Hindawi
Complexity
Volume 2022, Article ID 1066096, 12 pages
https://doi.org/10.1155/2022/1066096

*Research Article*

# Evaluation of Hot Money Drivers in China: A Structural VAR Approach

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Received 8 June 2021; Revised 6 April 2022; Accepted 17 May 2022; Published 4 July 2022

Academic Editor: Atila Bueno



This paper investigates the drivers of hot money in China. It develops a model based on expectation-variance utility theory in the theoretical analysis section. The model considers a foreign investor who faces the question of how to distribute his wealth between foreign and domestic assets. The model's analysis suggests that economic variations, such as expected domestic currency appreciation, rise in domestic asset return, drop in foreign asset return, domestic economic growth, decrease in domestic inflation, and rise in foreign asset risk will cause foreign investors to distribute more wealth in domestic assets. Therefore, hot money flows in, and vice versa. In the empirical analysis section, the paper estimates structural VAR models using data from 2000 to 2019 in China. The impulse response functions are consistent with the theoretical predictions: when there is a positive domestic inflation shock, hot money outflows increase (inflows decline) in the current period, but the response is not significant. When there is a positive domestic growth rate shock or positive domestic asset return rate shock, hot money inflows increase (outflows decline) in the current period, and the response reaches its peak in the next period. Furthermore, when there is a positive expected exchange rate shock, hot money outflows increase (inflows decline) in the current period. Of these drivers, the expected exchange rate has the largest impact on hot money, and the domestic growth rate has the most enduring effect.

## 1. Introduction

Since the 1980s, global financial integration has progressed rapidly and has been an important phenomenon in the world economy, facilitating large quantities of cross-border capital flows [1–4]. Latin America's debt crisis, the Mexican financial crisis, the Asian financial crisis, and the 2008 financial crisis have one thing in common: they were all accompanied by huge amounts of international capital flows. A large share of these flows constitutes hot money, defined as cross-border speculative capital flow [5].

Hot money attracts scholarly attention because of its multiple influences on recipient countries. Firstly, hot money can influence recipient countries' economic output [6]. Secondly, hot money affects stock markets [7–10]. Thirdly, it can inflate property prices and accelerate market volatilities [11]. Lastly, hot money is closely connected with crises. Hot money not only exacerbates economic volatilities and damages economic growth prospects during the crisis period [12] but also makes recipient countries more vulnerable to future adverse shocks [13]. These speculative capital flows can also cause systemic risk through banking system channels [14, 15]. Based on these findings, hot money is widely considered detrimental to the recipient country's financial stability.

Several previous studies have analyzed the drivers of hot money. The interest rate differential and expectation of an appreciation of the China Yuan (CNY), which is the official currency of China, are suggested to be the main drivers of hot money in China [16, 17]. Cheung and Qian (2010) show that China's hot money outflow (capital flight) is well explained by its history and covered interest differentials. The other possible determinants offer relatively small additional explanatory power [18]. Zhang and Shen (2008) show that the appreciation of the CNY and higher capital market returns are the determinants of hot money in China [19]. Zhao et al. (2013) find that hot money flows to China are related to the expected appreciation of the CNY, the change in house prices, and the change in the stock market index [20]. Zhang and Fung (2006) and Guo and Huang (2010) stress the importance of the stock market and real estate market factors [21, 22]. Davis et al. (2021) find that the energy price factor accounts for a significant share of the variance of capital flows [23]. Some researchers find that global risk is also an important factor in explaining hot money dynamics [24, 25]. Steinkamp and Westermann (2021) find that capital flight is positively correlated with development aid in Nepal [26]. Fratzscher et al. (2018) find that the Federal Reserve's quantitative easing increased the procyclicality of international portfolio flows [27]. Investors' experiences may also impact capital flows, and Malmendier et al. (2020) argue that investment experience effects can explain the tendency of investors to invest in domestic stock markets in periods of domestic crises and withdraw capital from foreign stock markets in periods of foreign crises [28]. Previous studies do not come to a consistent conclusion. The first possible reason is that they use different approaches to measure hot money, and some papers only consider hot money outflow (capital flight). The second possible reason is that the studies mainly use autoregressive distributed dag (ARDL) models or VAR models. These approaches have the problem that the reduced form residuals are typically not the shocks of interest in the viewpoint of economics.

This study evaluates the influence of different drivers of hot money in China.

As the first step in our analysis, we develop a foreign investor's asset allocation decision model based on expectation-variance utility theory. In this model, the foreign investor adjusts his portfolio when macroeconomic variables change and, therefore, short-term speculative capital flows across the border. We derive two findings from analyzing the model: firstly, the expected appreciation of the domestic currency, increase in the return of domestic assets, and decline in the return of foreign assets lead to hot money inflows. Secondly, domestic inflation, the domestic growth rate, and the risk of foreign assets' impact on hot money depend on whether the current position is long or short. If domestic and foreign positions are all long, which is typically the case, the expected appreciation of the domestic currency, increase in the domestic growth rate, the decline in the domestic inflation rate, and the increase of foreign asset risk cause hot money inflows.

The second step in our analysis involves studying the drivers of hot money in China, using the monthly data from 2000 to 2019. We estimate the structural VAR (SVAR) models and use impulse response functions to investigate drivers of hot money. Essentially, empirical results are consistent with our model's predictions: firstly, an increase in domestic inflation leads to a decline in hot money net inflows. However, the results are insignificant, both economically and statistically. Secondly, the expected appreciation of the domestic currency, an increase in the domestic growth rate, and a rise in domestic asset return rate lead to hot money inflows. We find currency appreciation to be the most significant of the three drivers. Moreover, the impact of the growth rate is persistent. We perform the robust test in two ways: alternative measurement of hot money and different sample periods. The test results indicate that our conclusions are not sensitive to the choice of sample data.

This study makes two contributions to the literature. Firstly, it analyzes the impact of the main economic variables on hot money through a simple short-term investment decision model. The model considers the possibility of a short sale, which extant studies have ignored. Secondly, we use the SVAR model to measure macroeconomic variables' impact on hot money. The SVAR method is superior to the VAR method in measuring economic shocks.

The paper is organized as follows: we develop a foreign investors' portfolio decision model in Section 2. Then, Section 3 discusses and estimates the SVAR model. Furthermore, robust tests are performed in Section 4, and finally, conclusions are drawn in Section 5.

