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The Effect of Changes in the U.S. Monetary Policy on China's Capital Market Stability and Trade between China and Korea

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KIEP & IMI project

Executive summary

This paper first reviews the trade structure between China and the Republic of Korea (hereafter referred as Korea) and the two countries' international capital flow. Then it discusses the effect of the Federal Reserve rate on UIP in both China and Korea, which turns out to be uninfluential through our analysis. Then we use VAR model and the extended model, the multivariate GARCH-DCC model to examine interaction between different factors. The result shows that positive-legged equity return would induce outflow and flow positively affects equity return. Sharp offshore RMB devaluation would cause domestic market plummets and higher legged spread means higher carry trade return. Besides, in the respect of capital control effects, offshore RMB devaluation would cause spread to be wider because of inelasticity of the onshore RMB rate. Carry trade return has positive and significant intercept. Finally, we argue that although the appreciation of USD has little impact on bilateral trade between China and Korea in short time, in long run, currency risk exists and it may cause significant fluctuations in the trade. We suggest that China and Korea should gradually use local currency to price their trade.

Key words: Bilateral trade, UIP, VAR model, multivariate GARCH-DCC model, RMB, Capital flow

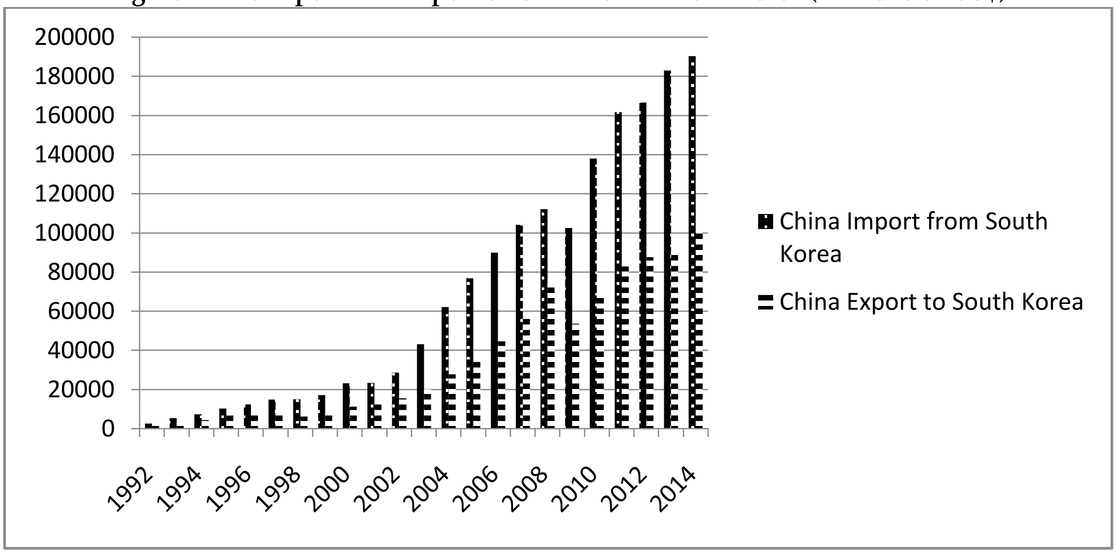
1. Introduction

Since the financial crisis of 2008, the world economic growth has slowed down. Nevertheless, the bilateral trade between China and Korea remained well performed. The size of trade grows consistently, and the trade structure becomes more rational. The negotiation of Free Trade Agreement (FTA) between China and Korea was launched in May, 2012, and both countries agreed with some terms regarding the tariff reduction and import quota, thus achieving the first step of the whole FTA negotiation in September 2013. The development of FTA between China and Korea is viewed as an important fundamental for bilateral trade. We review the trade patterns and international capital flow of the two countries to investigate the potential problems. We also provide policy implications to promote the bilateral trade and capital market stability.

1.1 The current status of bilateral trade between China and Korea

Ever since China and Korea established diplomatic relations in 1992, the bilateral trade between two countries experienced steady growth (except 2009 when global financial crisis deeply reduced the demand). In 2010, the total trade volume between China and Korea reached over US$ 200 billion, and the volume is still increasing. Although the global economy suffered slow-down in 2012, and the domestic cost of production (in terms of labor cost and environment cost) in China increased substantially, the bilateral trade between China and Korea has been kept on rising. The total trade volume in 2014 is more than 50 times of the initial volume in 1992. The export from China to Korea increased from US$ 2.4 billion in 1992 to US$ 100.4 billion in 2014, while the import of China from Korea increased from US$ 2.6 billion in 1992 to US$ 190.3 billion in 2014 (see figure 1). China has been the largest foreign market for Korea for more than 12 years, and it also has been the largest exporting country to Korea for more than 8 years.

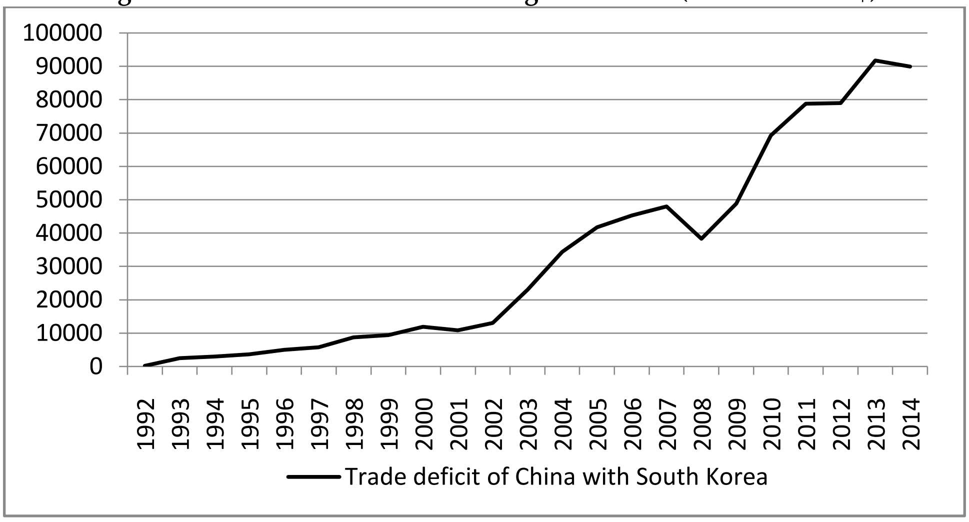
Figure 1. The Export and Import of China to and from Korea (millions of US$)



Source: CEIC data base.

Since 1992, China has been running trade deficit with Korea. With the deepening of the bilateral trade structure, the trade deficit of China is growing (see figure 2). In 2014, the deficit of China is US$ 90 billion, an increase of 370.8 times compared to 1992. This growth rate of China's deficit is much larger than the growth of total bilateral trade volume. There are many reasons for the fast growing deficit. First, the high growth rate of China's domestic economy provides Korea with a fast expanding market and demand. Second, the foreign direct investment (FDI) of Korea in China brought new opportunities for its export. The largest destination of Korean FDI has been China for 12 years, with the total investment volume of over US$ 50 billion. These FDI indirectly boom the export from Korea to China. In the third place, the variety of products varies significantly between goods shipping from China to Korea and goods shipping from Korea to China. Most goods exported from Korea to China are high value-added, technology-intensive, and capital-intensive products, such as automobile. However, goods exported from China to Korea are mostly low value-added and labor-intensive products. In this way, Korea is at a better position to earn surplus in trading with China.

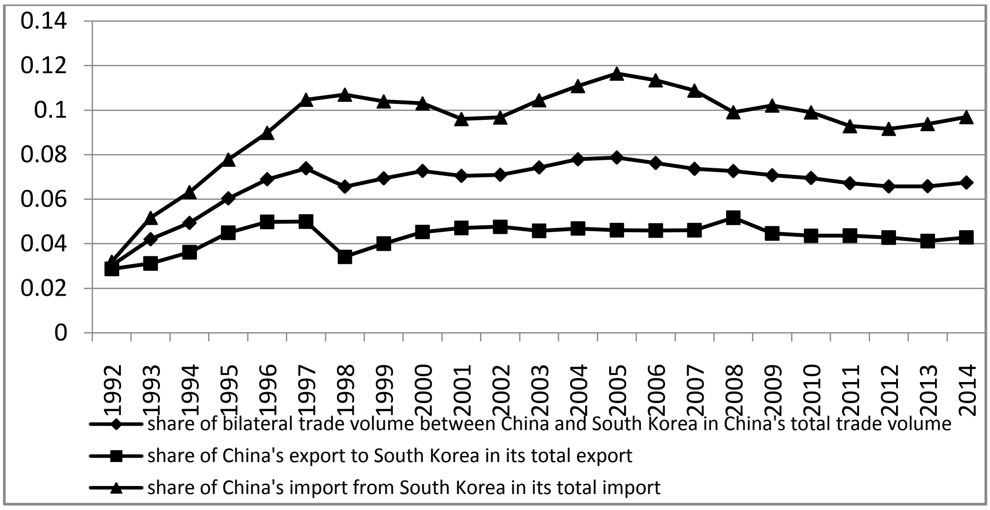
Figure 2. China's Deficit from Trading with Korea (millions of US$)



Source: CEIC data base

China has been the largest trading partner for Korea for 11 years, and Korea is currently the third largest trading partner of China, next to the United States and Japan. This shows that the two countries are economically dependent. Figure 3 shows the share of trading volume between China and Korea in China total trading volume, and shares of export and import volume of the bilateral trade in total China's export and import.

