On Canada’s Exchange Rate Regime*

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Abstract
In this paper we use a dynamic equilibrium model of the Canadian economy to investigate the degree of currency substitution between the Canadian dollar and the U.S. dollar which potentially has implications for the theory of optimum currency areas and can be used to evaluate the desirability of a monetary union between Canada and the United States. In doing so, we include Canadian and U.S. real money balances [adjusted for take-overs and acquisitions as discussed in Kottaras (2003)] in the representative agent’s utility function, to reflect the usefulness of both currencies in facilitating transactions, and estimate the degree of currency substitution between the Canadian dollar and the U.S. dollar using Hansen’s (1982) Generalized Method of Moments (GMM) estimation procedure.

Keywords: Currency unions; Exchange rate regimes; Currency substitution; Generalized method of moments
JEL classification: C22, F33

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1 Introduction

As the Bank of Canada’s former governor, Gordon Thiessen (2000-2001, p. 47), put it,

“[o]ne of the issues that has often surfaced over the years is the exchange rate for the Canadian dollar. Indeed, over the past couple of years, it has been a topic of considerable public discussion. That discussion has revolved around such questions as: Should we continue floating, or should we peg our currency to the U.S. dollar? In fact, should we even keep our own currency, or should we adopt the U.S. currency?”

The attention to the exchange rate regime stems from the long swings in the Canadian dollar per U.S. dollar nominal exchange rate, over the recent flexible exchange rate period — see, for example, Pinno and Serletis (2005) — and also from the recent creation of a single European currency (the euro) to replace the national currencies of member countries of the European monetary union. The debate in Canada has revolved around exchange rate alternatives and particularly around the issue of whether a floating currency is the right exchange rate regime for Canada or whether we should fix the exchange rate between the Canadian and U.S. currencies, as we did from 1962 to 1970 — see, for example, Murray and Powell (2002), and Murray, Powell, and Lafleur (2003).

A floating exchange rate gives Canada the flexibility to have different monetary conditions than the United States. In particular, a floating currency acts as a shock absorber, between the two economies, allowing us to respond differently to external economic shocks (such as, for example, fluctuations in world commodity prices) and domestic policy requirements. The costs of a floating currency come in two forms. First and most obviously, there are certain transactions costs which are large when the amount of cross-border and financial transactions is large, as is Canada’s case with the United States. A further cost is the fact that exchange rates fluctuate wildly in comparison with goods prices (in fact, almost as wildly as stock prices), although the effects of exchange rate volatility on macroeconomic quantities are difficult to be demonstrated. In this regard, as Fischer (2001, p. 21) recently put it,

“...hard pegs are more attractive today, particularly when viewed from the asset markets, than had been thought some years ago.
A small economy that depends heavily on a particular large economy for its trade and capital account transactions may wish to adopt that country’s currency. But it will need to give careful consideration to the nature of the shocks that affect it before the choice is made.”

Noting the European developments, the trend towards currency unions and dollarization in Latin America and Eastern Europe, and Japan’s recent interest in exploring alternative monetary arrangements, in this paper we investigate the issue of whether a floating currency is the right exchange rate regime for Canada or whether Canada should consider alternative monetary arrangements. We follow İmrohoroğlu (1994) and use a dynamic equilibrium (money-in-the-utility-function) model of the Canadian economy to estimate the degree of currency substitution between the Canadian dollar and the U.S. dollar, using Hansen’s (1982) Generalized Method of Moments (GMM) estimation procedure. In doing so, we use recent monetary data adjusted for take-overs and acquisitions, as discussed in Kottaras (2003), and a slightly different econometric methodology than the one presented and used by İmrohoroğlu (1994).

The rest of the paper is organized as follows. In the next section we briefly discuss İmrohoroğlu’s (1994) dynamic equilibrium model of a small open (monetary) economy and present the Euler equations that describe optimal choices. In Section 3 we discuss the data and in Section 4 we discuss Hansen’s (1982) Generalized Method of Moments (GMM) procedure that we use to estimate the model. In Section 5 we present our empirical findings and discuss the policy implications of our results. The last section summarizes and concludes the paper.