## 2. Theoretical Analysis

We develop a foreign investors' portfolio decision model based on mean-variance utility theory [29]. In this model, foreign investors distribute their wealth between domestic and foreign assets, and hot money flows when investors increase the share of domestic asset and vice versa. Hot money flows are endogenously decided in this way.

We assume that a foreign investor is ready to distribute one unit of foreign currency between domestic and foreign financial assets. The shares invested in the domestic and foreign assets are $f_h$ and $f_m$, respectively. Since the total wealth of the investor is one unit of foreign currency, $f_h$ and $f_m$ are also the market values of his assets, can be any real number, and must satisfy the following equation:

$$f_h + f_m = 1. \tag{1}$$

When the share is a negative number, the investor has short sold the relevant asset. For instance, when $f_h = 2$ and $f_m = -1$, the investor borrows one unit of foreign currency, converts the two units of foreign currency into domestic currency, and invests them in the domestic asset.

The return rates of the domestic and foreign assets are $I$ and $I_f$, respectively. The domestic growth and inflation rates are $y$ and $p$, respectively. The current exchange rate is $e$ units of domestic currency per unit of foreign currency. The procedure surrounding the foreign investor's short-term speculative investment in the domestic asset is such that, firstly, they convert foreign currency into domestic currency at the current exchange rate $e$. Secondly, he buys and holds domestic assets. At last, they sell the domestic asset and convert domestic currency back into foreign currency. When the investor decides to invest in domestic asset, the expected exchange rate is $e_f$. It is easy to see that an increase in $e$ indicates a depreciation of the domestic currency. The foreign investor's expected rate of return from the investment in domestic asset is $(1+I)e/e_f - 1$. The expected return rate from his portfolio is as follows:

$$E[R] = f_h\left(\frac{e}{e_f}(1+I) - 1\right) + f_m I_f. \tag{2}$$

It is assumed that the variance of the return rate of his domestic investment is $\sigma_h^2$ and the variance of the return rate of his foreign asset is $\sigma_m^2$. Furthermore, it is assumed that the return rate of the domestic investment and that of the foreign asset are uncorrelated, which is plausible when strict restrictions are imposed on domestic financial account transactions, and the domestic economy is sufficiently large, as in the case of China. It is also assumed that $\sigma_h^2$ is a function of domestic growth rate $y$ and inflation rate $p$. For the sake of simplicity, it is assumed further that the function is linear as follows:

$$\sigma_h^2 = a_0 - a_1 y + a_2 p^2. \tag{3}$$

In this regard, the parameters $a_0$, $a_1$, and $a_2$ are all positive. The $-a_1$ before $y$ indicates that domestic investment risk is negatively correlated with domestic growth rate. The positive $a_2$ indicates that the more stable the domestic prices, the less risky the domestic investment. Having summarized the above assumptions, the investor's portfolio return variance can be expressed as follows:

$$\sigma_R^2 = f_h^2\left(a_0 - a_1 y + a_2 p^2\right) + f_m^2 \sigma_m^2. \tag{4}$$

Based on classic mean-variance utility theory, we assume the foreign investor's utility function as $U(R, \sigma_R^2) = E[R] - 0.5\gamma\sigma_R^2$, where $R$ denotes portfolio return rate and $\gamma$ measures his risk aversion. Therefore, we derive the investor's utility maximization problem as follows:

$$\max_{f_h, f_m} f_h\left(\frac{e}{e_f}(1+I) - 1\right) + f_m I_f - 0.5\gamma\left(f_h^2\left(a_0 - a_1 y + a_2 p^2\right) + f_m^2\sigma_m^2\right), s.t. f_h + f_m = 1. \tag{5}$$

We express the Lagrange function for the above problem and develop first-order conditions as

$$\begin{aligned}
\frac{\partial L}{\partial f_h} &= \frac{e(1+I)}{e_f} - 1 - \gamma f_h\left(a_0 - a_1 y + a_2 p^2\right) - \lambda = 0,\\
\frac{\partial L}{\partial f_m} &= I_f - \gamma f_m \sigma_m^2 - \lambda = 0,\\
\frac{\partial L}{\partial \lambda} &= f_h + f_m - 1 = 0.
\end{aligned} \tag{6}$$

Solving the simultaneous equations, we have derived the following:

$$f_h = \frac{e(1+I)/e_f - 1 - I_f + \gamma\sigma_m^2}{\gamma\left[\sigma_m^2 + \left(a_0 - a_1 y + a_2 p^2\right)\right]}. \tag{7}$$

It is evident that $\partial f_h/\partial e_f < 0, \partial f_h/\partial I > 0$, and $\partial f_h/\partial I_f < 0$. The signs of those inequalities mean that expected domestic currency appreciation, an increase in the domestic asset return rate, and a decline in the foreign asset return rate cause the foreign investor to distribute more wealth in domestic asset, therefore, causing an inward flow of hot money.

$$\frac{\partial f_h}{\partial y} = \frac{a_1\left(e(1+I)/e_f - 1 - I_f + \gamma\sigma_m^2\right)}{\gamma\left[\sigma_m^2 + \left(a_0 - a_1 y + a_2 p^2\right)\right]^2}. \tag{8}$$

The sign of the above derivative is the same as the sign of the part $e(1+I)/e_f - 1 - I_f + \gamma\sigma_m^2$ in the numerator. Hence, it is the same as that of $f_h$. Therefore, when $f_h > 0$, $\partial f_h/\partial y > 0$; when $f_h < 0$, $\partial f_h/\partial y < 0$. The economic meaning of this outcome is that when the foreign investor holds a long position on the domestic asset, the high domestic growth rate will entice him to hold more of this long position, and there will be an inward flow of hot money. When the foreign investor holds a short position on the domestic asset, the high domestic growth rate will cause him to hold more of a short position on the domestic asset, causing an outward flow of hot money. The mechanism of the second result (the case of $f_h < 0$) is that when $f_h < 0$, the high domestic growth rate reduces the risk of the short position, low risk causes the investor to take more of both the short and long positions, causing an outward flow of hot money.

$$\frac{\partial f_h}{\partial p^2} = -\frac{a_2\left(e(1+I)/e_f - 1 - I_f + \gamma\sigma_m^2\right)}{\gamma\left[\sigma_m^2 + \left(a_0 - a_1 y + a_2 p^2\right)\right]^2}. \tag{9}$$

