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ABSTRACT

This paper explores the U.S and Canada Dollar monthly exchange rates from 1/1/1986 to 9/1/2019. The model shows that the U.S Dollar and Canada Dollar monthly exchange rate at time can be estimated using the Canada three month interest rate, U.S inflation rate, the price of oil, and U.S net exports. Ferraro, Rogoff, and Rossi (2011) explore the idea of forecasting exchange rates between Canada solely based on oil prices. Batten and Thornton (1985 p.22-23) discuss theory on inflation and interest rates determining currency exchanges. This paper will show that including all of these variables can be helpful in explaining the U.S and Canada Dollar exchange rate.

INTRODUCTION

Currency exchange rates are ever changing. But what is causing the daily volatility in exchange rates? I wanted to explore that question in this paper. Surely, we cannot predict the future exchange rates, if so I would not be writing this paper but instead investing in currency options. However, we can get a deeper understanding of the past rates and why the exchange rate moves one way or the other. I became interested in currency exchange rates as I began studying currency options in one of my financial engineering classes. I thought the idea of trading domestic currency for foreign currency in the future was an interesting concept. Along with this, I am in another economics course all about money, interest rates and trade. I was becoming interested in how a country sets interest, controls inflation rates, and interacts with international trading. I was able to understand and price the currency options in these classes, but I was unsure on how to speculate whether the option would be valuable in the future, and what caused one currency in regards to another country's currency to be more or less valuable.

Ferraro, Rogoff, and Rossi (2011) explore the ability to actually forecast exchange rate solely from oil prices in their paper "Can Oil Prices Forecast Exchange Rates?". There are also many other articles and papers that argue interest and inflation rates of a country play a big effect on that country's exchange rate. Batten and Thornton (1985 p.22-23) in their paper "The Discount Rate, Interest Rates, and Foreign Exchange Rates: An Analysis with Daily Data" explore interest rates differential and inflation rate differential between the two countries and the effect on the exchange rate. However in my paper, I will only be running a linear regression. I believe the theory and concepts are still relevant for analysing exchange rates.

DATA

FRED Economic Data, Economic Research from the Federal Reserve Bank of St. Louis, is where I gathered all of my data. The research done by FRED is in the top 1% of all economics research departments worldwide. FRED IS daily updated data and over 500,000 financial and economic data series. I believe the data used for this regression is accurate and reliable. The frequency of this time series model is monthly. However, for one independent variables the data was only offered quarterly and for another there was only data offered yearly. For those variables (pointed out in the VARIABLES section), I used the quarterly or yearly data to fill in the other months until the new year or the next quarter. Other than that, there were no missing data to have to deal with.

VARIABLES & THEORY

The Dependent Variable: *Canada/ U.S Foreign Exchange Rate*

The U.S and Canada dollar exchange rate is defined as how many Canadian dollars it takes to exchange for one U.S dollar. This is the variable of interest. I can think of a number of different independent variables that could potentially explain this dependent variable: government stability of one or both countries, trade tariffs between the countries, interest rates, net exports and inflation of the countries. Exchange rates are important for a country because it can affect aggregate demand for the country. And aggregate demand can cause recessions or financial stability in a country.

Explanatory Variables and Theory:

I will focus on four independent variables to try and explain the U.S and Canada exchange rate. The first being Canada's interest rate. This variable will be Canada's three month interest rate represented as a percentage (CA3MS). The expected sign for this variable's beta is negative. As Canada's interest rises, a Canadian bond will become more desirable and to buy a Canadian bond one would need Canadian dollars. This would increase the demand for Canadian dollars making the 'price' relatively higher (Mishkin 2016 p.411-417). You could then buy more goods (such as a U.S dollar) with the same amount of Canadian dollars. This would cause the exchange rate between the U.S and Canada to decrease. Inflation also plays a part in valuing a country's exchange rate. Inflation of a country is a way to calculate that currencies purchasing power. This variable is recorded as a percentage. I would expect the explanatory variable U.S inflation rate (USINF) to have a negative beta. As inflation rises, the value of the U.S dollar decreases which would make the U.S dollar "cheaper", meaning it would cost less Canadian dollars per U.S dollar. USINF was recorded on FRED as yearly data; I used the yearly inflation rate for all 12 monthly exchange rates that year. The next variable, oil (OIL), is quite important to the model for multiple reasons. OIL is record as price per barrel in U.S currency. According to Enerdata (2018), the United States is the number one country in oil consumption. This is not surprising considering the amount of consumption that is fueled by the oil industry in the United States. Also, according to The FRED Blog (2015), almost all of Canada's oil sector is exported to the U.S. This gives us reason to believe it could play a big factor into the U.S and Canada's exchange rates and ability to trade. It is important to note that Crude oil is usually priced in U.S dollars. If the price of oil increases, Canada will have more U.S dollars relative to what they had

