The Influence of Real Exchange Rate Changes of Yen on FDI Absorption in Japan

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Abstract. This paper empirically investigates the relationship between the real exchange rate of the JPY and FDI absorption in Japan from 1995 to 2020 using cointegration tests and Granger causality tests. On the one hand, when the exchange rate changes, there is a time lag in the investment decision of enterprises, on the other hand, foreign direct investment in enterprises in capital-importing countries often needs to be based on the expectation of future exchange rates. Therefore, this paper models the real effective exchange rate index of the yen with the different lag periods as well as the amount of direct foreign investment absorbed in Japan respectively. It is shown that at 95% significance level, the regression equation coefficients with a lag of 4,5,6 years between the two sides were statistically significant. There is neither a long-term stable cointegration relationship nor Granger causality relationship between the real effective exchange rate of the Japanese yen, or the fluctuation of the Japanese yen exchange rate complemented in the following studies, and the absorption of foreign direct investment in Japan. The results indicate that exchange rate behavior has no significant effect on attracting foreign investment in Japan's foreign exchange market. On this basis, the corresponding policy suggestions are put forward to maintain the stability of foreign exchange and capital markets.

Keywords: Cointegration test · Granger causality tests · Exchange rate · International Finance

1 Introduction

There are many factors that affect foreign direct investment (FDI). Considering the theory of relative labor cost, the exchange rate, as the current ratio between the two countries, may theoretically affect the scale and flow of FDI by affecting the relative price of international commodities. The depreciation of the currency of the capital-importing country generally increases the investment returns of foreign-invested enterprises, which in turn stimulates the growth of them, and vice versa.

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The existing research about the relationship between exchange rates and FDI can be broadly divided into two categories: the first one argued that the real exchange rate of each country has a significant impact on FDI in the same direction as the theoretical studies. Boyd et al. (2001) [1] found that the real exchange rate fluctuations in France, Germany, Japan, the United States, and the Netherlands, had a significant effect on foreign capital inflows from the 1970s to the 1990s by using an AR model. The second one argued that the empirical results do not guarantee the expected impact between exchange rates and FDI. Miles (1979) [2] found that the change of real effective exchange rate does not have an effective impact on foreign direct investment. Yu *et al.* (2007) [3] conducted an empirical study using a vector autoregressive error correction model and found that CNY appreciation between 1978 and 2006 does not lead to an expected decrease in FDI inflows, but surprisingly contributed to an increase in FDI.

According to the existing studies, Han (2014) [4], using a combination of comparative analysis and empirical analysis, proposed that the change of the real exchange rate of CNY against the USD has no distinct impact on US direct investment in China in the short term; while in the long run, the real exchange rate of CNY against the USD has a sustained effect on US direct investment inflow into China. Xiao (2013) [5], establishing a gravity model and introducing period dummy variables, analyzed the data from an empirical perspective and concluded that there is a negative correlation between the real effective exchange rate of CNY and the absorption of foreign direct investment in China, and the elasticity between the two varies in terms of different time periods. In a recent study, Huang (2022) [6] constructed the VAR model, which was confirmed again by empirical analysis. It can be seen that the depreciation of CNY has a facilitating effect on the absorption of FDI in China, while the appreciation of CNY will have an opposite effect; meanwhile, the impact of CNY exchange rate changes on FDI will be affected by different economic periods. Gan (2020) [7] further found that there are differences in the degree of impact of the real exchange rate on FDI due to regional differences.

This paper examines the impact of changes in the real exchange rate of the yen on the absorption of foreign direct investment in Japan. The data for this part of the empirical study are obtained from the Wind database, including annual data on the real effective exchange rate index of the yen (REER, 2010 = 100) and foreign direct investment in Japan (FDI, USD million) for 26 years, from 1995 to 2020, selected for Granger causality and cointegration analysis.

2 Materials and Methods

2.1 Theoretical Analysis

The exchange rate adopts Indirect Quotation, so in the part of analyzing the cointegration relationship between the exchange rate level and FDI, this paper mainly uses the real effective exchange rate index to portray. An increase in the real effective exchange rate index represents an appreciation of the country's currency, while a decrease in the real effective exchange rate index represents a depreciation of the country's currency.

The calculation of the real effective exchange rate index is based on the formula:

$$REER = \sum_{i=1}^{n} \alpha_i \times \left[\frac{(CPI \cdot R_i / CPI_i)_t}{(CPI \cdot R_i / CPI_i)_{t_0}} \times 100 \right] \quad (1)$$

In this formula, REER represents the real effective exchange rate index, CPI_i represents the consumer price index of the country's trading partner i, R_i represents the bilateral nominal exchange rate per unit of the country's currency to the currency of trading partner i, t_0 represents the base year of the country's real effective exchange rate index (the yen is based on 2010, $REER_{2010} = 100$), n represents the number of the country's trading partners, and α_i represents the share of trading partner i in the country's total foreign trade, satisfying $\sum_{i=1}^{n} \alpha_i = 1$. A real effective exchange rate index greater than 100 implies a consolidated appreciation of the yen relative to the base period of 2010, and less than 100 implies a consolidated depreciation of the yen.