The analysis of equation (9) is similar to that of equation (8). The sign of $\partial f_h/\partial p^2$ is contrary to that of $e(1+I)/e_f - 1 - I_f + \gamma\sigma_m^2$ in the numerator, so it is contrary to that of $f_h$. Therefore, when $f_h > 0$, $\partial f_h/\partial p^2 < 0$; when $f_h < 0$, $\partial f_h/\partial p^2 > 0$. The economic meaning in this regard is that when the foreign investor holds a long position on the domestic asset, the domestic price volatility will cause him to hold less domestic asset in the long position, causing an outward flow of hot money. Furthermore, when the foreign investor holds a short position on the domestic asset, the domestic price volatility will cause him to hold less domestic asset in the short position, causing a decline in the outflow of hot money. The mechanism underpinning the second result (the case of $f_h < 0$) is that when $f_h < 0$, domestic price volatility increases the risk of the short position, high risk leads the investor to take less of both positions, causing a decline in the outflow of hot money.

$$\frac{\partial f_h}{\partial \sigma_m^2} = \frac{\gamma\left[\sigma_m^2 + \left(a_0 - a_1 y + a_2 p^2\right)\right] - \left(e(1+I)/e_f - 1 - I_f + \gamma\sigma_m^2\right)}{\gamma\left[\sigma_m^2 + \left(a_0 - a_1 y + a_2 p^2\right)\right]^2}. \tag{10}$$

Regarding equation (10), the sign of derivative $\partial f_h/\partial\sigma_m^2$ is determined by the numerator's sign, which is determined by the two terms in the numerator. Those two terms happen to be the denominator and numerator of $f_h$, so we analyze the sign of derivative $\partial f_h/\partial\sigma_m^2$ in different subregions of $f_h$.

(i) $f_h > 1$: in this case, $e(1+I)/e_f - 1 - I_f + \gamma\sigma_m^2 > \gamma[\sigma_m^2 + (a_0 - a_1 y + a_2 p^2)] > 0$, so $\partial f_h/\partial\sigma_m^2 < 0$. This outcome means that when the foreign investor holds foreign asset in the short position and domestic asset in the long position, an increase in foreign asset risk causes the investor to reduce both positions, and therefore, there is an outflow of hot money.

(ii) $1 > f_h > 0$: in this case, $\gamma[\sigma_m^2 + (a_0 - a_1 y + a_2 p^2)] > e(1+I)/e_f - 1 - I_f + \gamma\sigma_m^2 > 0$, so $\partial f_h/\partial\sigma_m^2 > 0$, meaning that when the foreign investor holds both assets in long positions, an increase in foreign asset risk causes the investor to reduce the foreign asset long position and increase the domestic asset long position, and therefore, there is an inward flow of hot money.

(iii) $f_h < 0$: in this case, $e(1+I)/e_f - 1 - I_f + \gamma\sigma_m^2 < 0$; therefore, $\partial f_h/\partial\sigma_m^2 > 0$, showing that when the foreign investor holds domestic asset in a short position and foreign asset in a long position, an increase in foreign asset risk causes the investor to reduce both positions, and therefore, there is a decline in the outflow of hot money.

In summary, foreign investors typically hold both assets in long positions ($1 > f_h > 0$). In this case, expected domestic currency appreciation, a rise in the return on domestic asset, a decrease in the return on foreign asset, domestic economic growth, decreased domestic inflation, and increased foreign asset risk may all lead foreign investors to distribute more wealth in domestic asset, therefore causing inflows of hot money.

## 3. Empirical Analysis

*3.1. Sample and Data.* In this study, we use an SVAR model comprising seven variables. A large sample is preferred for producing robust results. Therefore, we choose the longest sample range available for the period 2000.9–2019.11. Variable definitions and explanations are as follows:

(1) Hot money (HM): for the time being, there are two main approaches to measuring hot money. The first one is the direct approach, the main idea of which is that hot money is hidden in the section titled "Net Errors and Omissions" of the Balance of Payments Statistics (BOPS). Thus, scholars may measure net flows of hot money based on net errors and omissions with some adjustments. The second method is the indirect approach. The main idea of the indirect approach is to attribute the inexplicable part of the variation in foreign exchange reserves (FER) to hot money. The World Bank report (1985) suggests measuring hot money using the following equation: hot money net inflow = variation in FER–current account surplus–foreign direct investment (FDI)—the variation in short-term foreign debts [30]. This paper uses the indirect approach. Data on FER, the current account, and short-term foreign debt are taken from China's State Administration of Foreign Exchange (SAFE) website. FDI data are taken from the Wind Economic Database. Hot money net flows in China for the period 2000.9–2019.11 are shown in Figure 1. Hot money net flows were relatively small before the 2008 financial crisis and increased gradually over 2008–2015. Before 2013, hot money inflows were more frequent than outflows, and the peak inflow occurred in September 2013. Since 2014, there has been an outward flow of hot money, with a peak in outflows occurring in December 2015. After 2015, hot money outflows are on a smaller scale.

(2) Economic growth rate Y: although this study uses monthly data, China's National Bureau of Statistics offers only quarterly GDP data. We substitute industrial value-added growth rate, which is monthly data, for GDP growth rate. Industrial value-added data are taken from the Chinese Economic Information Statistics Database.

(3) Inflation rate p: this study uses the consumer price index to measure the inflation rate, and the data come from the China Stock Market and Accounting Research Database.

(4) Domestic asset return rate (DAR): this study uses the Chinese three-month interbank offered rate to measure the domestic asset return rate, and the data in this regard are also taken from the Chinese Economic Information Statistics Database. We use the log difference of the original data.

(5) Foreign asset return rate (FAR): this study uses the three-month US dollar LIBOR to measure the foreign asset return rate, and the data are from CEIC Data's Global Database. We use the log difference of the original data.

