Long Swings in the Canadian Dollar

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June, 2004

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August 17, 2004

Abstract

This paper uses daily, monthly, and quarterly observations for the Canadian dollar - U.S. dollar nominal exchange rate over the recent flexible exchange rate period (from January 2, 1973 to June 11, 2004), and a new statistical model of exchange rate dynamics, recently developed by Engel and Hamilton (1990), to test the null hypothesis that the value of the Canadian dollar is characterized by long swings (i.e., it moves in one direction for long periods of time). Our results indicate that only with the quarterly data the segmented trends model outperforms the random walk model. In fact, the performance of the segmented trends models declines as the frequency of the data increases, suggesting that at higher frequencies the segmented trends model has a more difficult time in distinguishing trends.

Keywords: Segmented trends; Random walks; Exchange rate regimes.

JEL classification: C22, F33

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1 Introduction

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

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

The attention to the exchange rate regime stems mostly from the decline of the Canadian dollar against the U.S. dollar through the 1990s, but also from the recent creation of a single European currency, the euro, to replace the national currencies of twelve member countries of the European monetary union. The debate in Canada has revolved around exchange rate alternatives and particularly around the issue of whether a floating currency is the right exchange rate regime or whether we should fix the exchange rate between the Canadian and U.S. currencies, as we did from 1962 to 1970.

The recent depreciation of the Canadian dollar is difficult to reconcile with explanations that focus on commodity prices, productivity, interest rate differentials, and demand and supply shocks — see, for example, Schembri (2001). In this paper we use a new statistical model of exchange rate dynamics, developed by Hamilton (1989) and Engel and Hamilton (1990), to test the hypothesis that the value of the Canadian dollar is characterized by long swings (i.e., it moves in one direction for long periods of time). In doing so, we use daily, monthly, and quarterly data over the recent floating exchange rate period, from January 2, 1973 to June 11, 2004, and also evaluate the in-sample forecasting performance of the Engel and Hamilton (1990) stochastic, segmented time trends model.

The paper is organized as follows. In the next section we briefly discuss the segmented time trends model and in section 3 we discuss the data and present maximum likelihood estimation results, using the estimation procedure of Engel and Hamilton (1990). The final section provides a brief summary and conclusion.
2 Stochastic Segmented Trends

The Engel and Hamilton (1990) model considers the observed change in the nominal exchange rate, $y_t$, and postulates the existence of an unobserved variable, $s_t$, that takes on either the value one or two. This variable describes the ‘regime’ (or ‘state’) that the $y_t$ process was in at time $t$. When $s_t = 1$, $y_t$ is assumed to have been drawn from a $N(\mu_1, \sigma_1^2)$ distribution, and when $s_t = 2$, $y_t$ is distributed $N(\mu_2, \sigma_2^2)$. Hence, $\mu_1$ is the trend in the exchange rate when $s_t = 1$ and $y_t$ is distributed $N(\mu_1, \sigma_1^2)$, and $\mu_2$ is the trend in $y_t$ when $s_t = 2$ and $y_t$ is distributed $N(\mu_2, \sigma_2^2)$.

Changes between states are assumed to be the result of the following Markov process:

\[
\begin{align*}
p(s_t = 1 | s_{t-1} = 1) &= p_{11} \\
p(s_t = 2 | s_{t-1} = 1) &= 1 - p_{11} \\
p(s_t = 1 | s_{t-1} = 2) &= 1 - p_{22} \\
p(s_t = 2 | s_{t-1} = 2) &= p_{22}
\end{align*}
\]

We also assume that $s_t$ depends on past realizations of $y$ and $s$ only through $s_{t-1}$.

The model allows a variety of behavior, without imposing that the exchange rate is described by long swings. For example, as Engel and Hamilton (1990, p. 692) put it “there can be asymmetry between the two regimes — upward moves could be short but sharp ($\mu_1$ large and positive, $p_{11}$ small), whereas downward moves could be gradual and drawn out ($\mu_2$ negative and small in absolute value, $p_{22}$ large).” In the case where $p_{11} = 1 - p_{22}$, the exchange rate this period is completely independent of last period’s state, as in a random walk. The long swings hypothesis is that $\mu_1$ and $\mu_2$ are opposite in sign and that both $p_{11}$ and $p_{22}$ are large.\footnote{Note that this model is similar to a standard probability distribution known as a “mixture of normal distributions” — a superposition of two (or more) simple normal distributions. The difference between this model and the mixture of normals is that the draws of $y_t$ in this model are not independent — the probability that a given $y_t$ comes from one distribution depends on realizations of $y$ at other times.}
3 Data, Estimation, and Results

