 to 2010Q4 rather than ending at 2007Q4.[11] And the terms of trade ratio and the excess of Canadian over U.S. government consumption expenditures now turn out to be statistically significant and are therefore added.

```
ORDINARY LEAST SQUARES REGRESSION:  1974Q1 -- 2010Q4

Dependent Variable: Log of Real Exchange Rate

                              Coeff  Std-Err  T-stat   P-Val
Constant                      0.378   0.668    0.566   0.286
Log Commodity Prices          0.342   0.099    3.460   0.000
Log Energy Prices             0.140   0.037    3.801   0.000
Net Capital Inflow Difference 0.020   0.003    5.767   0.000
Govt Consumption Difference   0.017   0.010    1.711   0.045
Log Terms of Trade Ratio      0.326   0.193    1.691   0.047

Number of Observations:      148
Degrees of Freedom:          142
R-Squared:                   0.7586192629935458

Coefficient Standard Errors are Newey-West HAC Adjusted with Lag = 3

LM-Test for Serial Correlation of Residuals: Number of Lags = 3
    Chisquare Statistic = 610.702130496176   P-Value = 0.0
```

[11] For the original result, see page 159 of John E. Floyd, *Interest Rates, Exchange Rates and World Monetary Policy*, Springer 2010.

Statistical insignificance of the real GDP variables was attributed to the high-correlation between them and the ability of the other series to capture the trend in the data. It turns out, however, that the addition of the employment rates along with the real GDP variables for the period 1976Q1 to 2010Q4 for which employment rate data was available produces the result below. The terms of trade ratio and the difference of government consumption expenditures as percentages of GDP were both statistically insignificant but replacement of the logarithm of the ratio of the Canadian over U.S. terms of trade with the logarithm of the Canadian terms of trade alone resulted in a clearly statistically significant coefficient for the latter variable and a P-value for the government consumption difference variable that is too close to the 5 percent level to ignore.

```
ORDINARY LEAST SQUARES REGRESSION:   1976Q1 -- 2010Q4

Dependent Variable: Log Real Exchange Rate

                              Coeff  Std-Err  T-stat   P-Val
Constant                     -2.808    1.145  -2.453   0.008
Log Commodity Prices          0.441    0.118   3.725   0.000
Log Energy Prices             0.140    0.034   4.152   0.000
Net Capital Inflow Difference 0.026    0.004   6.270   0.000
Log Canadian Terms of Trade   0.738    0.285   2.590   0.005
Govt Consumption Differene    0.023    0.014   1.644   0.051
Log Canadian Real GDP         2.593    0.520   4.985   0.000
Log U.S. Real GDP            -2.288    0.459  -4.986   0.000
Canadian Employment Rate     -0.040    0.009  -4.238   0.000
U.S. Employment Rate          0.032    0.009   3.560   0.000


Number of Observations:      140
Degrees of Freedom:          130
R-Squared:                   0.8353665799855272

Coefficient Standard Errors are Newey-West HAC Adjusted with Lag =  3

LM-Test for Serial Correlation of Residuals:Number of Lags = 3
    Chisquare Statistic = 234.587514136516  P-Value = 0.0
```

This result is consistent with the Balassa-Samuelson hypothesis that an increase in domestic relative to foreign full-employment real income will increase the domestic real exchange rate and, at the same time, consistent with the idea that a short-run increase in domestic output due to greater utilization of domestic resources will increase its supply and cause the relative price of that output to fall.

One might question whether the two regressions shown above might be spurious. There are three reasons to believe that this is not the case. First, the logarithm of commodity prices is a stationary variable and the fact that it is statistically significant implies that the residuals of a regression that does not include it must also be stationary. This implies that the set of variables variables other than the commodity price variable are cointegrated. Second, a Johansen cointegration test for the five non-stationary variables in the the regression that did not include the real GDP and employment rate variables indicates rejection at the one-percent level of the null-hypothesis that there is not at least one cointegrating vector. And finally, while the chances of obtaining statistically significant coefficients in regressions of one non-stationary variable on another are quite high, the chances of obtaining nine statistically significant coefficients with the expected signs in regressions of a non-stationary variable on a constant and nine other non-stationary variables are surely close to zero.[12]

At this point it is important to recall that the net capital inflow variable is the net capital inflow into Canada from all countries as a percentage of Canadian GDP minus the net capital inflow from all countries into the U.S. as a percentage of that country's GDP. And these net capital inflow variables must equal the value of imports from minus exports to all countries. Since the net capital inflows into both Canada and the United States can arise as a consequence of technological and other developments in third countries, and capital flows into and out of those countries, a possible source of bias in the coefficient estimates in the regressions above is present. The correlation of capital flows into Canada with that country's real exchange rate with respect to the United States will depend on what is happening in third countries to influence their capital inflows and outflows. The real exchange rates of

[12]When ten non-stationary variables are independently constructed by summing normal random shocks having standard deviations of unity, and then one of these variables is regressed on the other nine, all variables will be statistically significant with positive (or pre-selected) signs in not even one of 1000 runs in almost every case.

those other countries with respect to the United States will also be changing through time so that a change in Canada's real exchange rate with respect to the United States will be correlated with changes in the real exchange rates of other countries with respect to the United States and will therefore not necessarily be a good measure of Canada's real exchange rate with respect to the rest of the world. Subsequent analysis based on the regression coefficient of the net capital inflow variable cannot routinely hold constant the real exchange rates of the U.S. with respect to third countries in order to specify that changes in Canada's real exchange rate with respect to the United States represent proportional changes in her real exchange rate with respect to the rest of the world.

To circumvent this problem we need to include in our regression the real exchange rates with respect to the United States of all the major trading countries in the world. This is, of course, impossible because of resulting degrees-of-freedom limitations. It turns out, however, that when the real exchange rates of the United Kingdom and Japan with respect to the United States are added individually to the regression, their coefficients turn out to be statistically insignificant and, when included together, both coefficients are statistically insignificant. There are insufficient data to enable the addition of the real exchange rate of the Euro Area with respect to the United States for the entire period. For the period 1999 onward, however, we can usefully add the real exchange rates of Japan, the Euro Area and the United Kingdom with respect to the U.S. to a regression that includes only the three main variables of interest. When we do this the real exchange rates of the Euro Area and the United Kingdom, but not Japan, turn out to be statistically significant when added separately but the Euro Area and U.K. real exchange rates both are statistically insignificant when added together. This is a classic case of multicolinearity. As the F-test below shows, the null hypothesis that the Euro Area and U.K. real exchange rates with respect to the U.S. together contribute nothing to the explanation of the Canadian real exchange rate with respect to the United States can be easily rejected.

ORDINARY LEAST SQUARES REGRESSION: 1999Q1 -- 2010Q4

Dependent Variable: Log Real Exchange Rate

	Coeff	Std-Err	T-stat	P-Val
Constant	-0.403	0.304	-1.326	0.096
Log Commodity Prices	0.465	0.085	5.464	0.000
Log Energy Prices	0.227	0.024	9.512	0.000
Net Capital Inflow Difference	0.022	0.004	5.139	0.000
UK vs US Real Exchange Rate	0.184	0.145	1.268	0.106
EA vs US Real Exchange Rate	0.023	0.126	0.184	0.427

Number of Observations:	48
Degrees of Freedom:	42
R-Squared:	0.9672678469701822
Adjusted R-Squared:	0.96337116208568
Sum of Squared Errors:	0.04069918824314939
F-Statistic:	248.2283981486915
P-Value	0.0

F-Test for exclusion of both E.A. and U.K. real exchange rates
F-Statistic = 14.431035572101907
P-Value = 2.1475246620994426E-6

While the sample size is small, bootstrapping to obtain coefficient estimates produces a range of coefficient values consistent with that obtained in the above regression as can be seen in the results below. And the coefficient of the net capital inflow variable, which will be important in subsequent analysis, is quite consistent with that obtained in the earlier real exchange rate regressions that did not include third-country real exchange rates with respect to the United States.

