ISSN: 2288-7709
JEMM website: https://accesson.kr/jemm
doi: http://doi.org/10.20482/jemm.2024.12.3.1

The Impact of the RMB Exchange Rate Expectations on Foreign Direct Investment in China

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Received: April 22, 2024. Revised: May 20, 2024. Accepted: June 05, 2024.

Abstract

Purpose: As a major economy attracting foreign investment, China is currently facing significant international economic pressure due to the appreciation of the RMB. Additionally, China is at a critical period of socio-economic development, where foreign direct investment (FDI) plays an indispensable role in stabilizing economic growth, adjusting industrial structure, and promoting economic transformation. **Research design, data and methodology:** This paper focuses on the relationship between RMB exchange rate expectations and FDI. It examines the magnitude of their relationship through empirical research using cointegration tests, Granger causality tests, and BVAR (Bayesian Vector Autoregression) analysis. **Results:** The comprehensive study of the empirical results in this paper concludes that there is a long-term cointegrated relationship between China's RMB exchange rate expectations and foreign direct investment, indicating that their relationship is stable in the long run. It is also found that RMB exchange rate expectations have a significantly positive impact in the short term, but this impact is not significant in the long term. **Conclusions:** The paper also considers the possibility of establishing a China-EU Free Trade Area in the future and offers policy recommendations regarding RMB exchange rate expectations and foreign direct investment.

Keywords: Expected RMB Exchange Rate, Foreign Direct Investment (FDI), Vector Autoregression Model, China-EU Free Trade Area

JEL Classification Code: B17, C32, F31, G15

1. Introduction

In recent years, China, as a major economy attracting foreign investment, has maintained steady growth in its national economy under a stable socialist economic development environment. The Chinese government is continuously improving policies and accelerating the pace of opening up. The cross-border trade in RMB and its convenience have thus been further enhanced, and the demand for RMB among investors worldwide is expected to rise further in the future. Meanwhile, China has long stood in the international market as a major country attracting foreign investment. Foreign Direct Investment (FDI) plays a significant and guiding role in improving China's production and management technology level, driving the transformation and upgrading of industrial structures, expanding exports, improving the balance of international payments, providing employment opportunities, and promoting the growth of the national economy.

From the perspective of RMB exchange rate expectations, the gradual appreciation of RMB is largely unfavorable for China to continuously maintain its

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attractiveness to foreign capital. This will indirectly affect the scale and profit reinvestment development of foreign investor enterprises, as well as the localization process of industries, bringing pressure to China's international payments and severely hindering the healthy development of China's processing trade industries. Moreover, relevant theories also indicate that the expected changes in the RMB exchange rate will have a significant impact on attracting foreign investment, as FDI, a form of transnational capital flow, is closely related to the fluctuations in the RMB exchange rate. It is evident that the appreciation of the RMB has gradually exerted enormous pressure on China's economy. Understanding the expected RMB exchange rate and its impact on FDI, and proposing beneficial countermeasures, is of great necessity and urgency.

One of the main objectives of this paper is to deeply analyze and study the relationship between the expected RMB exchange rate and FDI, and to provide countermeasures and preventive measures for potential financial risks that may arise under the global pandemic. Most importantly, it offers opinions on how China can maintain its international status and competitive advantages under the expectations of RMB appreciation. The purpose of this paper is to summarize the theoretical value basis of the expected RMB exchange rate and China's FDI, analyze the impact and transmission mechanism of the expected RMB to USD exchange rate on different investment paths (cost perspective, profit perspective, and speculative perspective) of FDI, and comprehensively understand the empirical results of the impact of RMB exchange rate expectations on China's FDI. The data for the expected RMB exchange rate are selected from the WIND database's monthly average data of the RMB Non-Deliverable Forward (NDF) from 2000-2020 and the actual utilization amount of FDI in the same period. The study investigates the magnitude of interconnection using cointegration tests, Granger causality tests, and BVAR vector autoregression analysis. The main purpose of this research is to verify whether the impact of the expected RMB to USD exchange rate on the scale and structure of China's FDI fully conforms to the scientific deductions of related economic theories. At the same time, it explores the feasibility of establishing a China-EU Free Trade Area. Finally, the paper concludes with a summary and policy recommendations.

Theoretically, since the formal announcement of the collapse of the Bretton Woods exchange rate system in the mid-1970s in the United States, most countries in the world have chosen to adopt international floating exchange rate systems. Since China's new round of foreign exchange rate management system reform at the beginning of 1994 and the reform of foreign exchange rate management for the convertibility of the RMB on current account transactions announced in 1996, China's foreign exchange management system has gradually become more relaxed. Currently, China's RMB exchange rate system is a managed floating exchange rate system. As the exchange rates of various countries' currencies have begun to fluctuate frequently and intensely, and the scale of speculative capital is getting larger, this poses a great challenge to global financial stability. As a major trading nation adhering to multilateralism, China must rationally expect the future RMB exchange rate in the operation of the foreign exchange market. It is necessary to appropriately intervene in or guide the future trend of the exchange rate to avoid risks and maintain its international competitiveness in attracting FDI. Moreover, in existing literature research, the study of this issue is not systematic and comprehensive. Therefore, under such circumstances, this paper theoretically innovates by linking the expected RMB exchange rate with FDI for analysis.