(6) Expected exchange rate (EER): this study uses a three-month nondeliverable forward in Hong Kong's offshore CNY market to measure the

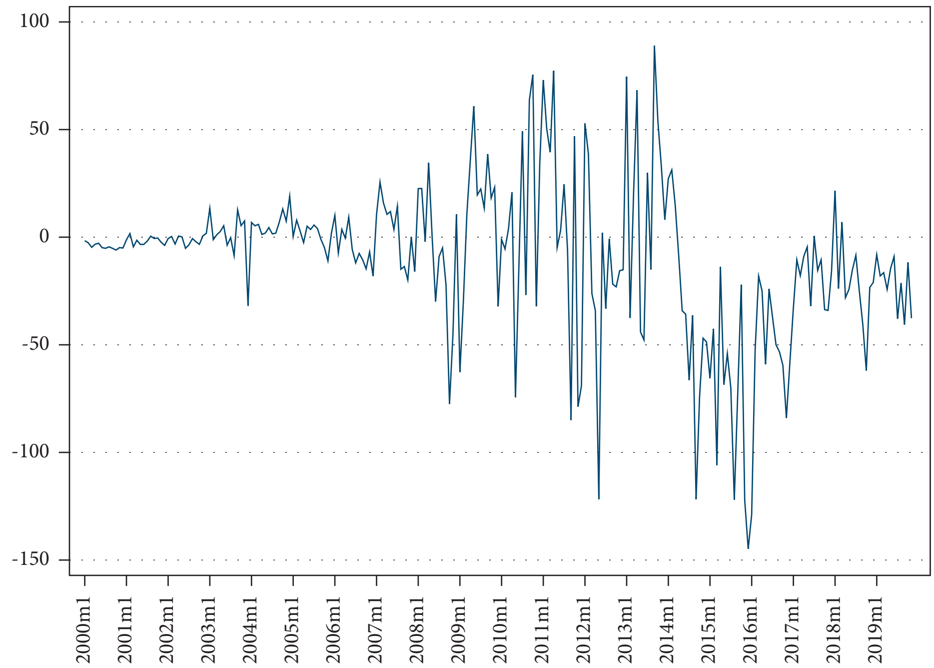


FIGURE 1: The hot money flows in China (billion USD). Source : Authors' calculations.

expected exchange rate of CNY against USD. In the offshore CNY market, CNY/USD exchange rates are in a direct quote. Therefore, the increase in the exchange rate indicates that the market expects CNY depreciation. The data are taken from CEIC Data's Global Database, and we use the log difference of the original data.

(7) Foreign asset risk: this study uses the market volatility index (VIX) offered by the Chicago Board Options Exchange (CBOE) to measure foreign asset risk. The VIX measures the expected price fluctuations in the S&P 500 index option and is often referred to as the "fear index." The higher the VIX, the higher investors' expected stock market fluctuation risk. The data are taken from the Wind Economic Database.

Table 1 shows the summary statistics of previous variables.

TABLE 1: Descriptive statistics.

| | Mean | Max | Min | SD | p50 |
|---|---|---|---|---|---|
| P | 2.369 | 8.700 | −1.800 | 1.974 | 2.100 |
| Y | 11.263 | 23.200 | −1.100 | 4.822 | 10.300 |
| DAR | 0.002 | 0.600 | −0.703 | 0.170 | 0.004 |
| EER | −0.001 | 0.053 | −0.033 | 0.009 | −0.001 |
| HM | 10.591 | 89.018 | 144.799 | 36.760 | −4.481 |
| VIX | 19.309 | 59.890 | 9.510 | 8.005 | 16.860 |
| FAR | −0.014 | 0.434 | −0.951 | 0.128 | 0.000 |

*3.2. SVAR Model Specification.* We have suggested that the SVAR model is more appropriate for this study, and now we discuss the model's specifications. Firstly, we introduce the general method of SVAR model identification. Then, we expound on the model's specification in this study.

We consider a general SVAR model. It consists of $M$ endogenous variables and K exogenous variables, and the maximum lag length is $p$. The SVAR model is written as follows:

$$Ay_t = A_1^S y_{t-1} + A_2^S y_{t-2} + \cdots + A_p^S y_{t-p} + C^s x_t + Bu_t, \quad (11)$$

where $y_t$ is $M \times 1$ endogenous variables vector; $x_t$ is $K \times 1$ exogenous variables vector; and $C^s$ is $M \times K$ coefficients matrix; $A$, $A_1^S$, $A_2^S$, …, $A_p^S$, and $B$ are $M \times M$ coefficients matrix. Furthermore, $u_t$ is a column vector that comprises $M$ random errors, reflecting the structural innovations. The components of $u_t$ are independently distributed with zero means, and the correlation matrix of $u_t$ is a unit matrix. Assuming that matrix A is nonsingular, left-multiply equation (11) by the inverse of A, to generate the following:

$$\begin{aligned} y_t = {} & A^{-1}A_1^S y_{t-1} + A^{-1}A_2^S y_{t-2} + \cdots + A^{-1}A_p^S y_{t-p} \\ & + A^{-1}C^s x_t + A^{-1}Bu_t. \end{aligned} \quad (12)$$

Let $A_1 = A^{-1}A_1^S$, $A_2 = A^{-1}A_2^S$, …, $A_p = A^{-1}A_p^S$, $C = A^{-1}C^s$, $\varepsilon_t = A^{-1}Bu_t$, we have reduced VAR

$$y_t = A_1 y_{t-1} + A_2 y_{t-2} + \cdots + A_p y_{t-p} + Cx_t + \varepsilon_t. \quad (13)$$

The specification of exogenous variables: the FAR and foreign asset risk VIX are data from the United States. The United States is the largest economy in the world. According to OECD statistics, the total value of US financial assets is 213,105.459 billion dollars, while the estimated hot money net flow in China in 2018 is −243.3 billion dollars (the negative sign indicates net inflow). Even if we consider the difference between net value and gross value, hot money flows in China are small compared to the size of the US financial market. Considering that hot money flows in China do not have to be between China and the United States, the impacts of hot money flows from China (to China) on the United States are negligible. Therefore, it is plausible to assume that hot money in China does not affect the US financial market. Therefore, we specify the FAR and the foreign asset risk VIX as exogenous variables.

We can consistently estimate the reduced VAR by the ordinary least square method. We need additional restrictions to identify structural VAR parameters from the reduced VAR. Specifically, we need $M(M-1)/2$ restrictions for the model with $M$ endogenous variables.