BOOTSTRAPPED COEFFICIENTS

Quantile	CONST	PCOMM	PENGY	DNCIN	REXUK	REXEA
.01	-1.0634	0.2597	0.1742	0.0121	-0.1317	-0.2147
.025	-0.9486	0.3023	0.1832	0.0136	-0.0788	-0.1841
.05	-0.8566	0.3347	0.1884	0.0151	-0.0371	-0.1504
.10	-0.7466	0.3591	0.1965	0.0165	0.0103	-0.1150
.25	-0.5764	0.4057	0.2102	0.0186	0.0855	-0.0471
.75	-0.1980	0.5079	0.2404	0.0239	0.2682	0.1111
.9	-0.0431	0.5600	0.2535	0.0265	0.3512	0.1877
.95	0.0869	0.5912	0.2625	0.0277	0.3921	0.2281
.975	0.1865	0.6131	0.2708	0.0285	0.4300	0.2621
.99	0.1865	0.6480	0.2750	0.0296	0.4660	0.2936
median	-0.3922	0.4554	0.2256	0.0214	0.1811	0.0325
mean	-0.3873	0.4580	0.2254	0.0213	0.1784	0.0356

Finally, it is necessary to determine whether unanticipated money supply shocks have had over-shooting effects on the Canadian real exchange rate with respect to the United States. To do this, four estimates of unanticipated shocks to the three monetary aggregates in Canada and the United States were calculated. First, 10-year running regressions of the current level of each monetary aggregate on two-years of quarterly lags of both that aggregate and domestic nominal GDP were used to obtain a fitted value for each period and then a forecasted value for each period based on the 10 previous years of data. Then two additional estimates were calculated by the same method based on two-years of quarterly lags of the relevant monetary aggregate alone, without the inclusion of lagged nominal GDP. The differences between the actual value and each forecasted or fitted value of each aggregate as a percentage of the forecasted or fitted value were then used as estimates of the unanticipated shock to the monetary aggregate in question. Each pair of the four unanticipated shock measures for the relevant Canadian and U.S. monetary aggregate were then added to the long-period regression that included real GDPs and employment rates. Our theory tells us that the Canadian unanticipated money shocks should be negatively related to the Canada vs. U.S. real exchange rate and that the U.S. unanticipated shock should be positively related. This positive relationship is expected because a U.S. unanticipated money shock will make monetary conditions easier in

the United States than in Canada, lowering world interest rates because the U.S. is a large country, and increasing the demand for money in Canada.

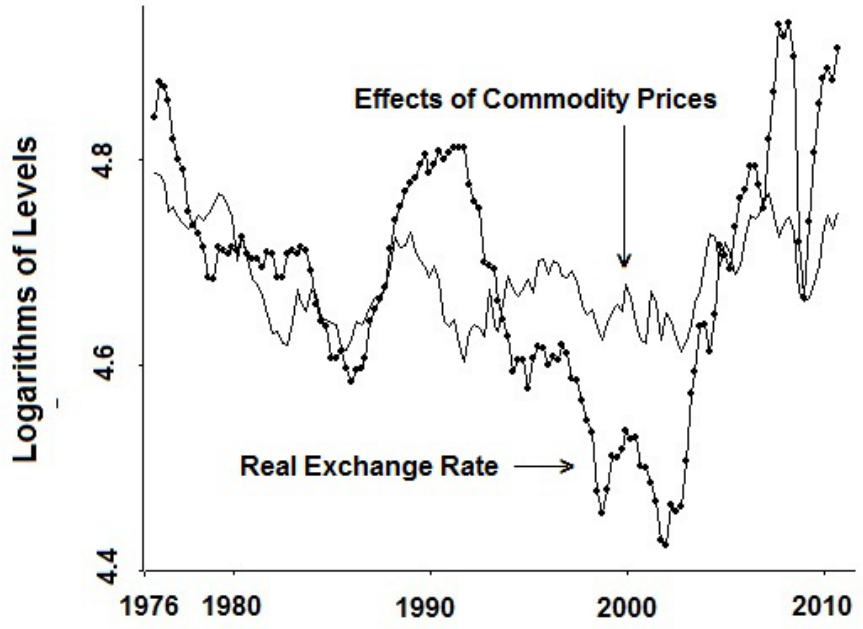
Of the twelve regressions produced by the addition of the above calculated unanticipated money shocks, in only one case was an unanticipated money shock variable statistically significant and in that case the statistically significant United States M2 shock had the wrong sign. These results are similar to those obtained in earlier research using a wider range of measures of unanticipated money shocks.[13] There is clearly no evidence of exchange rate overshooting, a result consistent with the Bank of Canada having followed an orderly markets approach to monetary policy. Any monetary policy undertaken by the Bank must have operated via gradual smooth adjustments of the nominal exchange rate.

What, then, were the most important factors determining the movements of Canada's real and nominal exchange rates with respect to the United States. Obviously, the main regression indicates that the world prices of energy and commodities excluding energy, capital movements into and out of Canada as compared to the United States and Canadian and U.S. output and employment were significantly related to the real exchange rate movements. But how important were specific individual factors? To answer this question, the effects of the individual variables on the real exchange rate over the sample period were calculated and, after adding constant amounts sufficient to equalize the mean value of each calculated effect with the mean value of the real exchange rate, plotted along with the real exchange rate.

The effect of world prices of commodities excluding energy is shown in the figure below. The decline in commodity prices was clearly related to the fall in the real exchange rate in the late-1970s and the decline and turn-around in the mid-1980s. And commodity prices were roughly related to the real exchange rate movements after 2002.

[13]See John E. Floyd, *Interest Rates, Exchange Rates and World Monetary Policy*, Springer, 2010, pages 209-222.

Figure 3: Effects of Commodity Prices Less Energy on the Real Exchange Rate of Canada with Respect to the U.S.



Graphical presentations of the effects of world energy prices and of the net capital inflow into Canada as a percentage of GDP minus the net capital inflow into the United States as a percentage of that country's GDP are encorprated in the Figure 4 and Figure 5 on the next page. As can be seen from top figure, the rises in energy prices following the late 1990s are clearly reflected in corresponding changes in the real exchange rate. And more importantly, as is clear in Figure 5, there was a rough but very strong relationship between net capital inflows into Canada as compared to the U.S. on the real exchange rate. The fact that the effect of the capital inflow difference lags the real exchange rate movements after 1990 may well reflect the time it takes for the inflow of financial capital to become translated into a flow of real capital through adjustments of the current account balance in response to resulting movements in the real exchange rate. The effects of Canadian and U.S. real GDPs and employment rates and of the Canadian terms of trade on the real exchange rate are plotted in Figures 7 and 8 on the subsequent page.