Figure 3. Share of Bilateral Trading Volume between China and Korea in China's Total Trade Volume

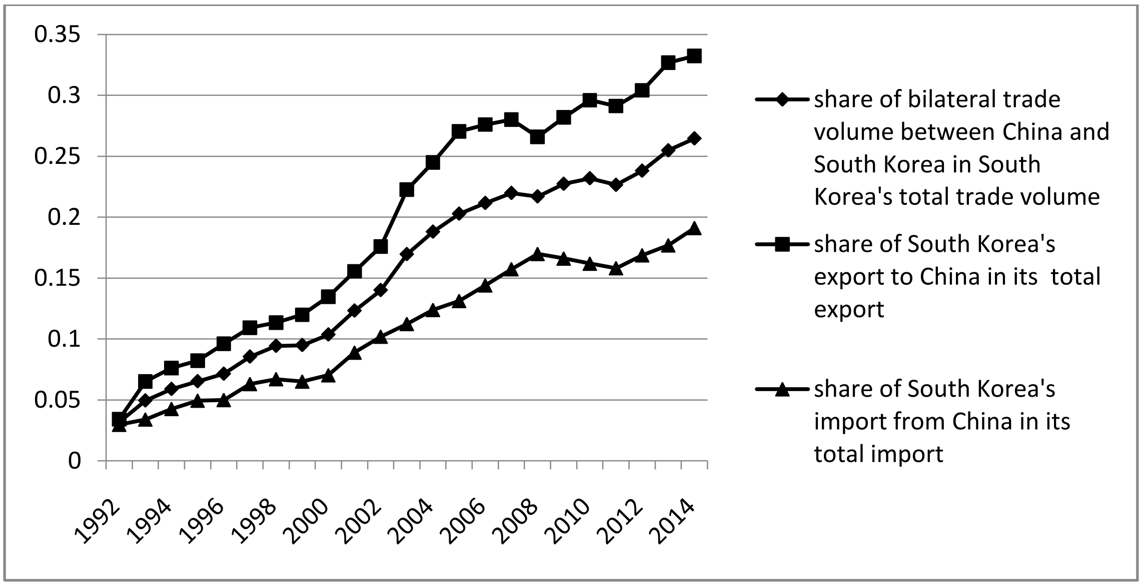


Source: CEIC data base

From figure 3, we see that over 10 percent of China's total imports come from Korea, and around 5 percent of China's exports are shipped to Korea. These shares remain stable, meaning that the trading volumes of China with Korea increase along with the country's total international trade.

In terms of share of bilateral trade volume between China and Korea in Korea's total trade volume, the data shows that China has become a more and more important trading partner of Korea (see figure 4).

Figure 4. Share of Bilateral Trading Volume between China and Korea in Korea's Total Trade Volume



Source: CEIC data base.

Figure 4 is impressive, as the share of Korea's export to China in its total export increased from around 3% to more than 30%. This says that over than one third of Korea's exports are shipped to China. The import of Korea from China has also gained significant importance in its total import, as around one-fourth of Korea's imports come from China in 2014. All shares in figure 4 show stable and fast growth, indicating that China is now the most important trading partner for Korea.

1.2. Degree of integration, trade combined index, and trade structure between China and Korea

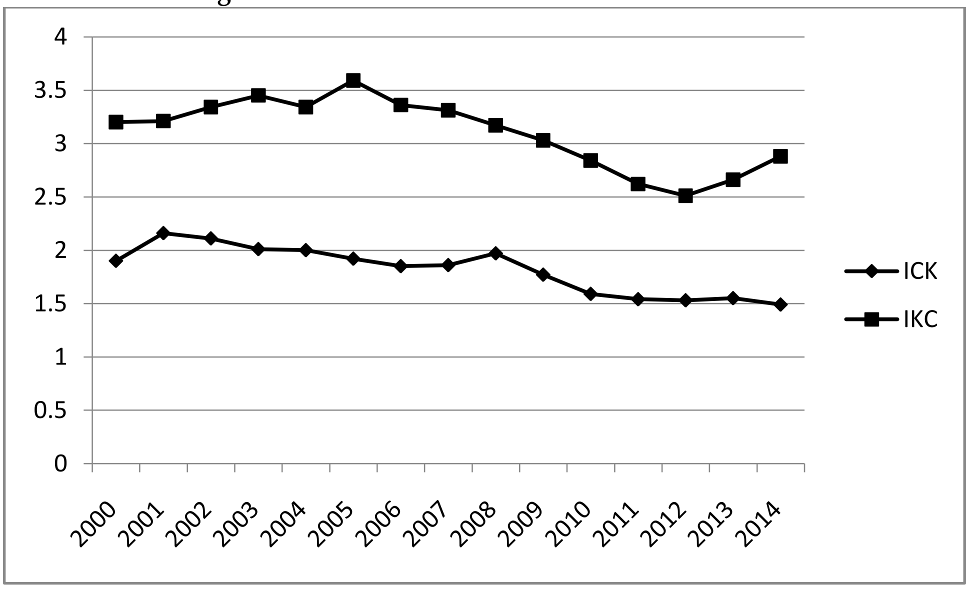
The Trade Combined Index is an index to feature the integration of two trading countries in international trade activities. This index is defined as follows: suppose two trading counties: China and Korea. Denote X_{CK} as the export from China to Korea, and X_C as China's total export. Also denote M_K as the total import of Korea, and M_W as the total import of the whole world. Then Trade Combined Index is defined as:

$$I_{CK} = \left({X_{CK}}/{X_C}\right) / \left({M_K}/{M_W}\right)$$

If I_{CK} is greater than 1, it says the two trading countries are more intensively integrated (or combined) than the world average. The larger is the Trade Combined Index, the more intensive this trading relationship is.

Following this definition, we find that both Trade Combined Index of China over Korea (I_{CK}) and that of Korea over China (I_{KC}) are larger than 1 for the past 14 years. Figure 5 shows the I_{CK} and I_{KC} from 2000 to 2014.

Figure 5. The Trade Combined Index of I_{CK} and I_{KC}.



Source: CEIC data base and authors' own calculation

From figure 5, we can see that both I_{CK} and I_{KC} are greater than 1, with I_{KC} much higher than I_{CK}. This shows that Korea's dependence on China's market is greater than China's dependence on Korea's market. During 2000 to 2014, both I_{CK} and I_{KC} show the pattern of first increase and then decrease. This change may be due to the two countries' industrial policy changes that affect the trading patterns, which we discuss later. For instance, Korea's domestic economic policy shifted its export towards other destinations in 2005, resulting a decreasing I_{KC} thereafter. Anyway, the large I_{KC} shows that China is the most important destination of Korea's export.

Regarding the trade structure, China and Korea differ in endowment, and this creates the opportunities for the two countries to trade, as the classic trade theory predicts. Compared to Korea, China is endowed with richer natural resources and lower-cost labor. This determines that the comparative advantage of China in trading with Korea is the resources-intensive and labor-intensive products. Indeed, the exports from China to Korea mainly concentrate on Textile, Leatherwear, and other out-sourcing products. On the other hand, Korea has comparative advantage in technology and capital, and the export from Korea to China mainly concentrates on capital-intensive and technology-intensive products such as electronic equipment, optical devices, and medical equipment.

With the development of China's domestic economy, the traditional comparative advantages of low labor cost and abundant resources are vanishing. China is upgrading its industry and has started to export more and more capital-intensive products. However, the technology level in China is still much lower than that in Korea, thus the comparative advantage theory still holds. In fact, we do observe that the bilateral trade between China and Korea has been changing from inter industry trade to intra industry trade. For example, the latest trading statistics show that over 39% of exports from Korea to China are electrical and electronic equipment, and so is the 34% of China's export to Korea.

1.3 Problems of the bilateral trade between China and Korea

Although China and Korea are mutually dependent on economic activities, there are still some problems in the ever-expanding bilateral trade.

