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International Interest Rate Differentials: The Interaction with Fiscal and Monetary Variables, and the Business Cycle*

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ABSTRACT

Adapting Den Haan’s (1996) methodology based on VARs, this paper documents stylized facts about various deviations from international no arbitrage conditions between Canada and the United States. The calculated statistics provide important information about the dynamics of the economic variables that is lost when the focus is solely on unconditional correlation coefficients. In particular, we find that a higher public debt path and slower economic growth in Canada are associated with higher real interest rates in that country relative to that of the US. These results may suggest that international interest rate differentials reflect, at least in part, a risk premium.

RÉSUMÉ

À l'aide d'une méthodologie adaptée de Den Haan (1996) basée sur les VAR, cette étude documente des régularités empiriques relativement à diverses déviations par rapport aux conditions internationales de non-arbitrage entre le Canada et les États-Unis. Les statistiques calculées fournissent de l'information pertinente, à propos de la dynamique entre les variables économiques, qui auraient été masquée en examinant uniquement des coefficients de corrélations non conditionnelles. En particulier, nous trouvons qu'un taus d'endettement public plus élevé et une croissance économique plus faible sont associés avec des taux d'intérêt réels plus élevés relativement aux taux américains. Ces résultats peuvent suggérer que les différentiels de taux d'intérêt reflètent, du moins en partie, une prime de risque.

1. Introduction

The empirical literature on international macroeconomics and finance is characterized by a number of puzzles. One of the most important of these is the persistence of differentials in real interest rates across countries. The existence of such differentials is a necessary, but not a sufficient, condition for monetary policy to have a stabilization role in an open economy. In addition, the differential in real interest rates encapsulates two other important issues — the persistence of nominal excess returns on foreign relative to domestic assets and any uncertainty about whether (relative) purchasing power parity holds. By excess returns is meant *ex post* deviations from uncovered interest parity. The existence, or absence, of each of these phenomena has important implications for international macroeconomic modeling, as well as, for economic policy. Despite a fairly extensive research effort, there is still no consensus on these issues, however.

Accordingly, it may be useful to return to basics and examine some of the key stylized facts in this area. Many recent advances in macroeconomics have begun with the documenting of various aspects of an economic puzzle, followed by the constructing of analytical economies in a dynamic general equilibrium framework that seek to replicate these stylized facts. Such stylized facts may also be a guide to potentially fruitful areas of research. This paper aims to make a first step in this process by documenting empirical regularities regarding statistical comovements between real interest rate differentials at various maturities between the United States and Canada, as well as other deviations from international arbitrage conditions, and variables representing fiscal policy, monetary policy and the state of the real economy in these countries. A standard accounting framework is used to decompose the real interest rate differential into its components such as excess returns and deviations from relative purchasing power parity. The sample is made up of quarterly observations from 1971Q1 to 1994Q1.

The United States-Canada pair of countries constitutes a very attractive case for the subject of our study for several reasons. First, their financial and goods markets are highly integrated. In particular, amongst all industrialized countries since World War II, Canada has the longest experience with liberalized capital markets and floating exchange rates. Restrictions on capital flows with the United States were removed in December 1951 and the last important restrictions on domestic interest rates were abolished in 1967, with the revisions of the Bank Act. Furthermore, Canadian investors have had virtually an unconstrained access to the U.S. capital market since the early 50s. Second, Canada is clearly a small open economy relative to the United States. Hence, one could expect that it would be a price-taker of the world real interest rate, while the United States would be expected to play a significant role in its determination. Third, as shown in Table 1, since the beginning of the most recent period of floating exchange rate between the two countries, real interest rate differentials have been quite variable and at times very large, even for government bonds of long maturity.[1]

The remainder of the paper is organized in three main parts. The first part is a selective review of the literature, the second part explains the methodology used to produce the stylized facts, including the accounting framework used to organize the investigation, as well as the data, and the third part discusses the results. Finally, there is a concluding section.

2. A Selective Review of the Literature

This section selectively reviews the empirical literature on real international interest rate differentials as well as on the key parity conditions in international economics used to organize this study. The paper uses three parity conditions to investigate real interest rate differentials — uncovered interest parity, which is further decomposed into covered interest parity and a foreign exchange risk premium, and relative purchasing power parity.

Several studies have shown that **differentials in real interest rates** across countries can be large and persistent. These studies typically use 3-month Euro-deposit rates and 3-month money market rates for the G-7.[2] First, they calculate the *ex post* real interest rate in each country. Then, assuming that expectations are formed rationally, regress the *ex post* real rate against the variables thought to determine the *ex ante* real rate and use the estimated values of the dependent variable as the measure of *ex ante* real interest rates. Next, they regress the *ex ante* real interest rate in each country on the *ex ante* U.S. real rate and test for their equality. The results

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1 In Table 1, for a given maturity, the *ex ante* measure of the real interest rate differential was computed as the difference between the nominal interest rate differential and a measure of the *ex ante* inflation rate differential. The latter is the 1-period ahead conditional forecast obtained from an ARIMA model.

2 See, for example, Cumby and Obstfeld (1984), Mishkin (1984), and Marston (1995).

appear to be somewhat sensitive to definitions and sample period, but generally the equality of *ex ante* real interest rates across countries is rejected, including for Canada and the United States.

This finding has been reinforced by other studies using a different methodology. For example, Gagnon and Unferth (1995), using annual data on the *ex post* real interest rate for 1 year euro-deposits denominated in the currencies of 9 OECD countries for the period from 1978 to 1993, estimate a common component in global real interest rates. They find the real interest rate in each country to be strongly correlated with this common factor. Nevertheless, significant real interest rate differentials do occur and persist. As well, Jorion (1996) investigates the equality of real interest rates at asset maturities from 3-months to 5-years across the United States, the United Kingdom and Germany. Over the 1973-1991 period, real interest parity was strongly rejected for all asset maturities.

To date, most studies have focused on the existence of the real interest differentials rather than their potential sources. Recently, Baxter (1994) and Head and Smith (1997) have considered some possible explanations of the differential. Baxter finds a statistical relationship between real exchange rates and real interest rate differentials at trend and business cycle frequencies. Head and Smith find a significant effect of expected consumption growth differentials and the inflation differential, but much of the persistence in the real interest rate differential remains unexplained.

From an accounting perspective, potential explanations of the real interest rate differential may be found in the literature on the excess returns puzzle and on relative purchasing power parity. Fama (1984) is a key paper in establishing the **"predictable excess returns puzzle"**.[3] Excess returns are measured as the *ex post* deviations from uncovered interest parity. Using a simple regression test, Fama shows that excess returns are predictable *ex ante* and the variance of these predictable returns is greater than the variance of the expected change in the exchange rate itself. Fama illustrates the degree of excess returns predictability and variability using a simple regression test. The test regresses the change in the spot exchange rate on the forward premium. If predictable excess returns are zero, the slope coefficient should be unity. Instead studies for a variety of currencies consistently find this coefficient to be significantly less

[3] For a comprehensive review of this issue, see Lewis (1995).

than unity and at times even significantly negative. Recall that if CIP holds excess returns can be expressed as the difference between the spot exchange rate in the future and the corresponding forward rate.[4] Owing to the properties of OLS regression estimates, an estimated value of less than one half implies that the variance of the predictable components of excess returns exceeds the variance of the linear prediction of the change in the exchange rate.

The attempted explanations of these findings fall into two broad groups — (1) a time-varying foreign exchange risk premium, and (2) expectational errors. Those studies that assume excess returns occur because uncovered interest parity (UIP) does not hold have tested alternative specifications that explicitly recognize the role of risk-aversion in determining the price of assets. To date, this line of research has met with limited success. Standard asset-pricing models can explain the existence of risk premiums, but they cannot reproduce the variation in the deviations from UIP observed in the data. Essentially, the factors that should theoretically determine the risk premium do not vary enough to explain the puzzle. According to these models, the variability must come from variables such as consumption, asset shares across countries, wealth shares, or the conditional variances and covariances. Overall, these variables do not exhibit sufficient variation to be able to explain the variance in predictable excess returns. Also, many studies have found that while the estimated parameters of risk-aversion are large, they are not statistically significant.[5]

The difficulty in establishing convincing evidence for the risk-premium hypothesis has motivated researchers to examine a variety of hypotheses about exchange rate expectations formation, including irrationality and speculative bubbles, learning, and peso problems.[6] Frankel and Froot (1987), for example, use surveys of expected exchange rates to show that *ex post* deviations from UIP through the mid-1980s were largely driven by systematic forecast errors.

There are two possible explanations for these repeated forecast errors. First, the exchange market is inefficient because its participants consistently overlook information that would improve the accuracy of their forecasts and, hence, their decisions. Second, the problem of

4 For Canada, the evidence supports CIP, but the joint hypothesis of UIP and market efficiency are rejected by the data, see Murray and Khemani (1989) and Fenton and Paquet (1997).

5 The first generation of these studies were refinements of the static, partial equilibrium CAPM model (Frankel, 1982, Lewis, 1988, and Engle and Rodriques, 1989).

6 Lewis (1994) contains an excellent discussion of the peso problem, while Frankel and Rose (1994) survey the literature on irrational expectations and speculative bubbles.

forecasting the exchange rate is more complicated than researchers perceive. For example, traders might take account of low-probability events with significant potential to affect the exchange rate that researchers ignore. This is often referred to as a "peso problem". In a short sample period such low-probability events are unlikely to materialize, creating the impression that market forecasts are biased.[7] Alternatively, the estimation period may include changes in the policy regime which the econometrician is able to discern immediately, but which market participants must learn about in real time.

In an interesting twist, Giorgianni (1997) uses survey data to proxy expected future spot rates in constructing risk premiums. This avoids the need to identify agents' information set, and yields valid measures of risk premiums even in the presence of learning or peso problems. He uses lira/dollar and lira/mark spot and forward exchange rates of 3 and 12 months maturity, and exchange rate expectations from the Financial Times Currency Forecaster survey for the period from 1987 to 1994. Giorgianni found this measure of the unconditional risk premium to be large relative to the forward premium, and volatile compared to the variability of the forward bias. As well, estimated structural models of this risk premium suggest that an anticipated expansionary fiscal policy is associated with a higher risk premium on lira-denominated assets.

These lines of research are relatively new and, although the results are encouraging, the issue remains unsettled. As Engle (1995) suggests "[a] likely outcome of future research is that risk premia, peso problems, learning, irrational speculative bubbles, as well as the effects of small transactions costs will be found to play a role in explaining forward rate bias."

The literature on **purchasing power parity** has been thoroughly surveyed by Froot and Rogoff (1995) and Breuer (1994). A substantial body of evidence suggests that the real exchange rate is not a random walk — shocks to the real exchange rate damp out very slowly over time. However, it is difficult to distinguish empirically between a real exchange rate that follows a random walk and a stationary real exchange rate that reverts very slowly, particularly in sample periods characterized by highly volatile floating exchange rates. A major innovation in the recent literature has been to look at much longer historical data sets. Johnson (1990), for example, examines 120 years of Canadian dollar/U.S. dollar exchange rate data. He is able to reject the

7 See Evans and Lewis (1995).

random walk hypothesis, and estimates a half life for deviations from PPP of 3.1 years. In general, the literature estimates that the half-life of deviations from PPP is about 4 years for exchange rates among major industrialized countries. Nevertheless, the puzzle remains as to why it takes so long for the real exchange rate to adjust to equilibrium (Rogoff, 1996).

