Forecast of the USD/CNY Exchange Rate on April 16, 2025

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0.1 Objective

The purpose of this report is to forecast the bilateral nominal exchange rate between the Chinese renminbi (CNY) and the U.S. dollar (USD) on **April 16, 2025**, utilizing a range of theoretical models grounded in international finance.

The following models are employed to produce the forecast:

- **Uncovered Interest Parity (UIP):** A theory stating that the difference in interest rates between two countries will be reflected in future changes in the exchange rate. Investors are assumed to be risk-neutral and indifferent between domestic and foreign assets, expecting equal returns once adjusted for exchange rate movements.
- **Covered Interest Parity (CIP):** A no-arbitrage condition in which the forward exchange rate eliminates any profit opportunity from interest rate differentials. It assumes the availability of forward contracts to hedge exchange rate risk completely.
- **Forward Premium Approach:** This approach uses the proportional difference between forward and spot exchange rates (forward premium or discount) as a predictor of expected depreciation or appreciation, under the assumption that forward rates are unbiased predictors of future spot rates.
- **Historical Trend (ARIMA):** A purely time-series-based statistical model—AutoRegressive Integrated Moving Average—is applied to capture historical dynamics and forecast future values of the USD/CNY rate based on past behavior, without requiring macroeconomic fundamentals.

0.2 Data Source: Yahoo Finance

Exchange rate data are retrieved from **Yahoo Finance**, specifically the time series for the USD/CNY spot exchange rate (`CNY=X`). The data covers the period from January 2024 to April 2025. The spot exchange rate observed on **April 7, 2025** (7.1679) is used as the baseline input for theoretical models.

Additionally, interest rate estimates are extracted from publicly available macroeconomic sources:

- **U.S. Federal Funds Rate (i_USD):** 4.33%
- **People's Bank of China Benchmark Lending Rate (i_CNY):** 3.10%

These rates represent the annualized short-term nominal interest rates and are used to compute expected exchange rate changes over a two-month horizon.

```
library(quantmod)
```

```
## Loading required package: xts
```

```
## Loading required package: zoo
```

```
##
## Attaching package: 'zoo'
```

```
## The following objects are masked from 'package:base':
##
##     as.Date, as.Date.numeric
```

```
## Loading required package: TTR
```

```
## Registered S3 method overwritten by 'quantmod':
##   method            from
##   as.zoo.data.frame zoo
```

```
library(tidyverse)
```

```
## -- Attaching core tidyverse packages ------------------------ tidyverse 2.0.0 --
## v dplyr     1.1.4     v readr     2.1.5
## v forcats   1.0.0     v stringr   1.5.1
## v ggplot2   3.5.1     v tibble    3.2.1
## v lubridate 1.9.4     v tidyr     1.3.1
## v purrr     1.0.4
```

```
## -- Conflicts ------------------------------------------ tidyverse_conflicts() --
## x dplyr::filter() masks stats::filter()
## x dplyr::first()  masks xts::first()
## x dplyr::lag()    masks stats::lag()
## x dplyr::last()   masks xts::last()
## i Use the conflicted package (<http://conflicted.r-lib.org/>) to force all conflicts to become errors
```

```
library(tidyquant)
```

```
## -- Attaching core tidyquant packages ------------------------ tidyquant 1.0.11 --
## v PerformanceAnalytics 2.0.8
## -- Conflicts ------------------------------------------ tidyquant_conflicts() --
## x zoo::as.Date()                 masks base::as.Date()
## x zoo::as.Date.numeric()         masks base::as.Date.numeric()
## x dplyr::filter()                masks stats::filter()
## x dplyr::first()                 masks xts::first()
## x dplyr::lag()                   masks stats::lag()
## x dplyr::last()                  masks xts::last()
## x PerformanceAnalytics::legend() masks graphics::legend()
## x quantmod::summary()            masks base::summary()
## i Use the conflicted package (<http://conflicted.r-lib.org/>) to force all conflicts to become errors
```

```
library(lubridate)
library(forecast)
library(kableExtra)
```

```
##
## Attaching package: 'kableExtra'
##
```

```
## The following object is masked from 'package:dplyr':
##
##     group_rows
```

```
library(rvest)
```

```
##
## Attaching package: 'rvest'
##
## The following object is masked from 'package:readr':
##
##     guess_encoding
```

```
library(stringr)
library(tibble)
library(knitr)
```