Figure 4: Effects of Energy Prices on the Real Exchange Rate of Canada with Respect to the United States

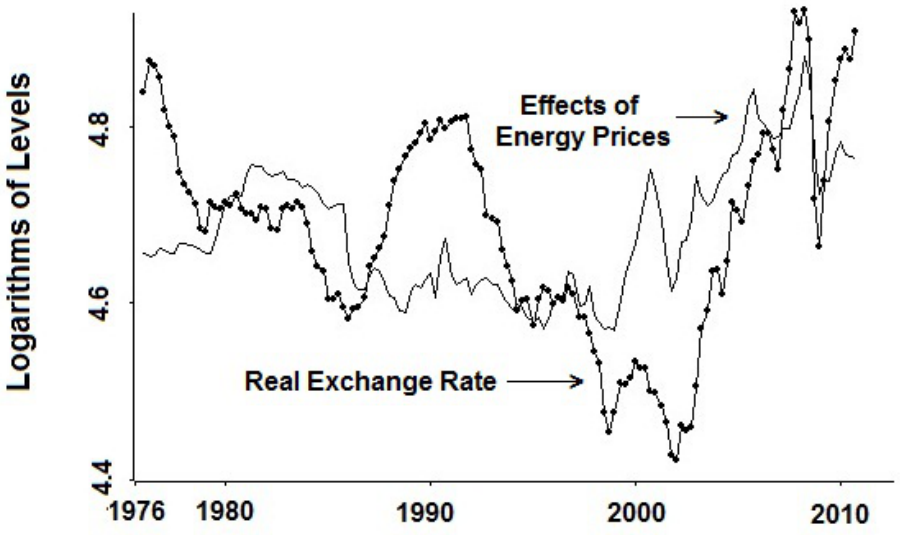


Figure 5: Effects of Real Net Capital Inflow Differences on the Real Exchange Rate of Canada with Respect to the U.S.

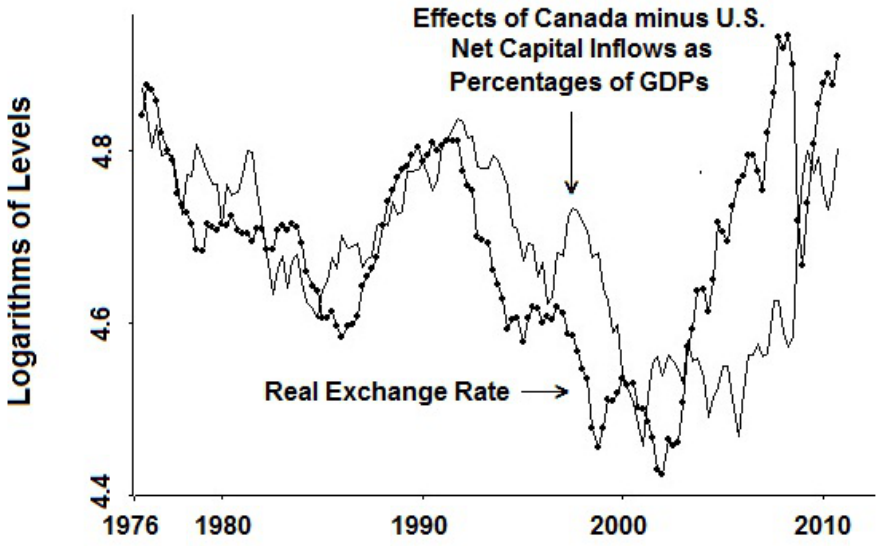


Figure 6: Effects of Real GDPs and Employment Rates on the Real Exchange Rate of Canada vs. U.S.

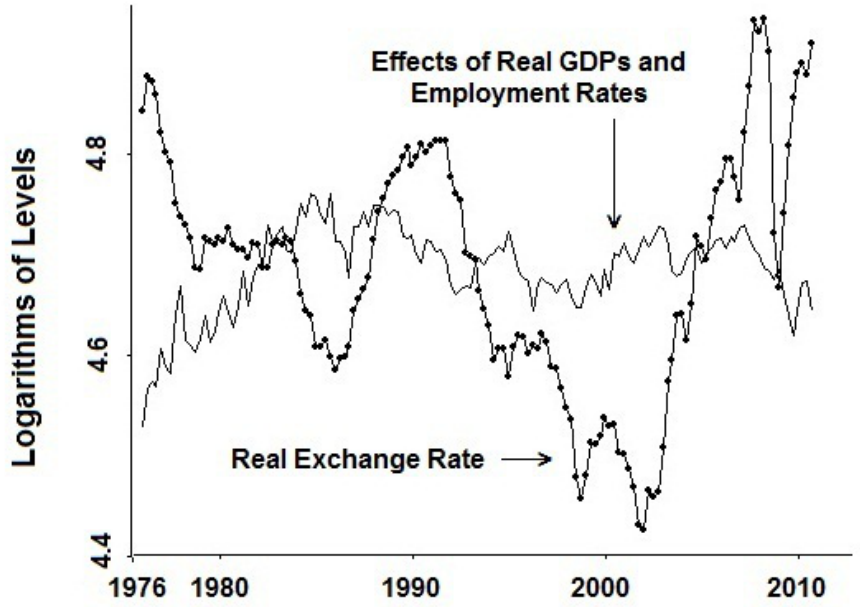
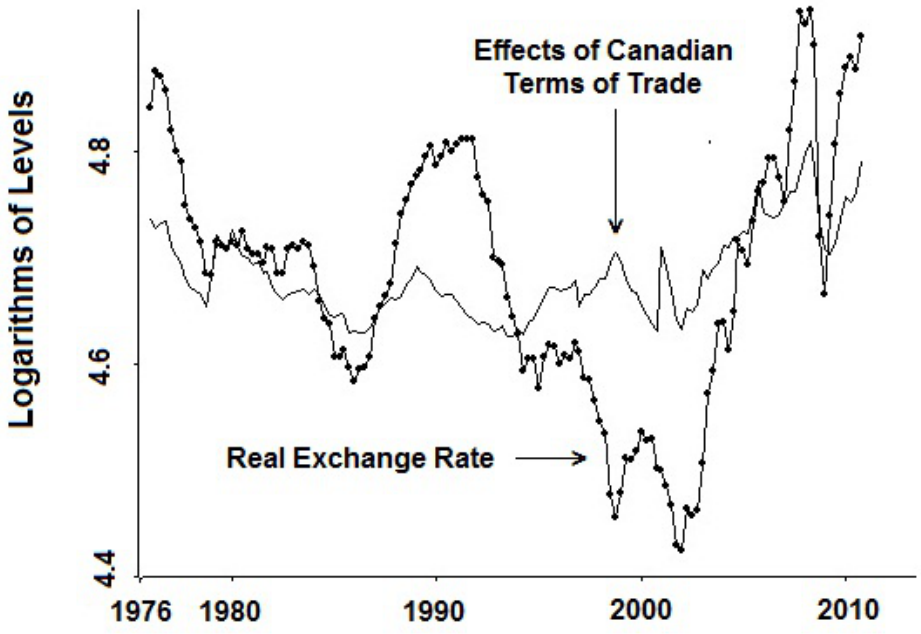


Figure 7: Effects of Canada's Terms of Trade on Her Real Exchange Rate with Respect to the U.S.



The real GDPs and employment rates together appear to have had a positive effect on the real exchange rate during the period before mid-1985 in which it declined substantially. And the Canadian terms of trade obviously had a positive effect in addition to that of commodity and energy prices and clearly contributed the increase that occurred after the year 2000 and to the downward spike during the latter years of that decade.