More recently, Lothian (1997) finds evidence of mean-reverting behaviour of real exchange rates in the current floating exchange rate period. On the basis of panel data for 23 OECD countries for the period from 1974 through 1990, unit root tests suggest that the real exchange rates of these countries can be characterized as mean-reverting. In addition, Lothian shows that both the volatility of real exchange rates and their correlation with nominal rates decrease significantly as data frequency is reduced.

There has also been some work on the effect of government spending shocks on deviations from PPP. Froot and Rogoff (1991) study data for twenty-two OECD countries for the period 1950-89. This period includes both fixed and floating exchange rate regimes. Their model allows for gradual factor adjustment across sectors, implying that the effects of government spending will only be temporary. They find that the differential in government spending consistently enters pooled regressions significantly and with the correct sign. Moreover, the result is robust for both the full sample and separate fixed and floating rate periods. Factor mobility across sectors eliminates the effect over the long run, but the half life is more than five years. De Gregorio, Giovannini and Wolf (1994) find similar results in a more static framework.

3. The Methodology

3.1 Uncovering stylised facts about comovements at different forecast horizons: DenHaan's VAR based methodology

The aim of this paper is to learn from the data, rather than to try to reject or not the restrictions of a particular model. Accordingly, to uncover regularities in the data with respect to comovements between the Canada-U.S. real interest rate differential at various maturities and differences between the two countries in the economic conjuncture, fiscal policy, inflation performance and monetary policy stance, we follow and adapt Den Haan's (1996) VAR based methodology.[8] That is, we investigate the conditional correlations of VAR forecast errors at

8 Another method first used in the vast modern business cycle literature has been to look at correlations between

different horizons (from 1 to 36 quarters ahead). The calculated descriptive statistics provide important information about the dynamics of the economic variables that is lost when the focus is solely on the unconditional correlation coefficient. This methodology also has an advantage over estimating impulse response functions, in that it does not involve the use of identifying assumptions, that may be restrictive and untestable.[9] While the procedure cannot discriminate between specific structural shocks, it captures nonetheless the effect of a typical shock of one of the system's variables on another variable. The estimated correlations from this procedure are derived from the covariances between the k-period ahead forecasts errors, which accumulates the effect over k periods of the sum of the products of the *k*-step impulse responses across all fundamental shocks. It is therefore a non-linear function of the impulses.

The first step in applying the methodology is to specify a VAR system in the levels of the variables, such as

$$\mathbf{Y}_t = \boldsymbol{\delta} + \boldsymbol{\Phi}(L)\,\mathbf{Y}_{t-1} + \boldsymbol{\varepsilon}_t, \tag{1}$$

where $\mathbf{Y}_t$ is a $N \times 1$ vector, $\boldsymbol{\Phi}(L)$ is a p-order matrix polynomial in the lag operator L, for which each matrix of coefficients $\boldsymbol{\Phi}_i$ is $N \times N$. In this paper, we will refer to a series of trivariate VARs, i.e. with $N = 3$. In practice, we have determined the lag length of each VAR system according to its ability to minimize the Hannan and Quinn information criterion, and the non-rejection of the statistical adequacy of the system's equations, on the basis of LM serial correlation tests on the residuals of the VAR's equations.[10] We have considered VAR specifications that involved up to 8 lags.[11]

Hodrick-Prescott (HP) filtered series. More recently, Baxter (1994) and DenHaan (1996) have computed correlations and cross-correlations between the components of series over specific frequency intervals. To isolate the movements of a series specific to a particular frequency interval, the raw series were previously subjected to the approximate band-pass (BP) filter proposed by Baxter and King (1994). However, following Cogley and Nason (1995), Guay and St-Amant (1997) have raised some issues about finite sample distortions at the business-cycle frequency that the HP and the band-pass filter can induce for series that are integrated or nearly integrated in levels. In these cases, since the peak of the spectrum of the raw series is not contained at the business cycle frequency, but is rather at the very low frequency, because the HP and BP filters are approximate but not ideal filters, too much weight is still given to the low frequency.

9 Notice also that economic theory has generally little to suggest in way of reasonable identifying restrictions in VAR systems involving variables such as real interest rate differentials and fiscal or monetary policy indicators in two different countries.

10 The information criterion expresses a trade-off between the goodness-of-fit and the parsimony of the specification.

11 In most cases, our procedure allowed to select a preferred specification without much ambiguity. In a few cases for which 2 different lag lengths appeared to be hard to distinguish from one another, we have computed the correlations on the basis of the two specifications. The results reported in this paper remained robust. Details are available upon request from the authors.

Sims, Stock and Watson (1990) shows that, in theory, the estimation of a VAR including either or both stationary and integrated variables in level form will yield asymptotically consistent and efficient estimates of its parameters. In effect, provided that enough lags are included in the system, any unit roots or cointegrating relationships would be implicitly accounted for and estimated. However, in a finite sample, if there were no cointegrating relationships between the I(1) variables of the system, the inclusion of their first-difference (i.e. the imposition of unit roots) would improve the precision of the coefficients' estimates. The same would be true if cointegration prevailed between some or all I(1) variables and a vector error-correction model was estimated. However, the imposition of false restrictions about the presence of unit roots and of cointegrations would produce inconsistent estimates. Based on these theoretical results, Den Haan (1996) advocates the estimation of VAR systems with their variables in levels.

However, Phillips (1995) shows that, in practice, forecasts and impulse responses beyond a 5-quarter horizon, based on unrestricted VARs in levels estimated with a finite sample are inconsistent and tend to random variables. By contrast, forecasts based on reduced rank regression, i.e. a vector error correction model that explicitly estimates cointegrating relationships (if any) and unit roots, are consistent and asymptotically optimal.[12] That is why each variable, included in the various trivariate VARs, was subjected to augmented Dickey-Fuller tests, and the cointegrating rank of each system was determined using Johansen's (1988) full information estimation of the VECM and Pitarakis and Gonzalo (PG) statistics.[13]

Hence, for each trivariate system, there are four possible cases:

-The system is estimated as a VAR in levels, if all variables are stationary;

-The system is estimated as a VAR in first-differences, if all variables are integrated and there is no cointegrating relationship;

-The system includes stationary variables in levels and integrated variables in first differences, if there is no cointegrating relationship between at least two I(1) variables;

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[12] Earlier results that we had found ignoring Phillips (1995) critique were often quantitatively different from the ones that we present in the current version of the paper, in which we determine empirically the evidence of unit roots and the cointegrating rank of the 3-variables system.

[13] Pitarakis (1993) has shown that the PG statistic performs better in finite samples when the statistic is compared to asymptotic critical values.

-The system is estimated as a VECM, if there are cointegrating relationships between the integrated variables of the system.

Once, the appropriate case has been identified and the system's coefficients have been estimated, we construct the 1 to 36-step ahead forecasts and forecast errors. Finally, the correlation between the *k*-step forecast errors of each of the variables we are interested in is computed.

For instance, say we want to document the comovements at various horizons between a typical shock on the Canada-U.S. real interest rate differential on a 10-year government bond $\left[r_{t,t+10y} - r^{*}_{t,t+10y}\right]$ and a typical shock on the Canadian government debt/GDP ratio $[b^{g}_{t}/y_{t}]$, for a given realised and forecasted path of the U.S. public debt/GDP ratio $[b^{g^*}{}_{t}/y^*{}_{t}]$. Suppose we find that the real interest rate differential is I(0), and that the two government debt ratios are I(1) yet without being cointegrated, then the vector $\mathbf{Y}_t$ is defined as $([r_{t,t+10y} - r^{*}_{t,t+10y}], \Delta[b^{g}_{t}/y_{t}], \Delta[b^{g^*}_{t}/y^{*}_{t}])'$. Because we are interested in the conditional correlations between the typical (reduced-form) innovation on the real interest rate differential and the typical (reduced-form) innovation on the Canadian debt/GDP ratio, the 1- to 36- step ahead forecast errors for the first two variables of the VAR will be computed and used to assess the correlation. We will consider correlations between 1 to 8 quarters ahead as short-horizon comovements, those between 9 and 20 quarters as medium- horizon comovements, and those between 21 and 36 quarters as long-horizon correlations.

A final econometric consideration concerns the assessment of the statistical significance of the correlations. One approach would be to estimate the standard errors of the correlations with a method of moments and Newey-West (1994) heteroskedasticity and serially-dependent consistent covariance matrix. However, this procedure would ignore the uncertainty stemming from the parameters.[14] Instead, we choose to proceed with Monte-Carlo integrations to compute Bayesian probability intervals of each correlation for a pair of *k*-quarter ahead forecast errors.[15,16]

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14 It also would not either reflect the asymmetry in the distribution of the correlations as explained hereafter.

15 The procedure we employ follows Kloek and vanDijk (1978), but is modified along the lines of Geweke (1988) to achieve a reduction in the variance of the experimental results by antithetic acceleration. The method of antithetic variates amounts to using each set of generated disturbances on the parameter estimates twice, with the sign reversed the second time. Hence, this technique allows a substantial reduction in the number of replications needed to obtain sufficiently accurate results from a Monte Carlo experiment. Experiments with a few of the cases considered in this paper suggested that 500 draws for a standard Monte Carlo simulation gave very similar results to those obtained from 100 draws and antithetic acceleration. Moreover, the time required for the computations of one graph of correlations up to a horizon of 36 quarters is reduced from more than 3 hours to about 30 minutes on a Pentium 90 Mhz, and the 32 bit version of Eviews 2.0.

16 While a 95% classical confidence interval makes an *a priori* statement about the probability that the true parameter value is

Essentially, this method amounts, for each replication, to drawing a variance-covariance matrix from an inverse-Wishart distribution, then using the drawn variance-covariance matrix to draw values for the matrix of VAR coefficients from a Gaussian distribution. Then the 1- to 36-quarter ahead forecasts errors, and the correlations between the set of pairs of forecasts errors at each horizon are reckoned and recorded. After 100 such replications, the antithetic acceleration produces 200 correlation values for each horizon. The last step consists in picking the 2.5 and 97.5 percentiles. Hence, a typical graph of our results will show the correlation between the shocks on the two variables of interest at various horizons and the 95 per cent probability interval.[17] Notice that the posterior probability interval is not necessarily distributed symmetrically around the estimated correlations. This arises because the estimated covariance of the *k*-step ahead forecast errors, which serves to compute the correlation, is a non-linear function of the VAR's vector moving average representation, for which the coefficients are themselves a non-linear function of the VAR's coefficient estimates.

3.2 The arithmetic of international arbitrage conditions

Let us first assume that Canadian and U.S. bonds have similar risk and liquidity characteristics. Provided that the financial and goods markets are well integrated across these two countries, the expected real interest rates on comparable *s*-period assets would tend to equalize and to respect the condition of *ex ante* real interest rate parity:

$$r^{e}_{t,t+s} = r^{e*}_{t,t+s}, \qquad (2)$$

where $r^{e}_{t,t+s}$ and $r^{e*}_{t,t+s}$ are the *ex ante* real interest rates on these assets in Canada and the U.S. respectively. Furthermore, since Canada is a small open economy relative to the United States, it should be a price-taker of the U.S. real interest rate.

However, if there is not perfect mobility of capital across these countries or if Canadian and U.S. bonds are not perfectly substitutable, then a real interest rate premium or differential ($drp^{e}_{t,t+s}$) would prevail, so that:

contained within some bounds, a Bayesian probability interval reports a probability statement *a posteriori* about the likelihood, conditional on the observed data, that the true parameter is within some bounds. Sims and Zha (1995) examine the theoretical properties and behaviour in practice of Bayesian probability intervals and conclude that they have a firmer theoretical foundation in small samples and are as good as, if not superior to, bootstrap intervals.

