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Research Article

The Impact of China's Capital Account Liberalization on the Direction of Cross-border Capital Flows

Zhengyang Zhang[1*], **Xiaogang Zhang**[2]

[1]Department of Economics and Finance, City University of Hong Kong, Hong Kong, China

[2]School of Art and Design, Guangdong University of Technology, Guangzhou, Guangdong Province, China

[*]**Correspondence to: Zhengyang Zhang,** Department of Economics and Finance, City University of Hong Kong, No. 83 Dazhi Road, Kowloon Tong, 999077, Hong Kong, China; Email: 1978465286@qq.com

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Abstract

Objective: This article aims to investigate the impact of China's capital account openness (OPEN) on cross-border capital flows (CCF).

Methods: The research utilizes the ARDL-ECM model for empirical analysis. It begins by summarizing existing literature on the topic and then proceeds to analyze the data spanning from 1998 to 2023. The study explores the long-term cointegration relationship between OPEN and CCF. Additionally, it investigates the correlation between the direction of openness and its effect on CCF. Notably, the research introduces the concept of the volatility of OPEN as an explanatory variable to understand its impact on various types of capital flows.

Results: The findings reveal a significant long-term cointegration relationship between OPEN and CCF. This relationship is significantly influenced by the direction of openness. Moreover, the study identifies that the volatility of OPEN notably affects different categories of capital flows. Furthermore, it observes that structural changes in net foreign securities investment are comparatively higher than those in net foreign direct investment.

Conclusion: This study underscores several recommendations for the ongoing process of capital account liberalization in China. Firstly, adjust OPEN flexibly to promote or restrict specific types of capital flows. Adopt elastic capital control measures for different types of capital flows to balance the stability of domestic capital markets and the activity of international capital flows. Secondly, careful adjust capital outflow openness to maintain economic environmental stability and prevent capital flight. Lastly, encourage long-term investment, particularly in the real economy and infrastructure sectors, and provide incentives for investors committed to long-term investment.

Keywords: capital account liberalization, direct investment, security investment, capital flow

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1 INTRODUCTION

With the ongoing development of China's economy and its increasing integration into the global financial system, the trajectory of its capital account liberalization has become a focal point for policymakers and scholars alike. The manner in which China opens its capital account, the sequencing of reforms, and the resulting impact on international capital flows have sparked debates and drawn significant attention in recent years.

However, amidst this discourse, a clear understanding of the precise implications of China's capital account liberalization on cross-border capital flows (CCF) remains elusive. Scholars have yet to reach a consensus on how capital account openness (OPEN) influences the direction and dynamics of international capital movements, particularly in the context of China's unique economic and political landscape.Some scholars believe that opening up capital accounts can promote economic growth, attract foreign direct investment (FDI) and capital inflows, and promote the development of financial markets. Other scholars are concerned that opening up capital accounts may lead to large-scale capital outflows, exacerbating financial market volatility, and thus damaging economic stability. Therefore, the related research topics are gradually shifting from promoting the economic benefits of capital account opening to financial fluctuations caused by capital account opening and many scholars are focusing on the maturity and prerequisite conditions of capital account opening[1].

This study seeks to address this gap by investigating the nuanced relationship between China's capital account liberalization and the direction of CCF. Specifically, our study endeavors to shed light on the intricate interplay between China's OPEN and CCF. By synthesizing theoretical insights and empirical evidence, we aim to contribute to a deeper understanding of the transmission mechanisms at play and provide valuable insights for policymakers grappling with the challenges and opportunities presented by capital account liberalization.

In order to achieve this goal, we first reviewed the existing literature, placing the debate surrounding China's capital account liberalization and its impact on CCF within the context of current research. While there have been some studies on the impact of China's capital account liberalization on CCF, few have considered the volatility of OPEN as a factor. This paper conducts empirical research to analyze the effects of different levels of OPEN and their volatility on various types of CCF. Based on the empirical findings, several policy recommendations are proposed to address the complexity of China's capital account liberalization process.

2 LITERATURE REVIEW

Existing literature on capital account liberalization and CCF has provided valuable insights, but there are still areas worthy of further exploration. Below are the main directions and existing research findings regarding capital account liberalization and CCF: According to neoclassical economic theory, cross-border capital should flow from developed countries with lower marginal returns to developing countries with higher marginal returns. However, in reality, the net inflow of capital into emerging economies falls far short of the levels predicted by neoclassical theory (known as the "Lucas paradox")[2]. Research results indicate that the impact of capital account liberalization on CCF is complex and diverse. Different types of capital flows may be affected to varying degrees and directions by capital account liberalization, influenced by multiple factors. Studies on both domestic and foreign capital markets have confirmed this point. For instance, Zhou et al.[3], Yao and Wang[4] have shown that the degree of China's capital account liberalization affects different types of CCF differently. Similarly, based on cross-national data, Zhang[5] found that relatively poor countries implementing capital liberalization face net inflows of FDI and portfolio investment. Empirical analysis by Prasad and Rajan[6] also demonstrated the differentiated impact of capital account liberalization on CCF. Capital account liberalization led to net inflows of securities investment and other investments in Denmark, Colombia, and Chile, while Sweden, Spain, and Finland experienced net capital outflows. Furthermore, some studies suggest that capital account liberalization may trigger bi-directional changes in capital flows, rather than a single trend. For example, Sedik and Sun[7] predict, based on historical experience, that future capital account liberalization in China will result in increased inflows and outflows of cross-border capital, with outflows exceeding inflows.

Given the complexity of the impact of capital account liberalization on CCF, many studies come to focus on exploring the reasons for the characteristics of CCF and investigating the mechanisms and conditions through which financial policies based on capital account liberalization affect them. Dai and Yu[8] found that capital account liberalization does not have a clear directional effect but influences the scale of capital flows by changing the degree of influence of relevant factors. Many studies also indicate that the degree of capital account liberalization may affect CCF by influencing certain macroeconomic factors, with the most significant being economic and political factors.

Economically, Aoki et al.[9] deduced through modeling analysis that the marginal productivity of capital and the level of interest rates in the market have a decisive impact on the direction of capital flows. Furthermore, many studies have pointed out that the impact of capital account liberalization on CCF largely depends on the level of financial deepening. Only when the level of domestic financial development is relatively high can FDI and net portfolio investment be attracted[10-12]. Hu and Dai[13] examined the time-varying linkage between capital account liberalization, short-term international capital flows, and exchange rates (EXR), finding that the response patterns of short-term international capital flows and EXR shocks to capital account liberalization follow short-term dynamic balancing rules, and the interactive transmission channels among the three gradually become smoother with the increase in the degree of openness.

Politically, Zhou[14] found that the improvement of a country's domestic institutional framework helps attract inflows of cross-border capital, while the appreciation of a country's currency significantly alleviates capital outflows. Guru and Yadav[15] studied the impact of capital controls on the total volume and composition of capital flows for different asset categories, finding that the effectiveness of capital controls is mainly due to the effectiveness of equity flow controls. Direct capital controls on inflows and outflows significantly reduce the inflow of debt and equity+FDI and the outflow of equity+FDI and derivatives. Da Silva and Pedro[16] interpreted capital flow policies from the perspective of political systems, proposing that right-leaning authoritarian regimes follow centralization while attempting to maintain control over the domestic private sector while integrating into the global market. Extreme closed or open capital account regimes depend on homogeneous conditions such as left-leaning authoritarian regimes and democratic regimes.