The Conduct of Monetary Policy

The complete lack of any observable relationship between unanticipated money supply shocks and the Canadian real exchange rate with respect to the United States suggests very strongly that, by using a orderly market approach to conducting monetary policy, the Bank of Canada follows pretty much the monetary policy of the U.S. Federal Reserve System.

It is clear from Figure 8 below that the pattern of real GDP changes was the same in both countries although the some movements are greater and others are smaller in one or other country. And the same is true of the two countries' unemployment rates plotted in Figure 9. The overall higher unemployment rate in Canada than in the United States is quite likely the result of different institutional conditions reflecting government policy relating to unemployment insurance. And it is probably the case that the major increase in the U.S. relative to Canadian unemployment rate during the past few years was due to the much greater severity of the recent financial-crises-induced recession in the U.S. because of differences in Canadian and U.S. regulation of their financial institutions.

Figure 8: Quarterly Year-Over-Year Real GDP Growth
Canada and United States

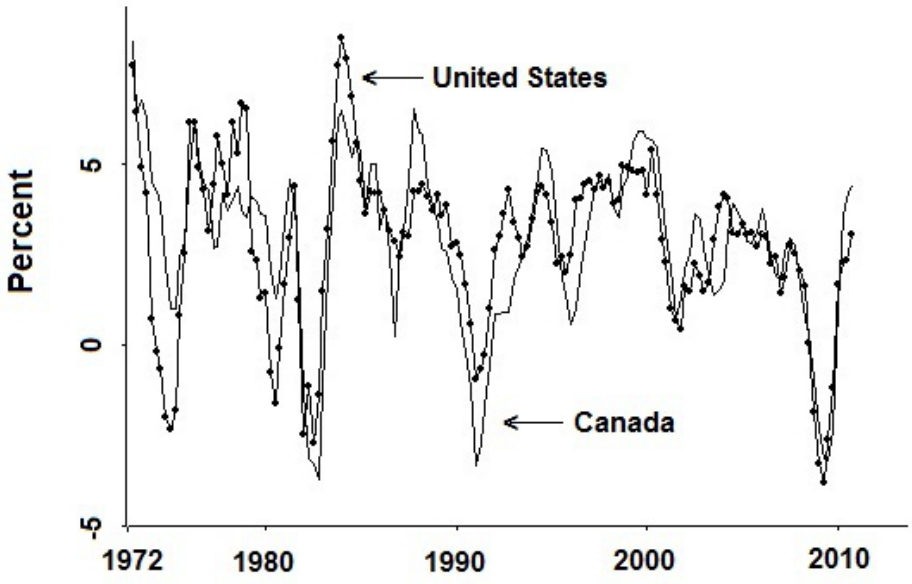
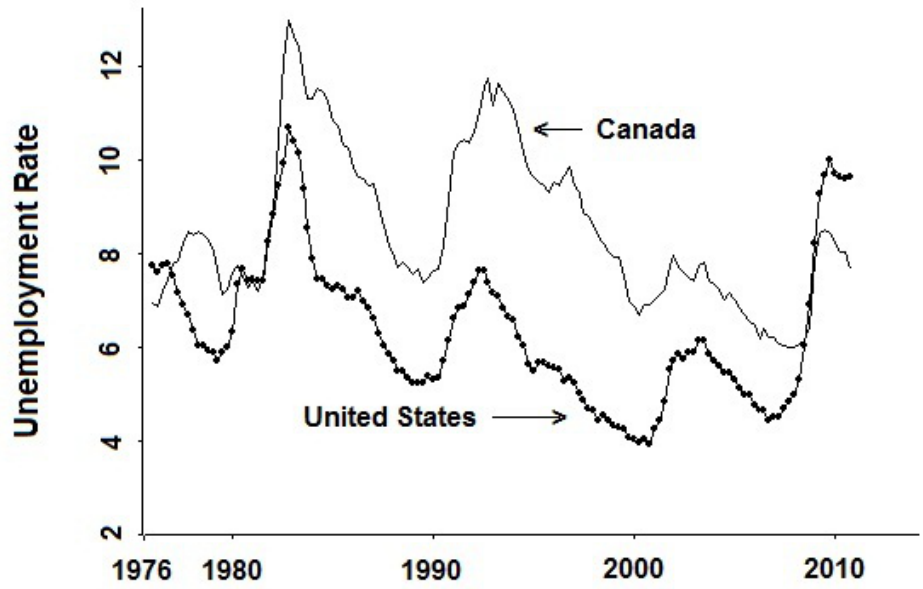
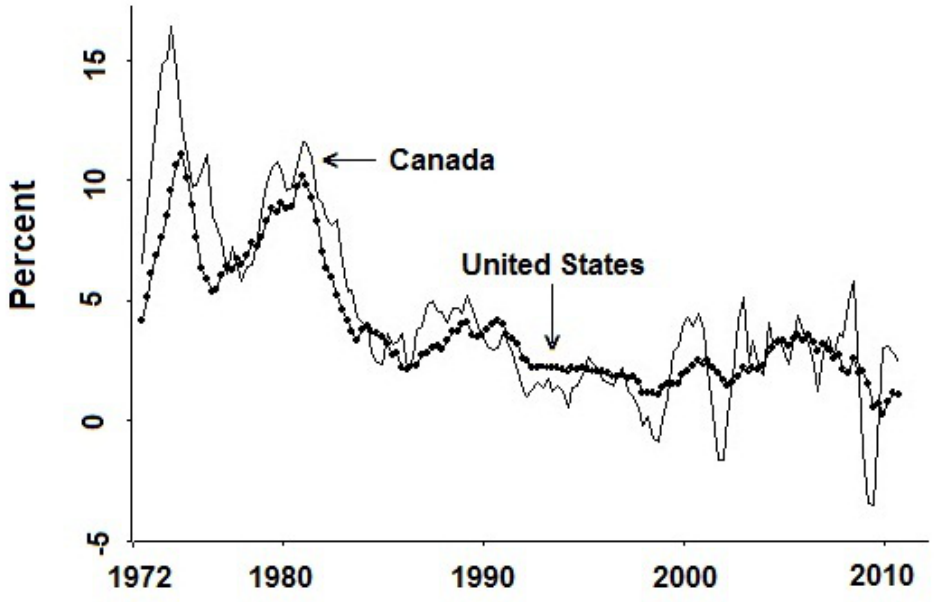


Figure 9: Percentages of Labour Force Unemployed in
Canada and the United States



The Canadian and United States year-over-year inflation CPI rates are plotted in Figure 10 below. Both inflation rates were very high until the mid-1980s, having peaked in the mid-1970s and again in the early-1980s. The Canadian inflation rate was much more variable than that in the United States and was clearly higher in the high-inflation period. After the mid-1980s the two inflation rates averaged much the same. Contrary to the situation with respect to real GDP growth, the Canadian inflation rate declined much more during the recent recession than the U.S. inflation rate but, since it also rose much more during the recovery, this may well be a reflection of its overall greater variability during the whole period, a variability that may be due as much to measurement issues as anything else.

Figure 10: United States and Canadian Year-Over-Year Inflation Rates



The two figures on the next page present further evidence that the Bank of Canada has been reproducing U.S. monetary policy.