We add identification conditions based on economic reality. For the convenience of further explanation, it is noted that the variables are ranked in the same order as in Table 1. Because price stickiness, growth rate shocks, and financial market shocks (including DAR, EER, and HM) do not contemporaneously affect inflation rate $p$, we assume $a_{12'} = 0$, $a_{13} = 0$, $a_{14} = 0$, and $a_{15} = 0$. Since output adjustment is slow, and this study uses monthly data, we assume that the growth rate will be contemporaneously unaffected by financial market shocks. Then, we have $a_{23} = 0$, $a_{24} = 0$, and $a_{25} = 0$. One thing that should be pointed out is that we use the nominal growth rate rather than the real growth rate. Then, price shocks will contemporaneously affect the growth rate, and we do not assume $a_{21} = 0$. The monetary policy (represented by the official central bank benchmark rate) is a significant and powerful factor determining and affecting China's interbank rate [31]. Other factors are negligible, so we assume $a_{34} = 0$ and $a_{35} = 0$. It takes time for the monetary authority to perceive price and output shocks. It also takes time for the monetary authority to formulate and implement monetary policy to affect domestic asset return rates (the interbank rate in this study). Therefore, we assume that price and output shocks will not contemporaneously impact the domestic interest rate, and we assume that $a_{31} = 0$ and $a_{32} = 0$. Finally, we assume that hot money is not strong enough to affect the expected exchange rate, which means $a_{45} = 0$. There are five endogenous variables in the model; therefore, we need at least $5 \times (5-1)/2 = 10$ restrictions to identify the structural model. Previous analysis suggests 12 short-term restrictions, so the model is identifiable. All the restrictions are summarized as follows:

$$A = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ a_{41} & a_{42} & a_{43} & 1 & 0 \\ a_{51} & a_{52} & a_{53} & a_{54} & 1 \end{bmatrix} B = \begin{bmatrix} b_{11} & 0 & 0 & 0 & 0 \\ 0 & b_{22} & 0 & 0 & 0 \\ 0 & 0 & b_{33} & 0 & 0 \\ 0 & 0 & 0 & b_{44} & 0 \\ 0 & 0 & 0 & 0 & b_{55} \end{bmatrix}. \tag{14}$$

*3.3. Model Specification Test.* Unit root test: the unit root test results are shown in Table 2, and all variables are stationary.

Table 2: Unit root test.

| Series | $z$ | Constant, trend, and lags | Stationary |
|---|---|---|---|
| P | −3.49 | (C, 0, 3) | Yes |
| Y | −4.78 | (C, t, 1) | Yes |
| DAR | −11.02 | (C, 0, 2) | Yes |
| EER | −13.80 | (C, 0, 0) | Yes |
| HM | −4.30 | (C, 0, 2) | Yes |
| VIX | −4.62 | (C, 0, 0) | Yes |
| FAR | −9.60 | (C, 0, 0) | Yes |

Table 3: Choice of VAR lags.

| Lags | FPE | AIC | HQIC | SBIC |
|---|---|---|---|---|
| 1 | 0.341 | 13.11 | 13.39* | 13.80* |
| 2 | 0.318 | 13.04 | 13.47 | 14.10 |
| 3 | 0.321 | 13.05 | 13.63 | 14.49 |
| 4 | 0.301* | 12.99* | 13.72 | 14.80 |

Table 4: Granger causality test.

| Null hypothesis | F statistics | $P$ value |
|---|---|---|
| HM does not Granger cause p | 6.210 | 0.013 |
| p does not Granger cause HM | 3.451 | 0.063 |
| HM does not Granger cause Y | 9.594 | 0.002 |
| Y does not Granger cause HM | 7.421 | 0.006 |
| HM does not Granger cause DAR | 0.160 | 0.689 |
| DAR does not Granger cause HM | 0.988 | 0.320 |
| HM does not Granger cause EER | 0.577 | 0.448 |
| EER does not Granger cause HM | 0.824 | 0.364 |

Choice of lag length: as shown in Table 3, the Hannan–Quinn information criterion (HQIC) and Schwarz's Bayesian information criterion (SBIC) recommend a model of one lag, whereas the Akaike information criterion (AIC) and final prediction error criterion (FPE) select a model of four lags. In this VAR model that includes five variables, the coefficient number will dramatically increase if we choose four lags. Therefore, to keep the model simple and stable, we choose a model of one lag.

VAR stationary test: we verify that the VAR system is stationary by checking that the reciprocal of the autoregression roots are all in the unit circle. We find that they are in the unit circle; however, the results are not displayed to keep the paper concise.

Granger causality test: this study investigates the Granger causality between hot money and macroeconomic variables, such as the domestic inflation rate, domestic economic growth rate, domestic asset return rate, and the expected exchange rate. The results are summarized in Table 4. The result reveals the existence of bidirectional causality between hot money and the domestic inflation rate and between hot money and the domestic growth rate. No statistically significant evidence supported Granger causality between hot money and the domestic asset return rate and between hot money and expected exchange rate. The main reason for the above results is that hot money, the domestic asset return rate, and the expected exchange rate are financial market variables, and the interactions among them