Research indicates that the impact of capital account liberalization on CCF is complex and diverse. A series of economic and political factors influencing CCF have been identified, including marginal productivity, market interest rates, financial development level (FIN), and political system. In conclusion, significant progress has been made in exploring the impact of capital account liberalization on CCF. However, further research is needed to reveal the complex interactions among capital account policies, macroeconomic factors, and market dynamics, providing a more detailed understanding of the transmission channels currently at play. Additionally, although many studies have focused on the impact of the degree of capital account liberalization, little research has explored the relationship between its volatility and CCF. Therefore, further research and exploration are needed for a more comprehensive understanding of the impact of capital account liberalization on CCF.

3 EMPIRICAL ANALYSIS OF THE IMPACT OF CHINA'S CAPITAL ACCOUNT LIBERALIZATION ON THE DIRECTION OF CCF

3.1 Variable Description

3.1.1 Dependent Variable

CCF refers to the movement of capital between different countries and regions for purposes such as hedging and speculation, closely linked to a country's OPEN. Generally, greater openness in the capital account correlates with more frequent and substantial international capital flows. In line with standard academic practice, this study employs the total scale method to standardize CCF. This involves dividing the actual value of CCF by the current year's GDP. The standardized scale encompasses various components including FDI, outward direct investment (ODI), inward securities investment (ISI), and outward securities investment (OSI). Following the approach of Zhou[3] and Ma[11], CCF are categorized into three types: direct investment flows, securities investment flows, and total capital flows, denoted as net foreign direct investment (NFDI), net foreign security investment (NFSI), and net cross-border capital flow (NCCF), respectively. The direction of CCF is indicated by net inflows, with positive values denoting net inflows and negative values denoting net outflows. The calculation formulas are as follows:

$$\mathrm{NFDI}_t = \mathrm{FDI}_t - \mathrm{ODI}_t \ (1)$$

$$\mathrm{NFSI}_t = \mathrm{ISI}_t\text{-}\mathrm{OSI}_t \ (2)$$

$$\mathrm{NCCF}_t = \mathrm{NFDI}_t + \mathrm{NFSI}_t \ (3)$$

3.1.2 Explanatory Variables

Accurate quantification and measurement of China's OPEN constitute the foundation and essential prerequisite for the analysis and decision-making in this study. Currently, the academic community employs two main methods to measure the degree of OPEN. The first method is the nominal openness measurement, also known as the de-jure measurement method. It relies primarily on sources such as the IMF's annual "Annual Report on Exchange Arrangements and Restrictions" or publications like the State Administration of Foreign Exchange's "Annual Report". This method quantifies the extent of policy and regulatory restrictions imposed by a country on various capital projects, thereby assessing the openness of the capital account. The second method is the actual openness measurement, also known as the de-facto measurement method. This approach calculates OPEN based on economic indicators related to capital account opening, such as the scale of capital flows, savings rate, and investment rate. Methods under this approach include the savings rate and investment rate correlation method, the interest rate parity method, and the aggregate method. It is worth noting that these two methods offer different perspectives on describing a country's OPEN, with each having its own advantages and disadvantages, and they are generally complementary[17].

Given the flexibility and accuracy of the fact-based measurement method compared to the regulatory-based approach, this study adopts the actual openness measurement method for quantification. Drawing on Kraay's (1998) aggregate method, this research constructs indicators to measure OPEN using the proportion of international capital inflows, outflows, and total flows to GDP. The calculation formulas are as follows[18]:

$$\mathrm{OPEN}_t = \frac{\mathrm{CI}_t + \mathrm{CO}_t}{\mathrm{GDP}_t} \times e_t \times 100\% \ (4)$$

$$\mathrm{OPENI}_t = \frac{\mathrm{CI}_t}{\mathrm{GDP}_t} \times e_t \times 100\% \ (5)$$

$$\mathrm{OPENO}_t = \frac{\mathrm{CO}_t}{\mathrm{GDP}_t} \times e_t \times 100\% \ (6)$$

CI represents international capital inflow and is expressed by the credit balance of China's non-reserve financial accounts in Section 2.2.1 of the balance of payments. CO represents international capital outflow and is expressed by the debit balance of non-reserve financial accounts in China's balance of payments. GDP refers to Gross Domestic Product (GDP), and E represents the closing EXR between the US dollar and the Chinese yuan.

3.1.3 Control Variables

To investigate the impact of OPEN on CCF, this study utilized EViews10 to test the stationarity and cointegration relationship of time series, using quarterly data from 1998 to 2023. Building upon previous research, a series of control variables were selected. Specific instructions for each control variable are provided as follows:

3.1.3.1 Gross Domestic Product Growth Rate (GDPG)

The economic growth rate of a country reflects the trend and vitality of its economic development. Typically, a higher economic growth rate indicates higher returns on investment and leads to more capital inflows. Therefore, the domestic economic growth rate is a significant factor affecting international capital flows. The calculation method is as follows:

$$\mathrm{GDPG}_t = \frac{\mathrm{GDP}_t - \mathrm{GDP}_{t-1}}{\mathrm{GDP}_{t\text{-}1}} \quad (7)$$

3.1.3.2 Inflation (INF)

The INF rate affects the opportunity cost and actual return of investors, thereby influencing their investment decisions. Hence, the INF rate plays a crucial role in shaping the global investment environment and international capital flows. This article adopts the commonly used method of measuring INF in various countries, utilizing the CPI as an indicator to assess the level of INF.

3.1.3.3 FIN

Besides the openness of capital accounts, the degree of financial deepening is also a significant factor influencing CCF. A high level of domestic financial development tends to attract FDI and securities investment, ultimately facilitating cross-border net capital inflows. Therefore, to comprehensively analyze the factors affecting CCF, this article includes the level of financial development as a control variable in the model. Referring to the FIN calculation method proposed by Yang and Chen (2015), the calculation formula is as follows:

$$\mathrm{FIN}_t = \frac{M_{2_t} + \mathrm{Market\ Cap}_t}{\mathrm{GDP}_t} \quad (8)$$

In the formula, FIN represents financial development indicators, and Market Cap represents the stock market value.

3.1.3.4 Actual EXR

A country's EXR level and policy can influence the purchasing power of its currency, leading to changes in speculative and preventive motives among individuals, thereby affecting CCF. This article analyzes the quarterly average EXR between the US dollar and the Chinese yuan.

3.1.3.5 Interest Rate Difference (IRD) between Domestic and International

According to the interest rate transmission mechanism's impact on CCF, it is evident that the IRD between domestic and foreign countries significantly influences these flows. Drawing inspiration from the measurement methods of Yao and Wang[4], this article uses the Federal Reserve benchmark interest rate as the proxy variable for international interest rates and the domestic one-year fixed deposit interest rate as the proxy variable for domestic interest rates. The calculation formula for the IRD is as follows:

$$\mathrm{IRD}_t = R_t\text{-}\mathrm{I}_t \quad (9)$$

In this formula, R represents the domestic interest rate and I represents the international interest rate.

