FORECASTING EXCHANGE RATES WITHIN THE CONTEXT OF AN INTERNATIONAL FINANCIAL MANAGEMENT COURSE

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Abstract

This paper describes a project in an international finance class that would require students to estimate the future value of a foreign currency, the Canadian dollar, by using a simple regression model. They would then be required to compare results to a market-based forecast using spot and future rates. By having students estimate and evaluate a regression equation using real economic data that are provided to them, they are much more likely to understand the process of fundamental forecasting and its limitations.

INTRODUCTION

International finance is one of the most difficult courses for graduate and undergraduate finance students to master. It requires a solid foundation in economic theory and an understanding of the key financial markets and instruments that facilitate trade and investment activity on a global scale. The typical finance textbook will emphasize exchange rate determination or how various economic factors such as inflation, economic growth, interest rates and government controls influence the value at which national currencies are traded in international markets.

Another topic of considerable importance is the *forecasting of exchange* rates. Madura (2006, pp. 266-268) identifies some of the corporate functions that make exchange rate forecasts so necessary:

- *Hedging decision*. Multinational corporations (MNCs) constantly face the decision of whether to hedge future payables or receivables in foreign currencies.
- *Short-term financing decision*. When large corporations borrow, they have access to several different currencies. The currency they borrow will ideally (1) exhibit a low interest rate and (2) weaken in value over the financing period.
- *Short-term investment decision*. Corporations sometimes have a substantial amount of excess cash available for a short time period. Large deposits can be established in several currencies. The ideal currency for deposits will (1) exhibit a high interest rate and (2) strengthen in value over the investment period.
- *Capital budgeting decision*. When an MNC's parent assesses whether to invest funds in a foreign project, the firm takes into account that the project may periodically require the exchange of currencies.
- *Earnings assessment*. The parent's decision about whether a foreign subsidiary should reinvest earnings in a foreign country or remit earnings back to the parent may be influenced by exchange rate forecasts.
- *Long-term financing decision.* Corporations that issue bonds to secure long- term funds may consider denominating the bonds in foreign currencies. They prefer that the currency depreciate over time against the currency they are receiving from sales.

Given the importance of forecasting as a topic, it is interesting to note the approach taken by a sample of International Finance textbooks. While Madura (2006), Giddy (1994), Levich (2001), Eun and Resnick (2007) have extensive coverage of forecasting in their textbooks, O'Brian (2006) and Eiteman, Stonehill and Moffett (2004) only cover the topic lightly. It may be that the latter authors believe it is futile to forecast exchange rates in as efficient market, therefore; less coverage of the topic is warranted. Nevertheless, most instructors would probably argue that students should be fully exposed to the topic and be knowledgeable about the feasibility of forecasting exchange rates. Yet, none of the textbooks mentioned above includes a "hands-on" project that would require students to take a set of real data and use regression analysis to derive their own forecast estimate.

Among the textbooks that do have extensive coverage, several forecasting techniques are typically included: technical, fundamental and market-based. The technical approach to forecasting is based on the assumption that history repeats itself. The technical analyst would identify past patterns by looking at currency charts or by considering various transaction data like trading volume to predict the future direction of exchange rates. Although many exchange rate traders use these techniques, academic studies tend to discredit their value. Fundamental forecasting is based on establishing an historical relationship between various economic variables and a targeted exchange rate using regression analysis, a well-established statistical technique. Many textbooks describe the use of market-based forecasts within the context of an efficient markets approach in which either current spot or forward (future) rates are the best predictors of tomorrow's exchange rate (for an excellent discussion see Eun and Resnick, pp. 149-150).

This paper proposes a project requiring students to estimate the future value of a foreign currency using a fundamental forecasting model. Nevertheless, one of the most controversial issues in the international economics literature concerns the role and usefulness of traditional economic fundamentals in explaining exchange rate behavior. Meese and Rogoff (1983) concluded that economic models could not outperform an efficient markets hypothesis. Goodman (1979) questioned the value of economic oriented foreign exchange rate forecasting services. Levich (1982) evaluated the performances of 13 forecasting services using the forward exchange rate as a benchmark. In a more recent study, Eun and Safherwal (2002) evaluated the forecasting performances of 10 major commercial banks using the spot exchange rate as a benchmark. In both studies, forecasting services as a whole failed to outperform market-based rates. Although some of these services may not have been providing forecasts based solely on economic fundamentals, this is a striking conclusion. Market-based rates are easily available and cost less while forecasting services charge a fee.