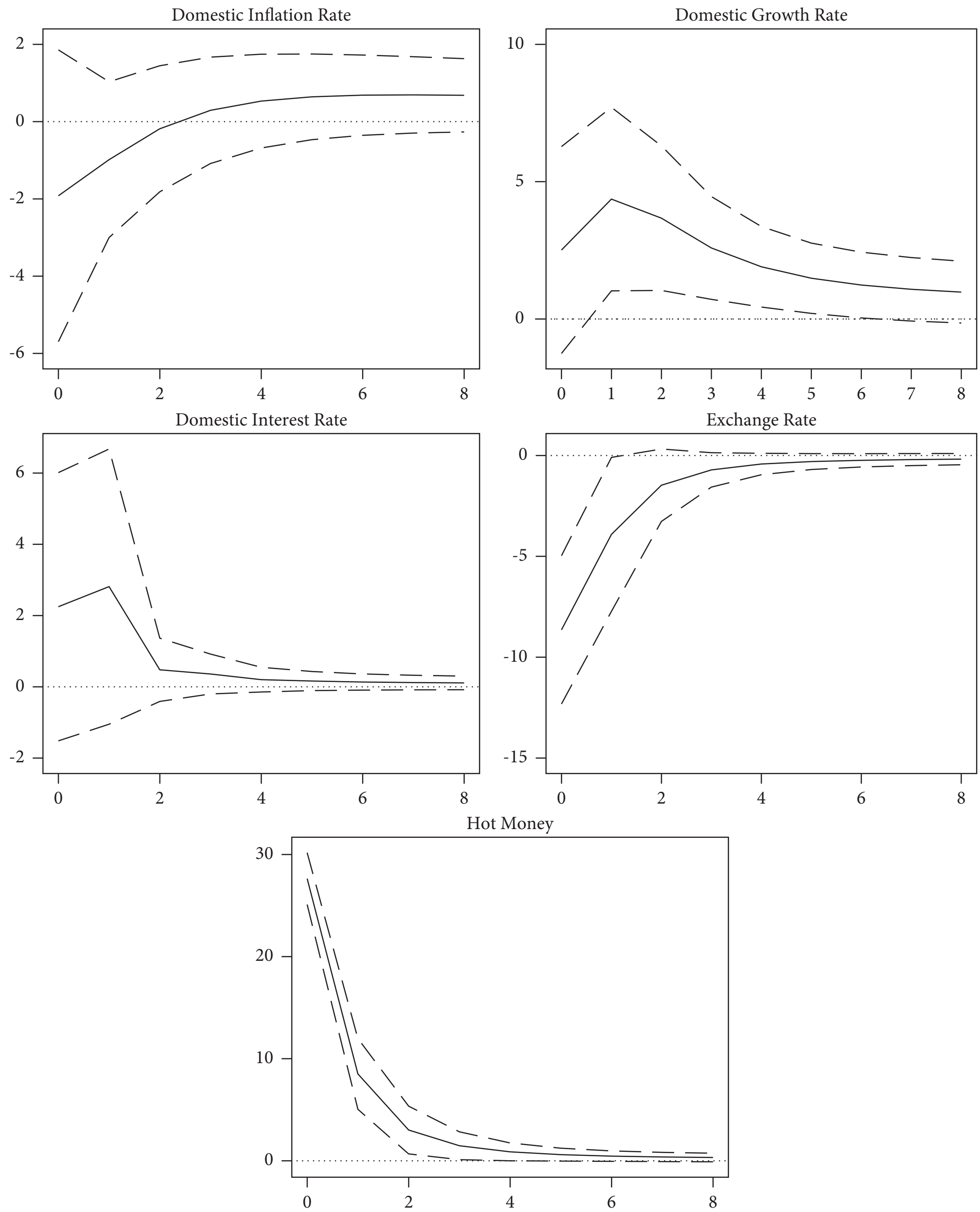


Figure 2: Impulse response functions of SVAR (full sample).

are so fast that we can only find a contemporaneous relationship in our monthly data. The discovery corroborates our view that it is necessary to consider contemporaneous relations and use the SVAR model.

*3.4. Impulse Response Analysis.* Because the coefficients in the SVAR model have no clear economic meaning when considered individually, this study uses the impulse response function (IRF) to analyze the economic meaning of the SVAR model. Figure 2 shows the responses of hot money to a positive standard deviation shock of five variables.

(i) When there is a positive domestic inflation shock of one standard deviation, hot money outflows increase (inflows decline) in the current period, and the response has diminished ever since. The response diminishes to zero two months later. The response is not statistically significant.

(ii) When there is a positive domestic growth rate shock of one standard deviation, hot money inflows increase (outflows decline) in the current period. The response peaks in the next period (month) and has diminished ever since. The response's attenuation is very slow, and the response is still statistically significant after eight periods (months). One standard deviation of $u_{2t}$ is 2.48, and the response peak is 4.37. Therefore, if the economic growth rate increases by 1%, hot money inflow will increase by 1.76 (4.37/2.48) billion dollars in the next month. Six months later, the response is 1.24. Therefore, if the economic growth rate increases by 1%, the hot money inflow will increase by 0.5 (1.24/2.48) billion dollars even after six months. Therefore, economic growth has a long-term effect on hot money.

(iii) One positive standard deviation shock in the domestic asset return rate attracts hot money inflow in the current period. The response peaks in the next period (month) and rapidly declines to zero after two months. One standard deviation of $u_{3t}$ is 0.16, and the hot money response in the current period is 2.25; then, if the domestic return rate increases by 0.1%, hot money inflow will increase by 1.41 (2.25 * 0.1/0.16) billion dollars in the current period. The response in the next period is 2.81, which is the peak value. If the domestic return rate increases by 0.1%, hot money inflow will increase by 1.76 (2.81* 0.1/0.16) billion dollars in the next period. The above results are not statistically significant but economically significant.

(iv) When there is a positive expected exchange rate shock of one standard deviation, hot money responds by peaking in the current period. The response peak is −8.64 billion dollars. The response rapidly declines to −3.91 and −1.47 billion dollars in the next two months, respectively, and it is not statistically significant three months later. One standard deviation of $u_{4t}$ is 0.0086. When the expected exchange rate increases by 1%, hot money outflow increases by 10.05 (86.4*1%/0.0086) billion dollars in the current month and 4.55 (3.91*1%/ 0.0086) billion dollars in the next month. The results are statistically and economically significant.

(v) For a positive standard deviation shock in hot money, the response of hot money itself over the next three months is 8.51, 3.02, and 1.48 billion dollars, respectively. As the standard deviation of $u_{5t}$ is 27.6 billion dollars, 10 billion dollars of hot money inflows in the current month will bring in 3.08, 1.09, and 0.54 billion dollars of hot money in the next three months, respectively. It appears that the hot money flow is quite persistent.

Table 5 presents forecast error variance decomposition for hot money in the model over 24 months. The results show that errors in the forecast of the hot money are greatly attributed to other variables than are ascribed to the variables in the model. In the first month, the error in the forecast of the hot money dominated itself. The EER accounts for 9% in the 24th month, while economic growth accounts for about 6%. The inflation and interest rates are insignificant in the forecast of hot money throughout all months.

Table 5: Forecast error variance decomposition.

| Step | *P* | Y | DAR | EER | HM |
|---|---|---|---|---|---|
| 1 | 0.0043 | 0.0074 | 0.0059 | 0.0875 | 0.8949 |
| 6 | 0.0054 | 0.0508 | 0.0132 | 0.0918 | 0.8388 |
| 12 | 0.0079 | 0.0560 | 0.0132 | 0.0912 | 0.8317 |
| 18 | 0.0095 | 0.0585 | 0.0132 | 0.0908 | 0.8281 |
| 24 | 0.0104 | 0.0598 | 0.0131 | 0.0906 | 0.8260 |

## 4. Robustness Test

*4.1. Postcrisis Subsample.* In this section, we analyze the subsample after the subprime mortgage crisis to see whether the results in the previous section are robust. We choose the postcrisis subsample for three reasons. Firstly, as shown in Figure 1, the hot money flows in China are greater in volume and variation after the financial crisis. Secondly, financial supervision and regulation policies varied considerably after the financial crisis in China. The internationalization of the CNY and financial opening-up in China progressed steadily during this period, marked by the pilot CNY settlement of cross-border trade, which began in 2009. At last, hot money flows were relatively small before the financial crisis, so the measurement error is a more serious problem for the precrisis subsample.

The postcrisis subsample started in January 2008. The HQIC and SBIC recommend a model of one lag. Furthermore, the model specification and identification conditions are the same as those of the full sample model. Impulse response functions are shown in Figure 3. The qualitative characteristics of the postcrisis subsample IRF are identical to those of the full sample IRF. Next, we quantitatively analyze the subsample IRFs.