3.2 Data Source

The quarterly data on FDI, ODI, ISI, and OSI are sourced from the sixth edition of the Balance of Payments and International Investment Position Manual (BPM6) compiled by the State Administration of Foreign Exchange. GDP, stock market value, and broad money supply (M2) data are obtained from the National Bureau of Statistics. GDP data is quarterly, while stock market value and M2 data are annual and interpolated to quarterly frequency. CPI, average EXR of US dollar to Chinese yuan, Federal Reserve benchmark interest rate, and domestic one-year fixed deposit interest rate are sourced from the WIND database on a monthly basis. The CPI data is quarterly and obtained using the arithmetic mean method, while the average EXR of US dollar to Chinese yuan, Federal Reserve benchmark interest rate, and domestic one-year fixed deposit interest rate are taken as quarterly end values.

3.3 Measurement of OPEN Volatility

Before estimating the long-term cointegration relationship between CCF and OPEN, a test for heteroskedasticity needs to be conducted on the sequence of OPEN to determine whether irregular fluctuations exist.

The ARCH-LM test is employed to examine the heteroskedasticity of the three types of CCF data (OPEN, OPENI, OPENO). The corresponding p-values for the test statistics are 0.04303, 0.00017, and 0.01038, respectively. Hence, at the 5% significance level, the null hypothesis of no ARCH effect is rejected, indicating that all sequences exhibit heteroskedasticity. To calculate the volatility of OPEN, this study utilizes a GARCH (1,1) model in subsequent analyses. The volatility term can be estimated as:

$$a_t = \sigma_t \varepsilon_t \quad (10)$$

$$\sigma_t^2 = \alpha_0 + \alpha a_{t-1}^2 + \beta \sigma_{t\text{-}1}^2 \quad (11)$$

Where ε_t are independent identically distributed with mean zero and variance one, $\alpha_0>0$, $\alpha\geq0$, $\beta\geq0$ and $\alpha+\beta<1$.

Table 1. Descriptive Statistical Results

	EXR	FIN	GDPG	INF	IRD	NCCF	NFDI	NFSI	OPEN	OPENI	OPENO
Mean	7.21	8.78	0.03	0.16	-0.04	0.05	0.04	0.01	0.01	0.04	-0.03
Median	6.89	8.76	0.08	0.23	0.22	0.05	0.04	0.01	0.01	0.04	-0.03
Maximum	8.28	13.08	0.21	1.03	2.75	0.16	0.08	0.08	0.09	0.12	0.04
Minimum	6.12	4.95	-0.26	-1.37	-4.00	0.00	0.01	-0.03	-0.05	-0.03	-0.13
Std. Dev.	0.81	1.88	0.12	0.41	1.95	0.02	0.01	0.02	0.03	0.03	0.03
Obs	102	102	102	102	102	102	102	102	102	102	102

Table 2. Spearman Correlation Analysis

	EXR	FIN	GDPG	INF	IRD	NCCF	NFDI	NFSI	OPEN	OPENI	OPENO
EXR	1.00										
FIN	-0.66	1.00									
GDPG	0.10	-0.30	1.00								
INF	0.01	0.04	-0.46	1.00							
IRD	-0.66	0.23	-0.05	-0.05	1.00						
NCCF	0.04	-0.21	0.22	0.06	-0.07	1.00					
NFDI	0.05	-0.40	0.18	0.08	0.15	0.61	1.00				
NFSI	-0.01	0.06	0.15	-0.04	-0.31	0.63	-0.14	1.00			
OPEN	0.19	-0.27	0.03	0.08	0.00	0.15	0.29	-0.08	1.00		
OPENI	0.11	-0.25	0.21	0.20	0.00	0.43	0.47	0.07	0.60	1.00	
OPENO	0.10	-0.02	-0.20	-0.04	-0.07	-0.23	-0.10	-0.17	0.50	-0.31	1.00

The volatilities calculated by GARCH(1,1) models are denoted as Vol, Vol(i), Vol(o) for OPEN, OPENI, OPENO respectively.

3.4 Descriptive Statistics and Correlation Analysis

Descriptive statistics are carried out on the variables involved in this study to calculate the mean value, median value, maximum value, minimum value and standard deviation. The results are shown in Table 1. Correlation analysis of variables is carried out and Spearman correlation coefficient among variables is calculated. The results are displayed in Table 2 (Both don't include volatility).

According to the correlation analysis, the correlation coefficients between NCCF and OPEN, OPENI, and OPENO are 0.15, 0.43, and -0.23, respectively. This indicates that net cross-border capital inflows are positively correlated with the openness of the capital account and inflow openness, while negatively correlated with outflow openness. The correlation coefficients between NFDI and OPEN, OPENI, and OPENO are 0.29, 0.47, and -0.10, respectively, indicating that NFDI inflows are positively correlated with the degree of OPEN and inflow openness, while negatively correlated with outflow openness. The correlation coefficients between NFSI and OPEN, OPENI, and OPENO are -0.08, 0.07, and -0.17, respectively, indicating that net securities investment inflows are negatively correlated with the degree of net OPEN and outflow openness, while positively correlated with inflow openness.

3.5 Unit Root Test

As this study employs time series data, it is necessary to conduct unit root tests on the variables to determine their orders. The Augmented Dickey-Fuller (ADF) test is employed in this study to conduct unit root tests on each variable, and the results are presented in Table 3.

From the above table, it can be seen that NCCF, NFSI, Vol(i), Vol(o), FIN, INF and IRD are stable at a significance level of 5%. NFDI, OPEN, OPENI, OPENO are stable at a significance level of 1%. The original sequences of Vol, EXR and GDPG are unstable, while the first-order difference sequences are all stable at a significance level of 1%. Hence, NCCF, NFDI, NFSI, OPEN, OPENI, OPENO, Vol(i), Vol(o), FIN, INF and IRD are 0-order single integer sequences, while Vol, EXR and GDPG are 1-order single integer sequences. To analyze the long-term correlation between various variables, further cointegration tests should be conducted.

3.6 Cointegration Test

3.6.1 Autoregressive Distributed Lag (ARDL) Boundary Cointegration Test and Estimation of Long-Term and Short-Term Coefficients

The cointegration relationship can be explained as a long-term stable equilibrium relationship between variables, and

Table 3. Unit Root Test Results

Variable	Test Form(C,T,K)	ADF Statistic	Critical Value at 5% Significance Level	P Statistic	Test Result
NCCF	(C,T,12)	-3.9007	-3.4554	0.0155	stable**
NFDI	(C,T,12)	-6.3299	-3.4549	0.0000	stable***
NFSI	(C,T,12)	-3.8006	-3.4554	0.0205	stable**
OPEN	(C,T,12)	-6.2517	-3.4549	0.0000	stable***
OPENI	(C,T,12)	-5.7093	-3.4549	0.0000	stable***
OPENO	(C,T,12)	-8.2920	-3.4549	0.0000	stable***
Vol	(C,0,0)	-1.4691	-1.9440	0.1319	unstable
Vol(i)	(C,T,12)	-3.7925	-3.4549	0.0209	stable**
Vol(o)	(C,T,12)	-4.007	-3.4568	0.0115	stable**
EXR	(C,0,0)	-1.0992	-1.9441	0.2449	unstable
FIN	(C,T,12)	-4.0011	-3.4589	0.0119	stable**
GDPG	(C,0,12)	-2.6155	-2.8912	0.0933	unstable
INF	(C,0,0)	-1.9777	-1.9441	0.0464	stable**
IRD	(C,0,12)	-3.2650	-2.8909	0.0190	stable**
DVol	(C,T,12)	-9.3567	-3.4558	0.0000	stable***
DEXR	(C,T,12)	-6.9260	-3.4554	0.0000	stable***
DGDPG	(C,T,12)	-81.0740	-3.4563	0.0001	stable***