First of all, the trade imbalance is significant and growing. For the past 24 years, the trade imbalance has always been the most headache problem for both China and Korea. Indeed, such deficit is large and growing, and Korea is China's largest source of trade deficit. The persistent and huge trade deficit of China with Korea is unfavorable to both countries. For China, growing trade deficit means that China has to use more and more foreign reserve to support the ever deepening bilateral trade. For Korea, growing trade surplus may result in resource loss and increase of domestic unemployment.

Second of all, the non-price competitiveness of Chinese products is low, and the competitiveness of Korean products is decreasing. Although China is the largest exporting country to Korea, the high-end products imported by Korea mainly come from Europe and the United States, rather than China. This shows that the non-price competitiveness of Chinese products is low, mainly in quality, packing, standardization, after-sale services and so on. Most of China's exports to Korea are labor-intensive and low value-added products. Although the prices are competitive, these products lack innovation and brand effect. This trading pattern is certainly not sustainable for the long-term bilateral trade relationships.

In the third place, the trade frictions between China and Korea are increasing. These frictions harm the bilateral trade development. It is because both China and Korea realize that having a healthy bilateral trade relationship is mutually beneficial that the two countries decide to develop Free Trade Agreement (FTA) to reduce the frictions.

1.4 Overview of China's international capital flow

Since 2001 when China joined WTO, the economy has been growing at a high speed. Both of China's current account and financial account are running into surplus, and large volume of international capital has entered the Chinese market. The additional foreign capital, admittedly, is important for the growing domestic economy, but also caused the RMB appreciation, inflation, and excessive liquidity problems and so on. If the inflow of foreign capital turned to be outflow, it might cause huge shocks to China's macro-economy. Therefore, it is important to study the influencing factors of China's international capital flow, such that Chinese government can be well prepared to deal with any international changes and shocks.

Early studies of international capital flow focused on the flow within developed economies. The influencing factors of the flow include interest rate, exchange rate, asset portfolio, monetary policies, and transaction cost. The latest researches study the flow between developed and developing economies, and the influencing factors are categorized to "Pull factors" and "Push factors".

The "Pull factors" are based on the conditions of domestic economy, such as return rate of investment, market conditions, institutional factors, credibility of the government and firms and so on. For example, Prasad and Wei (2005) find out that the interest rate spread between China and the U.S., the appreciation of RMB, and high growth rate of China's economy are important influencing factors that caused huge non-FDI foreign capital inflow to China. Ralhan (2006)'s empirical study shows that the size of foreign reserve and the growth rate of GDP are the most two important factors to attract foreign capital inflow, while the openness and inflation rate are not significant factors. In addition, political environment, credibility, and institutions also impact the capital inflow. Nordal (2001) finds out that political risk is negatively correlated with FDI in this country, and Reinhart and Rogoff (2004) find that the reason that international capital does not flow from rich country to poor country (the so called Lucas Paradox) is because the poor countries have low credibility in repaying the foreign debt.

The "Push factors" refer to the global economy, such as the world interest rate, foreign countries' economic fluctuations, and foreign countries' policies. For example, Calvo et al. (1993) argue that the primary cause of the debt crisis in Latin America in 1980s was the contractionary fiscal policy in the U.S. The increase of interest rate in the U.S. caused large volume of capital to leave Latin America and flow into the U.S. market.

Latest studies of influencing factors of international capital flow use the recent financial crisis as the background. For example, Fratscher (2011) finds out that the "Push factors" are the driving factors of international capital flow during the financial crisis between 2007 and 2008. However, since 2009 when the global economy began to rebound, the "Pull factors" are the dominating factors of the flow.

For China, the increasing short-term capital inflow since 2003 has drawn attentions. Li and Qian (2011) find out that the appreciation of RMB or the expectation of the RMB appreciation inhibit inflow of long-term foreign capital such as FDI but encourage inflow of short-term foreign capital. The interest rate spread between Chinese market and foreign markets is negatively correlated with FDI.

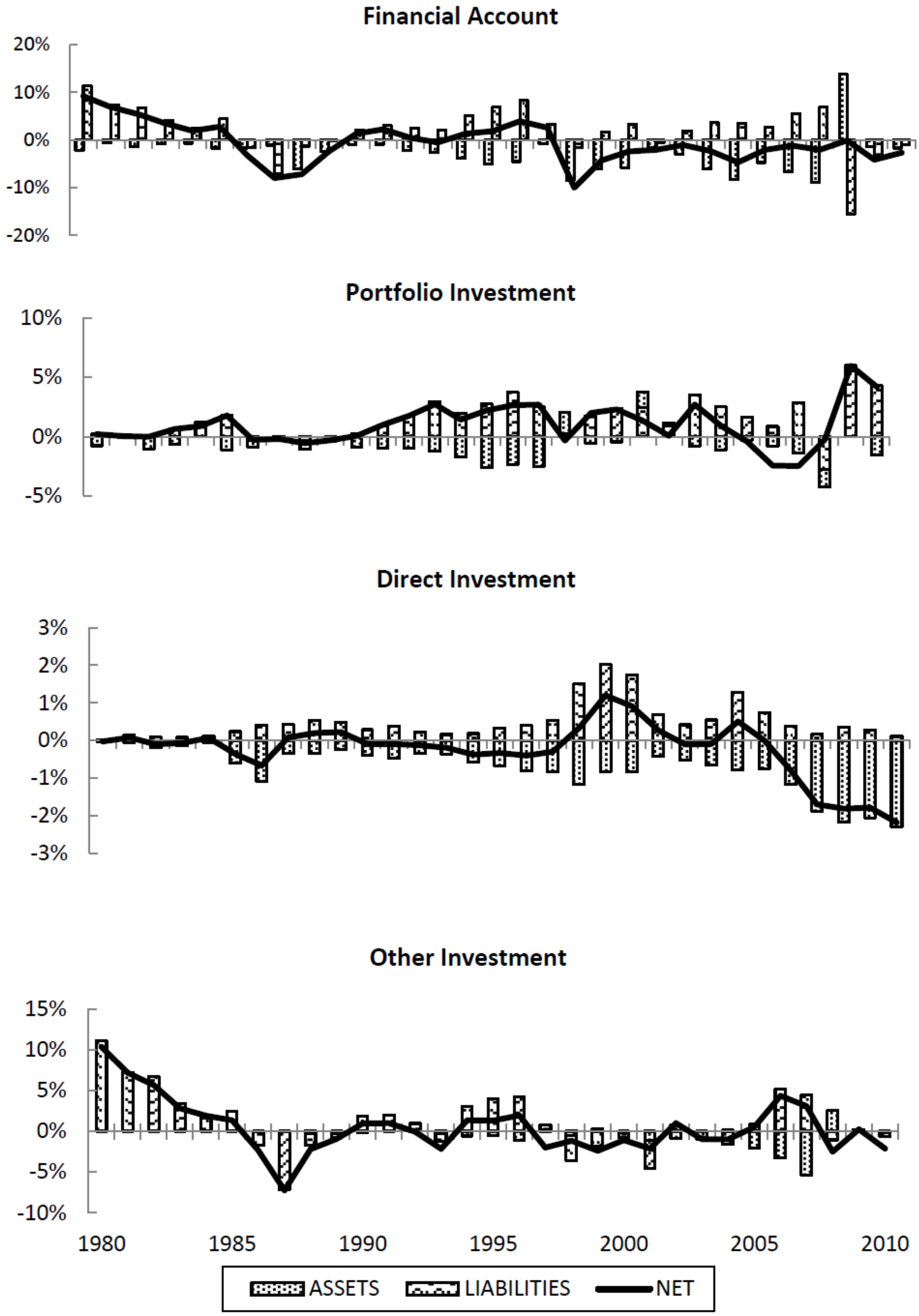
With the above discussion, we believe that the following factors (both push factors and pull factors) can influence China's international capital flow. These factors include GDP (gross domestic production), Interest rate spread (denoted as IRS), Inflation, Stock Price (denoted as SP), Real estate price (denoted as REP), China's wage level, RMB's nominal exchange rate (denoted as EX), the expectation of RMB appreciation (denoted as Epex), and Openness. Because China's capital account is regulated, the financial account cannot reflect the actual inflow. Therefore, we use Foreign Reserve minus Net Export to measure the total net international capital inflow (NCF). We further use FDI to measure the long-term international capital inflow and therefore NCF-FDI to measure the short-term international capital inflow (SCF).