2. Literature Review

Historically, the British socio-economist Thornton (1802) first proposed the concept of purchasing power parity (PPP), especially after the collapse of the Bretton Woods system in the 1970s when the world shifted towards a floating exchange rate system. Bilson (1978), Frankel (1979), and others developed the Monetary Model for short-term exchange rate forecasting, based on fundamental macroeconomic analysis. However, in recent years, as China's international openness and comprehensive competitiveness in enterprises have gradually strengthened and deepened, since the market-oriented reform of the exchange rate system in 2005, the RMB exchange rate has increasingly conformed to the market supply and demand mechanism. As China has become a major force in the world economy, it seems natural to consider the significant role its currency might play (Dobson & Masson, 2009). Jin and Zang (2013), based on monthly data on China's FDI and the Real Effective Exchange Rate (REER) from January 1997 to September 2012, developed a statistical model to test the impact of host country exchange rate changes on FDI. Post-2005 exchange rate reforms, the appreciation of RMB has been found to promote FDI, a phenomenon resulting from the recent change in the types of FDI flowing into China. Xing (2006) posits that China's exchange rate policy played a key role in the FDI boom, where RMB devaluation and its peg to the dollar enhanced China's competitiveness in attracting FDI. An empirical study based on Japanese FDI in nine manufacturing sectors in China from 1981 to 2002 suggests that the real exchange rate between RMB and Japanese yen is one of the significant determinants of Japanese FDI into China, with RMB devaluation significantly increasing FDI inflow from Japan, showing elasticity to changes in the real exchange rate.

Marquez and Schindler (2007) found that a 10% real appreciation of the RMB could reduce China's overall export share by nearly one percent, while the estimated response of imports was negligible and lacked precision. Ahmad et al. (2019) explored the relationship between the Chinese exchange rate, FDI inflows, and economic development, showing that China's economy benefitted from lower exchange rates during this period, and there was a direct long-term and short-term relationship between FDI inflows and economic development at an aggregate level, with Granger causality test results affirming these long-term and short-term associations. GMM(Generalized Method of Moment) estimates with dummy variables for the financial crisis and RMB exchange rate policy fluctuations also confirmed the growth-promoting impact of exchange rate and FDI inflow growth. Chiu and Ren (2019) employed the two-step difference GMM to explore the linear and nonlinear relationships between trade balance, savings rate, and real exchange rate between China and its 102 trading partners from 1995 to 2014, finding that RMB depreciation had varying effects on China's bilateral trade balance, depending on its high-income and low-income trading partners; while the savings rate had a nonlinear impact on China's bilateral trade balance. Li et al. (2015) discovered that RMB prices had a minimal reaction to exchange rate changes, indicating a relatively high pass-through to prices denominated in foreign currencies, while volumes reacted moderately and significantly. Additionally, more productive exporters priced higher in the market, although the pass-through rate was still high. Other heterogeneity sources, such as import intensity, distribution costs, the income level of the destination country, and foreign ownership, were also significant. Moreover, RMB appreciation reduced the likelihood of entering and staying in the export market.

Xing (2006), examining direct Japanese investment in nine major manufacturing sectors in China from 1981 to 2002, found that the real exchange rate between the RMB and the yen is one of the key determinants of Japan's direct investment in China. Therefore, China's exchange rate policy played a crucial role in the boom of its Foreign Direct Investment (FDI). Warren et al. (2023) used a gravity model based on a sample of 40 countries from 2001 to 2019 to assess the significance of exchange rates and exchange rate volatility on bilateral FDI inflows. They confirmed that exchange rate volatility negatively impacts bilateral FDI inflows, while currency devaluation has a positive and significant coefficient. On the other hand, the GDP variables of the host and home countries are positive and significant, proving that the economic size of the host and home countries remains a real factor in attracting FDI.

Zhang and Chen (2023) summarized the RMB exchange rate regime reform in China as roughly undergoing three phases every decade. They analyzed the leading and supportive reforms of each phase and reviewed their effects. Achieving a free-floating exchange rate is the ultimate goal, but it is unlikely to be realized in the short term. In the interim, it is suggested to set an annual target range for the real exchange rate of the RMB in the China Foreign Exchange Trade System (CFETS) basket arrangement and implement necessary capital controls. Ma and Wang (2019), using copula models to analyze and compare dependency structures, showed that the rise in commodity prices coincides with the appreciation of the Australian dollar and the depreciation of the Chinese yuan. They observed a weak correlation between steam coal prices and the Chinese yuan and a significant relationship between natural gas prices and the Chinese yuan. Dong et al. (2020) developed a multi-regional dynamic computable general equilibrium model to explore the impact of international oil price shocks and RMB exchange rate fluctuations on China's macroeconomy. Their results indicate that a decrease in international oil prices and RMB devaluation are beneficial for economic growth, though the impact of RMB devaluation is more pronounced. A rise in international oil prices will further widen the output gap between rich and poor regions, while a decline in oil prices and RMB devaluation will narrow regional development disparities.

Chen et al. (2020) using quantile regression analysis found that Economic Policy Uncertainty (EPU) impacts RMB exchange rate volatility asymmetrically and exhibits heterogeneity among different markets. China's EPU has a positive and significant impact on all quantiles of exchange rate volatility. The impact of EPU on exchange rate volatility has mixed effects with noticeable differences across economies. The EPU of the US, Europe, and Japan have significant impacts, while Hong Kong's EPU is not significantly correlated with exchange rate volatility. Wei et al. (2020) suggest that the spillover of the RMB exchange rate is influenced by internal financial reforms and external economic shocks. Additionally, the recent outbreak of COVID-19 has disrupted this system and the influence of the RMB. Smallwood (2019) used a flexible multivariate DCC-GARCH model to measure volatility and analyze the impact of exchange rate uncertainty on bilateral export growth to China's top ten export markets. The study indicates that exchange rate uncertainty has no impact on trade with the US, contrasting with the strong trade deterrent effects found with almost all other countries.