We use daily, monthly, and quarterly data on the Canadian nominal exchange rate (in $/Can$), over the period from January 2, 1973 to June 11, 2004. The raw data was taken from CANSIM II (series V121716). As Figure 1 shows the Canadian nominal exchange rate (in $/Can$) has experienced three long swings and a short swing over the period from January 2, 1973 to June 11, 2004 (the last day in our sample). The first long swing is a 30.76 percent depreciation from January 2, 1973 to February 4, 1986, the second is a 26.04 percent appreciation from February 4, 1986 to January 7, 1992, and the third is a 24.83 percent depreciation form January 7, 1992 to February 14, 2003. The short swing is an 11.29 percent appreciation from February 14, 2003 to June 11, 2004. Over the entire 30 year period the Canadian dollar depreciated by 27 percent.

We fit the segmented trends model to the data in units of percentage change (by taking logarithmic first differences of the raw data and multiplying by 100), and obtain maximum likelihood estimates of the parameter vector \( \theta = (\mu_1, \mu_2, p_{11}, p_{22}, \sigma_1^2, \sigma_2^2) \), using the estimation procedure discussed in detail in Engel and Hamilton (1990). The parameter estimates together with their standard errors are reported in Table 1. In the last column of the table we also include the Engel (1994) parameters estimates (who looks at this exchange rate and many others), obtained using quarterly data from 1973:3 to 1986:1.

For the monthly and quarterly frequencies, our results yield a negative trend, a positive trend, and persistence in states. For example, regarding the monthly data, the estimates associate regime 1 with a 0.1253 percent monthly fall in the Canadian dollar and regime 2 with a 0.7238 percent rise. Regimes 1 and 2 are also differentiated by the variances of the conditional distributions, according to which the exchange rate is more variable in regime 2 (when the Canadian dollar is appreciating) than it is in regime 1 (when it is depreciating).

Apriori, we define the segmented trend as being a valid alternative to a random walk specification if \( \hat{\mu}_1 \) and \( \hat{\mu}_2 \) have opposite signs, \( \hat{p}_{11} \) and \( \hat{p}_{22} \) are large, and also if the segmented trend model outperforms a random walk in a forecasting exercise (in our case in-sample). In our research, these three criteria are met only with the quarterly data. In particular we have a positive \( \hat{\mu}_1 \) and a negative \( \hat{\mu}_2 \). Additionally \( \hat{p}_{11} \) and \( \hat{p}_{22} \) are large, suggesting that if the system is in either state 1 or 2, it is likely to remain in that state.
In fact, $p$-values (reported in Table 1) for the Wald test statistics of the null hypotheses $H_0: \mu_1 = \mu_2$ and $H_0: p_{11} = 1 - p_{22}$ in general reject, at significance levels of 10% and 1%, respectively, both null hypotheses. When the previous two criteria are coupled with superior in-sample forecasting performance, as shown in Table 2, it appears that for a quarterly frequency the random walk model could be rejected in favor of the segmented trends model. Our results are in contrast with those of Engel (1994).

For daily and monthly frequencies, however, we are unable to reject the random walk specification in favor of segmented trends. As evidenced in Table 2, for the daily and monthly data the in-sample forecasting performance of the segmented trends specification is inferior to that of the random walk. The segmented trends model yields superior forecasting results only with the quarterly data, with the magnitude of improvement over the random walk specification being comparable to that reported by Engel and Hamilton (1990). In fact, our results show that the in-sample forecasting performance of the segmented trends models declines as the frequency of the data increases, suggesting that at higher frequencies the segmented trends model has a more difficult time in distinguishing trends — an issue not investigated by Engel and Hamilton (1990).

4 Conclusion

We have used daily, monthly, and quarterly observations for the Canadian dollar - U.S. dollar nominal exchange rate, over the recent flexible exchange rate period, and applied a new statistical model of exchange rate dynamics to test the null hypothesis of long swings in the Canadian exchange rate. Unlike Engel and Hamilton (1990), we cannot reject the null hypothesis that the exchange rate follows a random walk.