Our expectation is that, GDP is positively correlated with FDI, as better macro-economy may increase the sourcing countries' return on FDI. IRS is positively correlated with SCF, because short-term capital can gain higher return if interest rate in China is higher. However, IRS is negatively correlated with FDI, because the financing cost of foreign firms in China is higher. The relationship between inflation and capital inflow is ambiguous, as we need to further verify the reason of inflation. If inflation is a result of booming economy, it is positively correlated with FDI. However, if inflation is part of stagflation, it is negatively correlated with FDI. Anyway, foreign capital usually uses inflation and other macro variables to interpret conditions of domestic economy and potential monetary policy changes. The stock price and real estate price impact the return rate of foreign capital invested in China, thus they are positively correlated with NCF. Higher wage increases the cost of production in China, thus dampens the willingness of FDI in China. Exchange rate affects the cost of export, thus those FDI firms who are in international trade industry may pay strong attention to this variable. Appreciation of RMB dampens the willingness of these firms to invest in China. Expectation of RMB appreciation is believed to have significant impact on short-term capital flow that arbitrage the movement of exchange rate. Last but not least, openness should be positively correlated with capital inflow.

1.5 Overview of Korea's international capital flow

From figure 6 below, we can see that the absolute amount of assets and liabilities of Korea have increased significantly since 2000s. This shows that Korea has been under rapid financial integration. In addition, all the components of Korea's financial account, including portfolio investment, direct investment, and other investment (such as bank assets and liabilities) exhibit large fluctuations. This shows that Korea has been experiencing high volume of capital flows since the Asian Crisis.

Figure 6. International Capital Flow in Korea



Source: Kim et al. (2013)

Kim et al (2013) cast an empirical study to investigate the determinants of international capital flow in Korea, and they find that push factors, in particular world interest rate, play a more important role than pull factors in determining capital flows in Korea.

Among pull factors, current account has significant and negative effects on capital flows. The estimated coefficients vary in different sub periods. They also find that determinants of capital flows differ in specific components of the financial account. In particular, portfolio investment is more sensitive to internal and external economic environments compared to direct investment. The analysis on gross capital flows (liabilities and assets) show that the main determinants are slightly different than net flows.

In the next section, we analyze the dynamic relationship between net equity inflows, equity returns, and excess returns of carry trade in China and Korea. We use a VAR (vector auto-regressive) model and a VAR-MGARCH-DCC model to carry out this study. Particularly, we find that that capital controls and arbitrage opportunities on the local currency market dynamically affect each other in China. Capital inflows and equity returns are also closely connected to each other. But arbitrage opportunities on the currency market seem to have little impact on the Chinese equity market returns. In Korea, equity return has a significant impact on equity flows but the reverse is not true. Equity flow turns out to have little impact on equity return in the Korean market. Finally, we find that the Fed's interest rate policy had little impact on the profitability of currency trading between the RMB/KRW and US$.

2. Empirical Study of China and Korea's International Capital Flow and Impacts of Federal Funds' Rate

2.1 Background and overview

Understanding the facts is the basis to further analysis. Having got the overview of trade and capital flows between China and Korea, we can move our steps on to see what's happening between these two countries and other parts of the world.
There are burgeoning concerns about the federal funds rate's impacts on emerging markets, especially China and Korea, as the federal has intention to raise interest rate in the future and China and Korea are representative countries to be impacted. One of the biggest concern is capital will flow out as a result, which may result in strengthening in capital control. Economic theory suggests frictionless international capital flows should benefit all countries because market efficiency ultimately ensures capital to be allocated to the most productive sectors/countries, therefore the aggregate welfare improves globally thanks to the reduced cost of one unit of production. However, many countries, especially the emerging market economies (EMEs), tend to vote against this argument. Governments seem to be keener to impose restrictions on the capital inflow/outflow activities, and this becomes more common after the 2008 global financial crisis (Eichengreen, 2014). Policies as such are often backed-up by the concerns regarding domestic financial stability. Capital controls are seen in various forms, and there is much debate on whether these are suitable or efficient. Even though the IMF (IMF, 2011) suggests that the capital controls may be a valid tool of macroeconomic management when other tools become ineffective, some researchers, for example Straetmans (2013), Glick and Hutchison (2005), Bordo et al. (2001), Voth (2003) and Bekaert and Harvey (2000), insist on capital controls to have poor efficiency and limited effect on adjusting capital flows in practice. While other researchers, such as Aizenman and Pasricha (2013), Ahmed and Zlate (2014) and Glick (2005) support that capital control as a policy instrument appears to restrict capital flows effectively.

A re-emergence of controlling the cross-border capital flows is justified on the ground that policies as such can be seen as a governmental commitment to macro-prudence, and that an optimal response to distortions in financial markets. These controls are deemed to be an important tool to prevent the build-up of financial sector risks and to reduce the damage associated with sudden stops (Aizenman and Pasricha, 2013). It is until 2011 has the International Monetary Fund (IMF) recognized its validity to be a possible policy instrument of last resort.

Literature reveals a clear relationship between the macroeconomic conditions of a given EME, capital mobility and its capital control being an instrument to assist monetary sovereignty (Ahmed and Zlate, 2014). However, the mechanisms of capital controls have not been confirmed, and the intermediate conductive variables between capital controls and capital flows are not found. Exploring a potential path from capital controls to capital flows is one of the purposes of this article.

Unfortunately, current literatures are usually based on monthly or quarterly data, whose frequency hardly helps to identify short-term international capital flows and rapid market responses toward capital controls. The financial market may react to a policy change in less than a day, but monthly or more low-frequency data totally smooth the data. Due to that, the dynamic relationship between capital controls and capital flows or capital flows and foreign exchange markets are covered. Daily data used in this article is contributed to display real-time financial market reaction and restore accurate inter-market relationships.

Current literatures mainly use ordinary least square method and panel or sectional data to achieve their conclusions, omitting potential mutual and reverse causality. The assumptions of simple ordinary least square method have been violated, and it may lead to inaccurate causal relationship. Besides, for unbiased estimates within panel or sectional data, the assumption of no correlation between error terms and independent variables must be satisfied, which hints that the causality between dependent variables and independent variables is unidirectional. This inference seems hardly to be satisfied, because agents on financial markets always have their anticipation. Shocks on a market will meanwhile spill over to other markets and change agents' anticipation, the latter of which will change market with shocks again. Vector auto regression with multivariate GARCH model is established in this article and handles mutual causality.

Autocorrelation is also neglected by current literatures. Based on momentum theory, Jegadeesh and Titman (1993, 1995, and 2001) pointed out that both over action and delayed action exist in some stock markets. Okunev and White (2003) analyzed momentum strategy is profitability in foreign exchange markets, indicating the existence of autocorrelation of return series in stock markets and foreign exchange markets. In other words, autocorrelation represents a risk factor named momentum factor proposed in Carhart (1997) and ignoring this risk factor causes wrong causality.

A characteristic in stock markets or foreign exchange markets is volatility cluster which corresponds to the fat-tailed distribution of returns. Some extreme events such as Lehman Brothers' bankruptcy or Ruble Crisis can generate extreme stock or exchange rate plunge which seems impossible under the assumption of normal distribution.

Frequent Black Swan events remind researchers that extreme market conditions are not seemingly rare in financial investment. This kind of time-varying variance promoted researchers to describe the heteroscedasticity and GARCH model is one of the common methods.

China, a developing country with capital controls and high-volume equity flows, exists a mature offshore capital market but also a mature onshore capital market. Thus, China is one of the best countries which are appropriate for studying capital controls and equity flows. Unexpectedly, there are few papers focusing on China's capital controls or capital flows in recent years. This article tries to make up for the absence of studies which investigate capital controls in China.

This chapter is structured as follows. The second section is about theoretical analysis and some hypotheses are presented. The influence of federal interest on UIP of China and Korea will be tested in this part. In the third section, variables used in this article are defined and benchmark model as well as VAR model is introduced. The forth section shows the extended model. Multivariate GARCH-DCC model is introduced in this part. The last section draws the conclusion.

2.2 *Decomposition of equity flow return*

This paper mainly analyzes the dynamic relationship between net equity inflows, equity returns, and foreign exchange market gains in China and Korea. Data are collected including stock index of stock market $P_{country,t}$, USD/CNY onshore exchange rate $e_{China,t}$, USD/CNH offshore exchange rate $e'_{China,t}$, USD/KRW exchange rate $e_{Korea,t}$, USD interest rate $r_{USD,t}$, CNY interest rate $r_{China,t}$ and KRW interest rate $r_{Korea,t}$. United States ismodeled as the home country while China or Korea is modeled as the foreign country. All exchange rates are in direct quotations.