Yang et al. (2023) employed the GARCH-MIDAS model to investigate how openness and economic fundamentals – both observable and unobservable – affect the long-term volatility of offshore exchange rates. They found that trade openness reduced long-term volatility, while financial openness had no impact. Observable fundamentals, including growth, interest rates, and relative indicators of money supply, had a significant negative effect

on offshore volatility. Liu and Lee (2022) studied the nonlinear relationship between interest rates and exchange rates between China and the United States using a rolling window approach. The results showed that interest rate adjustments in the latter had a stronger impact on China-US exchange rate volatility than those in China. Moreover, changes in the China-US exchange rate had a slightly stronger impact on US interest rates than on Chinese rates.

Guo and Wang (2023) applied a time-frequency domain approach to study the spillover effects of the RMB (Renminbi) exchange rate among Regional Comprehensive Economic Partnership (RCEP) member countries. Using daily data from August 2010 to August 2022, they found significant interactions among the currencies of the RCEP region, primarily driven by short-term spillovers and responsive to major economic and political events. Xiao (2021) analyzed the impact of RMB exchange rate fluctuations on China's textile and garment industry imports and exports using the cointegration method. The results indicated a significant positive correlation between the real effective exchange rate and imports and exports, with a greater impact on exports. Additionally, there was a mutually reinforcing relationship between imports and exports.

Zhou (2022) discussed the advantages and disadvantages of RMB internationalization for China's import and export trade. RMB internationalization can positively promote national economic outcomes and trade structure adjustments. More importantly, RMB internationalization also provides positive leeway for monetary policy. Chao (2021) argued that changes in China's import and export trade actually reflected the appreciation and depreciation of the RMB, closely related to the total volume of China's import and export trade and the formulation of corresponding foreign exchange measures. Generally, an increase in the RMB exchange rate means RMB appreciation, which is favorable for imports, while a decrease signifies RMB depreciation and a reduction in export commodity prices, thus offering a greater price advantage for exports. Chinese enterprises should accurately grasp the rise and fall of the RMB exchange rate in overseas development and reasonably conduct import and export trade.

Chen et al. (2018) explored the impact of currency undervaluation and overvaluation on China's exports and the spillover effects of these misalignments on exports from nine major Asian economies. They found that the RMB was continuously but moderately undervalued and overvalued over time. Most Asian economies were affected by RMB exchange rate misalignments, using bilateral real exchange rates and weighted average real exchange rates to ensure the robustness of the model estimates. Cheung et al. (2016) studied China-US trade flows from 1994-2012, finding that China's export value to the US negatively reacted to the real appreciation of the RMB, while imports reacted positively. Further, the combined price effects of exports and imports meant that an increase in the real value of the RMB would reduce China's trade surplus.

Baek and Nam (2021) employed the NARDL method to demonstrate the asymmetric impact of the Korean won (KRW) to Chinese yuan (CNY) real exchange rate volatility on some (though not all types) of South Korean import and export industries in both the long and short term. Additionally, this asymmetric effect appeared to be industry-specific. Xu and Lien (2020) researched the impact of the US-China trade war on the dynamics of the Chinese yuan (CNY) and its major trade partners' currencies, combining the Generalized Autoregressive Score (GAS) model with the copula method for analysis. They found that the appreciation of the US dollar towards target currencies and the global economic downturn risks caused by the trade war might be factors driving the changes in exchange rates and dependencies between the CNY and its major trading partners' currencies. Iqbal et al. (2020) represented weather, the COVID-19 outbreak in Wuhan, and the Chinese economy (Chinese currency exchange rate) using daily average temperature (hourly data), daily new confirmed COVID-19 cases in Wuhan, and the RMB exchange rate, respectively. They employed Wavelet Transform Coherence (WTC), Partial Wavelet Coherence (PWC), and Multiple Wavelet Coherence (MWC) methods to analyze daily data collected from January 21, 2020, to March 31, 2020. The results revealed significant coherences between the series at different time-frequency combinations. Overall, the results suggested that rising temperatures played a minimal role in controlling or slowing new COVID-19 infections. The RMB exchange rate and COVID-19 showed phase asynchronous coherences at specific time-frequency points, indicating that the COVID-19 outbreak in Wuhan had a negative but limited impact on China's export economy.

Hooy et al. (2015), based on the Association of Southeast Asian Nations (ASEAN), found that the real exchange rate of the RMB had a significant positive effect on ASEAN's total exports to China, particularly in high-tech and medium-tech manufactured goods and parts exports, contributing to this effect. Wang and Zhu (2016) found that the widespread use of the USD/RMB in trade settlements had a more significant impact on Chinese exports. Overall, a 1% appreciation of the RMB against the USD led to a 1.532% decline in Chinese exports, while a 1% appreciation of the RMB nominal effective exchange rate only decreased by 0.42%. More importantly, for every 1% increase in USD/RMB volatility, Chinese exports declined by 0.579%. Zhang and Ouyang (2018) used a matched sample of the Annual Survey of Industrial Firms (ASIF) and Chinese Customs data from 2000-2006 to investigate firms'

responses to RMB exchange rate movements, including export activities and profitability. They found that while RMB appreciation reduced firm exports, it increased firm profitability, with import cost reduction and export structure upgrading being the reasons for the increase in firm profitability due to RMB appreciation, but no evidence supported the productivity channel.