Notes: ① D represents the first-order difference of the variable. ② The C in the test type represents the test equation with a constant term, and when the test equation does not contain a constant term, this term is 0; The second item is the time trend item, where T represents the time trend item, otherwise it is 0; The third term represents the maximum length of autoregressive lag. ③ ** (***) indicates rejection of the original hypothesis at a significance level of 5% (1%), the same below.

the testing of cointegration relationship is very important in establishing econometric models. Cointegration tests can generally be divided into tests for regression coefficients and tests for regression residuals. As the variables involved in this study are not of the same order and are all I (0) or I (1), the ARDL boundary cointegration test method is used for testing. To realize the test of cointegration relationships, an ARDL boundary cointegration testing model and error correction model (ECM)can be constructed as follows:

$$\Delta NCCF_t(\frac{\Delta NFDI_t}{\Delta NFSI_t})$$
$$\alpha_1 + \sum_{i=1}^{\rho_1} \beta_{1i}\,\Delta CCF_{t-i}(\frac{\Delta NFDI_{t\text{-}i}}{NFSI_{t\text{-}i}})$$
$$+ \sum_{i=1}^{\rho 2} \beta_{2i}\, \Delta\mathrm{OPEN}_{t\text{-}i}(\Delta\mathrm{OPENI}_{t\text{-}i}/\Delta\mathrm{OPENO}_{t\text{-}i})$$
$$+ \sum_{i=1}^{\rho_3} \beta_{3i}\Delta EXR_{t-i}$$
$$+ \sum_{i=1}^{\rho_4} \beta_{4i}\Delta FIN_{t-i} + \sum_{i=1}^{\rho_5} \beta_{5i}\Delta GDPG_{t-i} + \sum_{i=1}^{\rho_6} \beta_{6i}\Delta IRD_{t-i}$$
$$+ \sum_{i=1}^{\rho_7} \beta_{7i}\Delta INF_{t-i} + \sum_{i=1}^{\rho_8} \beta_{8i}\Delta Vol_{t-i}\ (\Delta Vol(i)_{t-i}/\Delta Vol(o)_{t-i})$$
$$+ \mu_1 NCCF_{t-i}(NFDI_{t-i}/NFSI_{t-i})$$
$$+ \mu_2 OPEN_{t-i}(OPENI_{t-i}/OPENO_{t-i}) + \mu_3\mathrm{EXR}_{t-i} + \mu_4\mathrm{FIN}_{t-i}$$
$$+ \mu_5\mathrm{GDPG}_{t\text{-}i} + \mu_6\mathrm{IRD}_{t\text{-}i} + \mu_7\mathrm{Inflation}_{t-i}$$
$$+ \mu_8\mathrm{Vol}_{t-i}(\mathrm{Vol}(\frac{i)_{t-i}}{\mathrm{Vol}(o)_{t-i})} + \varepsilon_{1t}\ (12)$$

$$\Delta NCCF_t(\frac{\Delta NFDI_t}{\Delta NFSI_t})$$
$$\alpha_1 + \sum_{i=1}^{\rho_1} \beta_{1i}\,\Delta CCF_{t-i}(\frac{\Delta NFDI_{t\text{-}i}}{NFSI_{t\text{-}i}})$$
$$+ \sum_{i=1}^{\rho 2} \beta_{2i}\, \Delta\mathrm{OPEN}_{t\text{-}i}\ (\Delta\mathrm{OPENI}_{t\text{-}i}/\Delta\mathrm{OPENO}_{t\text{-}i})$$
$$+ \sum_{i=1}^{\rho_3} \beta_{3i}\Delta EXR_{t-i}$$
$$+ \sum_{i=1}^{\rho_4} \beta_{4i}\Delta FIN_{t-i} + \sum_{i=1}^{\rho_5} \beta_{5i}\Delta GDPG_{t-i} + \sum_{i=1}^{\rho_6} \beta_{6i}\Delta IRD_{t-i}$$
$$+ \sum_{i=1}^{\rho_7} \beta_{7i}\Delta INF_{t-i} + \sum_{i=1}^{\rho_8} \beta_{8i}\Delta Vol_{t-i}\ (\Delta Vol(i)_{t-i}/\Delta Vol(o)_{t-i})$$
$$+\mu ECM_{t\text{-}1} + \varepsilon_{2t}\ (13)$$

Among them, Equation (12) is the ARDL boundary cointegration test model, and Equation (13) is the ECM; Δ represent the first-order difference of variables, ε_{1t}, ε_{2t} denoted as a random perturbation term and α_1 denoted as a drift term; ρ_i(i=1,2,3,4,5,6,7,8) is the optimal lag order determined by the AIC criterion; μ_i(i=1,2,3,4,5,6,7,8) represents the long-term correlation coefficient of the model, β_{ki}(k=1,2,3,4,5,6,7,8) represents the short-term correlation coefficient of the model, and $\mathrm{ECM}_{t\text{-}1}$ represents the lag error correction term.

The results of the cointegration tests are shown in Table 4:

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Table 4. Cointegration Test Results

Model Form	Optimal Hysteresis Period	F Statistic
I:FM(NCCF,EXR,FIN,GDPG,INF,IRD,OPEN,Vol)	(2,1,0,2,0,0,0,0)	5.0034
II:FM(NCCF,EXR,FIN,GDPG,INF,IRD,OPENI,Vol(i))	(1,0,0,2,0,0,0,1)	8.3398
III:FM(NCCF,EXR,FIN,GDPG,INF,IRD,OPENO,Vol(o))	(2,1,0,2,0,0,0,2)	8.8324
IV:FM(NFDI,EXR,FIN,GDPG,INF,IRD,OPEN,Vol)	(2,2,1,2,4,3,2,2)	5.8765
V:FM(NFDI,EXR,FIN,GDPG,INF,IRD,OPENI,Vol(i))	(2,0,3,2,4,2,0,3)	5.7964
VI:FM(NFDI,EXR,FIN,GDPG,INF,IRD,OPENO,Vol(o))	(2,1,3,2,2,0,0,4)	5.6118
VII:FM(NFSI,EXR,FIN,GDPG,INF,IRD,OPEN,Vol)	(3,1,0,0,2,0,0,0)	3.9230
VIII:FM(NFSI,EXR,FIN,GDPG,INF,IRD,OPENI,Vol(i))	(3,0,0,0,0,0,0,0)	4.2190
IX:FM(NFSI,EXR,FIN,GDPG,INF,IRD,OPENO,Vol(o))	(3,1,4,4,0,4,0,0)	6.8813