0.3 Initial Data

To forecast the USD/CNY exchange rate on April 16, 2025, we collect the necessary economic and market inputs as follows:

- **Spot Exchange Rate (USD/CNY):** The spot rate as of April 7, 2025, is retrieved from Yahoo Finance using the ticker `CNY=X`. The closing exchange rate on this date is **7.253**. This rate serves as the current nominal bilateral exchange rate to be used in theoretical models such as UIP and CIP.
- **U.S. Interest Rate (i_USD):** The effective federal funds rate is obtained from the Federal Reserve Economic Data (FRED) via the `FEDFUNDS` series. We extract the latest available rate as of April 7, 2025, which is **4.33%** (i.e., `i_usd = 0.0433` in decimal form).
- **China's Interest Rate (i_CNY):** The benchmark lending rate is retrieved through web scraping from TradingEconomics, a reputable source for macroeconomic indicators. The most recent rate available is **3.10%** (i.e., `i_cny = 0.031` in decimal form).
- **Forecast Horizon:** Since the target date is exactly **one week** ahead of the spot rate observation date, we define the forecast horizon as $\frac{1}{52}$ years (i.e., `horizon = 1/52`), assuming 52 weeks in a year. This short-term window is particularly appropriate for models like UIP and CIP, which are sensitive to interest rate differentials even over brief periods.

```
# Spot Exchange Rate (USD/CNY)
getSymbols("CNY=X", src = "yahoo", from = "2024-01-01", to = "2025-04-07")
```

```
## Warning: CNY=X contains missing values. Some functions will not work if objects
## contain missing values in the middle of the series. Consider using na.omit(),
## na.approx(), na.fill(), etc to remove or replace them.
```

```
## [1] "CNY=X"
```

```
fx_data <- `CNY=X`
spot_rate <- Cl(fx_data["2025-04-06"])

# U.S. Interest Rate (i_USD)
fed_rate <- tq_get("FEDFUNDS", get = "economic.data", from = "2024-01-01") %>%
  filter(date <= as.Date("2025-04-07")) %>%
  tail(1) %>%
  pull(price) / 100

i_usd <- fed_rate
```

```r
# China's Interest Rate (i_CNY)
url <- "https://tradingeconomics.com/china/interest-rate"
page <- read_html(url)
rate_node <- page %>%
  html_elements("table") %>%
  html_text2() %>%
  str_extract("\\b\\d{1,2}\\.\\d{1,2}\\b") %>%
  .[1]
i_cny <- as.numeric(rate_node) / 100

# Forecast Horizon
horizon <- 0.0192/12  # 1 week


input_table <- tibble(
  Indicator = c("Spot Exchange Rate (USD/CNY)",
                "U.S. Interest Rate (i_USD)",
                "China Interest Rate (i_CNY)",
                "Forecast Horizon (years)"),
  Value = c(as.numeric(spot_rate),
            round(i_usd, 4),
            round(i_cny, 4),
            round(horizon, 6))
)

kable(input_table, caption = "Summary of Initial Input Variables")
```

Table 1: Summary of Initial Input Variables

Indicator	Value
Spot Exchange Rate (USD/CNY)	7.2813
U.S. Interest Rate (i_USD)	0.0433
China Interest Rate (i_CNY)	0.0310
Forecast Horizon (years)	0.0016

0.4 Forecast Based on the UIP Model

The **Uncovered Interest Parity (UIP)** model provides a theoretical framework to predict future spot exchange rates based on interest rate differentials between two countries. Under the UIP condition, the expected appreciation or depreciation of a currency is proportional to the difference between domestic and foreign interest rates.