Fundamental models, however, do have their advocates especially as the forecast horizon lengthens (see MacDonald (1999), Giddy (1994) and Levich (2001)). It is argued that these forecasts may be useful under certain conditions and for specific corporate purposes. Gordon Leitch and J. Ernest Tanner (1991) suggest that conventional statistical tests such as R^2 in regression analysis may be misleading if one considers the usefulness or profitability of a forecast. While regression models that only explain a small percent of exchange rate changes may appear to be of little value, Levich (p. 271-278) shows that they may lead to profitable hedging strategies for the corporation. Nevertheless, given the strong theoretical and empirical basis for believing that exchange

rate markets are highly efficient, it is well to maintain a healthy skepticism about fundamental forecasts.

MODEL

A regression model will be used to forecast the value of the Canadian dollar with respect to the U.S. dollar (USD/CAD) for the third and fourth quarters 2005. Although other factors may be relevant, for simplicity (and because of the difficulty of quantifying some factors) the value of the Canadian dollar is assumed to be dependent on the following three economic variables[1]:

1. The growth in the U.S. economy relative to the growth in the Canadian economy as measured by the percentage change in real Gross Domestic Product (GDP) of the two countries.
2. The differential between U.S. and Canadian real short-term interest rates as measured by the Three-Month Treasury rate in each country less the rate of inflation.
3. The change in the differential between U.S. and Canadian inflation as measured by the consumer price index (CPI) in each country.

Quarterly data were collected over the period 1995 (second quarter) through 2005 (second quarter) for GDP, inflation and short-term interest rates for both the United States and Canada. The dependent variable is the quarterly Canadian exchange rate (CAD). The independent variables will be set up as follows:

1. Quarterly percentage change in the real GDP growth differential (U.S. real GDP growth minus Canadian real GDP growth), referred to as dGDP.
2. The quarterly short-term real interest rate differential (U.S. real Three Month Treasury rate minus the Canadian real Three Month Treasury rate), referred to as dRINT.
3. The previous quarterly percentage change in the inflation differential (U.S. inflation rate minus the Canadian inflation rate), referred to as $dINF_{t-1.}$ [2]

The raw data for the dependent and independent variables described above are provided in TABLE 1. The regression equation can be defined as:

$$CAD_t = b_o + b_1\, dGDP + b_2\, dRINT + b_3\, dINF_{t-1} + u$$

Where b_0 is a constant, b_1 measures the sensitivity of CAD to changes in dGDP, b_2 measures the sensitivity of CAD to changes in dRINT and b_3 measures the sensitivity of CAD to changes in $dINF_{t-1}$, u represents an error term. Using the historical data, the regression equation will estimate the coefficient values (b_0, b_1, b_2 and b_3). In other words, the regression equation will determine the direction and strength to which the Canadian dollar will be affected by each of the independent variables.

The regression coefficient b_1 is expected to be positive since the variable input is U.S. real GDP growth minus Canadian real GDP growth. Stronger relative GDP growth, and consequently greater U.S. income, will strengthen the CAD as Americans purchase more Canadian goods and hence demand more Canadian dollars.

The coefficient b_2 is expected to be negative, since the variable input is the short-term real interest rate differential (U.S. minus Canadian interest rates). If real interest rates in the U.S. were higher, for example, U.S. investors would likely reduce their demand for Canadian short-term financial assets. At the same time, Canadian investors would shift funds to the U.S. These financial flows, ceteris paribus, would tend to weaken the value of the Canadian dollar.

The regression coefficient b_3 is expected to be positive since the variable input reflects the previous quarterly percentage change in the inflation differential (U.S. inflation rate minus the Canadian inflation rate). When U.S. inflation increases relative to inflation in Canada, there should be greater U.S. demand for Canadian goods and less demand among Canadians for American goods. Upward pressure is therefore exerted on the Canadian dollar.