Mattoo et al. (2017) estimated the impact of China's exchange rate changes on the exports of developing countries in third-party markets. The degree of competition between China and its developing country competitors in specific products and destinations played a key role in the identification strategy. Tang (2015) used a cointegration VAR (CVAR) model to study the relationship between China's real exchange rate (RER) and economic growth, finding that the Chinese economy did not benefit from a lower RER and, in the long run, there was no direct link between RER and economic growth. Interestingly, according to empirical evidence, the Chinese economy appeared to be stimulated by export expansion and foreign capital inflows, suggesting that the long-term equilibrium RER is determined by foreign trade, foreign exchange reserves, and foreign direct investment. Miao et al. (2013) studied the sensitivity of stock returns of Chinese firms, classified by industry, to RMB exchange rate movements. Among the 16 Chinese industries, 7 recorded significant exposure evidence, also finding evidence of a size asymmetry effect. Additionally, they explored the characteristics of this exposure, finding significant exposure evidence among non-exporters in some industries. Xu et al. (2016) used micro-level data from Chinese firms and highly disaggregated customs data from 2000 to 2007 to study the impact of RMB exchange rate movements on the export behavior of Chinese multi-product firms. They found that real appreciation of the RMB had a negative impact on the export prices and quantities of Chinese multi-product firms, with significant differences among firms of different productivity and within the product ladder of multi-product firms. Moreover, the real appreciation of the RMB narrowed the export scope of multi-product firms and prompted firms to shift export sales towards their best-performing products. Thorbecke (2015) provided value-added exchange rate data for processing exports during 1993-2013 and reported that they significantly affected exports. Although the RMB appreciated by 36% from early 2005 to the end of 2013, the exchange rates of supply chain countries depreciated, mitigating the impact of RMB appreciation on the price competitiveness of processing exports. Eichengreen and Tong (2015) studied the impact of RMB revaluation on firm valuations, focusing on the effect of China's sudden monetary policy changes on 9753 manufacturing firms across 44 countries. RMB appreciation had no significant impact on the average valuation of firms in industries exporting to China. However, this "no result" obscured the positive impact on firms exporting final products to China, while the impact on those providing inputs for China's processing exports was negligible.

Thorbecke (2011) posited that for the largest export category - processing exports, the empirical evidence on the impact of RMB appreciation on Chinese exports is mixed. Since most of the added value of these goods comes from components produced by Japan, South Korea, and other East Asian supply chain countries, it is crucial to control for exchange rate changes in these countries. Xing (2012) analyzed the role of processing trade in China's bilateral trade balance and the impact of RMB appreciation on China's processing trade. Based on the panel data of bilateral processing trade between China and its partner countries from 1993 to 2008, empirical results indicated that real RMB appreciation would negatively impact processing imports and exports; a 10% real appreciation of the RMB would not only reduce China's processing exports by 9.1% but also decrease processing imports by 5.0%. The overall impact of RMB appreciation on the balance of processing trade and China's overall trade balance would be limited. McKinnon and Schnabl (2014) argued that the instability of the dollar standard, recently manifested in the Federal Reserve's near-zero interest rate policy, has caused concerns in emerging markets with naturally higher interest rates. China was provoked to accelerate the "internationalization" of the RMB, i.e., opening its domestic financial market to reduce its reliance on the dollar in trade invoicing and international payments. Whalley and Chen (2013) discussed the relatively new dual structure of China's onshore and offshore RMB markets. Its notable feature is that both offshore and onshore exchange rates are market-determined, but the onshore rate is anchored to the official spot rate, with a non-convertible capital account. Whalley and Wang (2011), considering the rapid growth of foreign exchange reserves in Asia (China, Japan, South Korea, and Taiwan) and revaluation pressure from trade partners, used data from 2005 to illustrate its application in the Chinese case. The results showed that the impact of RMB appreciation on the surplus is proportionally greater than on trade flows, and the changes in trade flows could be substantial. The different treatments of China's processing trade have a smaller impact on changes in China's trade flows under RMB appreciation conditions but a greater impact on changes in the surplus.

One of the significant factors influencing the expected volatility of China's real exchange rate is exchange rate fluctuation, and fluctuations in the RMB exchange rate will lead to multiple fluctuations in various economic variables.

3. Theoretical Basis of RMB Exchange Rate Expectation and FDI in China

3.1. Exchange Rate Prediction Models Based on Macroeconomic Fundamentals

Prediction Model: The premise for using exchange rate models based on economic fundamentals to form exchange rate expectations is that these models can significantly fit historical exchange rate changes and can relatively accurately predict future exchange rate changes.

3.1.1. Uncovered Interest Rate Parity (UIP) Prediction Model

$$S_t = i_t - i_t^* \tag{1}$$

In this context, S_t represents the logarithm of the nominal exchange rate in period t, while i_t and i_t^* respectively represent the logarithms of the domestic and foreign interest rates in period t. The economic significance of UIP can be broadly summarized as follows: The expected exchange rate fluctuation ratio of the renminbi is equal to the difference between the interest rate levels of the two countries (especially in the short term).