[17] Sim and Zha (1995) argue that, in a Bayesian context, a 68 per cent posterior probability interval — that would correspond to one standard error in the Gaussian case— may be a better indicator of the relevant range of uncertainty. Hence, showing a 95 per cent probability interval, makes it much harder for a correlation to appear "significant".

$$r^{e}_{t,t+s} = r^{e*}_{t,t+s} + drp^{\,e}_{t,t+s}. \qquad (3)$$

In order to organize both the presentations and the analysis of the stylized facts that we may uncover, it is useful to decompose this relationship further using the main international arbitrage conditions. Let $i_{t,t+s}$ and $i^{*}_{t,t+s}$ denote the nominal interest rate on comparable *s*-month assets in Canada and the U.S. respectively, while $\pi^{e}_{t,t+s}$ and $\pi^{e*}_{t,t+s}$ are the respective expected inflation rates over the same horizon. We can decompose deviations from ex-ante real interest rate parity as:

$$drp_{t,t+s} = r^{e}_{t,t+s} - r^{e*}_{t,t+s} = \{(i_{t,t+s} - i^{*}_{t,t,+s}) - [\log(e^{e}_{t,t+s}) - \log(e_t)]\}$$
$$+\{[\log(e^{e}_{t+s}) - \log(e_t)] - (\pi^{e}_{t,t+s} - \pi^{e*}_{t,t+s})\}, \qquad (2a)$$

or,

$$drp_{t,t+s} = duip_{t,t+s} + drppp_{t,t+s}, \qquad (2b)$$

where e_t is the spot nominal exchange in *t*, expressed in Canadian dollars *per* U.S. dollar. Hence, the *ex ante* deviations from real interest rate parity can be decomposed as the sum of the deviation from uncovered interest rate parity and the deviation from relative purchasing power parity. On one hand, provided that Canadian and U.S. assets are perfect substitutes, $duip_{t,t+s}$ would be zero in order to avoid leaving unexploited riskless arbitrage opportunities. If this term is different from zero, the two assets are imperfect substitutes. On the other hand, non-zero deviations from relative purchasing power parity mean that the real exchange rate is expected to change, indicating a lack of integration of the goods markets or a degree of imperfect substitution across goods (because of the existence of non-traded goods, for instance).

As there is some confusion in the literature on the relation of UIP to PPP and real interest rate equality, it is worth stressing that: capital market efficiency with risk neutral investors implies rational expectations UIP; while goods market integration implies *ex ante* PPP. Together they imply real interest parity. Accordingly, deviations from rational expectations real interest parity can be decomposed into the sum of deviations from rational expectations UIP and deviations from *ex ante* PPP. Real interest parity could fail either because capital markets are not integrated or goods markets are not integrated, or both. (Frankel and MacArthur, 1988). Finally, UIP by itself does not imply real interest parity.

By adding and subtracting $\log(f_{t+k})$ on the right-hand-side of equation (2), where $f_{t,t+s}$ is the period $t+s$ forward Canadian exchange rate as of period t, a further decomposition of the deviation from real interest rate parity is:

$$drp_{t,t+s} = r^{e}_{t,t+s} - r^{e*}_{t,t+s} = \{(i_{t,t+s} - i^{*}_{t,t,+s}) - [\log(f_{t,t+s}) - \log(e_t)]\}$$
$$+ \{[\log(f_{t,t+s}) - \log(e^{e}_{t,t+s})]\}$$
$$+ \{[\log(e^{e}_{t+s}) - \log(e_t)] - (\pi^{e}_{t,t+k} - \pi^{e}_{t,t,+s})\} \qquad (3a)$$

or

$$drp_{t,t+s} = dcip_{t,t+s} + lerp_{t,t+s} + drppp_{t,t+s} \qquad (3b)$$

The real interest rate differential is therefore also equal to the deviation from covered interest rate parity, plus the forward exchange rate risk premium and the deviation from relative purchasing power parity. A foreign exchange risk premium is awarded only when the return on an asset covaries with some benchmark (such as the return on the market portfolio, or the aggregate marginal rate of substitution in consumption) that makes risk undiversifiable (Frankel, 1979). The foreign exchange risk premium depends on the relative riskiness of domestic and foreign nominal assets.

3.3 Data: definitions, measurement issues and characteristics

The definitions and mnemonics of the variables used in this study are set out in Table 2. U.S. variables are denoted by an *. In our analysis, the business cycle is represented by the growth of real GDP. We also consider the inflation rate as possibly containing some relevant information about the dynamics of the deviations from international arbitrage. The variables representing fiscal policy are the ratios of federal debt, deficits and government spending to nominal GDP, while monetary policy is proxied by the slope of the yield curve.[18] Two measures of the slope of the yield curve have been used: the yield of 10-year Government of Canada bonds less the overnight interest rate (Fed funds rate in the U.S.), and that of the 10-year rate minus the 3-month interest rate.

[18] Bernanke (1990) and Clinton (1995) found that the slope of the yield spread is a good leading indicator of the U.S. and Canadian economies, respectively. They argued that it could be interpreted, at least in part as an indicator of monetary stance.

The *ex ante* inflation rate differentials were computed using an ARIMA model selected on the basis of Hannan and Rissanen's method. This approach is consistent with rational expectations, since the adopted specifications did not exhibit evidence of serial correlation. The forecasts from the relevant equation were used to measure *ex ante* real interest rate differentials. For assets whose maturity was less than a year, the inflation differential forecasts were constructed over the relevant horizon. For assets whose maturity was longer than a year, we used the forecast for the one-year inflation differential. (This is similar to Baxter, 1994, and Meese and Rogoff, 1988).

We found evidence of unit roots for the Canadian and U.S. debt/GDP ratios, deficits/GDP ratios, government spending/GDP ratios, and the yield-curve-slope variables. Hence, these variables were first-differenced in the VAR systems.

The inflation rates in both countries were found to be integrated. But they are also cointegrated with a one-to-one relationship. A VECM should be estimated to take into account Phillips' critique. For this reason, the VAR systems, that were used to assess the comovements between a typical shock to the Canadian expected inflation rate relative to that of its U.S. counterpart and various differentials, involved two variables: namely, the deviations from the no-arbitrage condition, and the *ex ante* inflation rate differential.

4. The results

The responses of the *ex ante* real interest rate differential, excess returns and deviations from relative purchasing power parity (correlations of forecast errors at various horizons) to changes in real output, fiscal variables and monetary policy related variables is shown in the accompanying charts contained in Figure 1 to Figure 15.[19] Our reading of these charts is as follows:

A typical shock to domestic output

Comovement with the real interest differential: For all maturities of assets, a higher level of domestic output (output in the foreign country unchanged) is correlated with a reduction

[19] We have also computed the same comovements with respect to the *ex post* real interest rate differentials. Since the results were similar, we do not report them, but they are available from the authors upon request.

in the domestic *ex ante* real interest rate relative to the foreign interest rate. This would be consistent with an improvement in the government's ability to pay or to service the debt, reducing its "global risk premium". This would also be consistent with a lower Canada-US real interest rate differential being favorable to the growth of the Canadian economy. Notice that the correlation is even more negative for long horizons (greater than 30 quarters). It is also more negative for longer maturity assets.

Comovement with *ex post* deviations from UIP: For assets with a maturity of up to one year (3- and 6-month assets), there is a statistically significant positive correlation, which is in the same direction as our findings for the real differential. This is therefore one element of the story. For the one year assets, the correlation has the same sign but the uncertainty about the correlations is large enough that the 95 per cent probability interval contains zero.

Comovement with *ex post* deviations from relative purchasing power parity: There is no statistically significant correlation with output at any of the maturities examined. Accordingly, the story is to be found within the elements of the excess returns relationship.

Comovement with the *ex post* exchange rate risk premium (forward rate less future spot rate): At the 3-month maturity, there is a significant negative correlation at all time horizons. This is coherent with the findings for the real interest differential.

Comovement with the terms of trade and the real exchange rate: While there tends to be a significant positive correlation between a typical innovation on the Canadian output growth rate and the terms of trade, there is no statistically significant correlation with the real exchange rate.

A typical shock to the ex ante inflation rate differential

Comovement with the real interest differential: For assets of all maturities, there is a significant and strong negative correlation with respect to the *ex ante* real interest rate. Basically, it appears that the conditional correlation quickly converges to its unconditional value.[20] This

[20] In this instance, notice that the unconditional covariance between the demeaned values of $(r^e - r^{e*})$ and $(\pi^e - \pi^{e*})$ amounts to computing $E[(r^e - r^{e*})(\pi^e - \pi^{e*})] = E[(R - R^* - (\pi^e - \pi^{e*}))(\pi^e - \pi^{e*})] = E[(R - R^*)(\pi - \pi^*)] - E[(\pi - \pi^*)^2]$. Hence, our finding of a negative correlation between $(r^e - r^{e*})$ and $(\pi - \pi^*)$ reflects that the variance of the *ex ante* inflation differential is larger than the covariance of the nominal interest rate differential with the inflation differential.

result appears to be the open economy counterpart of the negative correlation between the *ex ante* real interest rate and the *ex ante* inflation rate that was documented by Litterman and Weiss (1985). Accordingly, referring back to their argument, the presence of persistent components in both the *ex ante* real interest rate differentials and in the *ex ante* inflation rate differentials might possibly explain this negative correlation "even in the absence of any structural link between past" inflation differentials and future real interest rate differentials.

Comovement with *ex post* deviations from UIP: For all maturities from 3 months to 1 year, the correlation is positive and significant at all horizons. This correlation goes in the wrong direction to account for the observed correlation between the inflation rate and the *ex ante* real interest rate differentials. We also notice that the correlation is less precisely estimated for the 1 year maturity asset pairs, than for assets of shorter maturities.

Comovement with *ex post* deviations from relative purchasing power parity: This appears to be the place to look for the story underlying the negative correlation of the real interest rate differentials with the inflation rate differential, since we find a significant negative correlation at all horizons.

Comovement with the *ex post* exchange rate risk premium (forward rate less future spot rate): For all horizons, there is a statistically significant positive comovement of the exchange risk premium with the inflation rate differential.

Comovement with the terms of trade and the real exchange rate: The correlations of these variables with the inflation rate differentials are not statistically different from zero.

A typical shock to the government debt to GDP ratio

Comovement with the real interest differential: In general, an increase in domestic government debt relative to the size of the economy (the foreign country debt ratio unchanged) raises the *ex ante* domestic real interest rate relative to the foreign rate. The correlation is clearest for assets of 1 year and longer but there is a also a positive correlation for short maturities at longer horizons. For *ex post* rates, the correlation tends to be positive as well, but is estimated less precisely. The effect is negative in the very short run for shorter maturities.

Comovement with deviations from *ex post* UIP: It is generally not significant, except for a slight negative correlation when considering the 6-month Treasury bills.

Comovement with *ex post* deviations from relative purchasing power parity: For all considered maturities from 3-month to 1-year, there is a positive correlation throughout. These correlations are not very precisely estimated, but the probability intervals generally show greater uncertainty on the up side than on the low side of the correlations. A higher level of government debt is associated with a real depreciation. This would be consistent with a higher level of debt at some point being correlated with a reduction in domestic absorption.

Comovement with the *ex post* exchange rate risk premium (forward rate less future spot rate): Except for the first two quarters, the positive correlation is statistically insignificant.

Comovement with the terms of trade and the real exchange rate: There is a marginally negative correlation of the terms of trade with Canadian government debt/GDP ratio over the medium horizon. The typical innovation on the real exchange rate is slightly positively correlated with the public debt ratio at the very short horizon only.