The critical value of F-Bounds Test			
α=0.05		α=0.01	
I(0)	I(1)	I(0)	I(1)
2.17	3.21	2.73	3.9

Table 5. Long-Term Coefficients Estimated by the ARDL Model

	Long-term Coefficient (*p*-value)								
	Model I	**Model II**	**Model III**	**Model IV**	**Model V**	**Model VI**	**Model VII**	**ModelVIII**	**Model IX**
EXR	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	-0.01	0.00
	(0.46)	(0.21)	(0.76)	(0.26)	(0.55)	(0.52)	(0.62)	(0.11)	(0.74)
FIN	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	(0.18)	(0.39)	(0.20)	(0.35)	(0.35)	(0.01)	(0.57)	(0.25)	(0.47)
GDPG	0.25	0.31	0.28	0.28	0.47	0.38	0.00	0.03	-0.61
	(0.06)	(0.01)	(0.06)	(0.00)	(0.01)	(0.00)	(0.97)	(0.28)	(0.10)
INF	0.01	0.00	0.00	-0.02	0.00	0.01	0.00	0.01	0.02
	(0.40)	(0.94)	(0.77)	(0.17)	(0.90)	(0.16)	(0.95)	(0.19)	(0.14)
IRD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	(0.12)	(0.05)	(0.24)	(0.38)	(0.67)	(0.50)	(0.05)	(0.01)	(0.02)
OPEN	-0.21	-	-	-0.05	-	-	-0.23	-	-
	(0.16)			(0.51)			(0.05)		
OPENI	-	0.56	-	-	0.24	-	-	0.19	-
		(0.00)			(0.03)			(0.05)	
OPENO	-	-	-0.66	-	-	-0.14	-	-	-0.46
			(0.00)			(0.04)			(0.00)
Vol	3.36	-	-	6.66	-	-	2.51	-	-
	(0.39)			(0.00)			(0.45)		
Vol(i)	-	-2.89	-	-	-0.38	-	-	-2.25	-
		(0.13)			(0.84)			(0.07)	
Vol(o)	-	-	-16.10	-	-	0.26	-	-	-2.33
			(0.08)			(0.93)			(0.42)

The F statistics of all models are higher than the critical value at 1% significance level. Further establish the ARDL model and estimate the long-term coefficients. The results are shown in Table 5.

After confirming the long-run integration relationship, set the residual sequence as ECM and estimate the error correction equation. The short-term impacts between variables are estimated and the results are shown in Table 6

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Table 6. Coefficients and p-Values Estimated by the ECM

	ECM Coefficient (p-value)								
	Model I	Model II	Model III	Model IV	Model V	Model VI	Model VII	Model VIII	Model IX
DNCCF	0.46	0.33	0.63	-	-	-	-	-	-
(-1)	(0.04)	(0.05)	(0.01)						
DNFDI	-	-	-	0.43	0.45	0.30	-	-	-
(-1)				(0.03)	(0.05)	(0.20)			
DNFSI	-	-	-	-	-	-	0.29	0.34	0.38
(-1)							(0.13)	(0.08)	(0.04)
DEXR	-0.02	-0.02	-0.03	-0.01	0.00	-0.01	-0.02	-0.02	-0.01
	(0.22)	(0.28)	(0.04)	(0.11)	(0.70)	(0.10)	(0.11)	(0.22)	(0.20)
DEXR	-	-	0.03	-0.01	-	0.01	-	-	-
(-1)			(0.05)	(0.38)		(0.18)			
DFIN	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01
	(0.50)	(0.60)	(0.50)	(0.96)	(0.24)	(0.61)	(0.52)	(0.28)	(0.19)
DFIN	-	0.00	0.02	0.00	0.01	0.00	-	-	0.01
(-1)		(0.50)	(0.01)	(0.57)	(0.00)	(0.31)			(0.04)
DGDPG	0.19	0.01	0.03	-0.02	-0.06	0.04	0.01	0.01	0.01
	(0.02)	(0.91)	(0.68)	(0.68)	(0.20)	(0.44)	(0.64)	(0.66)	(0.91)
DGDPG	0.19	0.02	0.10	-0.08	0.07	0.08	-	-	-0.03
(-1)	(0.01)	(0.82)	(0.40)	(0.25)	(0.32)	(0.12)			(0.74)
DINF	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.01
	(0.38)	(0.37)	(0.33)	(0.90)	(0.95)	(0.48)	(0.03)	(0.21)	(0.09)
DINF	-	-	0.00	0.00	0.00	0.00	0.01	-	0.00
(-1)			(0.48)	(0.77)	(0.89)	(0.40)	(0.02)		(0.53)
DIRD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	(0.90)	(0.20)	(0.48)	(0.90)	(0.99)	(0.74)	(0.17)	(0.23)	(0.79)
DIRD	-	-	-0.01	-0.01	0.01	0.00	-	-	-0.01
(-1)			(0.00)	(0.00)	(0.00)	(0.09)			(0.00)
DOPEN	-0.07	-	-	0.06	-	-	-0.15	-	-
	(0.26)			(0.08)			(0.00)		
DOPEN	-	-	-	-0.13	-	-	-	-	-
(-1)				(0.01)					
DOPENI	-	0.31	-	-	0.17	-	-	0.11	-
		(0.00)			(0.00)			(0.04)	
DOPENI	-	-	-	-	0.00	-	-	-	-
(-1)					(0.95)				
DOPENO	-	-	-0.28	-	-	-0.05	-	-	-0.22
			(0.00)			(0.16)			(0.00)
DOPENO(-1)	-	-	-0.07	-	-	-0.01	-	-	-0.09
			(0.59)			(0.93)			(0.34)
DVol	-0.40	-	-	6.94	-	-	-1.50	-	-
	(0.92)			(0.00)			(0.62)		
DVol	-5.17	-	-	-9.87	-	-	-	-	-
(-1)	(0.17)			(0.00)					
DVol(i)	-	-2.27	-	-	-0.24	-	-	-0.99	-
		(0.11)			(0.82)			(0.00)	

DVol(i)	-	-	-	-	-0.36	-	-	-	-
(-1)					(0.74)				
DVol(o)	-	-	-7.92	-	-	-0.87	-	-	-5.39
			(0.02)			(0.65)			(0.06)
DVol(o)(-1)	-	-	-8.27	-	-	-5.75	-	-	-1.26
			(0.02)			(0.01)			(0.68)
ECM	-1.22	-0.86	-1.17	-1.32	-1.27	-1.19	-0.99	-0.99	-0.90
(-1)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)

(Although 4 is specified as the maximum lag order, the table merely displays to lag-1 term to save space).

According to the ARDL boundary cointegration test in Table 4, at significance levels of 0.05 and 0.01, all F statistics exceed the two critical values I(0) and I(1), while the adjustment coefficients in the ECM are significant. Therefore, there exists a long-term cointegrating relationship between CCFand OPEN.

Based on the estimation results of long-term and ECM coefficients in Tables 5 and 6, the following conclusions can be further summarized:

In the long run, the openness of capital inflows (OPENI) has a significant positive impact on the three types of net capital inflows, whereas the openness of capital outflows has a pronounced negative effect on the net flows of the three types of funds. This suggests a close relationship between the flow of cross-border capital and the degree and direction of OPEN. In the short term, the openness of capital account in different directions also significantly influences CCF. Short-term changes in the openness of capital inflows have a significant positive effect on FDI, securities investment, and total capital net inflows, while changes in the openness of capital outflows (including current and lagged terms) have a significant negative impact on the net outflows of various types of capital.