DATA

Historical Canadian exchange rates were taken from the Pacific Exchange Rate Service website. Figure 1 shows a chart of the monthly average exchange rates: U. S. dollars per Canadian dollar. Monthly rates were then averaged for each quarter over the forecast period.

U.S. real GDP (percentage change from the preceding period at annual rates) was taken directly from the Bureau of Economic Analysis (BEA) website. The Three-Month Treasury Bill rates (secondary market) were taken from the St. Louis Federal Reserve Board's economic data website (Fred) as was the consumer price index (all urban consumers) from which real U.S. interest rates were calculated. The data source for the CPI, of course, is the U.S. Bureau of Labor Statistics. The percentage changes in the CPI for each quarter were calculated (year/year) so as to be compatible to Canadian data.

Canadian data were carefully selected to be consistent with U.S. economic data and in some cases served as a limiting factor. Nominal GDP and GDP price deflators were taken from the Statistics Canada website from which real GDP and its quarterly percentage changes (year/year) were calculated. The quarterly percentage change in the CPI (year/year) and the Three-Month Treasury Bill rates were both taken directly from the (Central) Bank of Canada's website from which real Canadian interest rates could be calculated. Since these data sets were only available from 1995, it became a limiting factor in the time series.[3] All website URL's are provided in Appendix A.

When a regression model is used for forecasting, the independent variables for the future periods have an instantaneous influence on exchange rates and are unknown. Therefore these variables must themselves be forecasted. In this paper, however, an economic forecast of the U.S. and Canadian economies were available from the Bank of Montreal (BMO) and was used to estimate the following third and fourth quarter (2005) independent variables:

BMO Forecast
of Independent Variables

Independent Variables	Third QTR	Fourth QTR
dGDP	0.60	-0.30
dRINT	-0.20	0.12
$dINF_{t-1}$		1.10

The inflation differential $dINF_{t-1}$, however, is assumed to have a lagged impact on Canadian exchange rates so that the second quarter actual inflation differential is used to forecast the third quarter's exchange rate. The BMO inflation differential forecast for the third quarter is then used to forecast the Canadian exchange rate for the fourth quarter.

Students will be required to compare their forecast of exchange rates using the regression model with market-based forecast using current spot and future rates. The current spot rate (2nd quarter 2005) is available from the Pacific Exchange Rate Service. The future rates (Settle price) on June 30, 2005 for the September and December Canadian Currency Contracts were taken from the Chicago Mercantile Exchange (CME) historical database.

STUDENT PROJECT

This paper describes an international finance project that would require students to forecast Canadian exchange rates using the regression model described above. By having them estimate and evaluate a regression equation using real economic data, they are much more likely to understand the process of fundamental forecasting and its inherent limitations. Students in an undergraduate or graduate course in international finance should be capable of handling the statistical analysis, although instructors may want to review some regression basics in class before assigning the project. Regression coefficients would be estimated using a spreadsheet software package, such as Excel, and the historical data provided in Table 1.[4]

Students would then be required to assess the direction and statistical significance of the independent variables as well as the overall performance of the forecast model. This later feature of the assignment should reinforce some important topics in every international finance course–the discussion of exchange rate determination and various parity conditions such as Purchase Power Parity (PPP). After using the regression equation to forecast exchange rates for the third and fourth quarters (2005), students would then be required to compare their results to market-based forecasts using spot and future rates (see Madura, p. 275).

To see why the current spot rate may serve as a market-based forecast, assume the Canadian dollar is expected to appreciate against the U.S. dollar over the next month. This expectation is likely to encourage foreign exchange speculators to buy Canadian dollars now in anticipation of the currency's appreciation, which would force the price to

rise now. Thus, the Canadian dollars' current value may serve as a reasonably good estimate of what the currency may be worth in a month. Future (or forward) rates quoted for a specific date in the future are commonly used to forecast the spot rate on that future date (Madura, p. 275). For example, if speculators believe the value of the Canadian spot rate in three months will be $0.85, they might want to buy a Three-Month Canadian Currency Future contract for $0.80 and then sell (in three-months) at the higher expected spot rate. Thus, the current future contract should tend to move toward the market's expectation of what the spot rate should be in three months.[5]

Finally, students should be given the opportunity to reflect on these forecasts of Canadian exchange rates within the broader context of research on the value of fundamental forecasts and the apparent better accuracy derived from market-based forecasts and what that suggests about the efficiency of currency markets.