Figure 11: Deviations of Logarithms of United States Base Money, Money Stock and CPI from Trends

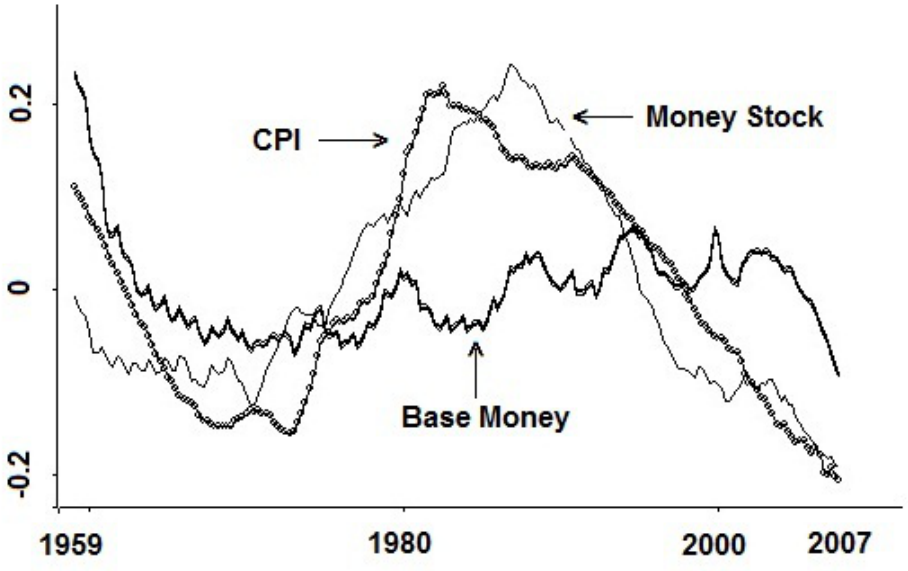
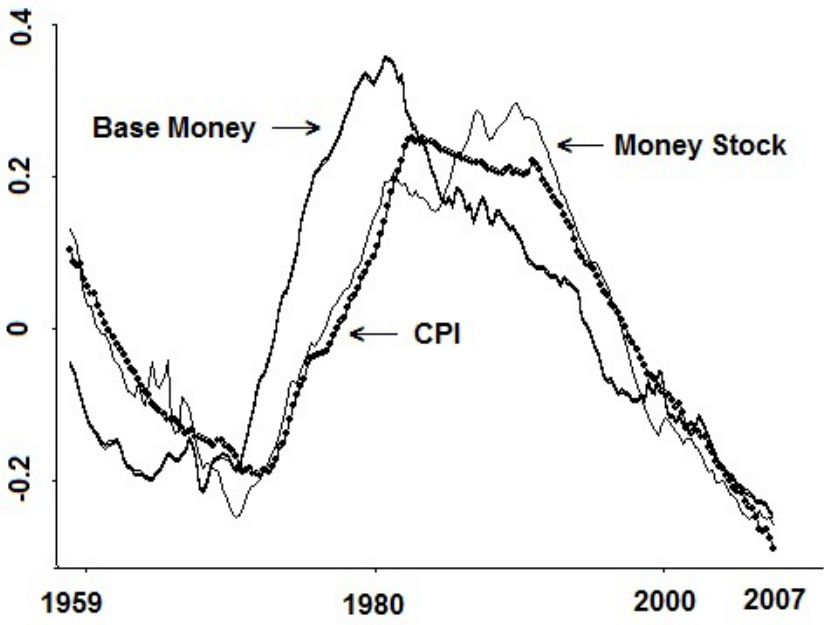


Figure 12: Deviations of the Logarithms of Canadian Base Money, Money Stock and CPI from Trends



The deviations from trend of the logarithms of domestic base money, the domestic money stock calculated as a simple average of M1 and M2, and the consumer price index are presented for the United States in Figure 11 and for Canada in Figure 12.

The underlying trends of the logarithms of the variables are upward since the years from the late-1960s to 1981 were years of very substantial inflation. Notice that the money supply and the consumer price index in the U.S. move more or less together, rising relative to trend until the early 1980s and then falling relative to trend thereafter while, at the same time, U.S. base money rose at a rather stable rate relative to trend all the way to the late-1990s. The United States authorities clearly failed to reduce the stock of base money relative to trend to compensate for the increase in the money multiplier, making the same error they made in the 1930s but in the opposite direction and with much less disturbing consequences. And it appears from Figure 11 that at least the initial decline in the money stock relative to trend after the early-1980s was not induced by a downward adjustment of base money. One possibility, noted in earlier research, is that U.S. government deregulation during that period resulted in an increase in the demand for money balances.[14]

It is clear from Figure 12 at the bottom of the previous page that the Bank of Canada financed the same degree of inflation in Canada that was occurring in the United States by adjusting the stock of base money as one would expect from an orderly markets approach to policy. Moreover, as noted in the earlier research just cited, it turns out that the authorities in Britain, Japan, France and Germany did essentially the same thing.

The central question here is whether Canada would have been better off following a monetary policy that was independent of and different from that followed in the United States. Given that Canadian monetary shocks operate through exchange rate changes and that overshooting is likely to occur if these shocks are not carefully controlled, attempts to follow a different policy than that being followed in the United States may lead to market instability. Moreover, apart from the period of inflation noted above, which hopefully will not be repeated, the U.S. policy makers have been doing about as well as

[14]See pages 327 to 340 of John E. Floyd, *Interest Rates, Exchange Rates and World Monetary Policy*, Springer, 2010, and R. A. Gilbert, "Requiem for Regulation Q: What It Did and Why It Passed Away", *Federal Reserve Bank of St. Louis Review*, February 1986, 22-37.

one could reasonably expect. Information is very imperfect and underlying changes in the economic situation can only be observed with a lag. And policy actions will produce results only with a further lag, perhaps one sufficiently long for the impact of the policy to occur after the problem being addressed has dissipated. It is well known that aggregate economic instability arises because the private sector has imperfect information about future forces driving the economy and as a result makes decisions that later turn out to be wrong. If the authorities have information that the private sector does not have, they might best simply publish it so that the private sector can properly take that information into account. If they do not have more information than the private sector has, their short-term monetary actions can make a situation worse by adding further variability to economic conditions and thereby increasing the uncertainty facing private decision makers. Accordingly, it is often argued that, apart from situations of financial crises like the one recently experienced, the monetary authorities should concentrate on providing stable monetary conditions over the long run that will provide an appropriate long-run inflation rate, and should avoid fruitless attempts to offset business cycles.

The situation is even more difficult for a small open economy like Canada than a big one like the United States. The Canadian authorities have to figure out what the U.S. authorities are doing and the impacts of those policies on both the United States and Canada. They then have to decide what effects various domestic policy actions will have, given the effects of U.S. policy, keeping in mind that domestic policy pressures on Canada's highly variable real exchange rate have the immediate effect of making its equilibrium level unobservable. Of course, the Bank of Canada can adjust the overnight rate at which banks can borrow and lend reserves from each other and from itself. To the extent that the impact is slow and gradual, appropriate non-overshooting pressures on the exchange rate may occur. And the variations of the overnight rate together with the presentation of an inflation target may help keep inflationary expectations within a desirable range. The problem is that no obvious effects of such policies are visible in the data, except in so far as they simply produce similar monetary conditions as exist in the United States.