2.2 Model Setting

The data selected for Granger causality and cointegration analysis includes annual data on the real effective exchange rate index of the yen (REER, 2010 = 100) and foreign direct investment in Japan (FDI, USD million) for 26 years, from 1995 to 2020.

Considering that on the one hand, there may be time lags in enterprises' investment decisions when exchange rates change; on the other hand, foreign investors' investments in enterprises in capital-importing countries are not completed within a year and often need to be based on expectations of future exchange rates, this paper models the real effective exchange rate index of yen with different lags and the amount of direct foreign investment in Japan respectively.

$$lnFDI_t = \beta_0 + \beta_1 lnREER_t + \varepsilon_t \tag{2}$$

In this formula, $lnFDI_t$ and $lnREER_t$ are the logarithmic series of REER, FDI, respectively, with the aim of eliminating possible heteroskedasticity. Based on the above structure, a regression model with eight different lags is established, and model j (j = 1,…,8) denotes that the real effective exchange rate of Japan in year t + j-1 is the independent variable and the real introduction of FDI into Japan in year t is the dependent variable.

3 Results and Discussion

3.1 Cointegration Test of Real Effective Exchange Rate and Foreign Direct Investment

Cointegration analysis requires homogeneous single integer. First, the logarithmic sequences of REER, FDI, that is $lnREER_t$, $lnFDI_t$, and their logarithmic first-order difference series $dlnREER_t$, $dlnFDI_t$ were subjected to the ADF unit root test, respectively, and the results of the stationarity of the series at the 5% significance level are shown in Table 1.

The values of the ADF test statistics after the first-order difference are less than the corresponding 5% critical value, indicating that the sequence is stationary and both variables are first-order single integer sequence I(1), which could avoid the "pseudo-regression" situation. Then, we try to establish its cointegration relationship by E-G two-step method.

Table 1. ADF Stationarity Test.

Variables	Test form (C,T,K)	ADF test statistic value	5% critical value	Subhead
lnF_t	(C,T,1)	−2.5722	−3.712	Unstable
dlnF_t	(N,N,1)	−4.3462	−1.964	Stable
lnR_t	(C,T,1)	−3.3961	−3.712	Unstable
dlnR_t	(N,N,1)	−3.881	−1.964	Stable

Note: The test form (C,T,K) denotes the constant term, time trend and lag order in the unit root test equation respectively

Estimates of the coefficients and significance of the 8 regression equation models in 1.2 using the OLS method are shown in Table 2. The overall goodness-of-fit results of the models are shown in Table 3.

At 95% significance level, the regression equation coefficients with a lag of 4,5,6 years between the two sides were statistically significant; The cointegration equation is univariate linear regression. The R-squared model with 6-year lag is the best model (R-squared = 0.1995), but only 19.95% of the variables can be explained by the

Table 2. Coefficient Estimation and Significance Test.

	Model1			Model5		
	Estimate	Pr(>|t|)		Estimate	Pr(>|t|)	
(Intercept)	11.9975	1.31E−09	***	15.935	2.03 E−10	***
lnREER	0.2046	4.66 E−01		−0.6563	4.04 E−02	*
	Model2			Model6		
	Estimate	Pr(>|t|)		Estimate	Pr(>|t|)	
(Intercept)	13.6687	6.35 E−10	***	16.277	2.41 E−10	***
lnREER	−0.16	5.95 E−01		−0.7301	2.43 E−02	*
	Model3			Model7		
	Estimate	Pr(>|t|)		Estimate	Pr(>|t|)	
(Intercept)	15.2668	1.31 E−10	***	15.7276	9.37 E−09	***
lnREER	−0.511	1.00 E−01		−0.6076	9.97 E−02	.
	Model4			Model8		
	Estimate	Pr(>|t|)		Estimate	Pr(>|t|)	
(Intercept)	15.9259	8.56 E−11	***	14.5185	5.92 E−07	***
lnREER	−0.656	3.72 E−02	*	−0.3402	4.28 E−01	

Note: ***, *, and - indicate significant at 99%, 95%, and 90% significance levels, respectively

Table 3. Goodness of Fit Test for Cointegration Equations.

	Model1	**Model2**	**Model3**	**Model4**
Residual standard error	0.2714	0.2753	0.265	0.2591
R-squared	−0.0184	−0.0305	0.0779	0.1523
	Model5	**Model6**	**Model7**	**Model8**
Residual standard error	0.2598	0.2506	0.2648	0.2888
R-squared	0.1533	0.1995	0.09583	−0.01926

Table 4. Granger Causality Test

Lag period	*H0*	*F-statistic*	*p-value*	*Conclusion*
1	dlnF_t -\> dlnR_t	1.1393	0.3027	Not rejected
1	dlnR_t -\> dlnF_t	0.0173	0.897	Not rejected
1	dlnF_t -\> dlnV_t	0.3486	0.5622	Not rejected
1	dlnV_t -\> dlnF_t	0.1145	0.739	Not rejected

model, which shows that there is no cointegration relationship between the real effective exchange rate of yen and foreign direct investment in Japan during the observation period.