If a home equity investor holding dollars invests on stock markets in China or Korea, the excess return at time t $R_{country,t}$ will be calculated as:

$$R_{country,t} = \ln \frac{P_{country,t+1} / e_{country,t+1}}{P_{country,t} / e_{country,t}} - r_{USD,t} \tag{1}$$

where $country = China, Korea$. It is easy to understand the above equation: the stock indexes denominated in USD at time t is $P_t / e_{country,t}$ and that at time $t+1$ is $P_{t+1} / e_{country,t+1}$. The return of a stock investor is $\ln \frac{P_{country,t+1}/e_{country,t+1}}{P_{country,t}/e_{country,t}}$ and the risk-free interest rate for a home investor is $r_{USD,t}$, so the excess return at time t is $\ln \frac{P_{country,t+1}/e_{country,t+1}}{P_{country,t}/e_{country,t}} - r_{USD,t}$.

Then exchange rates are considered. $e_{China,t}$ Indicates the onshore exchange rate of RMB and $e'_{China,t}$ indicates the offshore exchange rate of RMB, but Korea have only one exchange rate due to free capital flow. In order to facilitate the following discussion but without loss of generality, this article defines the offshore exchange rate of Won as $e'_{Korea,t} \equiv e_{Korea,t}$, where $e_{Korea,t}$ is the onshore exchange rate of Won

To identify the risk factors of equity investing, the excess return can be reconstructed as

$$\begin{aligned} R_{country,t} &= \ln P_{country,t+1} - \ln P_{country,t} - r_{country,t} \\ &+ \ln e_{country,t} - \ln e'_{conutry,t} - \ln e_{country,t+1} + \ln e'_{country,t+1} \\ &+ r_{country,t} - r_{USD,t} - \ln e'_{country,t+1} + \ln e'_{country,t} \end{aligned} \tag{2}$$

If the following variables are denoted by

$$\begin{aligned} Equity_{country,t} &\equiv \ln P_{country,t+1} - \ln P_{country,t} - r_{country,t} \\ Spread_{country,t} &\equiv \ln e_{country,t} - \ln e'_{country,t} - \ln e_{country,t+1} + \ln e'_{country,t+1} \\ UIP_{country,t} &\equiv r_{country,t} - r_{USD,t} - \ln e'_{country,t+1} + \ln e'_{conutry,t} \end{aligned} \tag{3}$$

the excess return can be rewrote as

$$R_{country,t} = Equity_{country,t} + Spread_{country,t} + UIP_{country,t} \tag{4}$$

Moreover, $Spread_{Koera,t} \equiv 0$.

$Equity_{country,t}$ is defined as $\ln P_{country,t+1} - \ln P_{country,t} - r_{country,t}$, in which $\ln P_{country,t+1} - \ln P_{country,t}$ is the log return of stock market in a country and $r_{country,t}$ is the risk-free interest rate at that country for foreign investors. Thus, $\ln P_{country,t+1} - \ln P_{country,t} - r_{country,t}$ is the risk premium of a foreign stock market, which is named $Equity_t$. This part of return corresponds to the risk of stock market volatility without any monetary factor.

$Spread_{country,t}$ equals $(\ln e_{country,t} - \ln e'_{country,t}) - (\ln e_{country,t+1} + \ln e'_{country,t+1})$. We denote $\ln e_{country,t} - \ln e'_{country,t}$ as $s_{country,t}$, which means the difference between onshore exchange rate and offshore exchange rate. In particular, $s_{Korea,t}$ is always zero so the following statement only applies to China.

$Spread_{country,t}$ has the same value with $\Delta s_{country,t}$ where $\Delta s_{country,t} \equiv s_{country,t} - s_{country,t+1}$. Obviously, the economic insight of $Spread_{country,t}$ is the change of onshore-offshore exchange rate spread. If capital control policy did not exist, there would be no onshore-offshore exchange rate spread and no division in the onshore and offshore currency exchange, as happened in Korea. On the other hand, onshore exchange rate USD/CNY reflects the inflow and outflow balance in the onshore foreign exchange market while offshore exchange rate USD/CNH reflects that in the offshore market. The offshore exchange rate USD/CNH is the equilibrium price under free capital flow, whereas the onshore exchange rate USD/CNY is the equilibrium price under capital control policy. Therefore, the onshore-offshore exchange rate spread, which is the price differential between free capital flow and capital control, may represent the intensity of capital control policy. Furthermore, $Spread_{country,t}$, which means onshore-offshore exchange rate spread change, indicates the direction of capital control policy changes. Specifically, when $Spread_{country,t}$ is positive, capital control policy is tightened; when $Spread_{country,t}$ is negative, capital control policy is relaxed. This part of return corresponds to the risk of capital control policy change and it is unique for foreign investment in China.

$UIP_{country,t}$ is denoted by $r_{country,t} - r_{USD,t} - \ln e'_{country,t+1} + \ln e'_{country,t}$. Suggested by Balvers (2014), currency risk premium is an indispensable part of international investment portfolio return, and the currency risk premium can be offered by zero-investment uncovered interest parity (UIP) portfolio. The return from an uncovered interest rate parity portfolio is $\ln e'_{country,t+1} - \ln e'_{country,t} + r_{country,t} - r_{USD,t}$, so $UIP_{country,t}$ represents the currency risk premium at time t. However, if uncovered interest rate parity held, the currency risk premium would be zero, so the existence of currency risk premium is called forward premium puzzle. Fama (1984), Sarantis (2006), Lothian (2011) pointed out that uncovered interest rate parity is not established in general conditions. Moreover, sovereign default risk and global risk are significant to explain the forward premium puzzle (Zhang, 2010; Coudert, 2013; Tse, 2013). Due to the current literature, the currency risk premium corresponds to the sovereign default risk and global risk.

Summarily, the excess return of investment on Chinese stock market for home fund investors can be divided into three parts, represented by $Equity$, $Spread$ and UIP individually. $Equity$ represents the risk premium of stock market in China, $Spread$ represents the onshore-offshore exchange rate spread change, and UIP represents the currency risk premium. These three variables representing three kinds of risk premium may affect short-term international equity flow and equity flow can affect simultaneously, so $Flow$, $Equity$, $Spread$ and UIP are chosen in the model.

2.3 *Data and description*

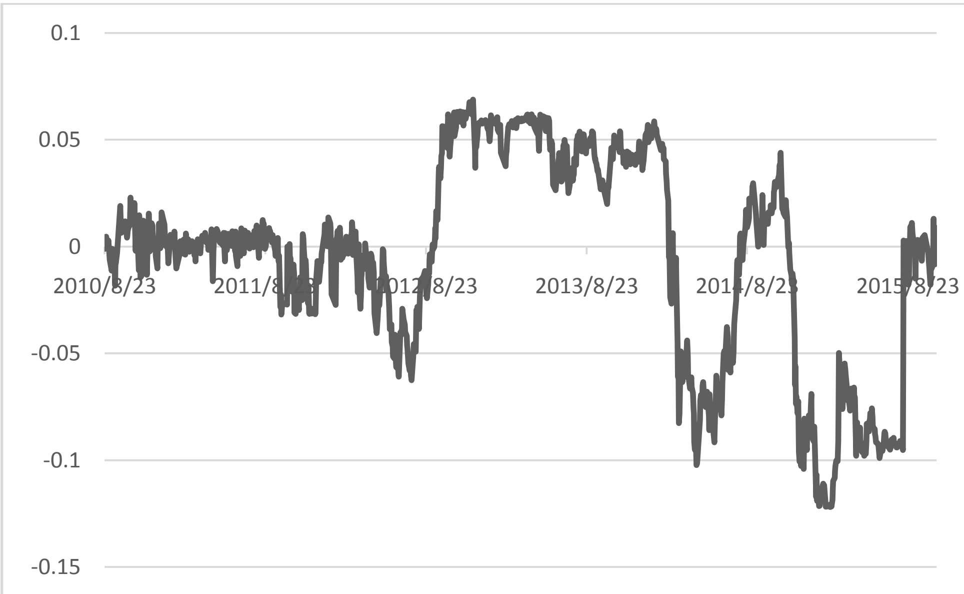
2.3.1 Data selection

Samples are recorded daily from 08/23/2010 to 10/28/2015, excluding unmatched data, in total 1159 observations. Short-term international equity flow, onshore-offshore exchange rate spread, stock market risk premium and uncovered interest rate parity are selected to build the model.