Given the evidence above, it would seem reasonable that, barring a huge world financial and economic crises or a rise in world and Canadian inflation of the magnitude experienced in the 1970s, the Bank of Canada should

continue with its present approach to monetary policy implementation. An additional feature of this orderly markets approach is that it will neutralize the Mundell-Fleming result that equilibrating real exchange rate movements will automatically offset the effects of fiscal policy under a flexible exchange rate regime—to the extent that the Bank of Canada continually finances the public's desire to adjust their desired money holdings, it will finance changes in those desired holdings that result from expansionary effects of fiscal policy on domestic output.

In the case of a world economic crises, which will necessarily affect Canada, the Bank will have to gradually force down the nominal and real exchange rates by controlled monetary expansion. Again, this control over the exchange rate will also allow short-term effects of expansionary fiscal policy to take effect. Here it should be kept in mind that this is not a beggar-thy-neighbor policy—to the extent that all countries put similar downward pressure on the value of their currencies, the world money supply will increase and world real interest rates will fall. In a situation where the domestic core inflation rate becomes unacceptably high, the Bank has to tighten money and put upward pressure on the nominal and real exchange rates leading to an increase in the domestic unemployment rate sufficient to induce price and wage setters to modify downward their expected inflation rates and reduce the rates at which they increase wages and prices through time. Once the expected inflation rate has adjusted downward to the appropriate level, that level can then be maintained by an orderly markets monetary policy that finances the desired growth rate of monetary holdings at the current inflation rate.

As a final task, the previous empirical real exchange rate analysis can be used to get an idea of the amount by which the Bank of Canada would have to force the nominal and real exchange rates down or up to expand or contract employment by a specified amount—say one percentage point. The purpose is to determine empirically the effect of a fall in the real exchange rate due to monetary policy on output and employment and the current account balance and net capital flow—that is, to empirically account for and measure the shifts and slope of the BT line in Figure 1 along with shifts of the SI line resulting from monetary policy induced short-run real exchange rate changes. Since considerable simultaneity is involved, the best approach is to write down equations representing the determinants of BT and SI and then see what can be accomplished using the estimated coefficients in the

basic regression that includes real GDPs and employment rates, incorporating other available information as necessary. The equation of the BT curve can be written as

$$q \;=\; \alpha + \beta\,\hat{B}_T + \gamma\,E \tag{19}$$

where q is the logarithm of the real exchange rate, $\beta < 0$ is the slope of the BT curve, $\hat{B}_T$ is the full-employment current account balance and associated full-employment net capital outflow as a percentage of the current full-employment level of domestic GDP under the assumption that the U.S. net capital inflow and full-employment GDP are unchanged and therefore incorporated in the constant term α. Finally, E is the Canadian employment rate (percentage of the labour force employed), with the U.S. unemployment rate being constant and also incorporated in α, and $\gamma < 0$ is the change in the log of the real exchange rate in response to a change in the percentage of the labour force employed. According to the basic regression result above, $\beta = -.026$, and $\gamma = -.04$. The actual current account balance, which is called B_T, is equal to the full-employment current account balance minus any increase in imports that results from a subsequent change in the employment rate.

$$B_T \;=\; \hat{B}_T - mY \;=\; \hat{B}_T - m\,\delta\,E \tag{20}$$

where m is the marginal propensity to import out of a change in current income Y and δ is the increase in that income, as a percentage of its full employment level, produced by a one percentage point expansion of the level of employment. Finally, it is necessary to impose the fact that savings minus investment under less-than-full-employment conditions must equal the less-than-full-employment current account balance—that is,

$$B_T \;=\; s\,Y - I \;=\; s\,\delta\,E \;-\; I\,, \tag{21}$$

where s is the marginal propensity to save out of the change in current income and I is a constant equal to the constant underlying level of domestic investment where, by construction, the real interest rate is unchanged and the level of employment and savings and investment do not change abroad. Equations (20) and (21) together yield the following expresion for $\hat{B}_T$,

$$\hat{B}_T \;=\; (m+s)\,\delta\,E \;-\; I\,, \tag{22}$$

which upon substitution into (19) yields

$$\begin{aligned} q &= \alpha + \beta\,(m+s)\,\delta\,E \;-\; \beta\,I + \gamma\,E \\ &= \alpha - \beta\,I + [\beta\,(m+s)\,\delta + \gamma]\,E\,. \end{aligned} \tag{23}$$

Rearrangement of the above equation produces the response of the employment rate to a monetary policy induced change in q.

$$E \;=\; A + \frac{1}{\beta\,(m+s)\,\delta + \gamma}\,q \tag{24}$$

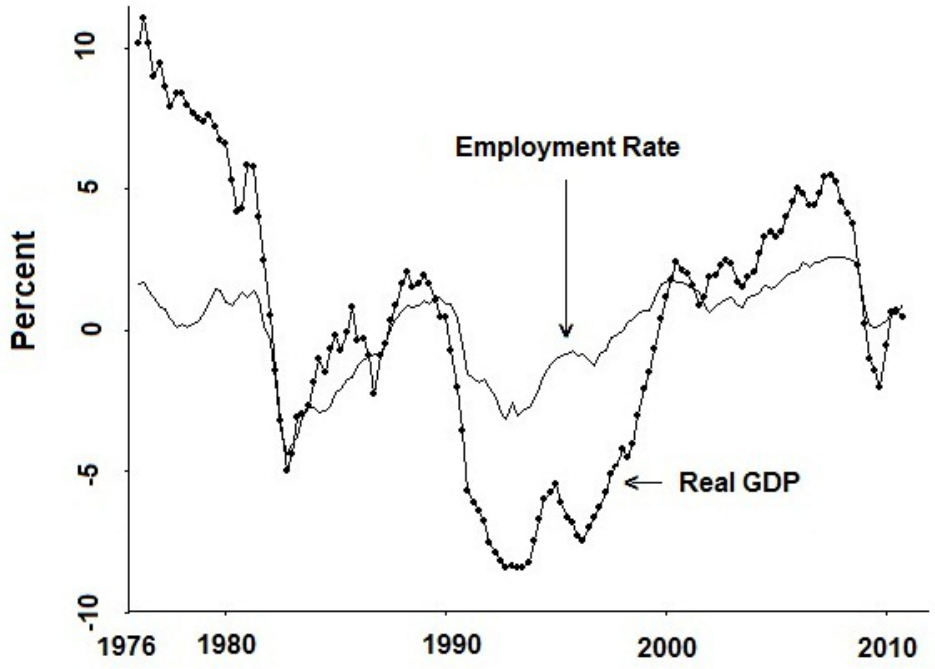
where

$$A \;=\; \frac{\alpha - \beta\,I}{\beta\,(m+s)\,\delta + \gamma}$$

is a constant term that incorporates exogenous shifts of the BT curve on account of forces beyond our present concern.

If the public fully understands what is happening and inter-temporally smoothes consumption, the entire transitory shock to income will be saved, so s will equal unity and m will equal zero. We then need only to specify a value for δ, which represents the effect of a one percentage point increase in the percentage of the labour force employed on the logarithm of the level of output. If the aggregate production function is Cobb-Douglas, this will equal the share of labour in output. There is controversy over the exact magnitude of this share because of the complexities of trying to estimate it from available data. A rough guess would postulate a share of 0.7. However, in the present circumstances where there is a variation of the level of employment of a given stock of labour under given technological conditions the possibility arises that the utilization of capital could change in a different way than it would under full-employment conditions—in particular, the current level of the capital stock could become over- or under-employed in the same way as labour. This would suggest a higher value for δ. In addition, of course, the elasticity of substitution of labour for capital in the full-employment situation may be different from the Cobb-Douglas value of unity. Under these circumstances it will be useful to attempt to calculate δ by regressing the level of output on the level of employment. A graph the time paths of the percentage deviation of Canadian real GDP from its trend level, along with the percentage of the labour force employed is presented on the next page.