It is suggested that students be given copies of the above sections of the papers (model, data and the description of the student project) along with the raw data in Table 1. Their regression results should be similar to Table 2. Here are some possible questions for them to address along with possible answers (shown in italics after each question).

REGRESSION RESULTS AND QUESTIONS

Question 1: Evaluate the direction and statistical significance of the independent variables as well as the overall performance of the forecast model.

In evaluating the significance of the independent variables, a useful rule of thumb is that if the absolute value of the T-statistic is greater or equal to 2, then the parameter estimate is statistically different from zero at the .05 level of significance (Baye, p. 100). In addition, a low P-value (lower than .05) suggests only a small chance that the true coefficients are actually zero. By these standards, the independent variables dGDP and dINF $_{t-1}$ are statistically significant whereas the variable dRINT is not. As hypothesized above, the coefficients of all three variables have the correct sign (dGDP and dINF $_{t-1}$ are positive; dRINT is negative) indicating that the model is consistent with economic theory.

The R-square (coefficient of determination) and F-statistic tell us about the overall performance of the forecast model (Baye, p. 100). The R-square, which tells us the fraction of the total variation in the dependent variable explained by the regression, is a very modest 22% in Table 2.[6] Nevertheless, the F-statistic, which allows one to objectively determine the statistical significance of any regression, suggests that there is only a 2.5 percent chance that the estimated regression model fit the data purely by accident.

In summary, two of the three independent variables were significant and all had the correct direction of influence on exchange rates. While the overall explanatory value of the regression is modest, raising questions about its value as a forecast tool, the regression equation is statistically significant.

Question 2: Use the regression equation and the BMO forecast of independent variables provided above to estimate third and fourth quarter Canadian exchange rates.

$$CAD_t = 0.68794 + 0.0074\ (dGDP) - 0.00145\ (dRINT) + 0.02596\ (dINF_{t-1})$$

A. Third quarter estimate (2005)

$$CAD_t = 0.68794 + 0.0074\ (0.6) - 0.00145\ (-0.20) + 0.02596\ (0.80) = 0.7134$$

policy. Secondly, using a forecasting service may help the CFO to avoid blame for an inaccurate currency forecast that ends up costing the firm much more than the consulting fee.

CONCLUSION

The paper describes an international finance class project that would require students to estimate the future value of a foreign currency, the Canadian dollar, using a simple regression model. They would then compare their results to market-based rates and reflect on the broader context of theoretical and empirical research that suggests exchange rate markets are highly efficient. The project should serve as a useful supplement to a chapter on forecasting and help reinforce other concepts in the course.

For those academics that are interested in the topic, there are opportunities for further pedagogical research on forecasting exchange rates. Alternatively, instructors who teach international finance at the graduate level may wish to engage students with a similar project. One possibility is to require students to estimate the future value of other foreign currencies by first collecting their own economic data and even developing more sophisticated forecast models. As with any econometric research project, data availability especially with regard to foreign sources of data may be a problem. The University of Michigan Library Document Center is an excellent starting point as a source of foreign government data. Their website (http://www.lib.umich.edu/govdocs/stforeign/) is a portal that contains access to government data sources in approximately 70 countries.

ENDNOTES

[1]According to Jamaleh (p.424) and Madura (pp.270-272) these economic variables are the primary driving forces found in fundamental forecasts. In addition, most international finance textbooks include a discussion of exchange rate determination in which these variables play a key role. The student project described in this paper will reinforce that material.

[2]Both Jamaleh (p.425) and Madura (p. 270) use an inflation differential variable that is lagged one period in their forecast model. Exchange rate markets are assumed to respond more slowly to the uncertainty associated with emerging CPI data.

[3]Although the regression analysis is limited to the period 1995 (2Q) to 2005 (2Q), students can easily handle forty-one observations and the sample size should be sufficient to test the statistical significance of the regression model.