before. This would decrease their demand for U.S dollars causing the U.S and Canada exchange rate to decrease as oil increased, meaning a predicted negative beta for the explanatory variable named OIL. The last independent variable is U.S net exports (NETEXP) in billions of U.S dollars which was recorded quarterly. U.S net exports is calculated by taking imports minus exports for the United States. Positive net exports means the United States exported more than they imported. Exchange rates decrease in response to increases in imports and increase in response to an increase in exports (Mashkin 2016 p.414). This would mean as net exports increase we would expect an increase in the U.S exchange rate, a positive beta. Table 1 is a statistical summary of the dependent variable and independent variables included in the model.

Table 1:

Variable	Obs	Mean	Std. Dev.	Min	Max
EXCAUS	405	1.264713	0.1623394	0.9553	1.5997
CA3MS	405	4.400202	3.36572	0.37579	13.8175
USINF	405	2.6054	1.171298	-0.35555	5.397956
OIL	405	44.08309	29.32457	11.35	133.88
NETEXP	405	-370.3283	244.4231	-805.63	-20.536

MODEL AND RESULTS:

The model created from the data collected from FRED is as a linear regression of the independent variables stated in the VARIABLES section and the dependent variable being the monthly U.S and Canada dollar exchange rate.

$$EXCAUS_t = \beta_o + \beta_{CA3MS} CA3MS_t + \beta_{USINF} USINF_t + \beta_{OIL} OIL_t + \beta_{NETEXP} NETEXP_t + \varepsilon_t$$

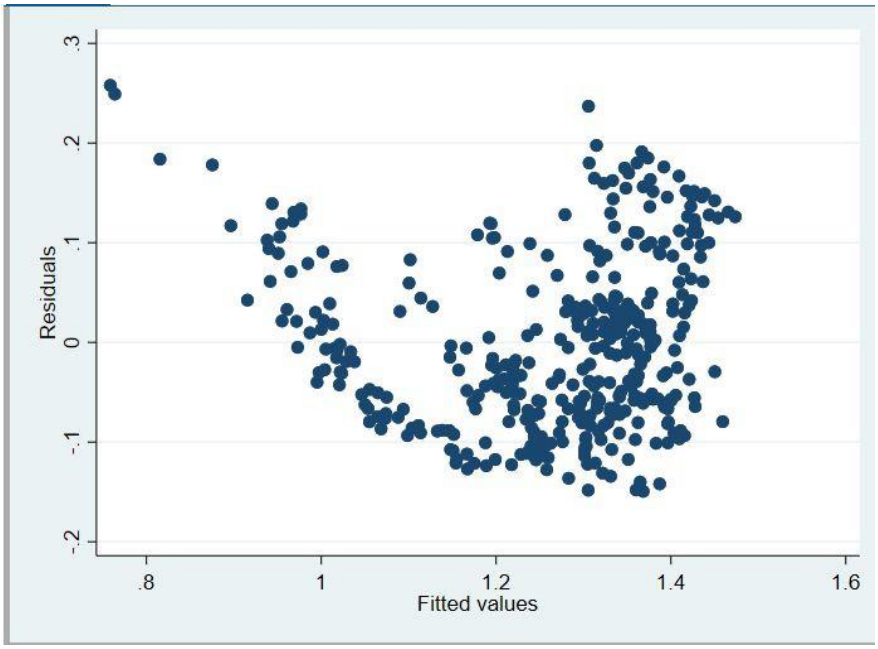
Table 2:

	Beta_hat	Robust Std. Err.	t	P>t	[95% Conf.	Interval]
CA3MS	-0.01367	0.0023045	-5.93	0	-0.0182034	-0.0091425
USINF	-0.01346	0.0058755	-2.29	0.022	-0.0250121	-0.0019107
OIL	-0.00665	0.0002813	-23.64	0	-0.0072045	-0.0060983
NETEXP	-0.00023	0.0000293	-8.02	0	-0.0002922	-0.0001772
INTERCEPT	1.566255	0.0165483	94.65	0	1.533722	1.598787

The model shows statistical significance for each of the explanatory variables at an alpha of 5% . Canada's three month interest rate, U.S inflation, oil price, and U.S net exports do a good job of explaining the dependent variable. These variables were chosen by combining theory from Mashkin (2016 p.414), Batten and Thornton (1985 p.22-23), and Ferraro, Rogoff, and Rossi (2011) into one linear model. I ran my regression with STATA/SE 16.0. The results are shown above in Table 2. It is important to check for multicollinearity to make sure that none of the independent variables are highly correlated which then could affect our test statistics. The highest VIF score was 4.85 meaning it is reasonable to believe there is no multicollinearity.