A typical shock to the government deficit to GDP ratio

Comovement with the real interest differential: For assets of 1-year maturity or longer, an increase in the Canadian government deficit (the U.S. government deficit ratio unchanged) is associated with an increase in the Canadian *ex ante* real interest rate relative to the U.S. rate, at most horizons.

There is a puzzle for this shock, however, in that there is no significant correlation for either **deviations from *ex post* UIP** or the **deviations from relative purchasing power parity**, with the exception of a small positive correlation for the 1-year *ex post* deviation from relative PPP. This raises the question of whether the source of the action is in the covariance between excess returns and the deviation from relative purchasing power parity.

Comovement with the *ex post* exchange rate risk premium (forward rate less future spot rate): The results are statistically insignificant.

Comovement with the terms of trade and the real exchange rate: Except for the very short horizons, there tends to be a significant negative correlation between the public government deficit/GDP ratio innovation and the innovations on both the terms of trade and the real exchange rate.

A typical shock to the government spending to GDP ratio

Comovement with the real interest differential: For all maturities and all horizons, an increase in the share of domestic government spending in the economy (for a given path of the share in the foreign country) is correlated with an increase in the *ex ante* domestic real interest rate relative to the foreign rate. This is especially clear for asset maturities greater than one year and longer horizons.

Comovement with *ex post* deviations from UIP: There is a statistically significant positive correlation at all horizons.

Comovement with *ex post* deviations from relative purchasing power parity: There is a negative correlation at longer horizons. This means that the change in the exchange rate is less than the inflation differential, hence the real exchange rate appreciates. This is consistent with a story of increased government spending leading to an increase in non-traded goods prices relative to the price of traded goods. However, it goes in the wrong direction for the observed correlations with the real interest rate differential. Accordingly, the source of the real differential movement must be within the excess return relationship.

Comovement with the *ex post* exchange rate risk premium (forward rate less future spot rate): There is a statistically significant and strong positive correlation with the Canadian government spending/GDP ratio over all horizons. This is similar to the finding for the real interest rate differential.

Comovement with the terms of trade and the real exchange rate: The correlations of these variables with the Canadian government spending/GDP ratio is negative beyond 5 quarters ahead. However, the upper bound of the 95 per cent probability interval often marginally encompasses zero.

A typical shock to the slope of the yield curve

Comovement with the real interest differential: For 1-year and beyond, there is generally a significant positive correlation, except for the interval around 25 to 29 quarters, where there is a temporary dip. There is however an issue here in that the two slope measures — 10-year minus overnight and 10-year minus 3-month — give different answers for very short maturities.

Comovement with *ex post* deviations from UIP: For all maturities considered, that are one year or less, we find significant negative correlations when considering the 10-year minus overnight measure of the yield curve slope. However, the other measure of the slope of the yield curve is significantly positively correlated with the 3-month deviations from UIP, but insignificantly negatively correlated for the 6-month and the 1-year deviations from UIP.

Comovement with *ex post* deviations from relative purchasing power parity: In most instances, the correlations are significant and coherent with the comovement with deviations from real interest parity. However, for the 10-year to 3-month spread the correlation for 3 months is negative and for 6 months the results are not statistically significant.

Comovement with the *ex post* exchange rate risk premium (forward rate less future spot rate): Again, the different measures of the yield curve give different results. For the 10-year-overnight spread, there is a significant negative correlation, while for the 10-year-3-month spread the correlation is of the opposite sign. These results are consistent with the results for excess returns.

Comovement with the terms of trade and the real exchange rate: The terms of trade are slightly negatively correlated over the medium horizon with both measures of the spread. There is no statistically significant correlation between the real exchange rate and the yield spread.

5. Conclusion

As a relative intertemporal price, the real interest rate plays a key role both in signaling the relative scarcity of consumption goods and output over time, and in transmitting the impact of various disturbances originating from either policy or non-policy sources. We can think of a country's real interest rate as the sum of two components, namely an idiosyncratic component and a world component, common to all countries. To date, economic theory suggests that the world real interest rate is likely the product of real conditions prevailing on the international credit market, that are determined by productivity shocks, life-cycle induced savings behavior and fiscal policy shocks. In the short run, world monetary factors may also have transitory effects. However, economic theory does not have a well spelled out story to explain an often large, variable and persistent country-specific component of a domestic real interest rate. This is important as a rise (decrease) in the real interest rate differentials will lead *ceteris paribus* to a crowding out (in) effect on investment that will lower (raise) the stock of physical capital and hence the future level of output capacity.

In particular, economic theory suggests that a small open economy, such as Canada, should be a price-taker of the world real interest rate. Given the very high degree of integration of both financial and goods markets between United States and Canada, one would expect arbitrage to remove quickly any real interest rate differentials. The Canada-U.S. experience shows that it is not so, neither for short-term nor long-term maturity government bonds. As documented in the literature, the Canada-U.S. real interest rate differential does not stem from deviations from covered interest rate parity, that would reflect existing or expected capital controls, different fiscal treatments or political uncertainty. It arises rather from a combination of deviations from relative purchasing power parity and an exchange rate risk premium. Until now, there had been little progress in linking these deviations with economic fundamentals.

In this paper, we have attempted to make some first steps in this direction by uncovering some empirical regularities — this amounts to gathering circumstantial evidence that may subsequently assist in identifying the reasons for the real interest rate differentials. The documenting of stylized facts remains part of a broader research program. It is important to underscore that the methodology employed does not and cannot establish strict causal links between the variables considered. Yet, the established stylized facts suggest directions for further research, particularly regarding model building, some testable implications and some new puzzles.

Adapting Den Haan's (1996) methodology, our aim was to document stylized facts about various deviations from international no-arbitrage conditions. Our results provide support for the methodology used. In particular, allowing for changes in the correlation coefficients over different time horizons and allowing for different processes in the two countries has enabled us to detect relationships that may not have been apparent with simpler approaches.

First, unlike most studies, we have amassed considerable evidence that may be compatible with the existence of a risk premium associated with an expansionary fiscal policy regime. For both a more expansionary deficit track and a higher share of government spending in the economy (and to a lesser extent higher deficits) there is a statistically significant positive correlation that is larger for longer-lived assets and longer-time horizons. This, in conjunction with the response to an output shock, is consistent with a risk premium in the exchange rate associated with expansionary fiscal policy. Second, based on the response to an inflation shock, there may be persistent deviations from the classical parity conditions owing to the sluggish adjustment of the nominal exchange rate to changes in inflation differentials. This warrants further investigation and may have implications for the conduct of macroeconomic policy.

Useful work might also be done on the impact of fiscal and monetary policies in theoretical structural models of open economies. In particular, it would be interesting to consider the potential impact of economic policies on expected movements in the real exchange rate, as well as on the forward exchange rate risk premium. This would help to establish rigorously a theoretical causal link between the state of the public finances and the real interest rate differentials. As mentioned above, our empirical results document statistically significant co-movements that suggest that the nature of the domestic government's budgetary and fiscal policies may play a key role in the interest rate faced by the open economy's households and firms.[21]

[21] One conjecture, that would need to be rigorously established or disproved in a structural model, is that an increase in an already high rate of public indebtedness may generate a widening of the real interest rate differentials. In an economy that is already subject to high marginal tax rates, a heavy tax burden and an important size of the government sector (as in Canada for instance), this effect might be more important. This could signify that the capacity of the economy that would be required to service and to pay back public debt may mean even higher expected future marginal tax rates *ceteris paribus*. One issue to be considered is whether this would then translate into an expected Canadian real exchange rate depreciation. Furthermore, if two countries have similar public debt-to-GDP ratios, the economy that is characterized by a heavier excess tax burden and a bigger size of the government sector, might have real interest rates that are higher than the world real interest rate.

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Table 1.
Descriptive statistics on the ex ante real interest rate differential
Canada/United States 1971Q1 - 1994Q1
(in basis points *per annum*)

Period	*Number of obs.*	*Mean*	*Standard Deviation*	*RMSE*	*Maximum deviation in absolute value*	*% of deviations in absolute value smaller than "n" basis points*			
						n=30	*n=50*	*n=75*	*n=100*
1-year Government Bond:									
1971Q1 - 1994Q1	93	109	268	288	766	10	15	17	24
1971Q1 - 1974Q4	16	-246	258	351	766	6	6	19	25
1975Q1 - 1978Q4	16	80	221	229	372	0	6	6	13
1979Q1 - 1982Q4	16	0	113	110	239	38	50	50	69
1983Q1 - 1986Q4	16	164	95	188	331	6	13	19	25
1987Q1 - 1990Q4	16	342	176	382	650	6	6	6	13
1991Q1 - 1994Q1	13	362	104	375	518	0	0	0	0
5-year Government Bond:									
1971Q1 - 1994Q1	93	62	198	206	577	15	22	31	42
1971Q1 - 1974Q4	16	-171	217	271	577	0	13	19	38
1975Q1 - 1978Q4	16	48	209	208	335	13	13	25	25
1979Q1 - 1982Q4	16	-2	80	78	163	25	44	63	88
1983Q1 - 1986Q4	16	81	78	110	236	38	44	56	69
1987Q1 - 1990Q4	16	193	129	230	411	13	13	19	25
1991Q1 - 1994Q1	13	262	69	270	371	0	0	0	0
10-year Government Bond:									
1971Q1 - 1994Q1	93	64	187	196	566	13	20	32	40
1971Q1 - 1974Q4	16	-135	237	267	566	6	13	13	38
1975Q1 - 1978Q4	16	53	187	188	300	6	6	13	19
1979Q1 - 1982Q4	16	-9	74	725	155	31	44	75	88
1983Q1 - 1986Q4	16	92	91	127	292	19	38	63	63
1987Q1 - 1990Q4	16	173	119	208	371	13	19	25	25
1991Q1 - 1994Q1	13	245	73	255	373	0	0	0	0