3.1.2. Purchasing Power Parity (PPP) Model

$$S_t = \beta_0 + \beta_1(p_t - p_t^*) + u_t \tag{2}$$

In this formulation, S_t represents the logarithm of the nominal exchange rate in period t, p_t and p_t^* are the logarithms of the domestic and foreign price levels in period t, respectively, u_t is the error term, and β_0 、 β_1 are parameters. The theory of Purchasing Power Parity (PPP) holds that: when there is a significant increase in the domestic price level, the nominal exchange rate may also rise noticeably, meaning a depreciation of the domestic currency relative to other foreign currencies; conversely, the domestic currency appreciates relative to foreign currencies.

3.1.3. Flexible Price Monetary Prediction Model (FPM M)

$$\begin{aligned} p_t - p_t^* &= m_t - m_t^* + \alpha(i_t - i_t^*) - \beta(n_t - n_t^*) \\ \therefore S_t &= \beta_0 + \beta_2(i_t - i_t^*) + \beta_3(m_t - m_t^*) + \\ &\quad \beta_4(n_t - n_t^*) + u_t \end{aligned} \tag{3}$$

In this model, S_t represents the logarithm of the nominal exchange rate in period t, $(p_t - p_t^*)$ is the difference in logarithms of the domestic and foreign price levels in period t, $(m_t - m_t^*)$ is the difference in logarithms of the domestic and foreign nominal money demands in period t, $(n_t - n_t^*)$ is the difference in logarithms of domestic and foreign output values in period t, u_t is the error term, and β_0 、 β_1 、 β_2 、 β_3 are parameters. The monetary model posits that: under conditions of monetary market equilibrium between both parties, the relative supply and demand of currencies between two regions or countries will determine the exchange rate of a region's or country's currency (which at this time can be simply viewed as the relative price of currencies between two countries).

3.1.4. Taylor Rule

$$\begin{aligned} S_t = \beta_0 &+ \beta_5(\pi_t - \pi_t^*) + \beta_6(i_{t-1} - i_{t-1}^*) \\ &+ \beta_7(q_t - q_t^*) + u_t \end{aligned} \tag{4}$$

In this model, S_t represents the logarithm of the nominal exchange rate in period t, $(\pi_t - \pi_t^*)$ is the difference in logarithms of the domestic and foreign inflation rates in period t, $(i_{t-1} - i_{t-1}^*)$ is the difference in logarithms of the domestic and foreign nominal interest rates in period t-1, $(q_t - q_t^*)$ is the difference in logarithms of the domestic and foreign output gaps in period t, u_t is the error term, and β_0 、 β_5、 β_6、 β_7 are parameters. The Taylor Rule monetary prediction model builds on the Flexible Price Monetary Prediction Model, taking into account the increased exogenous endogeneity of monetary policy (focusing on interest rates rather than money supply as the primary object of long-term monetary policy implementation).

3.2. Technical Fundamentals Analysis Model for Exchange Rate Expectations

The analysis of technical fundamentals refers to making reasonable judgments and predictions about future exchange rate trends by referencing past exchange rate trends and employing traditional mathematical and statistical principles. Technical basis analysis for exchange rate expectations can generally be divided into parametric and non-parametric statistical methods.

Under parametric statistics, there are two approaches: First, choosing a linear model. Currently, China employs a loosely supervised floating exchange rate system. Since the fluctuation in the exchange rate of the renminbi against the dollar is relatively small compared to other currencies, time series econometrics, like the ARMA model, are mostly used in parameter estimation, where the forecasted trends generally align with the fundamental trends of the exchange rate. Second, establishing non-linear models. Due to the multitude of factors affecting exchange rates, linear model predictions often have certain deviations, especially in the event of sudden incidents or when precision is inherently low. Hence, many scholars use non-linear models for exchange rate predictions. For instance, the GARCH model can achieve predictions with minimal short-term deviations

from actual values.

Whether it's a linear or non-linear regression model, the function expression of the regression model is preset and fixed. During model prediction and construction, it's only necessary to estimate the parameters using different observed values of variables. This implies that parametric regression model prediction requires numerous assumptions, and if some of these assumptions differ from actual conditions, it can lead to significant discrepancies between the predicted and actual outcomes. Conversely, in non-parametric estimation, the form of the regression function is likely to be unrealized and uncertain, with less restrictive assumptions. However, non-parametric estimation relies on large amounts of data, i.e., sample size.

4. Empirical Analysis of Renminbi Exchange Rate Expectations and Their Impact on Foreign Direct Investment in China

4.1. Selection of Variables and Data Processing

Table 1: Variable Description

Variable type	Variable name	Abbreviation
Dependent variable	Total actual utilization of foreign direct investment: cumulative value (US $10,000)	FDI
Independent variable	RMB Non-deliverable Forwards	NDF
Control variable	Total import and export monthly (USD 100 million)	TRADE
	Consumer Price Index CPI (same month last year =100)	CPI
	Market cash flow (million yuan)	M0
	Industrial added value above designated size year-on-year (same month last year =100)(%)	ADOVINDU

In this chapter, the dependent variable selected for this empirical analysis is the amount of foreign direct investment (FDI). In the paper, forward foreign exchange transactions without principal delivery can be used as a proxy variable for Renminbi exchange rate expectations. Therefore, the explanatory variable selected is the monthly average of Renminbi non-deliverable forwards (NDFs). The control variables chosen are total import and export volume in the current month (in billions of USD), Consumer Price Index (CPI) of the current month compared to the same month last year (previous year's same month = 100), money supply in circulation in the market (in millions of CNY): current month year-on-year comparison, and the year-on-year growth rate of industrial value-added above a designated size in the current month compared to the same month last year (previous year's same month = 100) (%). These control variables help to reduce the omitted variable problem. Considering the availability and measurability of data, this study selects monthly time series data from 2000 to 2020 as the research sample.