[4]Within Excel, have students click tools, and then data analysis (some computers may require operators to add-in the analysis tool pak) followed by regression. The dependent variable column should be added to the input Y-range and all independent variable columns should be placed in the input x-range. It is suggested that they request labels and a 95% confidence interval.

[5]While those who subscribe to the Efficient Markets Hypothesis may use either the current spot or current future (forward) rate to predict the future spot rate, which one is the best? According to Agmon and Amihvd (1981), the two registered largely comparable performances.

[6]One partial explanation may be related to the stable nature of Canadian exchange rates (relative to the U.S. dollar). This leaves very little quarter-to-quarter variation in the dependent variable to be explained by the regression equation.

[7]This valuation of forecast performance is suggested by Madura (p. 280).

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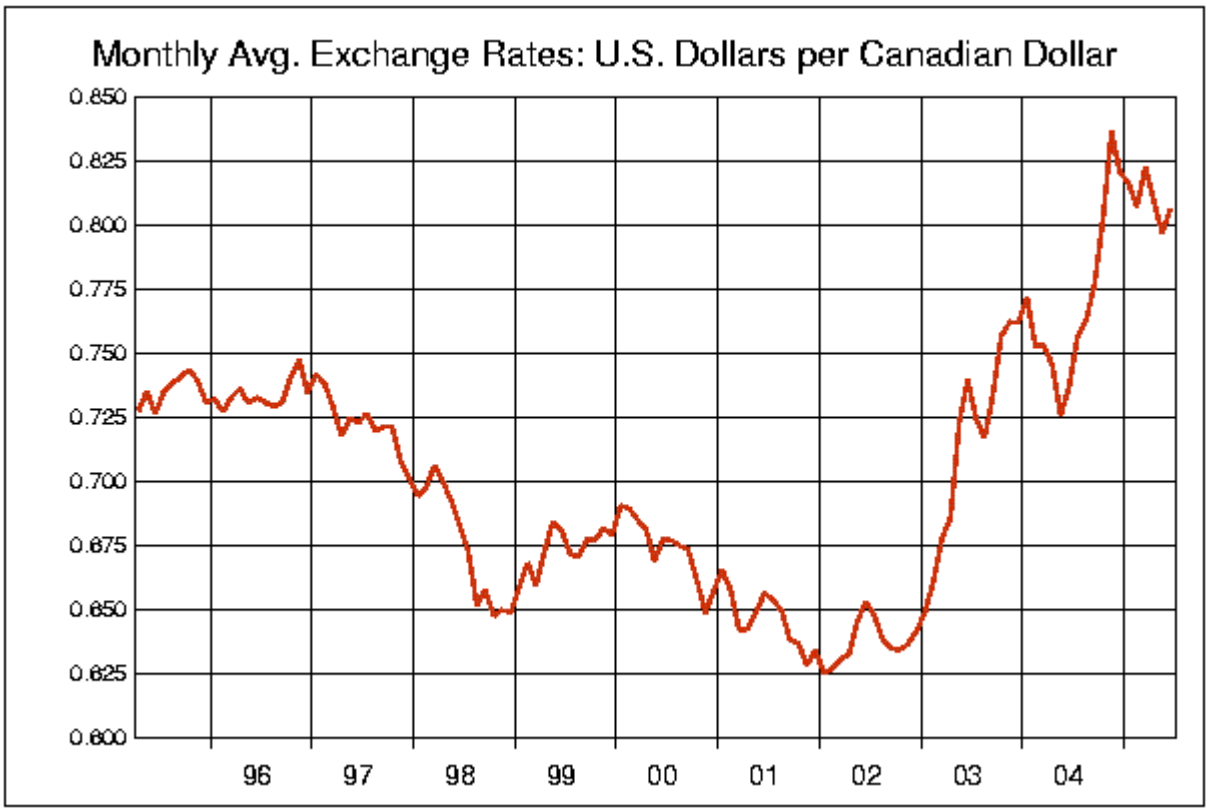
Appendix A

The following is a list of websites used for the paper:

