Foreign Currency Exchange Rate Forecast

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Introduction

The foreign exchange market is the largest and most liquid financial market in the world. Meese and Rogoff [**Meese**] have pointed out that even the simplest random walk model can defeat complex structural econometric models in foreign exchange forecasting. With the development of the computation and machine learning techniques, we are curious about whether we can address the "impossible mission" with the help of modern machine learning methods. In this project, we attempt to forecast the daily change in the foreign exchange rates of three majorly traded currency pairs using different kinds of machine learning techniques. We compare the prediction based on six criteria and then construct trading strategies based on our predicted trading signals to test if the forecasting methods can actually bring economic values.

Data

In this project, we mainly focus on the forecasting problem of the logrithm returns of three popularly traded currency pairs, namely US Dollar to British pound (USD/GBP), US Dollar to Euro (USD/EUR), and US Dollar to Japanese Yen (USD/JPY). We use the daily closed price of these foreign exchange rates from January 2001 to November 2018. Foreign exchange data is collected from Bloomberg Terminal.

For all of our machine learning based forecasting models, we incorporate three classes of explanatory features:

- Engineered FX rate feature : including simple moving averages of the return over the past 5, 10, 20, 60, and 120 days
- Financial market factors: S&P 500 index, the S&P 100 index, the Nasdaq index, the Dow Jones Industrial Average
- Economic factors: Consumer Price Index, Federal Funds, NBER based recession indicator, Federal Debt

The economic and financial data above are obtained from Center for Research in Security Prices(CRSP).

Approach / Methodology

We extensively tested different kinds of machine learning techniques in the application of foreign exchange forecasting. The machine learning methods we use include:

- Logistic Regression
- Random Forest
- Support Vector Machine
- Multi-layer Perceptron
- Lasso/Ridge

Experiment 1: Sign Prediction (Classification)

Objective:
Predict the sign of future exchange rate for long/short trading signals
Evaluation:
We will compare out-of-sample forecasting ability between these models as well as these models' losses on accuracy as well as some metrics. These metrics include Normalized Mean Square Error (NMSE), Mean Absolute Error (MAE), Directional Symmetry (DS), Correct Up trend (CU) and Correct Down trend (CD).

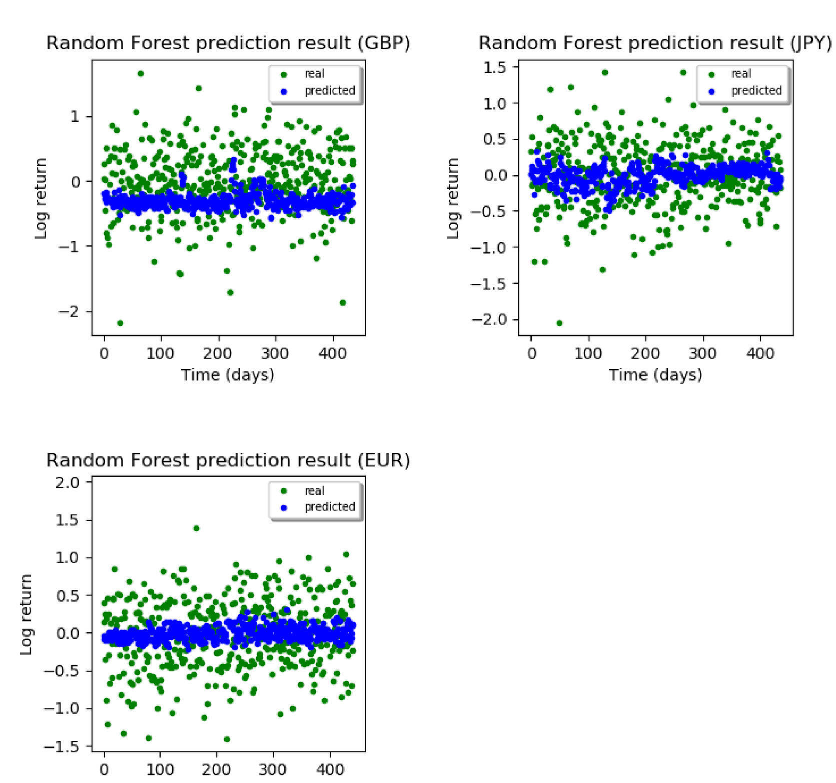
Experiment 2: Profit Simulator (Regression)

Objective:
Maximize profit via long/short currency pairs within a period of time
Evaluation:
We start with 100 dollars and trade between the three currency pairs without shorting.
First, compute the predicted return of the currency pair at time t:

$$return_t = \frac{ExchangeRate_t}{ExchangeRate_{t-1}} \quad (1)$$

Second, if all return values are larger than 1, than we do nothing; if there are some return values lower than 1, then we "switch" to the currency that has lowest exchange rate return with USD for one day and "switch" back.