2 Theoretical Foundations

We follow İmrohoroğlu (1994) and consider an economy made up of a large number of infinitely lived identical agents. At the beginning of each period, the representative domestic agent decides how much to consume, $c_t$, how much to hold in the form of domestic balances, $m_t$, and foreign balances, $m_t^*$, and how much to save in the form of an internationally traded bond, $b_t^*$. We assume that money services are produced using a combination of domestic and foreign real balances in a Constant Elasticity of Substitution
(CES) aggregator function, as follows

\[
x_t = f(h_t, h_t^*) = \left[ \alpha \left( \frac{m_t}{p_t} \right)^{-\rho} + (1 - \alpha) \left( \frac{m_t^*}{p_t^*} \right)^{-\rho} \right]^{-1/\rho}
\]

(1)

where \(0 < \alpha < 1\), \(-1 < \rho < \infty\), \(\rho \neq 0\), and \(h_t (= m_t/p_t)\) and \(h_t^* (= m_t^*/p_t^*)\) denote domestic and foreign real money balances, respectively. In the liquidity aggregator function (1), the elasticity of substitution is given by \(1/(1+\rho)\); \(\alpha\) and \((1 - \alpha)\) denote the shares of domestic and foreign real balances (respectively) in the production of money services. Aggregator functions like (1) have been pioneered by Chetty (1969) and used by Husted and Rush (1984), Poterba and Rotemberg (1987), and İmrohor glu (1994), among others.

We assume that the representative consumer’s preferences are given by

\[
u\left( c_t, m_t, m_t^* \right) = \left( \frac{c_t^{\sigma} x_t^{1-\sigma}}{1-\psi} \right) - 1
\]

(2)

where \(x_t\) is the liquidity aggregate given by equation (1). This utility function exhibits constant relative risk aversion in an aggregate of consumption and liquidity services. With these preferences and the liquidity aggregator function (1), the Euler equations for an interior solution are given by [see the second case presented in İmrohor glu (1994) for details regarding the derivations]

\[
\beta \left( 1 + r_t^* \right) \left( \frac{c_{t+1}}{c_t} \right)^{-1} \left[ \alpha \left( \frac{h_{t+1}}{h_{t+1}^*} \right)^{-\rho} + (1 - \alpha) \right]^{b} \times \left[ \alpha \left( \frac{h_t}{h_t^*} \right)^{-\rho} + (1 - \alpha) \right]^{-b} \left( \frac{h_{t+1}}{h_t^*} \right)^{-\rho b} - 1 = \varepsilon_{1,t+1}
\]

(3)

\[
\beta \sigma \left( \frac{c_{t+1}}{c_t} \right)^{-1} \left[ \alpha \left( \frac{h_t}{h_t^*} \right)^{-\rho} + (1 - \alpha) \right]^{-b} \left[ \alpha \left( \frac{h_{t+1}}{h_{t+1}^*} \right)^{-\rho} + (1 - \alpha) \right]^{b} \times \left( \frac{h_{t+1}^*}{h_t^*} \right)^{-\rho b} \left( \frac{p_t}{p_{t+1}} \right) + \alpha (1 - \sigma) \left[ \alpha \left( \frac{h_t}{h_t^*} \right)^{-\rho} + (1 - \alpha) \right]^{-1} \times \left( \frac{h_t}{h_t^*} \right)^{-\rho (1-\sigma)} - \sigma = \varepsilon_{2,t+1}
\]

(4)
\[
\alpha \left[ \alpha \left( \frac{h_t}{h_t^*} \right)^{-\rho} + (1 - \alpha) \right]^b \left( \frac{h_t}{h_t^*} \right)^{-\rho - 1} - (1 - \alpha) \left[ \alpha \left( \frac{h_t}{h_t^*} \right)^{-\rho} + (1 - \alpha) \right]^b \\
- \alpha \beta \left( \frac{c_{t+1}}{c_t} \right)^{\phi - 1} \left[ \alpha \left( \frac{h_{t+1}}{h_t^*} \right)^{-\rho} + (1 - \alpha) \left( \frac{h_{t+1}^*}{h_t^*} \right)^{-\rho} \right]^b \\
\times \left( \frac{h_t}{h_t^*} \right)^{-\rho - 1} \left( \frac{p_t}{p_{t+1}} \right) \left( \frac{e_{t+1}}{e_t} \right) + (1 - \alpha) \beta \left( \frac{c_{t+1}}{c_t} \right)^{a - 1} \\
\times \left[ \alpha \left( \frac{h_{t+1}}{h_t^*} \right)^{-\rho} + (1 - \alpha) \left( \frac{h_{t+1}^*}{h_t^*} \right)^{-\rho} \right]^b \left( \frac{p_t}{p_{t+1}} \right) = \varepsilon_{3,t+1} \tag{5}
\]

where $\beta \in (0, 1)$ is the subjective discount factor, $r_t^*$ denotes the realized real interest rate on $b_t^*$, $e_t$ is the nominal exchange rate (note that we do not impose purchasing power parity), $\phi = (1 - \psi)\sigma$, $b = -(1 - \sigma)(1 - \psi)/\rho$, and $\varepsilon_{j,t+1}$ for $j = 1, 2, 3$ are the Euler equation errors.