Based on the long-term coefficient estimates, at the 10% significance level, the volatility of OPENO has a negative impact on net cross-border capital inflows, while the volatility of OPENI negatively affects net inflows of securities investments. However, the volatility of net capital flow openness has a positive effect on net inflows of FDI at the 1% significance level. In the short term, the volatility of OPENO (including current and lagged terms) significantly negatively affects net inflows of various types of capital, whereas the short-term variation in OPENI volatility, except for its negative impact on short-term net securities investment inflows, has almost no significant effect on other types of capital flows.

The lagged terms of the three types of capital flows have a significant positive impact on the corresponding CCF, indicating the existence of inertia in CCF. This implies that the flow of funds in the previous period will increase the flow of funds in the current period.

In all ECMs, the error correction terms are significant at the 1% confidence level. The error correction coefficients range between -0.86 and -1.32, indicating that deviations from the long-term equilibrium state will be corrected at an annual rate of 86% to 132%, swiftly restoring equilibrium and maintaining economic stability and balanced development. For models I, III, IV, V, and VI, the error correction term coefficients are less than -1 but greater than -2. This indicates that differences between shocks and trends will be restored within less than a year. In this case, balance can be achieved through fluctuations in net capital flows, with the magnitude of fluctuations decreasing until the shocks eventually disappear, indicating the system's flexibility in absorbing external shocks.

Further diagnostic tests were conducted on each model, and the results are shown in Table 7. Among them, R square, standard error, AIC and SC are the relevant indicators of the original model, autocorrelation, normality and heteroscedasticity are residual tests. According to the test results, all models passed the autocorrelation test at the 5% significance level; Except for Model VI and Model VII, all other models passed the heteroscedasticity test at the 5% significance level. However, except for Model III, Model Vand Model VI, all other models didn't pass the normality test at the 5% significance level.

3.6.2 Granger Causality Test

Based on the aforementioned test results, it is evident that there exists a long-term equilibrium relationship among each variable. To further investigate the intrinsic relationships between variables, the next step is to conduct Granger causality tests. This study employs Granger causality tests based on ECMs to verify the causal relationships between variables, with the following test results presented in Table 8. (Null Hypothesis: X is not a Granger cause of Y):

According to the test results, it can be concluded that in the short term, there is a bidirectional Granger causality between cross-border net capital flows and OPEN, that is, the current degree of OPEN will have an impact on future CCF, and vice versa. More precisely, changes in net OPEN influence

Table 7. Diagnostic Testing of the Model

	Model I	Model II	Model III	Model IV	Model V	Model VI	Model VII	Model VIII	Model IX
R^2	0.45	0.53	0.58	0.72	0.68	0.68	0.44	0.40	0.61
Adj.R^2	0.38	0.47	0.51	0.62	0.58	0.59	0.37	0.34	0.49
SE	0.02	0.02	0.02	0.00	0.01	0.01	0.01	0.01	0.01
AIC	-5.28	-5.44	-5.51	-6.72	-6.64	-6.68	-5.83	-5.83	-5.99
SC	-4.94	-5.13	-5.12	-6.04	-6.00	-6.10	-5.46	-5.54	-5.35
Normality	59.06	24.91	5.62	19.74	4.21	0.24	12.31	12.62	17.16
	(0.00)	(0.00)	(0.06)	(0.00)	(0.12)	(0.89)	(0.00)	(0.00)	(0.00)
Autocorrelation	2.41	0.72	1.17	3.42	3.34	3.18	0.89	0.31	1.13
	(0.30)	(0.70)	(0.56)	(0.18)	(0.19)	(0.20)	(0.64)	(0.86)	(0.57)
Heteroscedasticity	1.49	0.05	1.58	0.45	0.31	6.03	4.40	0.91	0.51
	(0.22)	(0.83)	(0.21)	(0.50)	(0.58)	(0.01)	(0.04)	(0.34)	(0.47)

Notes: In the table, the columns of "autocorrelation" and "heteroscedasticity" indicate coefficients outside the parentheses, and the corresponding p-values inside the parentheses, the same below.

Table 8. Granger Causality Test Based on ECM

X Y	DNCCF	DNFDI	DNFSI	DOPEN	DOPENI	DOPENO	DVol	DVol(i)	DVol(o)
DNCCF	-	1.45	1.45	3.64	0.86	2.26	0.97	0.35	6.72
		(0.24)	(0.24)	(0.03)	(0.43)	(0.11)	(0.38)	(0.71)	(0.00)
DNFDI	0.16	-	0.16	3.24	0.03	3.69	2.67	0.19	4.44
	(0.86)		(0.86)	(0.04)	(0.97)	(0.03)	(0.07)	(0.83)	(0.01)
DNFSI	0.73	0.83	-	1.09	0.60	0.27	0.37	0.31	2.75
	(0.49)	(0.48)		(0.34)	(0.55)	(0.76)	(0.69)	(0.73)	(0.07)
DOPEN	7.60	3.29	5.30	-	1.84	1.84	3.62	1.12	2.28
	(0.00)	(0.04)	(0.00)		(0.17)	(0.17)	(0.03)	(0.33)	(0.11)
DOPENI	3.49	0.85	7.96	3.32	-	3.32	1.26	2.27	1.43
	(0.03)	(0.43)	(0.00)	(0.04)		(0.04)	(0.29)	(0.11)	(0.24)
DOPENO	4.50	1.20	4.86	0.09	0.09	-	2.77	0.69	5.62
	(0.01)	(0.30)	(0.01)	(0.91)	(0.91)		(0.07)	(0.51)	(0.00)
DVol	2.35	1.75	5.19	41.88	2.55	17.94	-	3.21	5.19
	(0.10)	(0.18)	(0.00)	(0.00)	(0.08)	(0.00)		(0.04)	(0.01)
DVol(i)	20.98	20.24	12.78	5.22	103.97	11.71	2.99	-	1.25
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.06)		(0.29)
DVol(o)	21.45	7.31	16.75	10.68	11.40	91.21	1.02	1.55	-
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.37)	(0.22)	

future values of net international capital inflows and net inflow of FDI. Changes in OPENO also has a influence on future values of NFDI inflow. Meanwhile, the three types of capital flows are Granger reasons for the OPEN volatilities. However in turn, not all types of volatilities passes Granger causality test with respect to CCF. The capital flows depend more on past values of volatility of OPENO than other volatilities.

3.6.3 Stability Test

The study employs the Cumulative Sum (CUSUM) and Cumulative Sum of Squares (CUSUMSQ) tests to examine the stability of long-term and short-term coefficients. The stability test results for Models I-IX are presented in graphical form, where each set of graphs displays CUSUM testing on the left and CUSUMSQ testing on the right, with the red dashed lines indicating the 5% significance boundary (Figure 1):

(1) For all CUSUM tests, most of the data lie within the 5% boundary for the estimated models, implying that the models are typically stable at 5% significant level.