Figure 13: Percentage Deviations of Canadian Real GDP From Trend and Employment Rate From Mean



The two series are obviously correlated and it is clear that the variation of real GDP around its trend is much greater than the variation of the percentage of the labour force employed. A regression of the logarithm of Canadian real GDP on the percentage of the labour force employed together with trend produces the result below.

```
ORDINARY LEAST SQUARES REGRESSION:  1976Q1 -- 2010Q4

Dependent Variable: Log of Canadian Real GDP

                        Coeff       Std-Err     T-stat      P-Val
Constant                2.574        0.173      14.859      0.000
Trend                   0.007        0.000      57.899      0.000
Employment Rate         0.014        0.002       7.277      0.000

Number of Observations:      140
Degrees of Freedom:          137
R-Squared:                   0.9942048936116979

Coefficient Standard Errors are Newey-West HAC Adjusted with Lag = 3

LM-Test for Serial Correlation of Residuals:  Number of Lags = 3
    Chisquare Statistic = 1358.4379478207427    P-Value = 0.0
```

Had the percentage deviation of real GDP from its trend been used and the trend variable omitted, the result would be the same except for the magnitude of the constant term. The fit is remarkably good but there is clearly substantial serial correlation in the residuals, the presence of which indicates that variables affecting real GDP are left out of the regression. The coefficient of the Canadian employment rate implies that an increase in the level of employment of one percent will lead to an increase in real GDP of 1.4 percent. This makes no sense—one would have to argue that the increase in employment of labour stimulates an even greater relative increase in the employment of capital. Indeed, as just noted, other factors than the employment rate are affecting real GDP. Thus, it is necessary to rely on information about the share of labour, possibly allowing for some increase in the utilization of capital, to establish a value for δ. Allowing for the possibility that increased capital utilization could accompany short-run employment expansion, a value for δ of around 0.7 would seem reasonable and an interval of 0.6 through 0.75 would seem a reasonable range to allow for error.[15]

[15]Colleague Margarida Duarte must be thanked for a helpful discussion of the range of possible values.

Assuming that a one-percent increase in the level of employment increases output by .7 percent of its full-employment level so that $\delta = .7$, and using the values of β and γ implied by the basic regression result, the total differential of (24) implies that

$$dE = -\frac{1}{(.026)(.7) + .04}\, dq \;= \frac{1}{.0582}\, dq \;= -17.18\, dq$$

which implies that a one percent or .01 fall in the logarithm of the real exchange rate will lead to a percentage increase in the level of employment of a bit more than 0.17 percent. And to increase the level of employment by 1 percentage point, the Bank of Canada would have to expand the money supply sufficiently to reduce the nominal and real exchange rate by about 6 percent. In the case where $\delta = .75$, the above magnitudes change to .0595 and 16.8 and when we let $\delta = .6$, they become .0556 and 17.98. So the range of real exchange rate devaluation required to increase the level of employment by 1 percentage point would be from 5.5 to 6 percent.

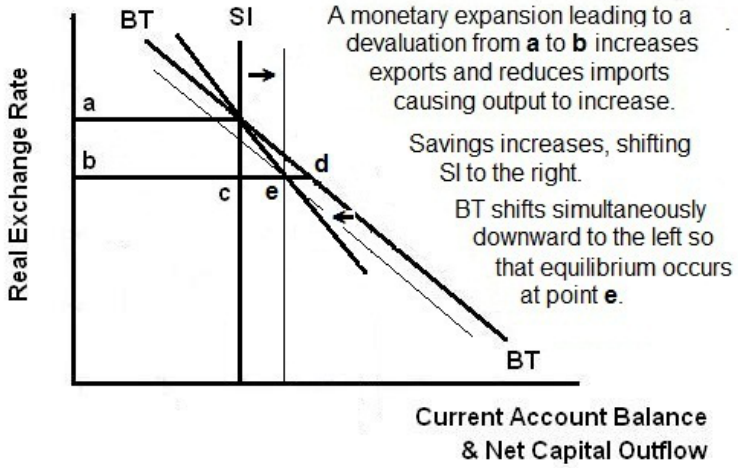
The assumption that the public regards the increase in current income as entirely transitory is probably unrealistic, given the lack of current information about the cause of the observed increase in its income. Suppose, to take the most extreme case, that the public incorrectly regards the observed increase in its income as permanent. A long-period average of the ratio of Canadian aggregate private consumption to gross national income yields, when subtracted from unity, a an estimated fraction of permanent income saved of approximately .22 and corresponding average ratio of imports of goods and services to gross national income is approximately .26. Using these values as measures of the marginal propensities, the above expression yields

$$dE = -\frac{1}{(.026)(.22 + .26)(.7) + .04}\, dq \;= \frac{1}{.0487}\, dq \;= -20.53\, dq$$

and a monetary expansion induced fall in the exchange rate of slightly under 5 percent would be required to increase the level of employment by 1 percent of the labour force. A smaller fall in the exchange rate and less monetary expansion is required because of the multiplier effect of expansion of consumption expenditure resulting from the increase in employment and income. When δ ranges between .6 and .75 the required fall in the exchange rate ranges between 4.75 and 4.94 percent.

As a rough guess one might conclude that to get a one percent increase in the fraction of the labour force employed, a monetary expansion sufficient to reduce the nominal (and real) exchange rate by between 5 and 6 percent will probably be required.

Figure 14: Real Exchange Rate Determination

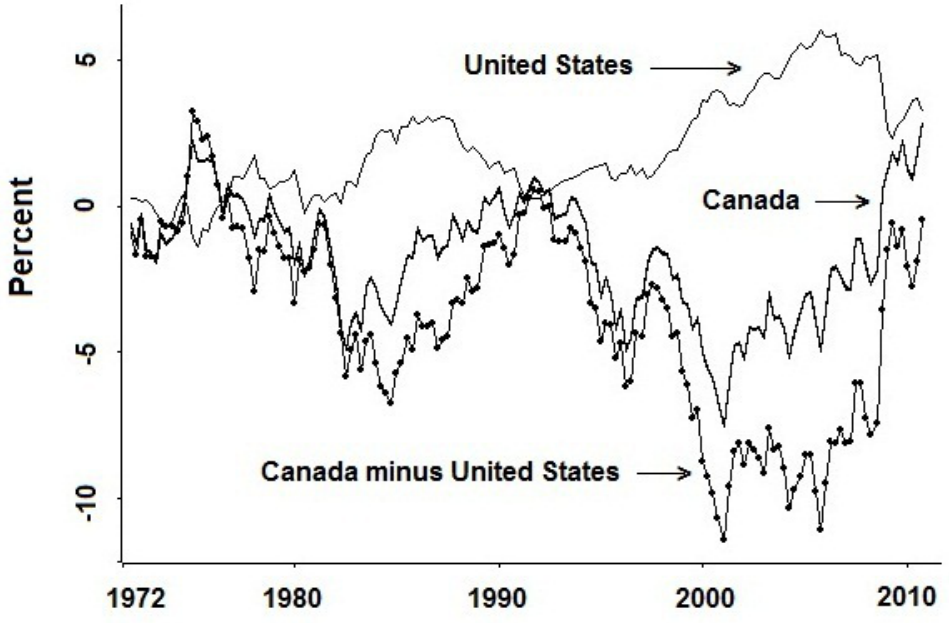


This result can be seen graphically in Figure 14 below. A fall in the real exchange rate from **a** to **b** will, because of the simultaneity issues involved, increase the current account balance by less than **c d** for one definite reason plus possibly another plausible reason. First, the associated short-run increase in employment will increase domestic relative to foreign output, reducing its value in world markets and shifting the BT curve downward to the left. In addition, it is quite likely that domestic residents will not realize that the observed increase in output and income is entirely transitory, with the result that consumption and imports will increase, shifting the BT curve downward to the left by an additional amount. The increase in the current account balance, and in savings relative to investment will thus be of a magnitude like **c e**. And in this event, although the current account balance will increase by less, the level of employment and income will increase by more as a consequence of the multiplier effect of the increase in consumption.