Prediction



Result and Discussion

Sign Prediction:

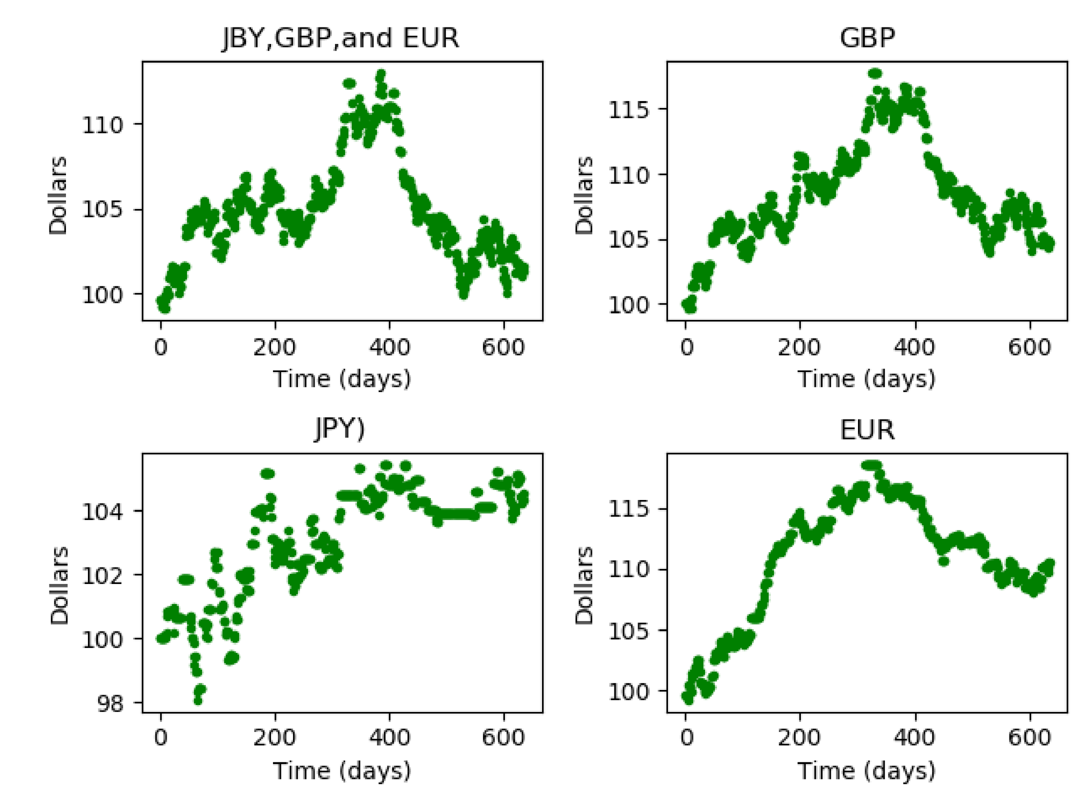
Model	Acc.	NMSE	MAE	DS	CU	CD
Lasso	0.52	1.90	0.95	0.52	0.47	0.58
Ridge	0.55	1.81	0.91	0.55	0.58	0.51
Logistic	0.51	1.97	0.98	0.51	0.45	0.57
SVM	0.51	1.95	0.97	0.51	0.57	0.52
Random Forest	0.53	2.03	1.02	0.49	0.44	0.49
MLP	0.52	1.92	0.96	0.52	0.54	0.52

Table 1: Comparison in predicting the sign of exchange rate among different machine learning techniques

Profit Simulator:

	GBP	JPY	EUR
Final	104.40	104.44	110.5
	GBP+JPY	JPY+EUR	GBP+EUR
Final	100.33	109.46	104.88
	GBP+JPY+EUR		
Final	101.30		

Table 3: Final cash in the experiment for all cases



Future Work

(1) Matching algorithm
(2) 3-D post estimation
(3) Recurrent Neural Networks: SRU, GRU, LSTM