4.2. Descriptive Statistics

For this sample, the monthly time series data from 2010 to 2020 have been chosen as the research data. The following table provides a descriptive analysis of each variable, showing the mean and fluctuation of each variable within this time period.

Table 2: Descriptive Statistics

	FDI	NDF	ADOVINDU	CPI	M0	TRADE
Mean	5031484	7.149	111.078	102.246	4329623	2312.285
Median	4340147	6.926	110.649	101.916	4092048	2437.429
Maximum	14437000	8.668	123.253	108.712	9324916	4856.817
Minimum	183200	6.113	93.912	98.254	1399604	282.041
Standard deviation	3384290	0.752	4.763	1.981	2241496	1262.552
Skewness	0.621	0.487	-0.0145	0.704	0.228	-0.142
Kurtosis	2.485	1.835	2.538	3.737	1.701	1.637
Jarque-Bera	19.012	24.182	2.252	26.551	19.918	20.371
Probability	0.000	0.000	0.325	0.000	0.000	0.000

4.3. Model Construction

In the model of this study, the primary focus is on examining the impact of Renminbi Non-Deliverable Forwards (NDFs) on Foreign Direct Investment (FDI) amounts. Control variables are also employed to address issues of spurious regression and heteroskedasticity. The econometric model constructed is as follows:

4.4. Stationarity analysis

Table 3: ADF test analysis of different variables

Variable	Prob.*	First difference variable	Prob.*
FDI	0.878	D(FDI)	0.003
NDF	0.416	D(NDF)	0.000
M0	0.998	D(M)	0.032
TREADE	0.779	D(TRADE)	0.027
CPI	0.017	D(CPI)	0.000
ADOVINDU	0.678	D(ADOVINDU)	0.000

In this study, Eviews 11 is chosen to conduct a stationarity analysis of the variables in the article. Stationarity analysis is carried out to test for serial correlation in the variables, which helps to reduce the effects

of spurious regression and non-randomness in errors. The main empirical reference method is one of the test analysis methods, which is the ADF (Augmented Dickey-Fuller) test. The test results (in Table 3) can directly yield two types of statistical outcomes. If all series fail to reject the hypothesis of a unit root at the 5% significance level of variance, it indicates that the variables in the two series might be non-stationary and should be considered for reference testing using the first-difference method theory.

After the first difference, all the above variable series can reject the hypothesis of a unit root at a 1% probability level. This means that the actual amount of foreign direct investment utilized (in ten thousand USD) FDI, Renminbi Non-Deliverable Forwards NDF (monthly average), total import and export volume in the current month (in billion USD), Consumer Price Index CPI of the current month compared to the same month last year (previous year's same month = 100), money supply in circulation in the market (in million CNY): current month year-on-year comparison, and the year-on-year growth rate of industrial value-added above a designated size in the current month compared to the same month last year (previous year's same month = 100) (%) all belong to first-order integrated series.

4.5. Co-integration test

Table 4: Analysis of trace statistics test

Hypothesized No. of CE(s)	Eigenvalue	Trace	0.05 Critical Value	Prob.**
None *	0.347	189.442	95.754	0.000
At most 1 *	0.117	83.631	69.816	0.003
At most 2 *	0.092	52.411	47.855	0.016
At most 3 *	0.081	28.713	29.796	0.065
At most 4 *	0.025	7.334	15.495	0.545
At most 5 *	0.004	1.007	3.841	0.324

Cointegration can be understood as a long-term and robust equilibrium relationship that must exist between non-stationary time series variables of different periods. In other words, in economics, the relationship between two non-stationary variables can be constructed directly through a highly linear combination process to establish a stable variable series. Therefore, this paper adopts the 16-lag Johansen cointegration test method to study the cointegration relationship between FDI and each independent variable.

From the results of Table 4, it can be understood that there is no cointegration relationship set between FDI and the various variables, with the trace statistic value at 189.44 2, significantly exceeding the 5% critical value of 95.754, leading to the rejection of the null hypothesis. This indicates that the short-term deviations between FDI and the various variables will be corrected in the long term, suggesting the existence of a long-term equilibrium, cointegration, and convergence relationship.

4.6. Correlation Matrix

This correlation matrix includes 252 observations. From the Table 5, it can be seen that the Pearson correlation coefficient between NDF and FDI is -0.042, with a significance level of 0.0000, indicating a significant negative correlation between NDF and FDI. This is consistent with the conclusions drawn earlier in the text.

Table 5: Pearson correlation test

Variable	FDI	NDF	M0	TRADE	CPI	ANOVINDU
FDI	1.000					
NDF	-0.442***	1.000				
M0	0.465***	-0.658***	1.000			
TRADE	0.641***	-0.723***	0.936***	1.000		
CPI	0.211***	-0.418***	0.289***	0.351***	1.000	
ANOVINDU	-0.335***	0.261***	-0.672***	-0.573***	0.086	1.000

Note: *** p < 0.01, ** p < 0.05, * p < 0.1.