(2) The CUSUMSQ test reject the null hypothesis of constant volatility at 5% significance level, indicating that the variables

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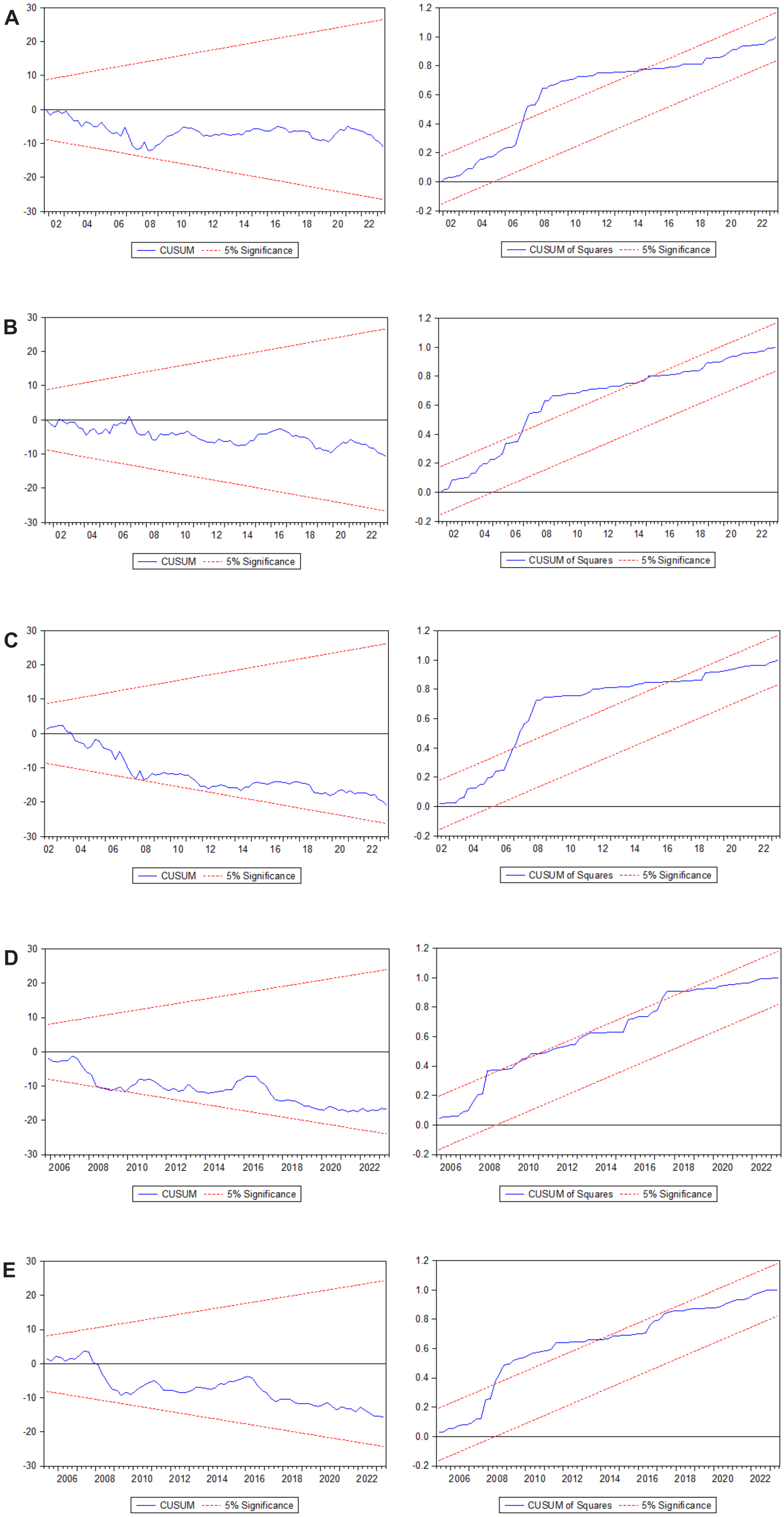

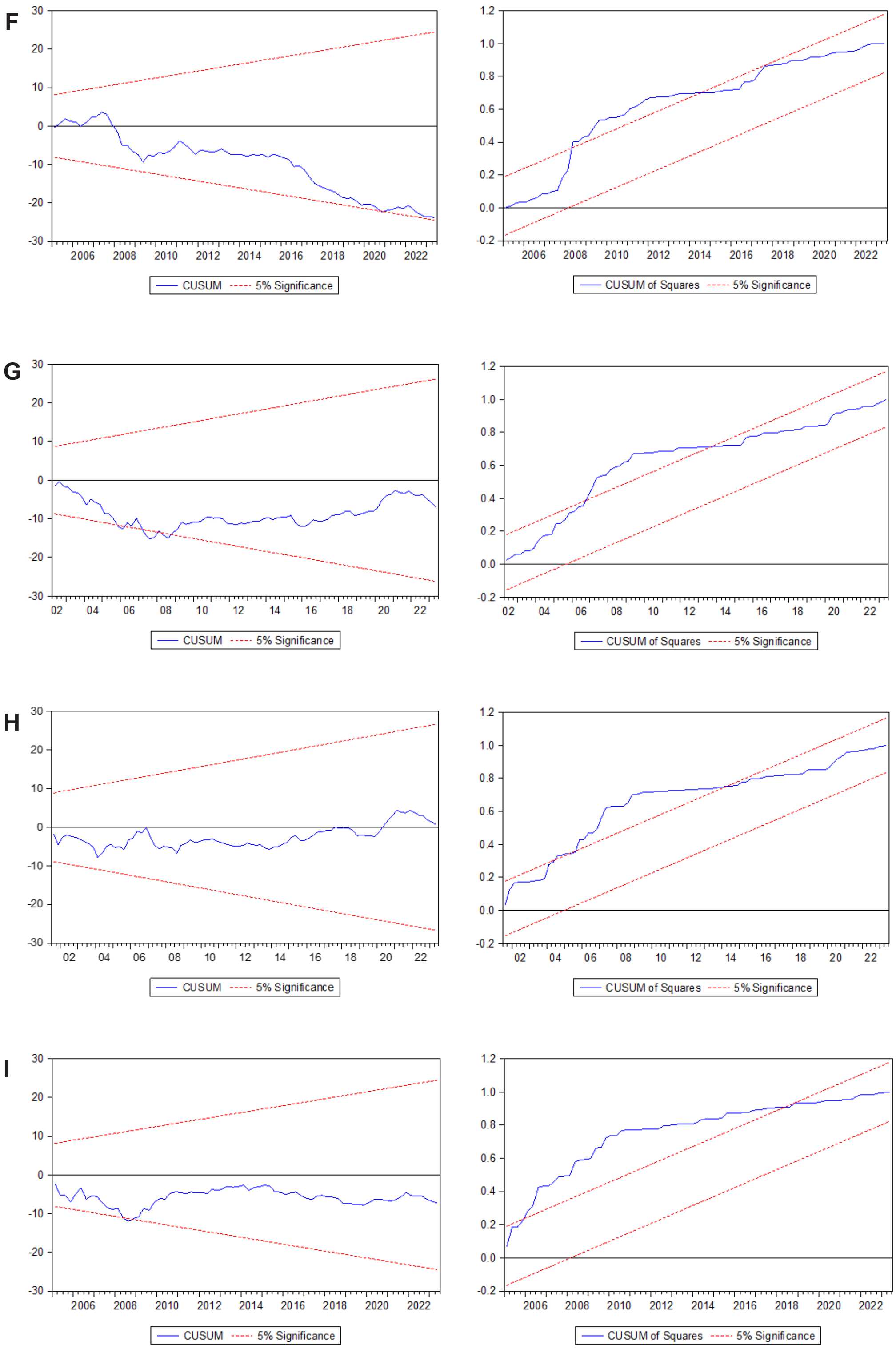

Figure 1. Models I-IX. A: Model I; B: Model II; C: Model III; D: Model IV; E: Model V; F: Model VI; G: Model VII; H: Model VIII; I: Model IX.