(1) The standard deviation of $u_{2t}$ is 1.38, and IRF reaches the maximum value of 5.79 one month later. Therefore, when there is a positive shock of 1% of the economic growth rate, hot money inflow will increase by 4.2 (5.79/1.38) billion dollars in the next month.

(2) The standard deviation of $u_{3t}$ is 0.12, and IRF reaches the maximum value of 4.22. When the domestic interest rate rises by 0.1%, hot money inflow will increase by 3.52 (4.22*0.1/0.12) billion dollars in the next month.

(3) The standard deviation of $u_{4t}$ is 0.01, and IRF reaches the maximum value of −10.44 in the current period (month). Therefore, when the EER rises by 1%, hot money outflow will increase by 10.44 billion dollars in the current month.

Comparing the postcrisis result with the full sample result, we can see that the impact of all drivers has intensified since the financial crisis. The impact of

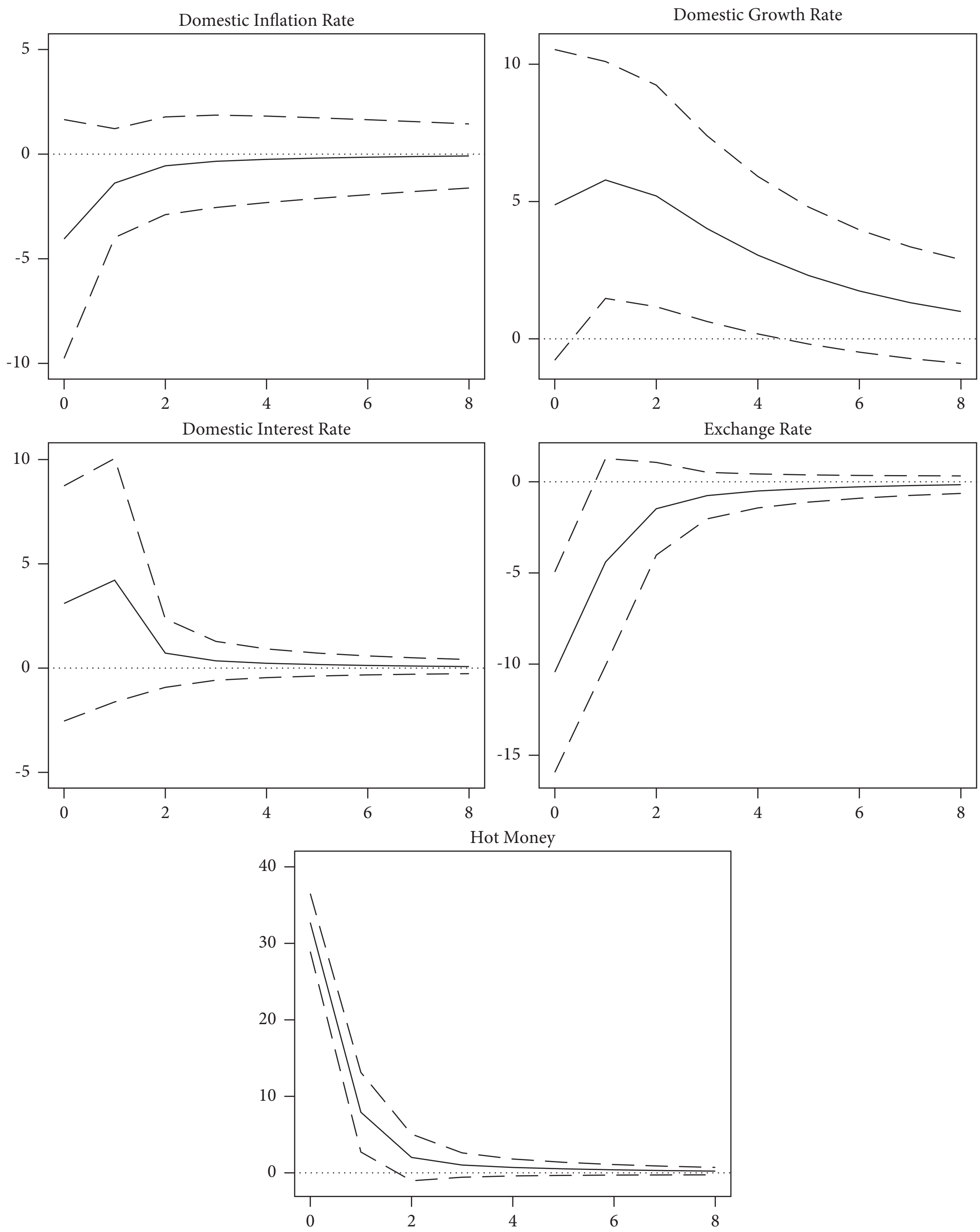


Figure 3: Impulse response functions of SVAR (postcrisis subsample).

the economic growth and domestic interest rates increased considerably, while that of the EER increased slightly.

*4.2. Alternative Measurement of Hot Money.* We measure hot money flow in China by an alternative approach to see whether the SVAR model is sensitive to the measurement approach. This section calculates hot money inflow using the following equation: hot money net inflow = variation in FER–net export–FDI. The sample period is 2000.9–2019.11, as we previously referred to as the full sample. The HQIC and SBIC recommend a model of one lag, and the model specification and identification conditions are the same as those of the full sample model.

Figure 4 shows the IRFs. The estimated matrix B is similar to that of the baseline model, which means that the sizes of standard deviation shocks are similar. We can compare IRFs directly. The two results are qualitatively the