4.7. Granger causality

Table 6: Granger causality test analysis

Null Hypothesis :	Obs	F-Statistic	Prob.
D(NDF) does not Granger Cause D(FDI)	250	7.978	0.000
D(FDI) does not Granger Cause D(NDF)	250	2.395	0.089

Cointegration tests are primarily used to examine the long-term equilibrium causality relationship between two variables. On this basis, it is also necessary to further test the mutual influence between the two variables. This paper mainly uses the Granger causality test method for analytical testing. The Granger causality test (Table 6) requires that all variables be stationary. The paper conducts analytical testing using the Granger causality test method. The Granger test demands that all variables are stable.

Therefore, the selected NDI and FDI data are obtained after first-order differencing. Based on the data in this table, it can be concluded that: on one hand, since the Renminbi Non-Deliverable Forward (NDF) can reject the unit root hypothesis at the 1% level, it indicates that NDF can explain Foreign Direct Investment (FDI); on the other hand, since Foreign Direct Investment (FDI) can entirely reject the unit root hypothesis at the 1% level but cannot completely reject the unit root hypothesis at the 0.5% level, it suggests that Foreign Direct Investment (FDI) has no explanatory power over the Renminbi relative to the Non-Deliverable Forward (NDF).

4.8. Establishment of Bayesian VAR (2) Model

Firstly, it must be clarified that the prerequisite for the applicability of a VAR model is that the data must all be st ationary (otherwise, spurious regression may occur); if Gra nger causality occurs between vectors, there must be some

form of causality between these vectors (which is the causa lity in statistics), then it is necessary to conduct a Granger c ausality test. All the above data have already passed the stat ionarity test and the Granger causality test.

Table 7: Analysis of lag (p) selection of VAR model

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-10891.321	NA	2.50e+31	89.324	89.408	89.356
1	-9419.737	2858.748	1.94e+26	77.545	78.158	77.796
2	-9221.854	374.701	5.14e+25	76.232	77.345*	76.681*
3	-9163.612	107.402	4.29e+25	76.058	77.678	76.714
4	-9118.342	81.114	3.99e+25*	75.971*	78.121	76.856
5	-9096.321	38.598	4.49e+25	76.083	78.751	77.158
6	-9069.058	46.227	4.85e+25	76.155	79.337	77.435
7	-9030.527	63.495	4.79e+25	76.134	79.834	77.622

Since the maximum lag order p of explanatory variabl es in the VAR model is too small, it may lead to autocorrel ation among residuals and adversely affect the consistency of parameter estimation (in Table 7).

Therefore, in this model, p=8 is chosen to eliminate residuals to the greatest extent possible. Using the LR (Likelihood Ratio) test, here the lag period k=8 is chosen to maximize the LR value, which determines the F-value at 83.222; using the Final Prediction Error (FPE) criterion, since this criterion considers the error between predicted and actual values, the basic principle is to choose the lag period k=4 with the smallest error, which determines the p-value at 3.99e+25; using the Akaike Information Criterion (AIC), fundamentally defined as $AIC=2k-2\ln(L)$, where k is the number of parameters, and L is the likelihood function. This criterion is based on the assumption that the model's errors follow an independent normal distribution. Here, the lag period k=4 is chosen to minimize the AIC value, determining the F-value at 75.971; using the Schwarz Criterion (SC), according to this criterion, lagged variables are added to the model until the SC value no longer decreases, thus selecting the lag period k=2 that minimizes the SC value and determining the F-value at 77.346; finally, using the Hannan-Quinn Criterion (HQ): $HQ=-2\ln(L)+\ln(\ln(n))*k$, where L is the maximum likelihood under the model, n is the number of data points, and k is the number of variables in the model, the lag period k=2 is chosen to minimize the HQ value, with the p-value at 76.678.

Table 8: Bayesian VAR (2) model analysis

Variable	Coefficient	Std.	T statistic
D(FDI(-1))	0.392	0.057	[6.865]
D(FDI(-2))	-0.024	0.042	[-0.618]
D(NDF(-1))	-106153.912	1279213	[-0.081]
D(NDF(-2))	210711.232	1258011	[0.166]
D(ADOVINDU (-1))	-39832.423	47420.512	[-0.838]
D(ADOVINDU (-2))	-9203.316	37494.021	[-0.144]
D(CPI(-1))	-23938.826	161349	[-0.148]
D(CPI(-2))	-2525.958	148334	[-0.017]
D(M0(-1))	-0.726	0.31800	[-2.278]
D(M0(-2))	-0.373	0.25569	[1.458]
D(TRADE(-1))	1118.236	434.454	[2.578]
D(TRADE (-2))	386.575	318.617	[1.214]
C	8706901.123	1.1E+07	[0.816]
Adj. R^2	0.512		
F-statistic	22.754		

In summary, it is found that the selected p-values differ under various criteria. Considering that VAR vector autoregression requires a large sample size, and Bayesian VAR (BVAR) can provide a better fit when dealing with a large number of parameters and limited data, this paper adopts Bayesian vector autoregression to address the issue of having more parameters and relatively less data.

In this context, the paper chooses to establish a Bayesian VAR(2) model based on the minimum SC statistic (77.34619). The adjusted R-squared of this model is 0.535, indicating that the explanatory and control variables explain 53.5% of the variation in differenced FDI. According to the analysis of the model, it can be observed that both lagged 1-period and lagged 2-period NDF significantly influence FDI.

4.9. Impulse Response Plots

Based on the analysis of the impulse response plots, in the short term, the Renminbi Non-Deliverable Forward (NDF) exhibits a slight negative relationship with Foreign Direct Investment (FDI). This suggests that as the NDF value decreases, indicating a stronger appreciation of the Renminbi, the impact on FDI is positive, leading to an overall negative correlation between NDF and FDI in the short term. In other words, a one-standard deviation shock in NDF results in a negative impact on FDI. However, in the long term, the influence of NDF on FDI is not significant.