Short-term international net equity inflows are downloaded from EPFR Global dataset and the source of the remaining data is Bloomberg. Interest rate of CNY, KRW and USD is represented by China interbank 7-day national debt reserve repurchase, the Bank of Korea Base Rate, effective federal fund rate, individually. The representative stock index in China and Korea is CSI 300 index and KOSPI index, and Exchange rates USD/CNY, USD/CNH and USD/KRW are used in this article. Especially, onshore exchange rate

USD/CNY data is selected from Bloomberg, not from State Administration of Foreign Exchange (SAFE) in China. Figure 7 illustrates the differential of Bloomberg USD/CNY and SAFE USD/CNY and it is obvious that the USD/CNY data from Bloomberg is significantly different from SAFE. Bloomberg claims that their exchange rate data is from their BGN algorithm, a pricing algorithm that produces highly accurate bid and asks FX quotes in real-time. BGN quotes are designed to represent market-consensus executable prices and are derived from hundreds of quote providers, including top tier money-center and regional banks, broker-dealers, and inter-dealer brokers, as well as FX electronic trading platforms. However, SAFE USD/CNY exchange rate is published by the People's Bank of China, which means that it is not real market exchange rate. In a word, the Bloomberg exchange rate is real market price, but the SAFE exchange rate is merely official guide price.

Figure 7. The Spread between Bloomberg USD/CNY and SAFE USD/CNY (RMB per USD on vertical axis)



2.3.2 Summary statistics

Table 1. Summary Statistics

Variable	Mean	Standard Error	Skewness	Kurtosis[1]	Jarque-Bera
China					
Flow	−0.0148	0.4341	8.7083***	193.9469***	1831159.5855***
Spread	0.0000	0.0014	0.0812	13.8852***	9303.8369***
Equity	0.0001	0.0168	−0.4708***	3.9545***	797.3241***
UIP	0.0001*	0.0019	−3.5279***	59.0662***	170737.4634***
Korea					
Flow	0.0110***	0.1083	0.1043	2.8249***	387.4752***
Equity	0.0001	0.0108	−0.3815***	4.3521***	941.9691***
UIP	0.0001	0.0055	−0.3635***	2.0352***	225.3528***

[1] Excess kurtosis statistics display here.
† significant at 0.1 level
* significant at 0.05 level
** significant at 0.01 level
*** significant at 0.001 level

Note: In Table 1, Flow stands for the net capital flow; Spread stands for the difference of the onshore (CNY) and offshore (CNH) RMB rates; Equity stands for the A-share market return; UIP stands for the currency premium as shown in equation (5).

Table 1 reports basic summary statistics. The mean of currency risk premium in China is significantly positive, which is approximately 0.01% per day and the average net inflow in Korea is 11 million dollars per day. The first statement implies that carry trades which earn profit through may exist the interest rate spread between China Other mean variables are not significantly different from zero. It is not saying that the exchange rate spread, which is represented by figure 8, is not insignificant. Because of the presence of official guide USD/CNY exchange rate, the exchange spread, to a certain extent, suggests the government's target of capital control. Therefore, the exchange rate spread change drops a hint at government's attitude, to flow in or to flow out.

The skewness of *Flow* in China is positive, indicating that the amount of days when net capital flees from China is quite bigger than that when flows entering China, which easily leads to financial crisis. The skewness of *Equity* is negative in both country, implying that the stock market falls faster than rising speed. The skewness of *UIP* in both China and Korea is negative, representing the risk premium is mainly concentrated in the positive direction. All of seven variables are fat tailed and Jarque-Bera statistics reject normality null hypothesis for all four variables at 0.001 significant level.

2.3.3 Unit root test

Non-stationary time series data may generate spurious regression, so unit root test is a necessary part in a time series model. This article presents Augmented Dickey-Fuller test (1981) results in table 2 and lag selection is based on Akaike information criterion. The null hypothesis that the series has a unit root can be rejected by all four variables, whether trend is included or not. Thus, *Flow*, *Spread*, *Equity* and *UIP* follow stationary process.

Figure 8. The Spread between USD/CNY and USD/CNH

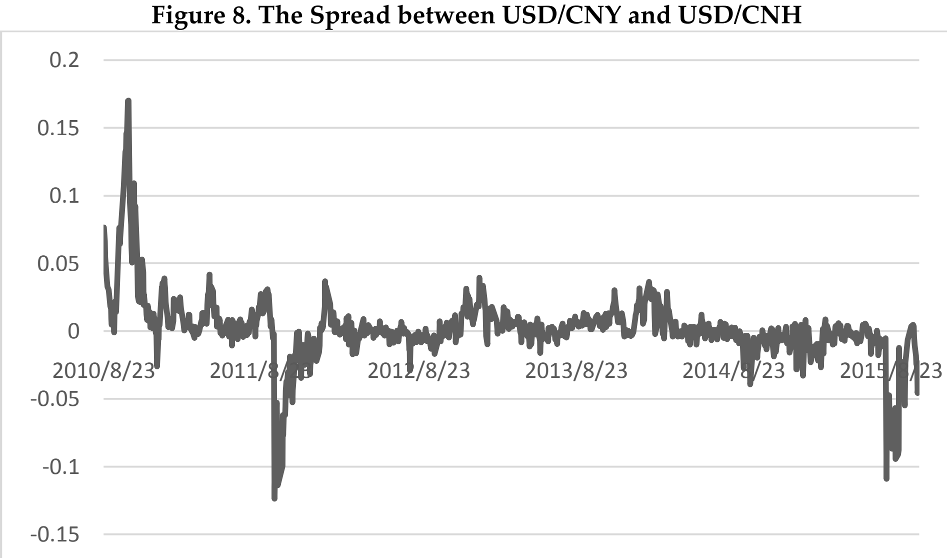


Table 2. Augmented Dickey-Fuller Test Results

	With trend	No trend
China		
Flow	-4.7367**	-4.5157**
Spread	-14.5679***	-14.5758***
Equity	-10.1785***	-10.1411***
UIP	-16.6298***	-16.4395***
Korea		
Flow	-8.8922***	-8.7874***
Equity	-7.3282***	-7.3365***
UIP	-16.3621***	-16.3241***

† significant at 0.001 level
* significant at 0.001 level
** significant at 0.001 level
*** significant at 0.001 level

2.3.4 Basic analysis of UIP and Federal fund rate

Bernanke et al (2005) presents that stock market has reaction on Federal Reserve policy, in particular, unanticipated changes in the federal fund rate results in stock index changes. However, whether foreign stock market is associated with the federal fund rate has not been fully studied. This article is mainly concerned about this question.

The basic theory on international capital flow, the uncovered interest parity, suggests that the existence of uncovered interest parity premium causes cross boarder capital flows if there is no capital control. Capital flows can in turn affect the stock market. Hence, the first questionwe ask is whether the US interest rate policy has significantly affected changes in the uncovered interest parity premium, UIP , since the federal fund rate directly related to the definitionof the uncovered interest rate premium. We use aVAR(1) model consisting of the effective federal fund rate and uncovered interest rate premium to investigate the interaction between the federal fund rate and uncovered interest rate premium. The effective federal fund rate is denoted as $r_{USD,t}$.

The basic VAR(1) model is as follows:

$$\begin{aligned} UIP_{country,t} &= \beta_{country,11} UIPcountry, t-1 + \beta_{country,12} r_{USD,t-1} + \varepsilon_{conutry,1} \\ r_{USD,t} &= \beta_{country,21} UIPcountry, t-1 + \beta_{country,22} r_{USD,t-1} + \varepsilon_{conutry,2} \end{aligned} \quad (5)$$

where $country = China, Korea$. If $\beta_{country,12}$ and $\beta_{country,21}$ are neither significantly different from zero, there is no significant interaction between the federal fund rate and uncovered interest parity premium in a particular country.

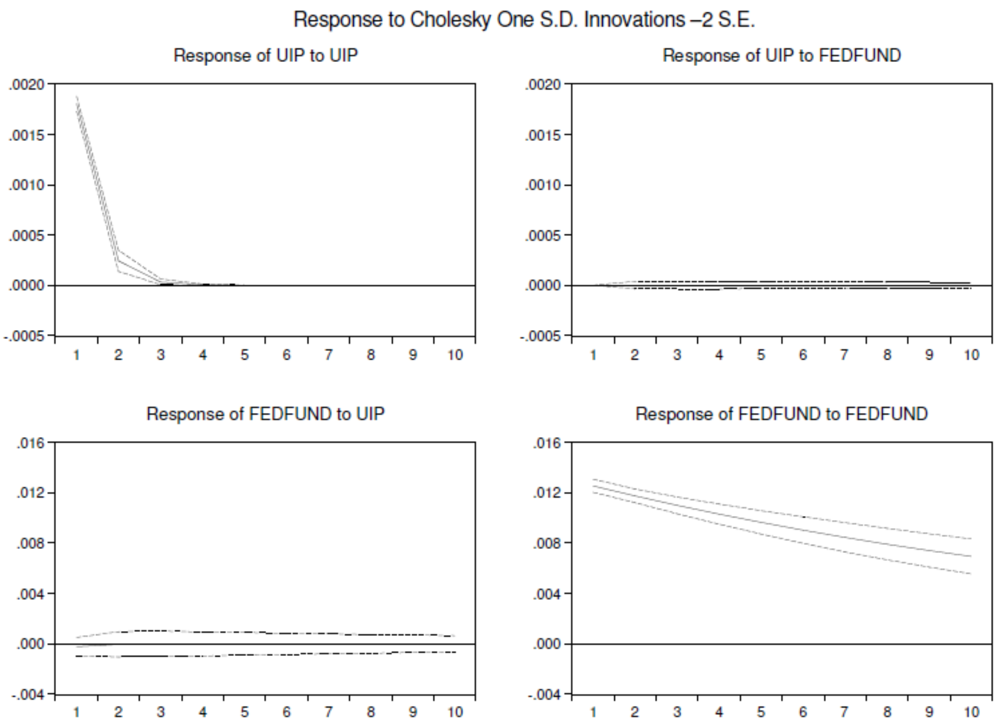
Table 3. Basic AR(1) Model of Federal Fund Rate and UIP