It should be noted that we also attempted to investigate the robustness of our empirical results (reported in Section 5 below) to alternative specifications of preferences and technology. In particular, we took direction from the approach employed by Poterba and Rotemberg (1987) and assumed that the representative agent faces portfolio adjustment costs that are proportional to the square of the percentage change in nominal asset holdings. Separately, we attempted to introduce a third asset (domestic personal savings deposits) and compare the degree of currency substitution to that of domestic asset substitution, as in Serletis and Rangel-Ruiz (2005). Both extensions, however, served to increase the nonlinearity of an already extremely nonlinear system and we were unable to successfully estimate either extension.

3 The Data

We take Canada to be the small open (domestic) economy and the United States the world (foreign) economy. We use quarterly, seasonally adjusted data over the period from 1981:1 to 2003:1 (a total of 89 observations) on real per capita aggregate domestic consumption, domestic money balances, and foreign money balances. Given that this is a representative agent model, to obtain real aggregate domestic consumption, we divide personal expenditures on nondurables and services (CANSIM II series V1992047 plus V1992119) by Canadian population fifteen years and older (CANSIM II series V2091030)
and the Canadian consumer price index (retrieved from the IMF’s International Financial Statistics, series code 15664ZF). We use the M1 monetary aggregate, adjusted for take-overs and acquisitions as discussed in Kottaras (2003), to capture domestic nominal balances. This series is seasonally adjusted [using the SAMA command in TSP/GiveWin (version 4.5)] and converted to real per capita terms by dividing by population and the consumer price index, as we did for personal consumption.\footnote{The continuity adjusted data is available as an R (http://cran.at.r-project.org) package at http://www.bank-banque-canada.ca/pgilbert/money.html.}

The amount of U.S. currency held by Canadians is unobservable. Moreover, there is no breakdown of U.S. dollar deposits held by Canadians into demand and time deposits — in fact, the distinction between demand and notice deposits is not so clear anymore, even for Canadian dollar deposits, and we think that most of the U.S. dollar deposits held by Canadians are effectively demand deposits. For these reasons, in this paper we use nonbank Canadian resident foreign currency deposits (U.S. dollar deposits must account for almost all of this), again adjusted for take-overs and acquisitions as discussed in Kottaras (2003), as a proxy for currency and demand deposits denominated in U.S. dollars and held by nonbank, nonofficial Canadians (whose mailing address is in Canada). Since this series [MB482, in Kottaras (2003)] is the value of the deposits in Canadian dollars, we seasonally adjust the series and convert it to real per capita terms by dividing by population and the consumer price index, as we did for Canadian M1.

Finally, we use the three-month (constant maturity) Treasury bill rate in the United States as the nominal interest rate. This series is converted to a realized real interest rate series by dividing it by the gross inflation rate in the United States as measured by the rate of increase in the U.S. consumer price index (retrieved from the IMF’s International Financial Statistics, series code 11164ZF).

4 GMM Estimation

Let $\boldsymbol{\theta} = (\alpha, \beta, \rho, \sigma, \psi)$ be the vector of free parameters to be estimated. The theoretical relations that $\boldsymbol{\theta}$ should satisfy are orthogonality conditions between a nonlinear function of $\boldsymbol{\theta}$, $f(\boldsymbol{\theta})$, and a $q$-dimensional random vector of instrumental variables $\mathbf{z}_t$ (referred to as the ‘information set’), expressed
as follows

\[ E \left[ f(\theta)'z \right] = 0 \]

The generalized method of moments estimator selects estimates of the parameter vector, \( \hat{\theta} \), so that the sample correlations between \( f(\theta) \) and \( z \) are as close to zero as possible, as defined by the following (quadratic) criterion function

\[ J(\theta) = (g(\theta))' W g(\theta) \]

where \( g(\theta) = f(\theta)'z \) and \( W \) is a symmetric positive definite weighting matrix. Any symmetric positive definite \( W \) will yield consistent parameter estimates, but as Hansen (1982) has shown, setting \( W \) equal to the inverse of the asymptotic covariance matrix of the sample moments, \( S \), produces asymptotically efficient parameter estimates. We used the Bartlett kernel, as discussed by Newey and West (1987), to weight the autocovariances in computing the weighting matrix.