in models experienced structural changes between 1998Q1 and 2023Q2 and the change of statistic structure happened at around 2008. Moreover, parameter stability of ModelIV-VIare relatively higher, which indicates that the structural change in NFDI from 1998Q1 to 2023Q2 is relatively low. last three models show higher instability, which implies a higher degree of structural change in net foreign security investment.

3.7 Empirical Research Conclusions

This study employs a de-facto measurement approach to analyze quarterly data on OPEN from the first quarter of 1998 to the second quarter of 2023. The investigation explores the relationship between the openness of various capital project directions and net flows of FDI, net flows of securities investment, and net flows of total capital. Cointegration test results indicate a long-term cointegrating relationship among the variables. Further establishment of an ARDL-ECM model and analysis of long-term and short-term coefficients yield the following conclusions:

Long-term and short-term estimations of model coefficients reveal significant impacts of OPEN on various forms of CCF, closely related to the direction of OPEN. Specifically, the impact of OPENI (including its lagged values) on net flows of various cross-border capitals is predominantly positive, while the impact of OPENO (including its lagged values) is predominantly negative. This suggests that liberalization of capital inflows in China promotes net inflows of various forms of capital in both the long and short terms. Similar effects are observed regarding capital outflow liberalization, albeit in the opposite direction.

Based on the analysis of the volatility of capital project openness, the impact of capital project openness volatility on various capital flows is not entirely uniform. The volatility of capital flow openness can be considered a risk factor, indicating potential economic and political uncertainties. Decreased volatility signifies a more stable economic environment, making capital allocation more attractive to investors, especially in the context of crucial long-term stability, such as in direct investments. Therefore, the volatility of capital inflows and outflows negatively affects certain specific international capital flows. Additionally, the observed differences in the impact of volatility on net capital flow openness may also be related to the investment time horizon. Direct investment typically involves long-term commitments, while securities investments may be more short-term and liquid. Long-term direct investment may be less sensitive to short-term fluctuations, as investors may prioritize factors such as market size, stability, and growth potential over short-term volatility. Moreover, due to its involvement with tangible assets and real economic activities, direct investment is often considered relatively stable and predictable. Conversely, short-term investments, such as securities investments, may react more significantly to immediate fluctuations.

Furthermore, CUSUMSQ test results indicate significant structural changes in all types of CCF in China from 1998 to 2023, with varying magnitudes of capital changes. The approximate year of structural change is around 2008, attributed to the global financial crisis leading to significant changes in global capital flow patterns, resulting in structural upheavals in various CCF. Models IV-VI demonstrate higher parameter stability, while Models VII-IX exhibit greater instability. This suggests relatively lower structural changes in NFDI from 1998Q1 to 2023Q2 compared to structural changes in net foreign securities investment. This reflects the heightened activity and fluidity of securities investments in cross-border financing activities, making them more sensitive to market changes and thus more prone to inflows or outflows. Conversely, direct investments exhibit relative long-term stability and lower sensitivity to changes in capital project openness.

4 POLICY RECOMMENDATIONS

4.1 Flexibly Adjusting the Degree of OPEN to Achieve Economic Policy Objectives

The results from both the long-term and short-term analyses demonstrate the significant impact of the degree of OPEN on various types of CCF. Therefore, policymakers may consider adjusting the degree of OPEN to promote or restrict specific types of capital flows in order to achieve economic policy objectives. Flexible capital control measures can be adopted for different types of capital flows to balance the stability of domestic capital markets with the activity of international capital flows. Specifically, given the significant positive impact of OPENI on various forms of CCF, policymakers may consider gradually relaxing restrictions on capital inflows, particularly in sectors that can stimulate economic growth and technological advancement. However, caution should be exercised to prevent sudden uncontrolled surges in capital inflows that could lead to asset bubbles and financial instability. On the other hand, while acknowledging the negative impact of OPENO on net capital flows, measures to relax capital outflow controls should be approached with caution, with careful monitoring to prevent excessive capital flight and maintain the stability of the domestic financial system.

4.2 Prudently Adjusting OPENO to Emphasize Economic Environmental Stability

Due to the differential response of different types of capital flows to the volatility of OPEN, policymakers should also consider the sensitivity of different types of capital flows to volatility. According to short-term coefficient estimates, the short-term volatility of OPENO has a significant negative impact on the net inflow of various types of capital, implying that an increase in the volatility of OPENO may lead to net capital outflows. Therefore, frequent major adjustments to capital outflow policies during periods of openness should be avoided to prevent undermining the stability of the economic environment and causing significant capital flight. The government can enhance the coordination between economic and political policies, such as adjusting fiscal and monetary policies, coordinating trade and investment regulations, to reduce uncertainty and create a more stable and predictable environment for investors.

4.3 Promoting Long-Term Investment to Enhance Market Resilience

Given that the short-term impact of OPENI on types of capital flows other than securities investment is relatively minor, the associated risks are comparatively lower. Consequently, policymakers can encourage businesses and investors to engage in long-term investment, particularly in the real economy and infrastructure sectors, to enhance economic stability. Incentives such as tax breaks, grants, or infrastructure support can be provided to investors committed to long-term investment to shift the focus from short-term volatility to sustainable long-term stable growth, thereby enhancing market resilience. Other measures, such as investing in infrastructure and mechanisms to enhance market resilience against external shocks, collaborating with other countries and international organizations to share information, and promoting diversification of funding sources and investment destinations to reduce reliance on specific types of capital flows, can also strengthen market stability.

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Conflicts of Interest
The authors declared there is no conflict.

Author Contribution
Zhang Z conceived the idea for the study, conducted the primary research, and drafted the initial manuscript. Zhang X contributed to refining and revising the manuscript, providing critical feedback, and incorporating additional content. Both authors c and approved the final version of the manuscript.

Abbreviation List
ARDL, Autoregressive distributed lag
CCF, Cross-border capital flows
CPI, Consumer Price Index
ECM, Error correction model
EXR, Exchange Rate
FDI, Foreign direct investment
FIN, Financial development level
GDP, Gross Domestic Product
GDPG, Gross Domestic Product Growth Rate
INF, Inflation
IRD, Interest rate difference
ISI, Inward securities investment
NCCF, Net cross-border capital flow
NFDI, Net foreign direct investment
NFSI, Net foreign security investment
ODI, Outward direct investment
OSI, Outward securities investment
OPEN, Capital account openness
OPENI, Capital inflow openness
OPENO, Capital outflow openness

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