Among the variables, the influence of Total Imports and Exports on FDI is most pronounced in the short term, and they exhibit a positive relationship. Market Cash Flow, Consumer Price Index, and Above-Scale Industrial Added Value show similar effects to NDF in the short term, acting as deterrents to FDI growth. This implies that under loose monetary policies, due to relatively abundant domestic capital, there is a certain reduction in China's reliance on Foreign Direct Investment. Additionally, the improvement in consumer consumption levels and the expansion of above-scale industries suggest a gradual increase in the country's economic development, which further reduces the demand for foreign capital, manifesting as a depreciation of FDI.

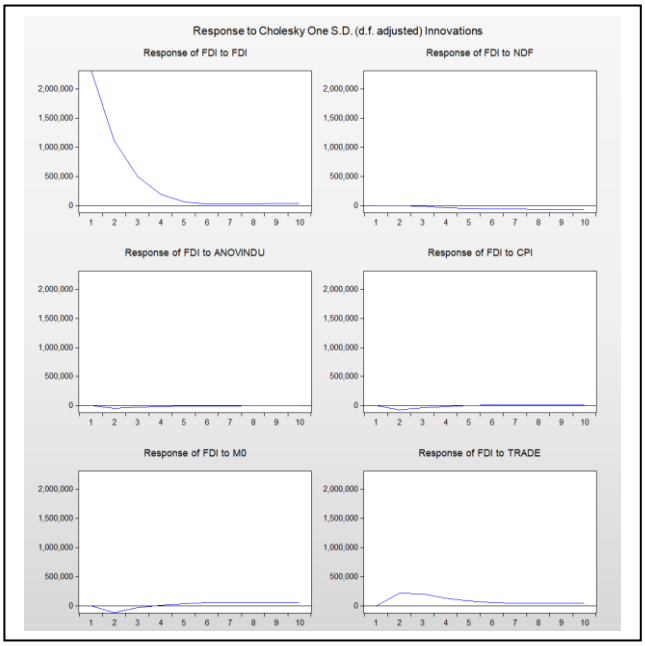

Figure 1: Pulse response analysis diagram

5. Conclusions

In this study, we conducted an empirical analysis of the relationship between Renminbi exchange rate expectations and the scale and structure of Foreign Direct Investment (FDI) in China from 2010 to 2020. The purpose was to examine the impact of Renminbi exchange rate expectations on FDI and assess whether it aligns with relevant economic theories. We also discussed the feasibility of establishing a China-EU Free Trade Zone in light of recent economic policies. The key findings are as follows:

(1) Regarding the formation of Renminbi exchange rate expectations, it was observed that due to the challenges of aligning rational expectations with real-market conditions, the accuracy of Renminbi exchange rate expectations is not guaranteed. Therefore, fundamental models of Renminbi exchange rate expectations may not necessarily outperform random walk models in predicting exchange rate movements. While econometric principles can forecast and quantify changes in exchange rate volatility, they often lack a strong theoretical foundation, making it challenging to explain medium to long-term Renminbi exchange rate fluctuations.

(2) In the analysis of the pathways through which Renminbi exchange rate expectations affect both the size and structure of FDI in China, several conclusions were drawn. From a cost perspective, when the expectation is that the Renminbi will appreciate, the production costs for foreign investors in China, such as labor costs, increase, reducing the rate of return on investment. Consequently, Renminbi appreciation tends to have a dampening effect on FDI in the short term. Conversely, from a profit and speculative standpoint, the potential for increased returns due to Renminbi appreciation and speculative profit opportunities tend to stimulate FDI in the short term. This indicates that profit and speculative motives dominate over cost considerations in the short run.

(3) In forecasting the future Renminbi exchange rate trends, we considered factors such as the significant difference in economic growth rates between China and the United States, the significant decline in the U.S. Dollar Index, China's current account surplus exceeding expectations, and China's increased openness to financial markets. Based on these factors, we predict a continued appreciation trend for the Renminbi in 2021.

(4)Regarding the current state of foreign investment in China, statistics indicate an imbalance in the source regions of foreign direct investment. Furthermore, there has been a gradual shift in the focus of foreign direct investment towards the tertiary industry. Therefore, it is suggested that potential foreign investors in China are primarily from developed countries. Additionally, there is potential for foreign investment to become a significant driving force for the domestic economy.

(5)Through empirical analysis of the relationship between Renminbi Non-Deliverable Forward (NDF) and Foreign Direct Investment (FDI), it was found that there may be a long-term cointegration relationship between the two. This implies that their relationship is stable in the long run, and NDF has a significant and negative impact on FDI. Therefore, it can be concluded that profit and speculative motives dominate over cost considerations, especially in the long term. However, it should be noted that NDF based on the Renminbi's exchange rate expectations does not significantly affect FDI in the context of long-term economic development.

In summary, this study sheds light on the complex relationship between Renminbi exchange rate expectations and Foreign Direct Investment in China. While cost considerations play a role in the short term, profit and speculative motives appear to be the dominant factors influencing FDI. Moreover, the impact of Renminbi exchange rate expectations on FDI is less significant in the long term. These findings provide valuable insights into the dynamics of foreign investment in China and its interaction with exchange rate expectations, contributing to a better understanding of China's economic landscape.

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