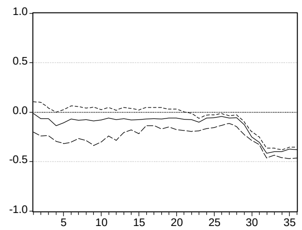
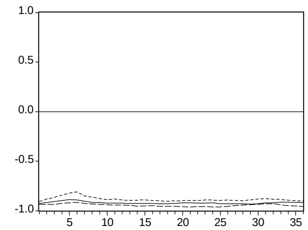
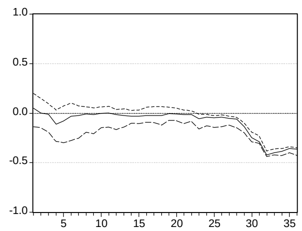
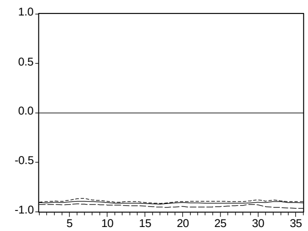
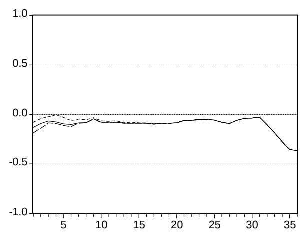
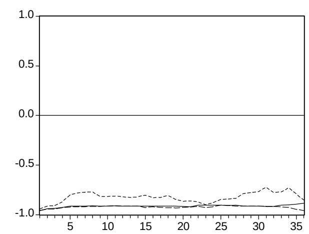
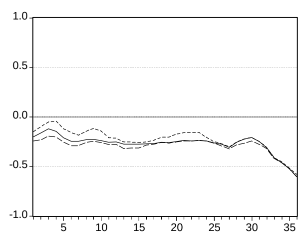
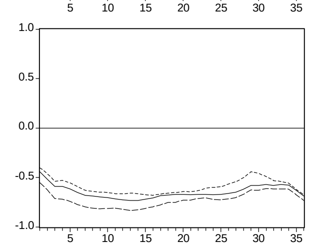
Table 2. ***Mnemonics and definitions of variables***[1]	
Ex ante deviations from real interest rate parity:	$drp_{t,t+s} = r^{e}_{t,t+s} - r^{e*}_{t,t+s}$
Ex post deviations from real interest rate parity:	$drp_{t,t+s} = r_{t,t+s} - r^{*}_{t,t+s}$
Ex post deviations from uncovered interest parity:	$duip_{t,t+s} = [\log(e_{t+s}) - \log(e_t)] + i^{*}_{t,t+s} - i_{t,t+s}$
Ex post deviations from relative purchasing power parity:	$drppp_{t,t+s} = [\log(e_{t+s}) - \log(e_t)] + \pi^{*}_{t,t+s} - \pi_{t,t+s}$
Ex post deviations from covered interest parity:	$dcip_{t,t+s} = [\log(f_{t,t+s}) - \log(e_t)] + i^{*}_{t,t+s} - i_{t,t+s}$
Ex post exchange rate risk premium (in log):	$lerp_{t,t+s} = \log(f_{t,t+s}) - \log(e_{t+s})$
Terms of trade (in log):	$ltotc_t = \log(imp_t) - \log(exp_t)$
Real exchange rate (in log):	$lare_t = \log(e_t) + \log(P^{*}_t) - \log(P_t)$
Output growth variables:	$\Delta\log(y_t),\ \Delta\log(y^{*}_t)$
Federal Gross Public debt variable:	$(b^{g}_t/y_t),\ (b^{g*}_t/y^{*}_t)$
Federal government deficit variables:	$(\Delta b^{g}_t/y_t),\ (\Delta b^{g*}_t/y^{*}_t)$
Federal government spending variables:	$\log(G_t/y_t),\ \log(G^{*}_t/y^{*}_t)$
Slope of the yield curve: 10-year yield minus overnight rate:	$[i_{t,t+10y} - i_{t,t+on}],\ \left[i^{*}_{t,t+10y} - {}_{fedf}i^{*}_{t,t+on}\right]$
Slope of the yield curve: 10-year yield minus 3-month rate:	$[i_{t,t+10y} - i_{t,t+3m}],\ \left[i^{*}_{t,t+10y} - i^{*}_{t,t+3m}\right]$
Inflation rate variables:	$[(P_{t+s}) - \log(P_t)],\ [\log(P^{*}_{t+s}) - \log(P^{*}_t)]$

[1] The variables *e*, *f*, *imp*, *exp*, *P*, *y*, b^g, and *g* are respectively: the spot exchange rate; the forward exchange rate; the import deflator; the export deflator; the price level; real GDP; Federal public debt; and federal government spending.

Figure 1.

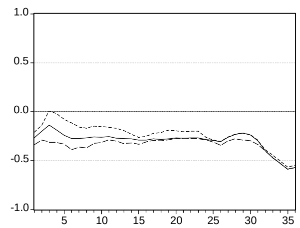
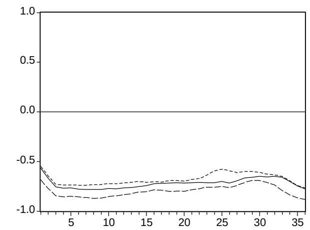
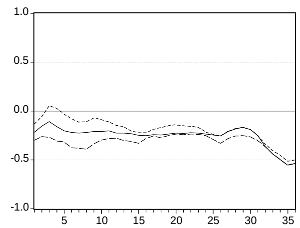
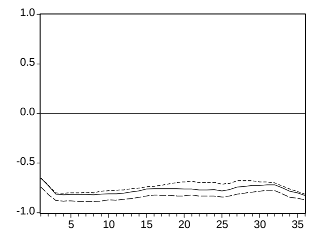
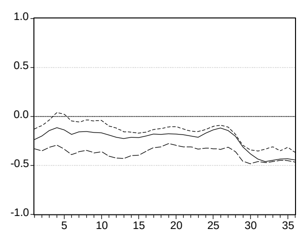
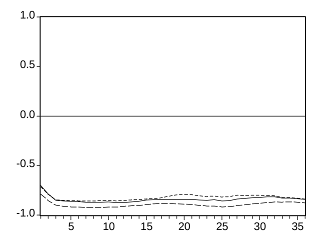
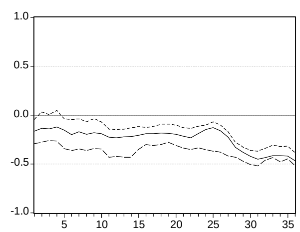
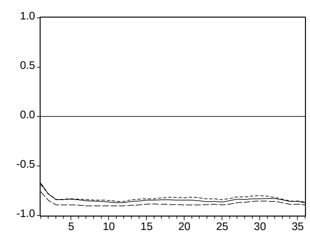
Stylised Facts on Open Macroeconomy Variables: Canada vs. the U.S. Sample: 1971Q1 - 1994Q1.

VAR Based Evidence.

Open Macroeconomy		Correlation at 1- to 36-quarter horizons with	
		output growth	inflation
Ex ante deviations from real interest rate parity	3 m CP		
	3 m T-bill		
	6 m T-bill		
	1 yr gov. bond		

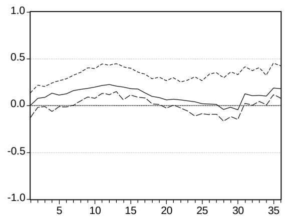
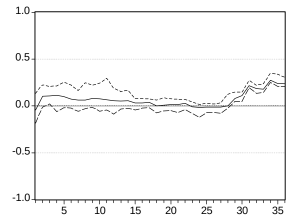
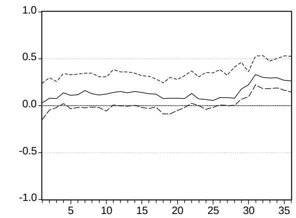
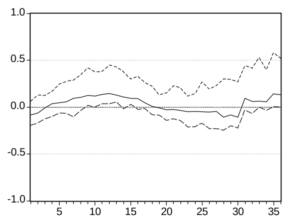
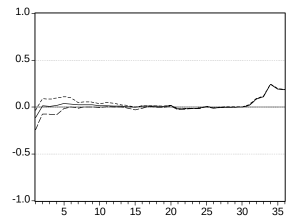
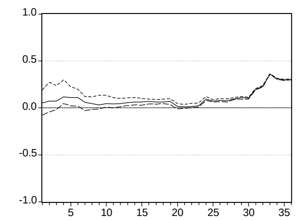
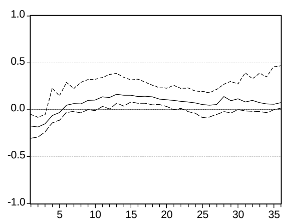
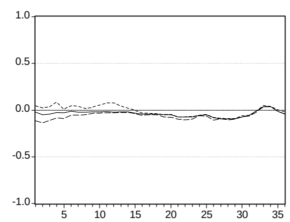
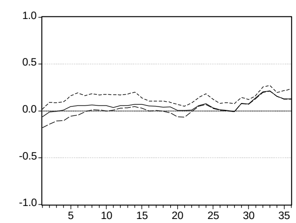
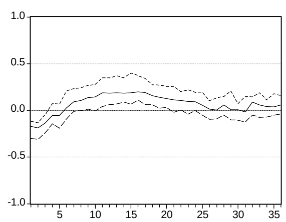
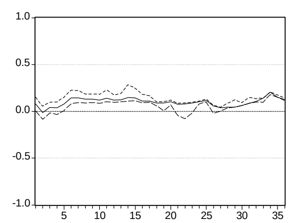
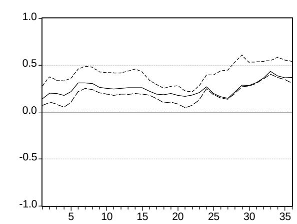
Note: Each graph shows the correlation between the k-quarter ahead forecast errors of the two relevant VAR equations and its asymptotic 95% probability interval (based on 100 draws of Monte Carlo integration with antithetic acceleration).

Figure 2.
Stylised Facts on Open Macroeconomy Variables: Canada vs. the U.S. Sample: 1971Q1 - 1994Q1.
VAR Based Evidence.

Open Macroeconomy Variables		Correlation at 1- to 36-quarter horizons with	
		output growth	inflation
Ex ante deviations from real interest rate parity	3 yr gov. bond		
	5 yr gov. bond		
	7 yr gov. bond		
	10 yr gov. bond		

Note: Each graph shows the correlation between the k-quarter ahead forecast errors of the two relevant VAR equations and its asymptotic 95% probability interval (based on 100 draws of Monte Carlo integration with antithetic acceleration).

Figure 3.
Stylised Facts on Open Macroeconomy Variables: Canada vs. the U.S. Sample: 1971Q1 - 1994Q1.
VAR Based Evidence.

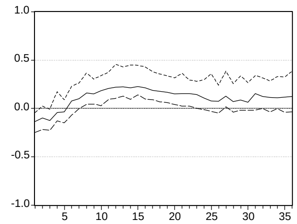
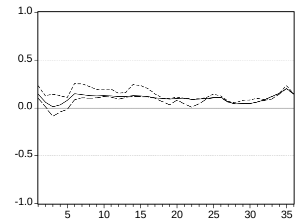
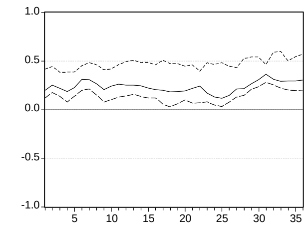
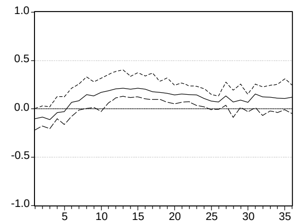
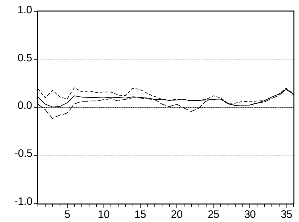
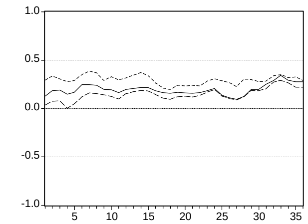
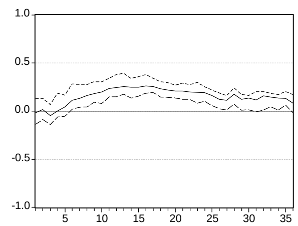
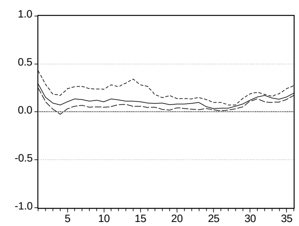
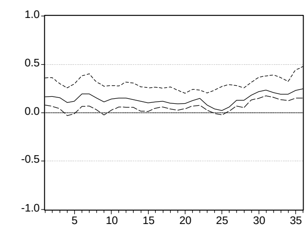
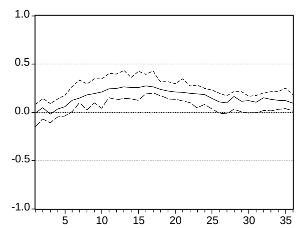
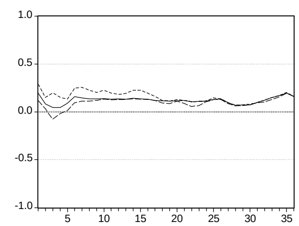
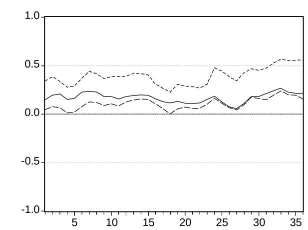
Open Macroeconomy Variables		Correlation with fiscal policy variables at 1- to 36-quarter horizons with: Gov. debt/GDP	Gov. deficit/GDP	Gov. spending/GDP
Ex ante deviations from real interest rate parity	3 m CP			
	3 m T-bill			
	6 m T-bill			
	1 yr gov. bond			

Note: Each graph shows the correlation between the k-quarter ahead forecast errors of the two relevant VAR equations and its asymptotic 95% probability interval (based on 100 draws of Monte Carlo integration with antithetic acceleration).