All estimation is performed in TSP/GiveWin (version 4.5) using the GMM procedure — our programs are available upon request. As already noted, to obtain GMM estimates we need to express each moment condition as an orthogonality condition between an expression that includes the parameters and a set of instrumental variables. In doing so, we used the MASK command in TSP and matched the instruments (which are the variables lagged once) with the variables as they appear in the Euler equations, (3), (4), and (5). This results in 20 orthogonality conditions which are used to minimize \( J(\theta) \) by choosing 5 parameters, \( \alpha, \beta, \rho, \sigma, \) and \( \psi \). In this regard it should be noted that Imrohoroglu (1994) applied every instrument from each of three instrument sets to each estimation equation. He then checked the robustness of his results by decreasing the number of instruments in subsequent sets from the base set. In contrast, we do not vary our instrument set in this manner, because as previously mentioned, by using the MASK command in TSP we are able to precisely match the instruments with the estimation equation within which they appear.

When the number of instruments exceeds the number of parameters to estimate (as in our case), the estimation is overidentified and not all of the orthogonality conditions will be met. In our case we have 15 overidentifying restrictions and we can use the \( J \)-statistic to test the validity of the overidentifying restrictions. Under the null hypothesis that the overidentifying restrictions are satisfied, the \( J \)-statistic times the number of observations (in
our case 86) is asymptotically distributed as $\chi^2$ with degrees of freedom equal to the numbers of overidentifying restrictions (in this case 15).

5 Empirical Results

The estimation results are reported in Table 1. As results in nonlinear estimation are often sensitive to the initial parameter values, we randomly generated 10,000 sets of initial parameter values, restricting each of $\alpha$, $\beta$, $\psi$, and $\sigma$ in the interval [0,1] and $\rho$ in the interval [−1,25]. We chose the starting $\theta$ that led to the lowest value of the objective function. Moreover, the starting $\theta$ was also subjected to random sensitivity analysis to ensure that there were no values in its neighborhood that would yield improvements to the objective function. The parameter estimates reported in Table 1 are the ones that minimize the objective function and satisfy the theoretical relations, equations (3), (4), and (5), as closely as possible.

The $J$ statistic is small relative to the degrees of freedom (see the third last row of Table 1) and hence we cannot reject the overidentifying restrictions of the model at conventional significance levels. The estimate of $\alpha$ of 0.99561 (with a $p$-value of less than 0.000) is very close to 1 — recall that $\alpha$ is the share of domestic real balances in the production of (domestic) liquidity services. In fact, we tested the null hypothesis of $\alpha = 1$ (against the alternative of $\alpha < 1$), using the $C$-statistic proposed by Eichenbaum, Hansen and Singleton (1988). This test is similar to a likelihood ratio test and the $C$-statistic is calculated as the difference between the restricted and unrestricted models’ $J$-statistics. The $C$-statistic is distributed as $\chi^2$ with degrees of freedom equal to the number of restrictions (in this case 1). As shown in the second last row of Table 1, the $C$-test rejects the null hypothesis of $\alpha = 1$, suggesting that foreign balances do have a statistically significant role in the production of domestic liquidity services.

The estimate of the discount factor $\beta$ is less than 1 although it is not statistically different from 1, consistent with previous research in this area. The estimate of $\sigma$ is 0.99377 with a $p$-value of less than 0.000, suggesting that our included assets do yield utility — the null of $\sigma = 1$, corresponding to the case where the included assets yield no utility, is rejected by the $C_{\sigma}(1)$ statistic reported in the last row of the table. Also, the estimate of the coefficient of relative risk aversion $\psi$ is 0.25633 with a $p$-value of 0.970, suggesting that preferences are statistically different from logarithmic preferences (the case
when $\psi = 1$).

Consistent with the estimate of $\alpha$, the estimate of $\rho$ (of 3.01363 with a $p$-value of less than 0.000) implies an elasticity of currency substitution, $1/(1 + \rho)$, of 0.249, a bit lower than the highest estimate of 0.3037 reported by İmrohoroğlu (1994), using quarterly data over the period from January, 1974 to June, 1990. This lower estimate of the elasticity of currency substitution is consistent with Canada’s recent adoption of inflation targeting as its monetary policy regime. In particular, in February 1991 the Bank’s governor and the minister of finance jointly announced a series of declining inflation targets, with a band of plus and minus one percentage point around them. The targets were 3 percent by the end of 1992, falling to 2 percent by the end of 1995, to remain within a range of 1 to 3 percent thereafter. The 1 to 3 percent target range for inflation was renewed in December 1995, in early 1998, and again in May 2001, to apply until the end of 2006.