Our results are also consistent with those reported by Serletis and Shahmoradi (2004), who use various tests from dynamical systems theory, such as for example, the Nychka et al. (1992) chaos test, the Li (1991) self-organized criticality test, and the Hansen (1996) threshold effects test, and present evidence against chaos and $1/f$ spectra, but consistent with threshold autoregressive (TAR) nonlinearities in the Canadian exchange rate, thereby supporting a stochastic nonlinear origin for this series.

Although the phenomenon of long swings is difficult to reconcile with explanations under dominant models of exchange rate determination, as Engel...
and Hamilton (1990, p.710) put it, it “deserves more attention from exchange rate theoreticians.” Moreover, the long swings phenomenon seems to be relevant in the recent debate in Canada of whether a floating currency is the right exchange rate regime or whether we should consider alternative monetary arrangements.
References


Figure 1. The Time Series of the $/Can$ Nominal Exchange Rate
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Frequency Estimates</th>
<th>Engel’s (1994) Estimates</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Daily</td>
<td>Monthly</td>
</tr>
<tr>
<td>$\mu_1$</td>
<td>-.0061 (.009)</td>
<td>-.1253 (.055)</td>
</tr>
<tr>
<td>$\mu_2$</td>
<td>-.0027 (.003)</td>
<td>.7238 (.551)</td>
</tr>
<tr>
<td>$p_{11}$</td>
<td>.9647 (.006)</td>
<td>.9973 (.003)</td>
</tr>
<tr>
<td>$p_{22}$</td>
<td>.9779 (.003)</td>
<td>.9794 (.048)</td>
</tr>
<tr>
<td>$\sigma^2_1$</td>
<td>.1698 (.007)</td>
<td>1.0776 (.081)</td>
</tr>
<tr>
<td>$\sigma^2_2$</td>
<td>.0316 (.001)</td>
<td>4.1020 (1.49)</td>
</tr>
</tbody>
</table>

Hypotheses Tests:

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\mu_1 = \mu_2$</td>
<td>.715 .127 .102 .910</td>
</tr>
<tr>
<td>$p_{11} = 1 - p_{22}$</td>
<td>&lt; .001 &lt; .001 &lt; .001 .104</td>
</tr>
</tbody>
</table>
### Table 2. In-Sample Mean Squared Forecast Errors

**Daily Data**

<table>
<thead>
<tr>
<th>Forecast Horizon (Days)</th>
<th>7</th>
<th>14</th>
<th>21</th>
<th>28</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random Walk</td>
<td>.0846</td>
<td>.1765</td>
<td>.2655</td>
<td>.3535</td>
</tr>
<tr>
<td>Segmented Trend</td>
<td>.0846</td>
<td>.1766</td>
<td>.2655</td>
<td>.3538</td>
</tr>
<tr>
<td>Percent Improvement</td>
<td>-.0172</td>
<td>-.0365</td>
<td>-.0587</td>
<td>-.0785</td>
</tr>
</tbody>
</table>

**Monthly Data**

<table>
<thead>
<tr>
<th>Forecast Horizon (Months)</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random Walk</td>
<td>1.2507</td>
<td>3.0160</td>
<td>4.7558</td>
<td>6.5911</td>
</tr>
<tr>
<td>Segmented Trend</td>
<td>1.2523</td>
<td>3.0296</td>
<td>4.7567</td>
<td>6.5406</td>
</tr>
<tr>
<td>Percent Improvement</td>
<td>-.1216</td>
<td>-.4500</td>
<td>-.0180</td>
<td>.7669</td>
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</table>

**Quarterly Data**

<table>
<thead>
<tr>
<th>Forecast Horizon (Quarters)</th>
<th>1</th>
<th>2</th>
<th>3</th>
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<tr>
<td>Random Walk</td>
<td>.5131</td>
<td>1.1854</td>
<td>1.9396</td>
<td>2.8731</td>
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<tr>
<td>Segmented Trend</td>
<td>.4882</td>
<td>1.1007</td>
<td>1.7872</td>
<td>2.6589</td>
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<tr>
<td>Percent Improvement</td>
<td>4.8556</td>
<td>7.1496</td>
<td>7.8608</td>
<td>7.4561</td>
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