Figure 4.

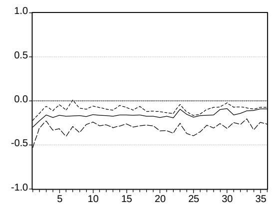
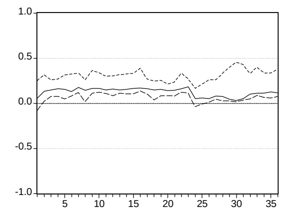
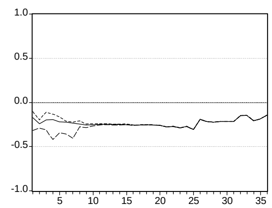
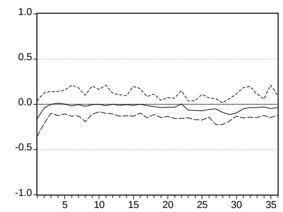
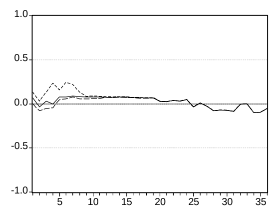
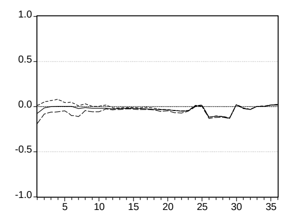
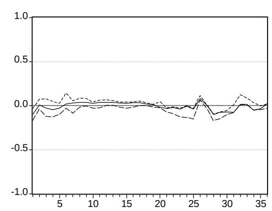
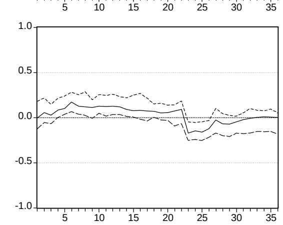
Stylised Facts on Open Macroeconomy Variables: Canada vs. the U.S. Sample: 1971Q1 - 1994Q1.

VAR Based Evidence.

Open Macroeconomy Variables		Correlation with fiscal policy variables at 1- to 36-quarter horizons with		
		Gov. debt/GDP	Gov. deficit/GDP	Gov. spending/GDP
Ex ante deviations from real interest rate parity	3 yr gov. bond			
	5 yr gov. bond			
	7 yr gov. bond			
	10 yr gov. bond			

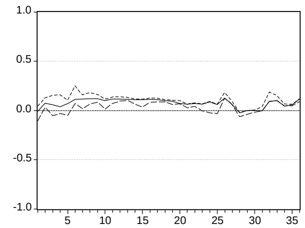
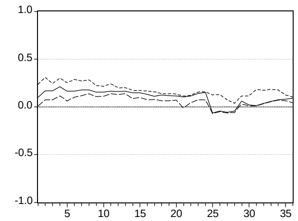
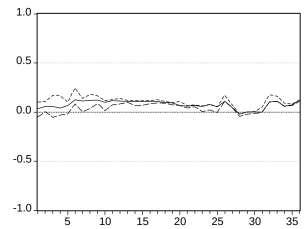
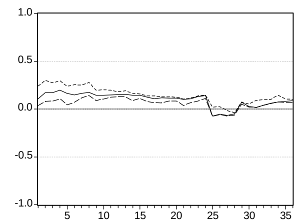
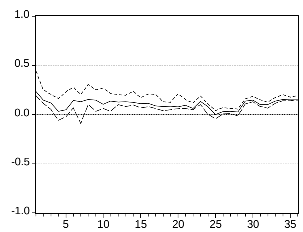
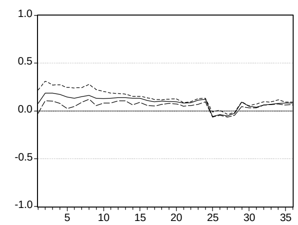
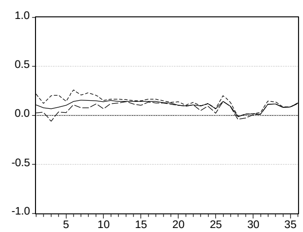
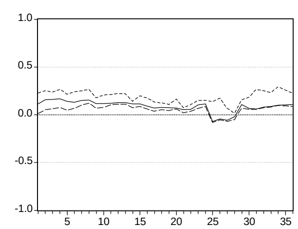
Note: Each graph shows the correlation between the k-quarter ahead forecast errors of the two relevant VAR equations and its asymptotic 95% probability interval (based on 100 draws of Monte Carlo integration with antithetic acceleration).

Figure 5.
Stylised Facts on Open Macroeconomy Variables: Canada vs. the U.S. Sample: 1971Q1 - 1994Q1.
VAR Based Evidence.

Open Macroeconomy Variables		Correlation with monetary policy variables at 1- to 36-quarter horizons with	
		ns10yon	ns10y3
Ex ante deviations from real interest rate parity	3 m CP		
	3 m T-bill		
	6 m T-bill		
	1 yr gov. bond		

Note: Each graph shows the correlation between the k-quarter ahead forecast errors of the two relevant VAR equations and its asymptotic 95% probability interval (based on 100 draws of Monte Carlo integration with antithetic acceleration).

Figure 6.
Stylised Facts on Open Macroeconomy Variables: Canada vs. the U.S. Sample: 1971Q1 - 1994Q1.
VAR Based Evidence.

Open Macroeconomy Variables		Correlation with monetary policy variables at 1- to 36-quarter horizons with	
		ns10yon	ns10y3
Ex ante deviations from real interest rate parity	3 yr gov. bond		
	5 yr gov. bond		
	7 yr gov. bond		
	10 yr gov. bond		

Note: Each graph shows the correlation between the k-quarter ahead forecast errors of the two relevant VAR equations and its asymptotic 95% probability interval (based on 100 draws of Monte Carlo integration with antithetic acceleration).

Figure 7.

Stylised Facts on Open Macroeconomy Variables: Canada vs. the U.S. Sample: 1971Q1 - 1994Q1.

VAR Based Evidence.

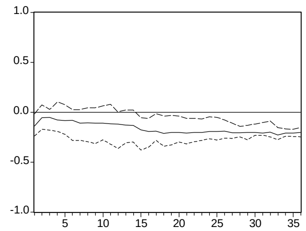
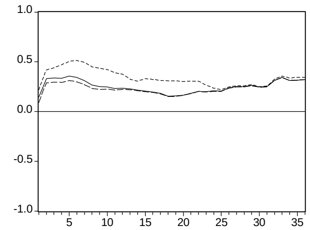
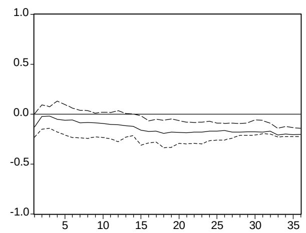
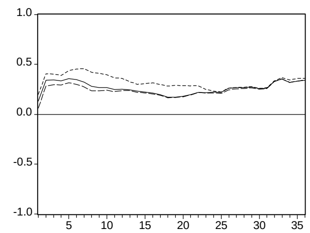
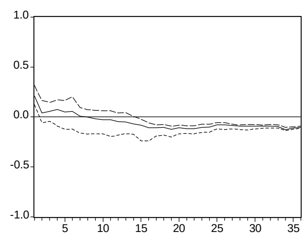
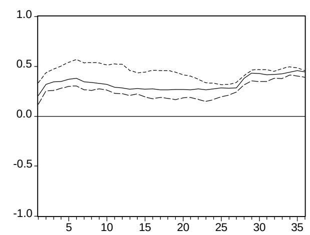
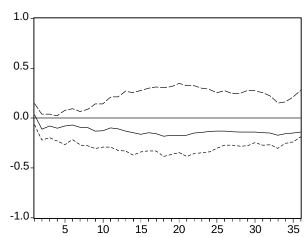
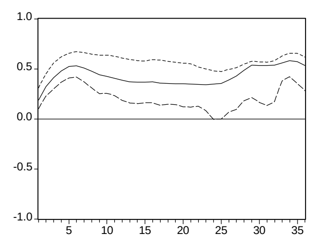
<table>
<tr><td colspan="2" rowspan="2">Open Macroeconomy Variables</td><td colspan="2">Correlation at 1- to 36-quarters horizon with</td></tr>
<tr><td>output growth</td><td>inflation</td></tr>
<tr><td rowspan="4">Ex post deviations from uncovered interest parity</td><td>3 m CP</td><td></td><td></td></tr>
<tr><td>3 m T-bill</td><td></td><td></td></tr>
<tr><td>6 m T-bill</td><td></td><td></td></tr>
<tr><td>1 yr gov. bond</td><td></td><td></td></tr>
<tr><td colspan="4">Note: Each graph shows the correlation between the k-quarter ahead forecast errors of the two relevant VAR equations and its asymptotic 95% probability interval (based on 100 draws of Monte Carlo integration with antithetic acceleration).</td></tr>
</table>

Figure 8.
Stylised Facts on Open Macroeconomy Variables: Canada vs. the U.S. Sample: 1971Q1 - 1994Q1.
VAR Based Evidence.