3.2 Supplementary Problem of Cointegration Relationship

Theoretically, the real exchange rate level can measure the current value of currency and mainly affects the entry cost of foreign capital flowing into the domestic market; The real exchange rate level with lag period can reflect the exchange rate expectation as well as the future change trend of currency value, meanwhile it affects the future cost and return of foreign investment to some extent. Exchange rate fluctuation can be used to measure the change of currency value level in a certain period, and mainly affects the exchange rate risk that foreign capital may face.

Therefore, in this paper, the impact of exchange rate volatility (volatility) on the absorption of FDI is studied in addition to the above-mentioned level of real effective exchange rate in the current period and in the presence of lags, referring to Shinji Takagi (2011) [8] approach, taking the monthly standard deviation of yen exchange rate in the past year as the proxy variable of exchange rate fluctuation in that year, with data from Yahoo and Blomberg.

In the new definition of the cointegration relationship between exchange rate volatility and foreign direct investment, all variables are integration of order one. The obtained model R-squared is 0.0089 which is a poor fit and fails the model test, proving that there is also no cointegration relationship between yen exchange rate volatility and foreign direct investment in Japan.

3.3 Granger Causality Test of Exchange Rate and Foreign Direct Investment

Based on the above definition of the real effective exchange rate level and exchange rate volatility, this paper further examines whether there is Granger causality between them and foreign direct investment, in which a 6-year lag relationship is considered to exist between the real effective exchange rate level of the yen and foreign direct investment in Japan.

The Granger causality test requires the sequences to be stable, so the actual analysis object is the sequences after the first-order difference, that is, the real effective exchange rate return (dlnR_t), the exchange rate fluctuation change (dlnV_t) and the foreign direct investment change (dlnF_t). The results are shown in Tables 1, 2, 3 and 4. The original hypothesis is that there is no Granger causality in the corresponding direction, and the four directions among the two groups of variables can not reject the original hypothesis at 95% significance level, which shows that there is no Granger causality in statistics.

4 Result Analysis

The reason for the discrepancy between empirical results and theoretical research is that the devaluation of domestic currency will lead to the increase of resource-oriented FDI, but the decrease of market-oriented FDI on the It will also lead to the decrease of market-oriented FDI on the other hand The impact of exchange rate level on FDI depends on the type and motivation of investment, therefore, adopting cointegration analysis and Granger causality test using static linear method may be distorted in measuring the real effective exchange rate and the impact of exchange rate fluctuation on FDI.

In addition, the economic situation in Japan during that period showed that the Japanese economy had almost stagnated in the decade following the bubble crisis in 1990. During that period, Japan had an aging and childless population structure, and domestic consumption demand is unstable, while foreign demand is weak. Therefore, Japan's attraction to FDI has weakened. On the other hand, the world economic environment in the late twentieth and early twenty-first centuries was turbulent, with the Asian financial crisis of 1997, the US subprime mortgage crisis of 2008, the European financial crisis of 2011 and so on, all of which were characterized by extensive damage and widespread impact. At the same time, the re-emergence of trade protectionism and investment protectionist views, which led to a more cautious behavior of investors making international investments. This may also be one of the reasons that Japan's FDI absorption was lower than expected.

5 Conclusions

Measuring from two aspects of real effective exchange rate level and exchange rate fluctuation the co-integration relationship and Granger causality between exchange rate and foreign direct investment, it is found that there is a certain difference between theoretical research and the real foreign exchange market performance of JPY. The influence of exchange rate level and fluctuation on foreign direct investment in Japan is not significant, which shows that the depreciation of yen is not a reliable motive of

foreign direct investment in Japan. Therefore, compared with taking foreign exchange intervention measures to devalue the local currency, maintaining the relative stability of the yen exchange rate may be conducive to enhancing foreign investors' trust in the yen, and thus play a positive role in foreign exchange and capital markets.

On the issue of expanding FDI absorption, the Japanese government can consider formulating appropriate tax incentives, granting appropriate financing incentives and other related policies. Zou (2015) [9] showed that 2005 to 2014, total FDI from North America accounted for 36.7%, Europe for 40% and Asia for 22.9%. The signing of the Japan-ASEAN Free Trade Agreement allowed ASEAN and Japan each to play a better role in the protection of investors. Therefore, the Japanese side can shift the focus of FDI absorption to target Asian countries.

Finally, a country's absorption of FDI may be influenced by its own conditions and also the world economy. During the period 1995–2020, Japan suffered several financial shocks, as well as the population structure went to aging and the economic situation went to pessimistic. The Asian financial crisis, the US subprime mortgage crisis and the European financial crisis during this period also made the international financial environment very unstable and may lead to a reduction in investors' willingness. Therefore, we will later add factors such as macroeconomic situation and the effect of the world economy environment to build the model again to test the accuracy of the findings.

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