Finally, the fact that a monetary expansion induced fall in the real exchange rate of between five and six percent will increase domestic employment by one percentage point does not mean that the Bank of Canada should try to use nominal exchange rate manipulation to achieve less variability of the Canadian unemployment rate. First of all, as the Bank of Canada begins moving the nominal and real exchange rates it loses sight of their equilibrium level and, hence, the magnitude of the effect of its policy. Second, the Bank of Canada observes the unemployment rate and current output with a substantial lag, and the effects of its change in the real exchange rate on output and employment will only take place after a further lag. As a result, the expansion of employment induced by Bank policy may well begin to occur just as the economy is recovering from the recession and thereby accentuate subsequent inflationary pressure. Monetary manipulation of the nominal and real exchange rates is a useful policy only under the circumstances in which the Bank of Canada needs to bring about a significant change in the underlying domestic core inflation rate, or in the event of a catastrophic world crises.

The analysis has focused on the excess of the net capital inflow into Canada as a percentage of that country's GDP over the net capital inflow into the United States as a percentage of U.S. GDP. That focus was based on ease of exposition. As can be seen from the Figure 15 below, the United States experienced a net capital inflow for all but the early years of the period examined and Canada experienced net capital outflows (negative net capital inflows) for all but three small intervals over the period.

Figure 15: Net Capital Inflows as Percentages of GDP



Of course, while monetary policy is necessarily operating through movements of the real and nominal exchange rates, there is no reason for the Bank of Canada to engage in public discussion regarding the pressures it is putting or planning to put on the Canadian dollar. It should merely announce future monetary expansion or contraction and give the reason why. The last thing the Bank of Canada needs is to be regarded as responsible for the level of the dollar in the international market and therefore be under constant pressure from private interests to raise the dollar or lower it—or do both!

In this regard it is important to make clear that there is no way that the monetary authorities can bring about a permanent change in the real exchange rate. Once wages and prices have adjusted to policy induced changes in aggregate demand and employment the price level will have changed to completely reverse the policy induced change in the real exchange rate and the nominal value of the currency will have adjusted proportionally in the opposite direction to the price level. Attempts to permanently lower the

real exchange rate will merely result in continual increases in the domestic inflation rate. Recently, the Chinese government has been accused by U.S. interests of lowering the country's real exchange rate to make its exports more competitive in world markets. To lower its real exchange rate by trade policy, a country would have to tax exports and thereby reduce rest-of-world demand for the domestic currency or subsidize imports to increase the supply of the domestic currency on the international market. Neither of these policies would make political sense in a democratic country. The usual restrictive trade policies involve taxing imports or subsidizing exports. This has the effect of reducing the supply of domestic currency on the foreign exchange market as a result of reduced imports and increasing the demand due to increased exports. The domestic real exchange rate—that is, the international value of domestic output—will rise as a result of the increased world demand for domestic output. Another possible way to reduce a country's real exchange rate would be for the government to run a budget surplus and invest it abroad, which the Chinese government may in fact be doing. There are two problems with this type of policy for a democratic country in which the public is informed about government policy. First, the private sector may compensate by reallocating private savings from foreign to domestic investment to offset its increased indirect foreign investment exposure. In addition, a continuous government budget surplus is not likely to be acceptable to voters who would rather receive government benefits than pay taxes. Of course, a government can easily cause capital to flow abroad and the country's real an nominal exchange rates to fall by incompetent policy actions that make the country a poor place to invest!

APPENDIX

The sources of the data series used in this study are as follows, where IMF/IFS refers to the *International Monetary Fund: International Financial Statistics*, FRED refers to the Federal Reserve Bank of St. Louis database, NIAS refers to the United States National Income Accounts Statistics. An additional database used was the Canadian database CANSIM.

1) Canadian Nominal Exchange Rate ($Can per $US)— IMF/IFS 156/RF

2) Japanese Nominal Exchange Rate (Yen per $US) — FRED EXJPUS

3) U.K. Nominal Exchange Rate ($US per Pound) — FRED EXUSUK

4) Euro Area Nominal Exchange Rate (Euro's per US$) — IMF/IFS 163/RF

5) US$ Prices of Commodities Less Energy — CANSIM V36383 and V52673497

6) US$ Prices of Energy — CANSIM V36384 and V52673498

7) Canadian Consumer Price Index — IMF/IFS 156/64

8) United States Consumer Price Index — IMF/IFS 111/64

9) Japanese Consumer Price Index — FRED JPNCPIALLQINMEI

10) United Kingdom Consumer Price Index — FRED GBRCPIALLMINMEI

12) Euro Area Consumer Price Index — IMF/IFS 163/64H

13) Index of United States Export Prices — IMF/IFS 111/75

14) Index of United States Import Prices — IMF/IFS 111/76X

16) Index of Canadian Export Prices — IMF/IFS 156/75

17) Index of Canadian Import Prices — IMF/IFS 156/74

18) Canadian Nominal GDP — IMF/IFS 156/98B.C

19) United States Nominal GDP — IMF/IFS 111/98B.C

20) Canadian Implicit GDP Deflator — IMF/IFS 156/99BIR

21) United States Implicit GDP Deflator — IMF/IFS 111/99BIR

22) Canadian Exports of Goods and Services — IMF/IFS 156/90C.C

23) Canadian Imports of Goods and Services — IMF/IFS 156/98C.C

24) U. S. Exports of Goods and Services — IMF/IFS 156/90C.C

25) U. S. Imports of Goods and Services — IMF/IFS 98C.C

26) Canadian Government Consumption Expenditure — IMF/IFS 156/91F.C

27) U. S. Government Consumption Expenditure — IMF/IFS 111/91F.C

28) Canadian Percentage of Labour Force Unemployed — CANSIM V2062815

29) U. S. Percentage of Labour Force Unemployed — FRED UNRATE

30) Canadian Base Money — CANSIM V37145

31) Canadian M1 — IMF/IFS 156/34..B and V37127

32) Canadian M2 — IMF/IFS 156/34B + 136/35 and CANSIM V37128

33) U. S. Base Money — FRED BOGAMBNS

34) U. S. M1 — FRED M1NS

35) U. S. M2 — FRED M2NS

36) Canadian Gross National Income — IMF/IFS 156/99AC

37) Canadian Private Sector Consumption — IMF/IFS 156/99F.CZ