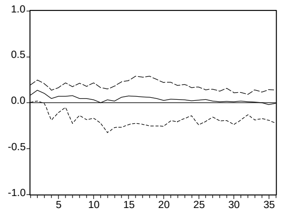
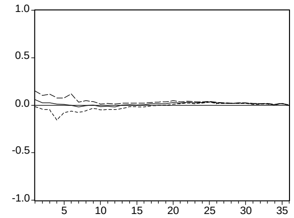
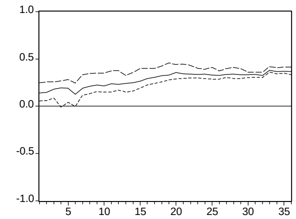
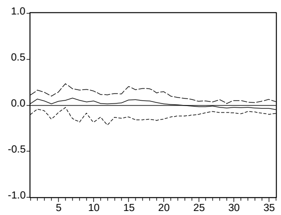
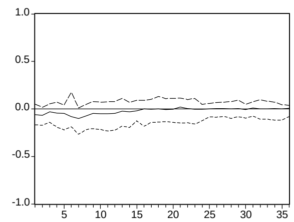
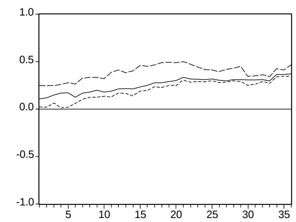
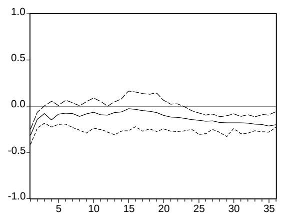
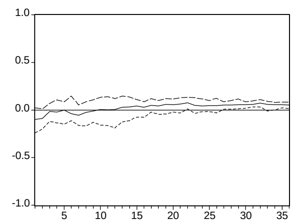
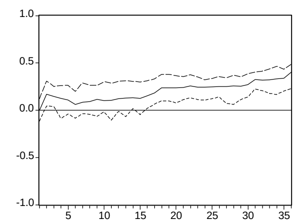
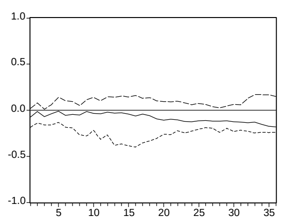
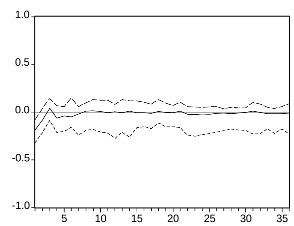
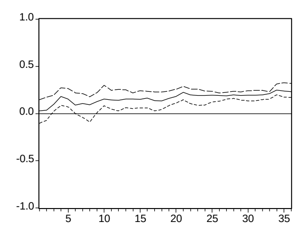
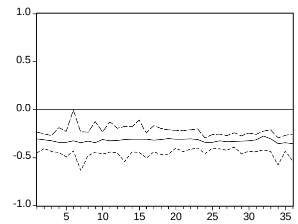
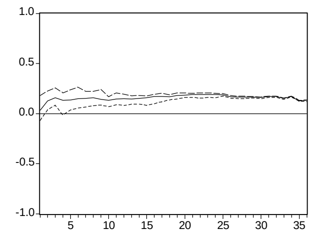
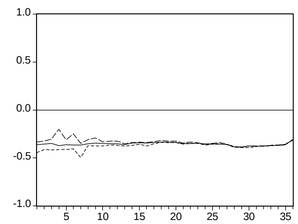
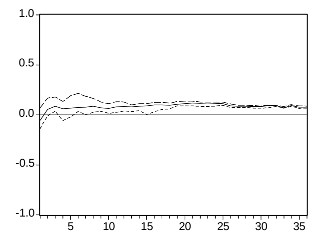
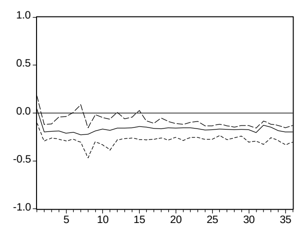
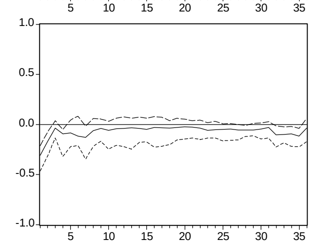
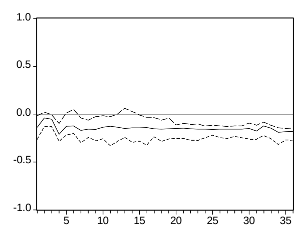
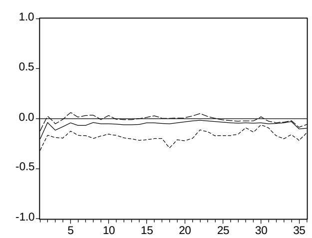
<table>
<tr><td colspan="2" rowspan="2">Open Macroeconomy Variables</td><td colspan="3">Correlation with fiscal policy variables at 1- to 36-quarter horizons with</td></tr>
<tr><td>Gov. debt/GDP</td><td>Gov. deficit/GDP</td><td>Gov. spending/GDP</td></tr>
<tr><td rowspan="4">Ex post deviations from uncovered interest parity</td><td>3 m CP</td><td></td><td></td><td></td></tr>
<tr><td>3 m T-bill</td><td></td><td></td><td></td></tr>
<tr><td>6 m T-bill</td><td></td><td></td><td></td></tr>
<tr><td>1 yr gov. bond</td><td></td><td></td><td></td></tr>
<tr><td colspan="5">Note: Each graph shows the correlation between the k-quarter ahead forecast errors of the two relevant VAR equations and its asymptotic 95% probability interval (based on 100 draws of Monte Carlo integration with antithetic acceleration).</td></tr>
</table>

Figure 9.

Stylised Facts on Open Macroeconomy Variables: Canada vs. the U.S. Sample: 1971Q1 - 1994Q1.

VAR Based Evidence.

Open Macroeconomy Variables		Correlation with monetary policy variables at 1- to 36-quarter horizons with: ns10yon	ns10y3
Ex post deviations from uncovered interest parity	3 m CP		
	3 m T-bill		
	6 m T-bill		
	1 yr gov. bond		

Note: Each graph shows the correlation between the k-quarter ahead forecast errors of the two relevant VAR equations and its asymptotic 95% probability interval (based on 100 draws of Monte Carlo integration with antithetic acceleration).

Figure 10.

Stylised Facts on Open Macroeconomy Variables: Canada vs. the U.S. Sample: 1971Q1 - 1994Q1.

VAR Based Evidence.

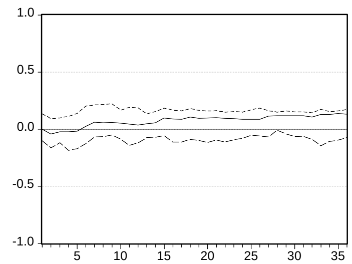
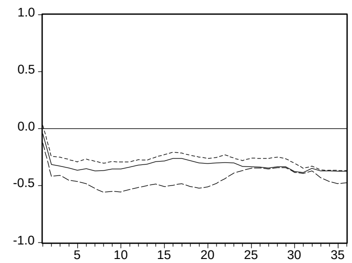
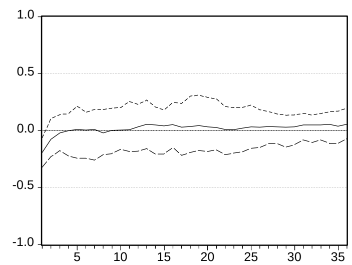
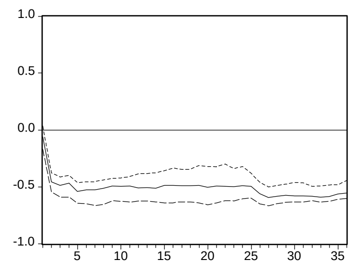
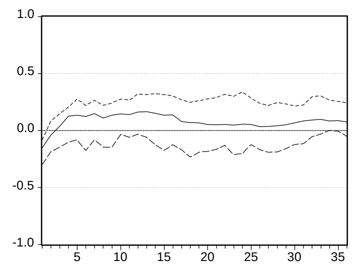
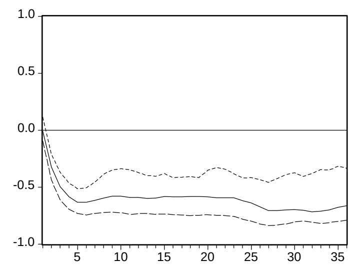
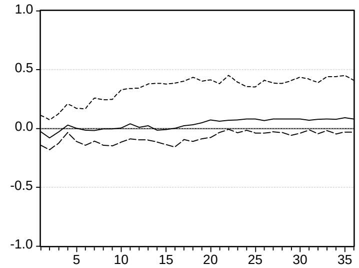
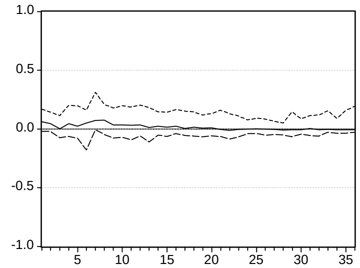
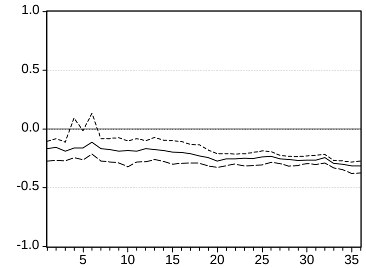
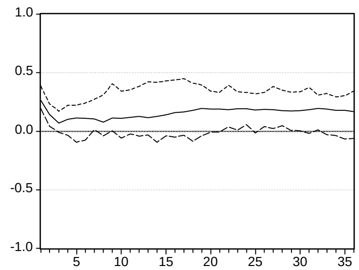
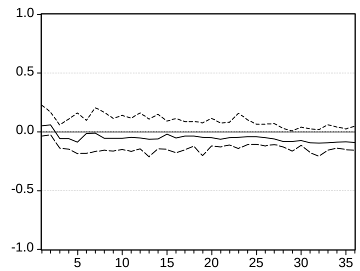
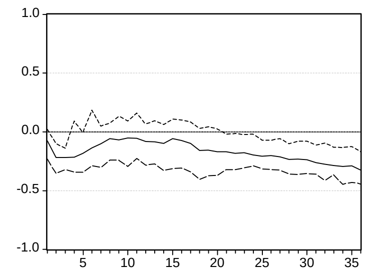
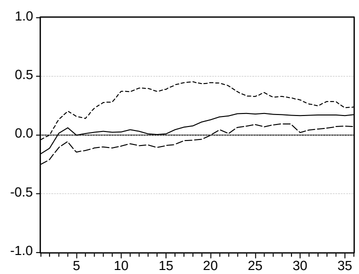
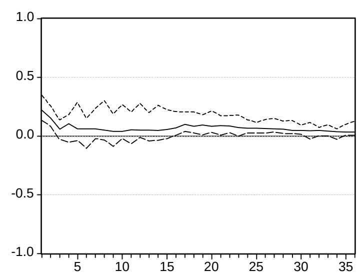
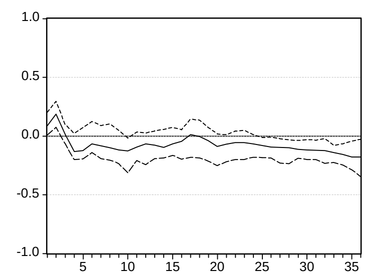
<table>
<tr><td colspan="2" rowspan="2">Open Macroeconomy Variables</td><td colspan="2">Correlation at 1- to 36-quarter horizons with</td></tr>
<tr><td>output growth</td><td>inflation</td></tr>
<tr><td rowspan="3">Ex post deviations from relative purchasing power parity</td><td>3 m</td><td>
</td><td>
</td></tr>
<tr><td>6 m</td><td>
</td><td>
</td></tr>
<tr><td>1 yr</td><td>
</td><td>
</td></tr>
<tr><td colspan="4">Note: Each graph shows the correlation between the k-quarter ahead forecast errors of the two relevant VAR equations and its asymptotic 95% probability interval (based on 100 draws of Monte Carlo integration with antithetic acceleration).</td></tr>
</table>

Figure 11.
Stylised Facts on Open Macroeconomy Variables: Canada vs. the U.S. Sample: 1971Q1 - 1994Q1.
VAR Based Evidence.