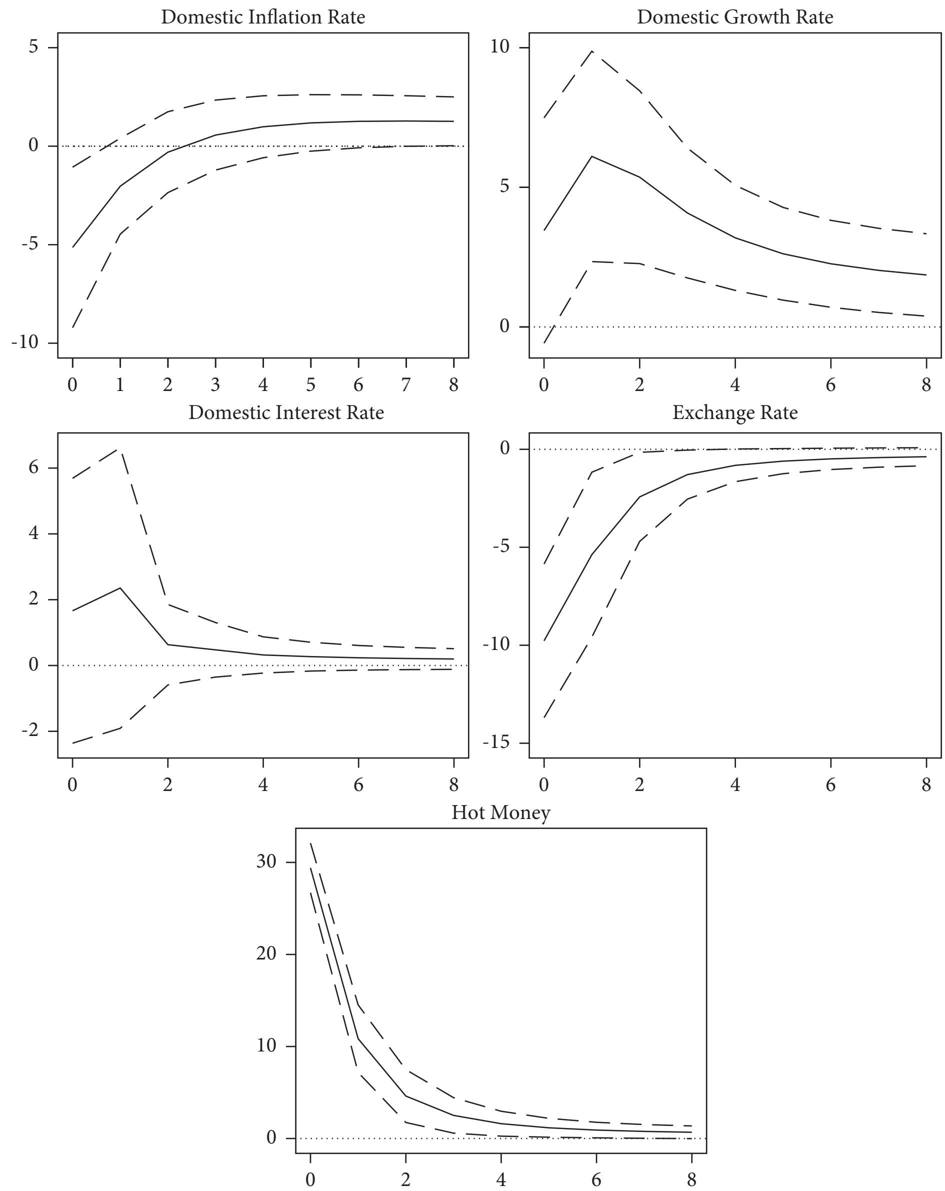


Figure 4: Impulse response functions of SVAR (alternative measurement of hot money).

same: hot money negatively responds to price shock. It positively responds to growth rate shock, and the IRF peaks in the next period. Additionally, it positively responds to domestic return rate shock and negatively responds to EER shock. It positively responds to its own shock. IRFs are quantitatively very close, except that hot money's response to price shock is slightly larger.

## 5. Conclusions and Policy Implications

This paper explores the main drivers of hot money and quantifies their influence in China. Firstly, we develop a portfolio decision model from the viewpoint of a foreign investor (speculator) according to expectation-variance utility theory. We show that in the case of the foreign investor holding both long positions of the two countries' assets, the factors that cause the foreign investor to allocate more wealth to domestic asset and cause hot money net inflows to increase include the following: expected domestic currency appreciation, rise in domestic asset return, drop in the foreign asset return, domestic economic growth, decrease in domestic inflation, and increase in foreign asset risk. Secondly, we estimate the SVAR models and find the empirical results accord with theoretical model predictions. We also find that the expected exchange rate is the most influential of all the hot money drivers, and the domestic growth rate is the most enduring.

The theoretical implications of the study are twofold. The first implication is that the expected exchange rate is the most important driver of hot money in China. The other drivers are not as important as existing theories predicted. The second implication is that the majority of variations in hot money are left unexplained. Therefore, it is necessary to advance a better theory to describe hot money flows, such as a theory including expectations of political change. Furthermore, the regime shift caused by the adoption of electronic money may also explain part of the variations in hot money flows [32].

The policy implications of this study are as follows: firstly, when hot money flows out, raising the domestic interest rate helps mitigate hot money outflows. Our findings show that the policy effect is not significant, so monetary policy is not an effective policy tool to control capital flight. Secondly, the expected exchange rate is the most influential driver of hot money in the short run. Therefore, it is important to enhance investors' confidence in the domestic economy to reverse the trend of capital flight. Credible policy declaration is an efficient and low-cost way to ameliorate investors' expectations if the monetary authority is trusted, so policy declaration is an ideal way to control hot money. Thirdly, stable economic growth can attract hot money in both the short and long run. Thus, the steady growth of the economy is the ultimate way to keep hot money under control.

## Data Availability

The Foreign Exchange Reserve data, Current Account data, and foreign debts data used to support the findings of this study are deposited on the website of the State Administration of Foreign Exchange of China (http://www.safe.gov.cn/safe/tjsj1/). The Foreign Direct Investment and Market Volatility Index data used to support the findings of this study were supplied by Wind Information Technology Company Limited under license and so cannot be made freely available. Requests for access to these data should be made to Wind Information Technology Company Limited (www.wind.com.cn). The economic growth rate and Chinese interbank offered rate data used to support the findings of this study were supplied by the Chinese Economic Information Statistics Database under license and so cannot be made freely available. Requests for access to these data should be made to China Economic Information Network (www.cei.cn). The inflation rate data used to support the findings of this study were supplied by China Stock Market and Accounting Research Database under license and so cannot be made freely available. Requests for access to these data should be made to Shenzhen CSMAR Data Technology Company (www.gtarsc.com/). The US dollar LIBOR and 3-month NDF data used to support the findings of this study were supplied by CEIC Data's Global database under license and so cannot be made freely available. Requests for access to these data should be made to CEIC Data (https://www.ceicdata.com/en).

## Conflicts of Interest

The authors declared that they have no conflicts of interest.

## Acknowledgments

Hu gratefully acknowledges the financial support of the Anhui Province Federation of Social Sciences (2020CX056) and the Education Department of Anhui Province (SK2021A0654, SK2019A0586).

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