Graph 1 below can help check for heteroskedasticity. It plots the residuals and the fitted values. This is to check the variances of the error term as it moves along the regression. It is hard to tell exactly from Graph 1 whether there is heteroskedasticity or not; the graph is definitely not clear enough to conclude homoskedasticity for the variances of the error term. To check again, I will run Whites's Test below.

Graph 1:



Run White's Test:

White's test for Ho: homoskedasticity

Against Ha: unrestricted heteroskedasticity

chi2(14) = 136.61

Prob > ch2 = 0.0000

Therefore we have to reject the null hypothesis at any significance level meaning there is some form of heteroskedasticity within the model. To deal with this, I will just use robust standard errors to correct the heteroskedasticity. The robust standards are shown in table 2. Robust standard errors will help correct and give the model more trustworthy values for the standard errors without changing the coefficients.

DISCUSSION

As I look at the signs of the estimated coefficients in Table 2, they reflect what was predicted by theory and literary review in the variables section, except U.S net exports. U.S net exports unexpectedly had a negative estimated coefficients. An explanation for this could be U.S net exports has imports and exports from many different countries, not just between Canada. So it could be true that U.S net exports strictly between Canada could result in the correct sign for the estimated coefficient, positive. An improvement to the model could be to look at the net exports only between Canada and the United States instead of U.S total net exports. As Canada's interest rate increases by one percent, the exchange rate decreases by .01367. An increase in the U.S inflation rate by one percent decreases the exchange rate in the model by

.01346. As the price per barrel increases by one U.S dollar the exchange rate decreases by .00665. Finally as U.S net exports increase by 1 billion U.S dollars the exchange rate decreases by .00023. The model explains .73 of the variation in the dependent variable, U.S and Canada dollar exchange rate, around the mean value. It is also important to mention that the 95% confidence interval for all variables have consistent signs on both ends of the interval.

Both regression models I based my paper off were not linear regressions. I believe my model could be improved if I transformed the model into a non-linear regression. Even with just a linear regression, all the independent variables were significant in explaining U.S and Canada dollar monthly exchange rates. Also more observations could help create a better model. The model also might be improved if I had monthly U.S inflation rate instead of yearly. Similarly with U.S net exports, if they were reported monthly recorded perhaps the model would better explain the monthly exchange rates. Something noteworthy from Ferraro, Rogoff, and Rossi (2011 p.2) is they find that the "effects of oil price changes on exchange rates are very short lived". They find the effect of oil on exchange rates is much stronger on daily or weekly rates rather than monthly or year exchange rates. From their findings, I can say that this paper could be improved upon by using a higher frequency in data (on a daily basis vs. a monthly basis).

As trade agreements change between countries, I would imagine there would be changes to exchange rates. The changes from NAFTA to USMCA occuring will be interesting to follow and see the effect on the exchange rates between Canada, U.S, and Mexico (Mo 2019). Trade agreements help against manipulation in currencies (Bergsten 2018). So the more trade agreements made the less able a country is able to manipulate their currency in order to benefit through trade.

Canada and the United States have similar economies and markets, along with the fact that both countries are on the same continent. It would be interesting to run a regression with the U.S and different countries' exchange rates to see if the results would be similar. I believe that the model might not explain those currency exchange rates as well because there would be very big differences in a lot of variables not included in the model such as government stability, economic performance, public government debt, tariffs and trade terms.

CONCLUSION

Exchange rates, similarly to stock prices, will be impossible to perfectly predict. However, we can create models to try and explain why they are the way they are. In this paper, I was able to explain monthly exchange rates between the Canada dollar and the U.S dollar with the explanatory variables of the three month interest rates of Canada, U.S inflation rates, oil prices, and U.S net exports. After running the regression with the data I obtained through FRED, I was able to see statistical significance at an alpha of 5% for all independent variables in the model. The coefficient for Canada interest rate and U.S inflation was negative which was consistent with what the theory showed (Mishkin 2016 p.412-417). As foreign interest rates rise, currency exchange rates for the domestic country will fall between the two countries. As domestic inflation increases, domestic exchange rates will fall. Oil and net exports were also seen to decrease exchange rates as they increase. It was interesting learning about the currency rates and the variables that play a role in explaining them. Just like most things, there is always so much more to be learned when it comes to currency exchange rates.

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