	China		Korea	
Variable	$UIP_{China,t}$	$r_{USD,t}$	$UIP_{Korea,t}$	$r_{USD,t}$
$UIP_{China,t}$	0.1325***	0.0956	-0.0576*	-0.0883
	(4.6067)	(0.4701)	(-1.9844)	(-1.2562)
$UIP_{China,t}$	0.0000	0.9362***	-0.0060	0.9398***
	(0.0302)	(91.6688)	(-1.4950)	(96.1458)
constant	-0.0001	0.0075***	0.0006	0.0070
	(-0.6185)	(5.9347)	(1.1124)	(5.8276)

† significant at 0.001 level
* significant at 0.001 level
** significant at 0.001 level
*** significant at 0.001 level

The empirical results from Table 3 imply that the Federal Reserve interest rate policy does not significantly affect the uncovered interest rate premium, both in China and in Korea. Impulse response analysis presented in Figure 9 and 10 also show that interaction between the uncovered interest rate parity premium and the effective federal fund rate are unrelated to each other.

Figure 9. Impulse Responses for the Chinese Model



2.4 Benchmark model

In order to analyze the dynamic relationship between capital flows, equity return, and uncovered interest parity premium, a VAR model is used as the benchmark. The VAR model estimates theinteractions between the means of the variables under the assumption that error items follow multivariate normal distribution.

Capital flows are basically driven by its returns ($R_{country,t}$) which are affected by the three decomposed components ($Equity_{country,t}$, $Spread_{country,t}$, $UIP_{country,t}$) of the returns. Reversely, capital flows can also prompt changesinthe return components. In addition, these three components can affect each other directly. Thus, a VAR model is necessary to identify and control such dynamic interactions.

The major difference between China and Korea is their difference in capital mobility, which is indicated by the variable $Spread$. According to the definition, the spread of "onshore" exchange rate and "offshore" exchange rate in Korea is always zero, $Spread_{Korea} \equiv 0$ (using quote respects for facts that there is only one exchange rate in Korea), but the spread in China is non-negligible, as shown in figure 8, $Spread_{China} \neq 0$.

The lag orders in our VAR models are selected by the Akaike information criterion, and for both the Chinese and Korea models the optimal lag is 5. The estimation results are presented in table 4 and 5:

Figure 10. Impulse Responses for the Korean Model

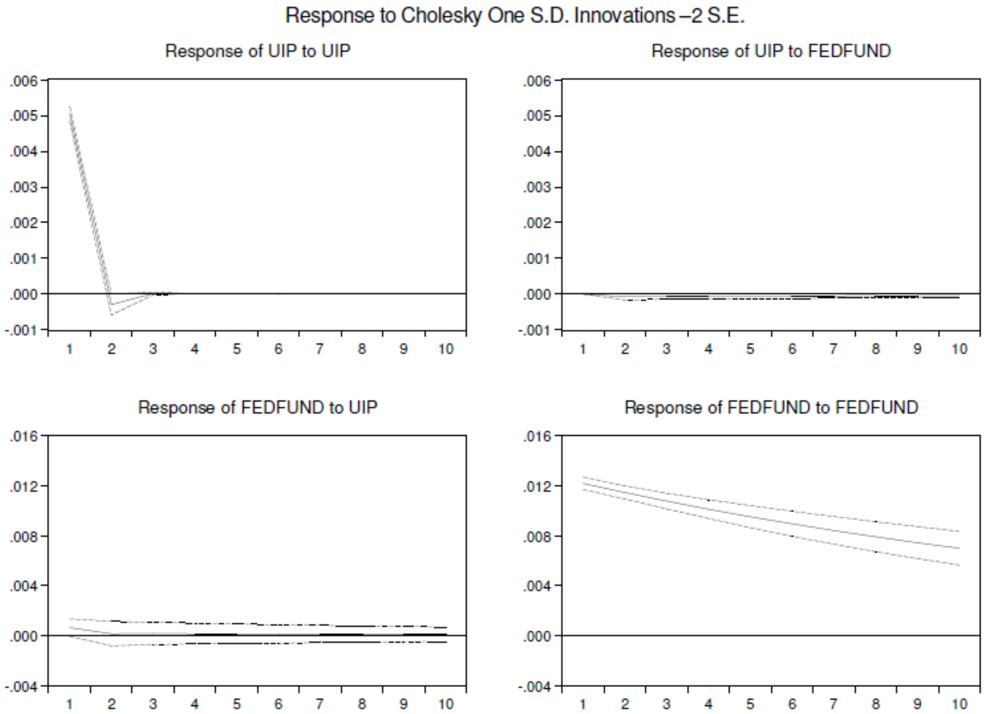


Table 4. Estimates of VAR Model of China

	Flow (i=1)	Spread (i=2)	Equity (i=3)	UIP(i=4)
Panel A: Mean Spillover Effect LR statistics (p-value)				
$\beta_{i1,1}$	0.3400^{***}	0.0000	0.0002	0.0001
	(11.4568)	(−0.0598)	(0.1656)	(0.4731)
$\beta_{i1,2}$	0.0209	0.0001	0.0000	−0.0001
	(0.6675)	(0.8249)	(0.0281)	(−0.7533)
$\beta_{i1,3}$	0.1978^{***}	0.0001	-0.006^{***}	0.0001
	(6.4569)	(0.8054)	(−4.6023)	(0.4434)
$\beta_{i1,4}$	−0.0276	0.0000	0.0036^{**}	−0.0001
	(−0.8777)	(−0.1124)	(2.6982)	(−0.708)
$\beta_{i1,5}$	−0.0213	−0.0001	0.0036^{**}	0.0001
	(−0.7135)	(−0.5975)	(2.8934)	(0.7056)
$\beta_{i2,1}$	−5.7646	-0.2476^{***}	−0.366	0.1813^{**}
	(−0.4664)	(−5.5855)	(−0.7012)	(3.0702)
$\beta_{i2,2}$	11.0718	−0.0555	−0.4018	−0.0306
	(0.8825)	(−1.233)	(−0.7583)	(−0.5114)
$\beta_{i2,3}$	18.9938	-0.1116^{*}	0.366	0.1506^{*}
	(1.5167)	(−2.4844)	(0.6919)	(2.5177)
$\beta_{i2,4}$	5.973	−0.0331	$-0.9008^{\dagger}$	−0.0222
	(0.4797)	(−0.7407)	(−1.713)	(−0.3728)
$\beta_{i2,5}$	1.4984	−0.0483	0.0857	0.0403
	(0.1224)	(−1.1003)	(0.1658)	(0.6895)
$\beta_{i3,1}$	−0.7421	0.0023	0.0342	$-0.0065^{\dagger}$
	(−1.0519)	(0.9009)	(1.1474)	(−1.9249)
$\beta_{i3,2}$	−0.4138	−0.0003	−0.0234	−0.0028
	(−0.5905)	(−0.1103)	(−0.7917)	(−0.8294)
$\beta_{i3,3}$	2.0367^{**}	0.0009	−0.0055	−0.0028
	(2.923)	(0.3548)	(−0.1873)	(−0.8278)
$\beta_{i3,4}$	-1.3747^{*}	0.0002	0.0713^{*}	0.0001
	(−1.9626)	(0.0926)	(2.4101)	(0.0261)
$\beta_{i3,5}$	-1.4556^{*}	0.0015	0.0213	−0.0052
	(−2.0793)	(0.5946)	(0.7215)	(−1.5674)
$\beta_{i4,1}$	11.873	-0.1512^{***}	0.6202	0.2557^{***}
	(1.2791)	(−4.5434)	(1.582)	(5.7668)
$\beta_{i4,2}$	15.3444	0.091^{**}	−0.3365	-0.1421^{**}
	(1.6309)	(2.6979)	(−0.8467)	(−3.1629)
$\beta_{i4,3}$	13.2847	0.0006	0.515	0.0539
	(1.4074)	(0.018)	(1.2917)	(1.1958)
$\beta_{i4,4}$	3.3744	−0.0476	−0.0523	0.0428
	(0.3573)	(−1.4056)	(−0.131)	(0.9493)
$\beta_{i4,5}$	1.5948	−0.0245	0.0105	0.0339
	(0.1721)	(−0.7375)	(0.0269)	(0.7654)
γ_i	−0.0139	0.0000	0.0000	$0.0001^{\dagger}$
	(−1.1638)	(0.794)	(−0.0027)	(1.9168)
Panel B: Mean Spillover Effect LR statistics (p-value)				
Flow	226.9378^{***}	4.8605	36.1826^{***}	2.6766
	(0.0000)	(0.4331)	(0.0000)	(0.7497)
Spread	3.2424	78.0632^{***}	4.9798	37.7981^{***}
	(0.6627)	(0.0000)	(0.4184)	(0.0000)
Equity	18.8669^{**}	3.0368	8.7081	17.9094^{**}
	(0.002)	(0.6943)	(0.1213)	(0.0031)