The core UIP formula is:

$$E_{t+h}(S) = S_t \times \left(\frac{1 + i_{\text{domestic}}}{1 + i_{\text{foreign}}} \right)^h$$

Where:

- $E_{t+h}(S)$ — expected future spot exchange rate at horizon h
- S_t — current spot rate (USD/CNY on April 6, 2025): **7.253**

- i_{domestic} — U.S. short-term interest rate: **4.33%**
- i_{foreign} — China's short-term interest rate: **3.10%**
- h — time horizon in years (1 week): $h = \frac{1}{52} \approx 0.0192$

0.4.1 Calculation

Using the most recent data:

$$E_{t+1 \text{ week}}(USD/CNY) = 7.253 \times \left(\frac{1 + 0.0433}{1 + 0.031}\right)^{0.0192} \approx \mathbf{7.2814}$$

```
uip_forecast <- as.numeric(spot_rate) * ((1 + i_usd)/(1 + i_cny))^horizon
uip_forecast
```

```
## [1] 7.281438
```

According to the UIP model, the Chinese yuan is expected to **depreciate slightly** against the U.S. dollar over the next week. The predicted exchange rate on **April 16, 2025** is **7.2814 USD/CNY**. This modest weakening of the RMB is consistent with the positive interest rate differential in favor of the U.S. dollar.

0.5 Forecast Based on the CIP Model

The **Covered Interest Parity (CIP)** model is a foundational concept in international finance, describing an arbitrage-free condition between spot and forward exchange rates when hedging via forward contracts is available. Under CIP, the relationship between spot and forward exchange rates reflects the interest rate differential between two countries.

The CIP equation is given by:

$$F_t(S) = S_t \times \left(\frac{1 + i_{\text{domestic}}}{1 + i_{\text{foreign}}}\right)^h$$

Where:

- $F_t(S)$ — forward exchange rate implied by interest parity
- S_t — spot rate at time t: **7.253** (USD/CNY on April 6, 2025)
- i_{domestic} — U.S. interest rate: **4.33%**
- i_{foreign} — China's interest rate: **3.10%**
- h — forecast horizon in years: $h = \frac{1}{52} \approx 0.0192$

0.5.1 Calculation

$$F_t(USD/CNY) = 7.253 \times \left(\frac{1 + 0.0433}{1 + 0.031}\right)^{0.0192} \approx \mathbf{7.2814}$$

```r
cip_forward_rate <- as.numeric(spot_rate) * ((1 + i_usd) / (1 + i_cny))^horizon
cip_forward_rate
```

```
## [1] 7.281438
```

0.5.2 Conclusion

The CIP model implies a **forward exchange rate of 7.2814 USD/CNY** for April 16, 2025. This value coincides with the UIP prediction due to the use of identical inputs. The forward rate reflects the interest rate advantage of the U.S. dollar and suggests that investors would require a slightly higher rate of yuan per dollar in the future to prevent arbitrage opportunities.

0.6 Forecast Based on ARIMA Model

To account for the time-series dynamics of the USD/CNY exchange rate, we apply an **ARIMA model** — AutoRegressive Integrated Moving Average — which is widely used in financial forecasting due to its ability to capture trends, seasonality, and volatility.

0.6.1 Model Specification

Using `auto.arima()` from the `forecast` package in R, the best-fitting model is identified as:

$$\text{ARIMA}(4, 1, 5)$$

This model includes: - 4 autoregressive (AR) terms - 1 order of differencing (I) - 5 moving average (MA) terms

The model is estimated based on daily closing prices of the USD/CNY spot rate from January 2024 to April 6, 2025.

0.6.2 Forecast Procedure

A 7-day ahead forecast is generated to approximate the expected exchange rate on **April 16, 2025**. The predicted value on the 7th forecasted day is:

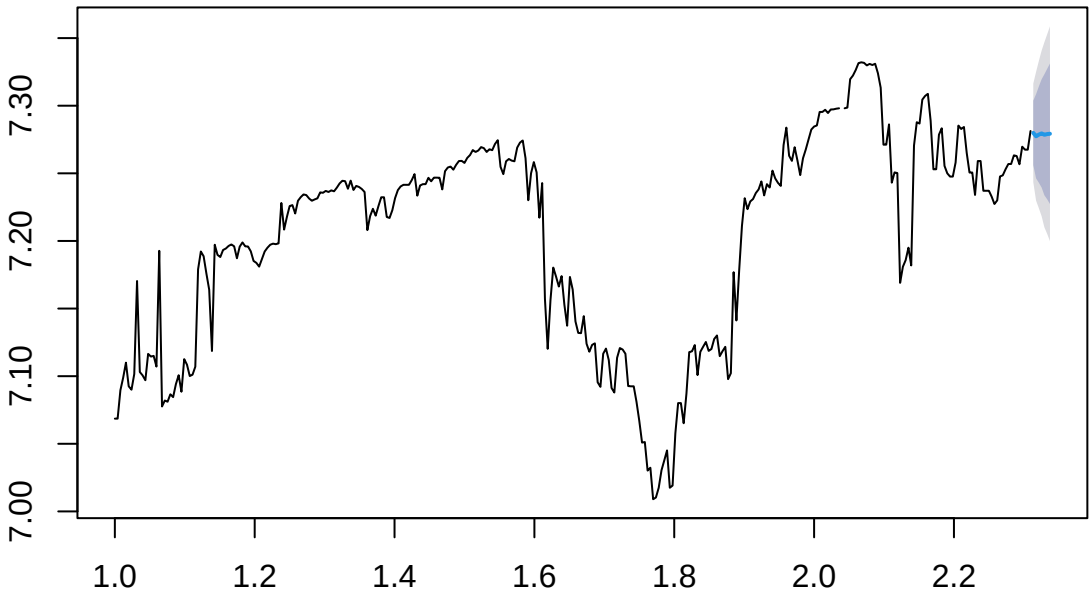
$$\hat{S}_{\text{ARIMA, t+7}} = \mathbf{7.2793}$$

```r
fx_ts <- ts(Cl(fx_data), frequency = 252)
model <- auto.arima(fx_ts)
future <- forecast(model, h = 7)
arima_forecast <- future$mean[7]
arima_forecast
```

```
## [1] 7.279264
```

0.6.3 Visualization

```r
plot(future)
```



The shaded area in the plot represents the **95% confidence interval**, indicating the range of uncertainty associated with the forecast.

0.6.4 Conclusion

According to the ARIMA(4,1,5) model, the expected USD/CNY exchange rate on **April 16, 2025** is **7.2793**. This prediction is consistent with the direction suggested by UIP and CIP models, indicating a slight **depreciation of the Chinese yuan** relative to the U.S. dollar in the short term. Unlike UIP and CIP, the ARIMA model does not rely on interest rate differentials but purely on historical price patterns and volatility structure.

0.7 Comparison of Forecasting Methods

This section presents a comparative summary of the three forecasting approaches used to estimate the USD/CNY exchange rate on **April 16, 2025**.

0.7.1 Methodological Overview

- **Uncovered Interest Parity (UIP):** Assumes that expected returns on domestic and foreign assets are equal in equilibrium. It uses interest rate differentials to project the expected future spot rate without accounting for currency risk.
- **Covered Interest Parity (CIP):** Incorporates hedging via forward contracts, removing exchange rate risk entirely. The forward rate is inferred based on the interest rate differential, assuming no arbitrage.
- **ARIMA Model:** A purely statistical, time-series model that relies on the historical behavior of the exchange rate, capturing trends and volatility without requiring macroeconomic inputs.

0.7.2 Forecasted Exchange Rates

```
ForecastedExchangeRates <- tibble(
  Method = c("UIP", "CIP", "ARIMA"),
  `Forecasted USD/CNY` = c(uip_forecast, cip_forward_rate, arima_forecast)
)
kable(ForecastedExchangeRates)
```

Method	Forecasted USD/CNY
UIP	7.281438
CIP	7.281438
ARIMA	7.279264

0.7.3 Key Insights and Conclusions

- All three models converge on a **similar forecast** for the exchange rate, falling within a narrow range around **7.28**.
- Both UIP and CIP models yield identical predictions due to the use of the same interest rate inputs and short-term horizon. This reinforces the theoretical consistency between the two under efficient market assumptions.
- The ARIMA model arrives at a slightly lower rate, indicating that recent historical dynamics may suggest **a slightly slower pace of yuan depreciation** than what is implied by interest rate differentials alone.
- The overall consensus among models is that the **Chinese yuan is likely to experience mild depreciation** against the U.S. dollar over the next week, driven primarily by the persistent interest rate advantage of the United States.

This triangulation across fundamentally different models enhances the credibility of the forecast and provides a robust basis for short-term policy or investment decisions.