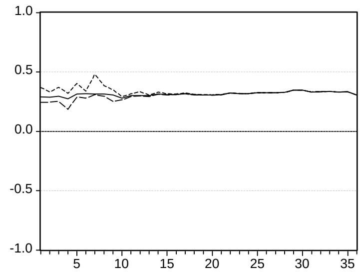
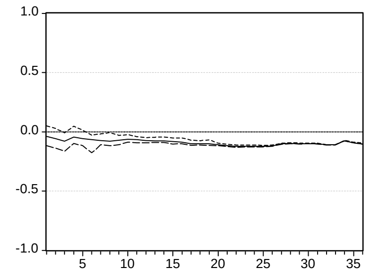
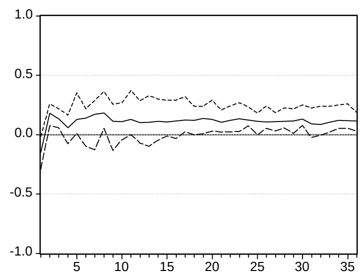
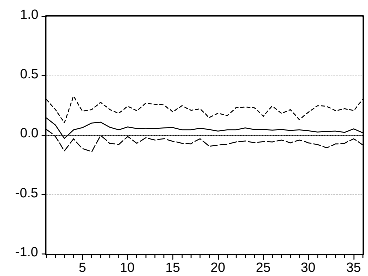
Open Macroeconomy Variables		Correlation with fiscal policy variables at 1- to 36-quarter horizons with		
		Gov. debt/GDP	Gov. deficit/GDP	Gov. spending/GDP
Ex post deviations from relative purchasing power parity	3 m			
	6 m			
	1 yr			

Note: Each graph shows the correlation between the k-quarter ahead forecast errors of the two relevant VAR equations and its asymptotic 95% probability interval (based on 100 draws of Monte Carlo integration with antithetic acceleration).

Figure 12.

Stylised Facts on Open Macroeconomy Variables: Canada vs. the U.S. Sample: 1971Q1 - 1994Q1.

VAR Based Evidence.

<table>
<tr><td colspan="2" rowspan="2">Open Macroeconomy Variables</td><td colspan="2">Correlation with monetary policy variables at 1- to 36-quarter horizons with</td></tr>
<tr><td>ns10yon</td><td>ns10y3</td></tr>
<tr><td rowspan="3">Ex post deviations from relative purchasing power parity</td><td>3 m</td><td>
</td><td>
</td></tr>
<tr><td>6 m T-bill</td><td>
</td><td>
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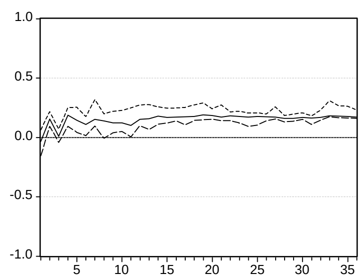
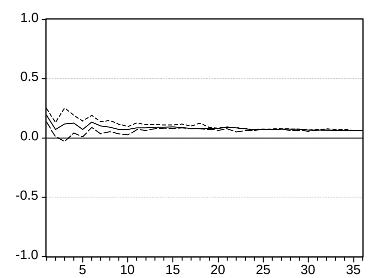
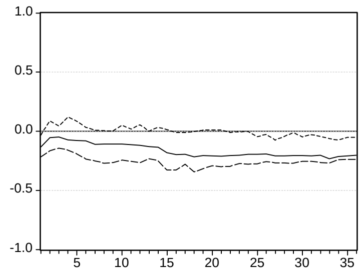
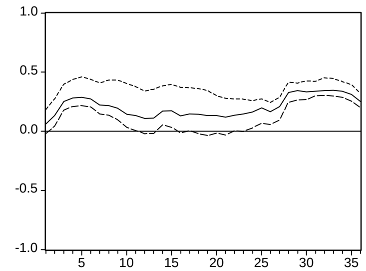
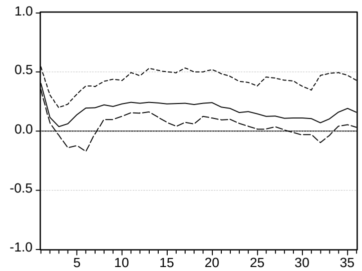
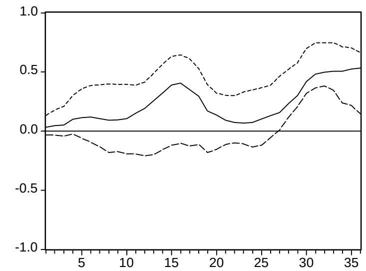
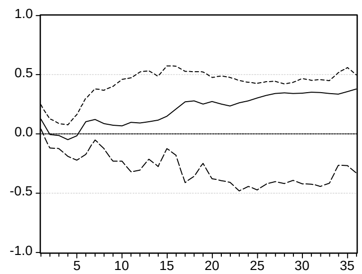
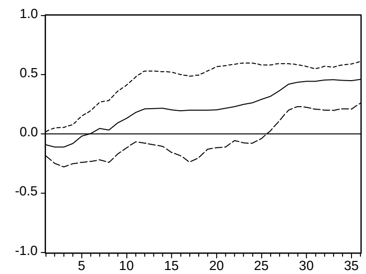
<tr><td>1 yr</td><td>
</td><td>
</td></tr>
<tr><td colspan="4">Note: Each graph shows the correlation between the k-quarter ahead forecast errors of the two relevant VAR equations and its asymptotic 95% probability interval (based on 100 draws of Monte Carlo integration with antithetic acceleration).</td></tr>
</table>

Figure 13.

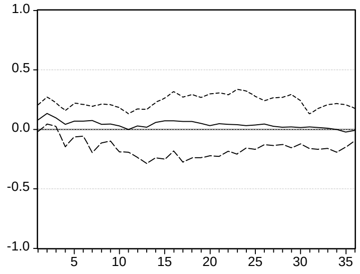
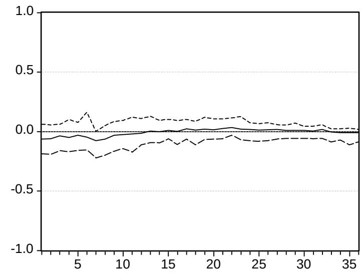
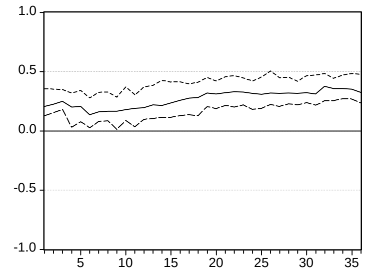
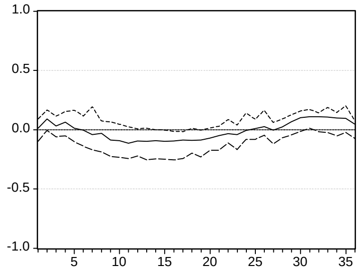
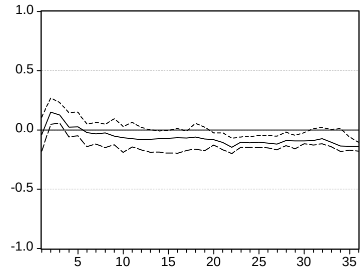
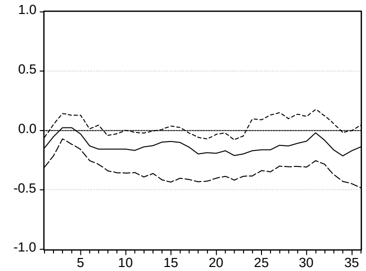
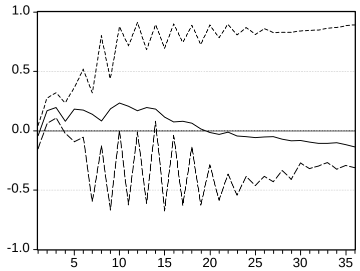
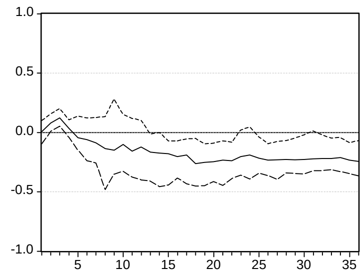
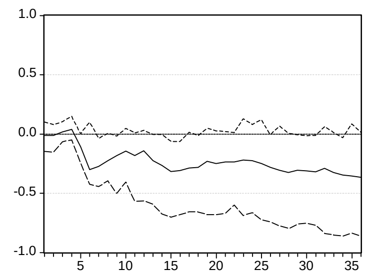
Stylised Facts on Open Macroeconomy Variables: Canada vs. the U.S. Sample: 1971Q1 - 1994Q1.

VAR Based Evidence.

Open Macroeconomy Variables	Correlation at 1- to 36-quarter horizons with	
	output growth	inflation
3-month *ex post* exchange rate risk premium		
Terms of trade		
Real exchange rate		

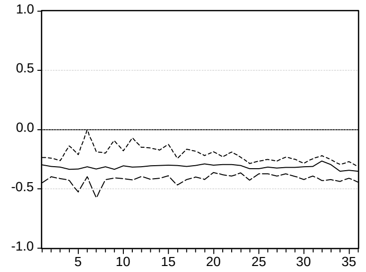
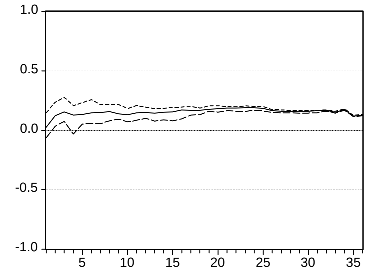
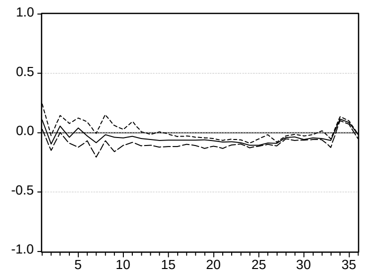
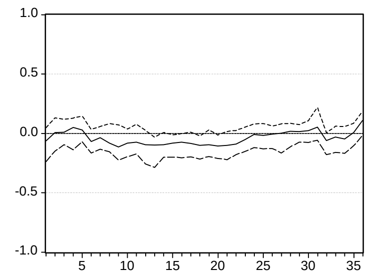
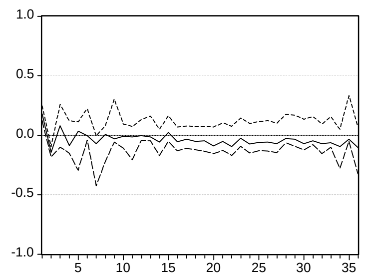
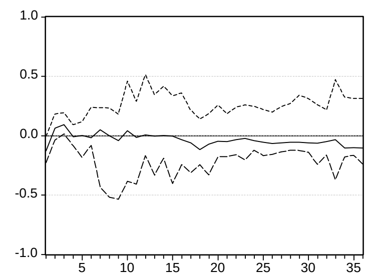
Note: Each graph shows the correlation between the k-quarter ahead forecast errors of the two relevant VAR equations and its asymptotic 95% probability interval (based on 100 draws of Monte Carlo integration with antithetic acceleration).

Figure 14.
Stylised Facts on Open Macroeconomy Variables: Canada vs. the U.S. Sample: 1971Q1 - 1994Q1.
VAR Based Evidence.

Open Macroeconomy Variables	Correlation with fiscal policy variables at 1- to 36-quarter horizons with		
	Gov. debt/GDP	Gov. deficit/GDP	Gov. spending/GDP
3-month *ex post* exchange rate risk premium			
Terms of trade			
Real exchange rate			

Note: Each graph shows the correlation between the k-quarter ahead forecast errors of the two relevant VAR equations and its asymptotic 95% probability interval (based on 100 draws of Monte Carlo integration with antithetic acceleration).

Figure 15.
Stylised Facts on Open Macroeconomy Variables: Canada vs. the U.S. Sample: 1971Q1 - 1994Q1.
VAR Based Evidence.

Open Macroeconomy Variables	Correlation with monetary policy variables at 1- to 36-quarter horizons with	
	ns10yon	ns10y3
3-month *ex post* exchange rate risk premium		
Terms of trade		
Real exchange rate		

Note: Each graph shows the correlation between the k-quarter ahead forecast errors of the two relevant VAR equations and its asymptotic 95% probability interval (based on 100 draws of Monte Carlo integration with antithetic acceleration).