1. Bank of Canada (http://www.bankofcanada.ca/en/intro)
2. Bank of Montreal Economics (BMO) (http://www.bmo.com/economic/)
3. Bureau of Economic Analysis (http://www.bea.gov/)
4. Chicago Mercantile Exchange (http://www.cme.com/)
5. Pacific Exchange Rate Service (http://fx.sauder.ubc.ca/)
6. Statistics Canada (http://cansim2.statcan.cal/)
7. Statistical Resources on the web-foreign government data sources - University of Michigan Library (http://www.lib.umich.edu/govdocs/stforeign/)
8. St. Louis Federal Reserve Board Economic Data - Fred http://research.St.Louisfed.org/fred2/)

FIGURE 1

PACIFIC Exchange Rate Service



Time period shown in diagram: 1/Apr/1995 - 30/Jun/2005

TABLE 1 (DATA)

EXCHANGE RATE FORECAST --- CANADIAN DOLLAR

TIME PERIOD	USD/CAD	dGDP	dRINT	dINF-1
95Q2	0.72939	0.9	-1.95	0.7
95Q3	0.73746	3	-1.38	0.2
95Q4	0.73746	1.3	-0.6	0.2
96Q1	0.73046	2.3	-0.77	0.7
96Q2	0.73260	5	-1.01	1.4
96Q3	0.72993	-1.2	-0.27	1.4
96Q4	0.74074	0.9	0.61	1.5
97Q1	0.73584	-0.9	0.85	1.1
97Q2	0.72150	1.7	1.27	0.8
97Q3	0.72202	0	1.25	0.6
97Q4	0.70972	-0.4	0.1	0.6
98Q1	0.69930	-0.9	-0.53	1
98Q2	0.69109	1.9	-0.4	0.5
98Q3	0.66007	0.2	-1.03	0.7
98Q4	0.64851	-0.5	-1.11	0.8
99Q1	0.66181	-2.8	-0.91	0.6
99Q2	0.67476	-0.9	-0.75	0.7
99Q3	0.67295	-1.2	-0.41	0.4
99Q4	0.67889	0.8	-0.33	0.6
00Q1	0.68776	-4.3	0.31	0.1
00Q2	0.67568	2	-0.66	0.8
00Q3	0.67476	-5.5	-0.36	0.8
00Q4	0.65531	1.1	-0.59	0.8
01Q1	0.65445	-2.4	-0.38	0.2
01Q2	0.64893	0.8	-1.15	0.4
01Q3	0.64683	-0.8	-0.3	-0.1
01Q4	0.63291	5.1	-0.31	0
02Q1	0.62775	-2.1	-1.45	0.9
02Q2	0.64350	-1.1	-0.74	-0.3
02Q3	0.64103	-1.3	-1	-0.2
02Q4	0.63694	-2.2	-0.68	-0.8
03Q1	0.66225	-1.3	-0.51	-1.5
03Q2	0.72780	4.9	-0.91	-1.3
03Q3	0.72464	6.1	-1.16	-0.5
03Q4	0.75988	0	-1.79	0.1
04Q1	0.75873	1.8	-0.95	-0.1
04Q2	0.73529	-1.7	-2.07	1.3
04Q3	0.76511	0.6	-1.26	0.8
04Q4	0.81900	1.1	-0.99	0.7
05Q1	0.81500	2	-1.01	1.2
05Q2	0.80386	-0.3	-0.3	0.8

TABLE 2
SUMMARY OUTPUT

Regression	*Statistics*
Multiple R	0.468801622
R Square	0.219774961

Adjusted R	Square	0.156513471
Standard	Error	0.046510716
Observations		41

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	0.022545823	0.007515274	3.474071854	0.025527478
Residual	37	0.080040127	0.002163247		
Total	40	0.102585951			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.687937642	0.011118932	61.87083798	5.83917E-39	0.665408546	0.710466739	0.665408546	0.710466739
dGDP	0.007396565	0.003079187	2.40211619	0.021435257	0.00115754	0.013635591	0.00115754	0.013635591
dRINT	-0.001446336	0.010110687	-0.14305027	0.887026694	-0.021932533	0.01903986	-0.021932533	0.01903986
dINF-1	0.025959499	0.011075088	2.34395429	0.024560392	0.00351924	0.048399758	0.00351924	0.048399758