Our finding of a low degree of currency substitution between the Canadian dollar and the U.S. dollar is consistent with Canada’s recent low inflation record and implies that U.S. dollar deposits in Canada do not provide a good substitute for the domestic (Canadian) currency. Moreover, low currency substitution has implications for the theory of optimum currency areas — see Mundell (1961), McKinnon (1963), Canzoneri and Rogers (1990), and Swofford (2000) — that has recently been used to evaluate the desirability of a monetary union between Canada and the United States. Although we made no attempt to establish or indicate what level of currency substitution will be indicative of a feasible optimum currency area, it seems that low substitutability between domestic and foreign assets indicates the absence of a viable single currency North American zone.

Our results are similar (lower magnitude but same conclusions) to those obtained by İmrohoroğlu (1994) and, when considered jointly with his results, imply that currency substitution is actually decreasing over time. At first glance this appears counterintuitive; if for no other reason one might reasonably expect that Canadian consumers have been increasing their U.S.-asset holdings as part of an international portfolio diversification strategy. However, as reported by Murray and Powell (2002), although there has been a trend towards increasing international diversification (particularly in U.S. assets), U.S.-dollar deposits held by Canadian residents in Canadian banks as a percentage of broad money (M3), were actually lower in the 1990’s than they had been during the late 1970s and early 1980s. Our finding of a lower currency substitution than that reported by İmrohoroğlu (1994) is consistent
with the conclusions of Murray and Powell (2002) that “[by] many measures Canada is less dollarized now than it was 20 years ago and bears little resemblance to economies that are typically regarded as truly dollarized.”

6 Conclusion

Although Canada’s experience with a flexible exchange rate over 46 of the past 54 years has been a good one, recently there has been a debate around exchange rate alternatives and particularly around the issue of whether a floating currency is the right exchange rate regime for Canada — see, for example, Schembri (2001). An alternative exchange rate arrangement is the adoption of a ‘currency board,’ in which the domestic currency is backed 100% by a foreign (reserve) currency (such as the U.S. dollar) and the exchange rate between the two currencies is fixed. A currency board is thus a variant of a fixed exchange-rate regime with an even stronger commitment mechanism, since domestic money can be issued only if it is fully backed by foreign reserves. In fact, a currency board arrangement is the modern day equivalent of a fully backed gold standard with foreign reserves taking the place of gold reserves. Currency boards have recently been adopted by countries such as Hong Kong (1983), Argentina (1991), and Lithuania (1994) with the U.S. dollar, and Estonia (1992), Bulgaria (1997), and Bosnia (1998) with the euro. In addition, several countries in Eastern Europe and the former Soviet Union are considering adopting a currency board with the euro.

Another possible exchange rate arrangement is ‘dollarization’ — one country’s use of another country’s money (which may not be the U.S. dollar). Dollarization is another variant of a fixed exchange-rate regime, with an even better commitment device than a currency board. In particular, dollarization avoids the possibility of a speculative attack on the domestic currency and also eliminates the inflation-bias problem of discretionary policy (arising from attempts to stimulate the economy and incentives to monetize the public debt). However, dollarization is subject to the usual disadvantages of a fixed exchange-rate regime — it implies the loss of an independent monetary policy, the inability of the central bank to act as a lender of last resort, and the loss of seigniorage (the revenue that the government receives by issuing money). Recently, Ecuador adopted full dollarization and El Salvador announced its determination to do the same. Currency boards and dollarization, however, are strong measures that tend to be applied in extreme
circumstances. They have been advocated as monetary policy strategies for emerging market countries, especially in parts of Latin America that have had a long history of monetary instability.

In this paper we have taken an optimum currency area approach to the problem of whether a floating currency is the right exchange rate regime for Canada or whether we should consider a currency union with the United States. Although our methodology is far removed from the usual criteria used to establish an optimum currency area [see, for example, Mundell (1961), McKinnon (1963), and Canzoneri and Rogers (1990)], we have followed Swofford (2000) and Serletis and Rangel-Ruiz (2005) and assumed that a low degree of currency substitution is consistent with monetary independence and a high one with an optimum currency area.

Our approach is also different from that recently taken by Murray and Powell (2002) and Murray, Powell, and Lafleur (2003) in investigating the same issue, but our results support Murray and Powell’s (2002, p. 11) conclusion that “there is no evidence that Canadians have lost faith in their currency and are beginning to adopt the U.S. dollar. Moreover, as long as Canadian monetary policy continues to achieve its policy objective of low and stable inflation this is likely to remain the case.” We conclude that Canada should continue the current exchange rate regime (allowing the exchange rate to float freely with no intervention in the foreign exchange market by the Bank of Canada) as well as the current monetary policy regime (of inflation targeting).
References


### Table 1

**GMM Estimates:**

Equations (3), (4), and (5)

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<th>Estimate</th>
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<td>$\psi$</td>
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