UIP	7.4915	64.0628***	4.3521	92.3052***
	(0.1866)	(0.0000)	(0.4999)	(0.0000)
	Panel C: Univariate Residual statistics (p-value)			
$Q(5)$	1.2331	0.5348	0.3556	0.2266
	(0.9417)	(0.9908)	(0.9965)	(0.9988)
$Q(10)$	12.5455	11.9058	19.4245*	2.5976
	(0.2502)	(0.2914)	(0.0352)	(0.9894)
$Q^2(5)$	109.3172***	97.2497***	189.9787***	10.5174†
	(0.0000)	(0.0000)	(0.0000)	(0.0618)
$Q^2(10)$	111.7894***	132.3535***	241.7756***	12.7061
	(0.0000)	(0.0000)	(0.0000)	(0.2406)
Panel D: Multivariate Residual statistics (p-value)				
$Q(5)$	6.003(1.0000)			
$Q(10)$	152.3293(0.6548)			
$Q^2(5)$	626.8872***(0.0000)			
$Q^2(10)$	1086.6301***(0.0000)			

† significant at 0.001 level
* significant at 0.001 level
** significant at 0.001 level
*** significant at 0.001 level

Table 5. Estimates of VAR Model of Korea

	Flow (i=1)	Equity (i=2)	UIP(i=3)
Panel A: Mean equation coefficient (t-statistics)			
$\beta_{i1,1}$	0.1546^{***}	0.0031	0.0027
	(5.1828)	(0.9424)	(1.6373)
$\beta_{i1,2}$	0.1594^{***}	0.0029	-0.002
	(5.3116)	(0.8843)	(-1.2276)
$\beta_{i1,3}$	0.0744^{*}	-0.0013	-0.0044^{**}
	(2.4569)	(-0.3982)	(-2.6384)
$\beta_{i1,4}$	0.0946^{**}	-0.0002	0.0017
	(3.1606)	(-0.0549)	(1.032)
$\beta_{i1,5}$	0.0933^{**}	$-0.0058^{\dagger}$	0
	(3.1661)	(-1.7745)	(-0.0192)
$\beta_{i2,1}$	1.2524^{***}	-0.0012	0.0108
	(3.9136)	(-0.0344)	(0.6111)
$\beta_{i2,2}$	-0.3222	-0.018	-0.0022
	(-1.0033)	(-0.5095)	(-0.1241)
$\beta_{i2,3}$	$0.5279^{\dagger}$	-0.0332	-0.0222
	(1.648)	(-0.9416)	(-1.2579)
$\beta_{i2,4}$	0.0061	-0.022	0.0064
	(0.019)	(-0.6239)	(0.365)
$\beta_{i2,5}$	0.1217	$-0.0595^{\dagger}$	0.0006
	(0.3796)	(-1.6862)	(0.0364)
$\beta_{i3,1}$	0.781	-0.0055	-0.083^{*}
	(1.2245)	(-0.0783)	(-2.3676)
$\beta_{i3,2}$	1.2949^{*}	0.0345	0.056
	(2.0208)	(0.489)	(1.589)
$\beta_{i3,3}$	0.5031	0.0079	0.0766^{*}
	(0.7884)	(0.1122)	(2.1844)
$\beta_{i3,4}$	0.8599	-0.0269	0.0027
	(1.3499)	(-0.3835)	(0.0774)
$\beta_{i3,5}$	0.1764	-0.0263	-0.0173
	(0.2773)	(-0.376)	(-0.4959)
γ_i	0.0041	0.0001	0.0001
	(1.4139)	(0.2319)	(0.7387)
Panel B: Mean Spillover Effect LR statistics (p-value)			
Flow	177.9501^{***}	6.6336	15.3192^{**}
	(0.0000)	(0.2493)	(0.0091)
Equity	19.4664^{**}	6.0771	2.9851
	(0.0016)	(0.2988)	(0.7023)
UIP	8.1022	0.7061	17.7876^{**}
	(0.1507)	(0.9826)	(0.0032)

Panel C: Univariate Residual statistics (p-value)			
$Q(5)$	0.1858	0.0899	0.0389
	(0.9993)	(0.9999)	(1.0000)
$Q(10)$	8.5051	12.9807	1.7515
	(0.5796)	(0.2248)	(0.9979)
$Q^2(5)$	83.1168^{***}	268.4068^{***}	92.4962^{***}
	(0.0000)	(0.0000)	(0.0000)

$Q^2(10)$	114.4954^{***}	463.4485^{***}	201.5474^{***}
	(0.0000)	(0.0000)	(0.0000)

Panel D: Multivariate Residual statistics (p-value)

$Q(5)$	1.7057(1.0000)
$Q(10)$	65.6033(0.9752)
$Q^2(5)$	482.7418^{***}(0.0000)
$Q^2(10)$	831.6299^{***}(0.0000)

† significant at 0.001 level
* significant at 0.001 level
** significant at 0.001 level
*** significant at 0.001 level

Panel A focuses on conditional mean function coefficients and Panel B gives an mean spillover effect test. Combined with these two panels, it is observed that only *Equity* is not significantly influenced by its lag values in both the Chinese and Korea models whereas the other variables are autoregressive series. The results imply that stock market risk premium cannot be predicted by historical data. Moreover, *Flow*, *Spread* and *UIP* have momentum on daily basis. More specifically, in the model of China, first-order to five-order lags of *Flow* are significant at 0.01 level in the conditional mean equation of *Flow*; first-order to five-order lags of *Spread* are also significant at 0.01 level in conditional mean equation of *Spread*; only the second order lag of *Equity* is significant at 0.05 level in conditional mean function of *Equity*; first-order and forth-order lags of *UIP* are significant at 0.001 level, fifth-order lag is significant at 0.01 level, and third-order lag is significant at0.05 level. In the model of Korea, all of five lag order of *Flow* are significant at 0.01 level in conditional mean equation of *Flow* and only first and third order of *UIP* are significant at 0.05 level in conditional mean equation of *UIP*. The complex dynamic relationships in each variable also suggest that the VAR model is necessary to capture those dynamic effects.

The dynamic interaction can also be seenfrom results in Panel B. In the model of China, Panel B points out *Equity* have spillover effect to *Flow* at significance level 0.01, which means that the change of *Equity* can affect *Flow*. Similarity, in the model of Korea, *Equity* have spillover effect to *Flow* at significant level 0.01. Combined with the estimated coefficients in panel A, those results imply that positive lagged equity return would induce outflows in China and inflows in Korea. This phenomenon can be explained by the difference in investors' behaviors. Capital inflows to China are mainly driven by speculative purpose due to the capital control and resulting market inefficiency while Korea has free capital mobility so market is more efficient. Therefore, in China, capital flows in and earn some short term positive return and quickly flows out. In Korea, capital inflows are longer-term investments, so a positive current return will attract more long-term investment and the cashing out of short-term speculators has less impact on the net capital flows.

Due to capital controls, the following discussion concerning exchange rate spread only applies to China. *UIP* is a variable indicating carry trades, and the intercept of *UIP*, the long-term effect of uncovered interest parity premium, is marginally significant in China, implying that positive carry trades during the sample period. *Spread* have a significance of mean spillover effect and positive signs of coefficients from *Spread* to

UIP implies that higher lagged spread means higher carry trade return and the increasingly restrict capital controls induce higher carry trades. On the other hand, offshoreRMB devaluation would cause spread to be wider due to inelasticity of the onshore RMB rate, as shown in the mean spillover effects from UIP to $Spread$. Net capital flows positively affect equity returns, especially for a money-driven stock market. In addition, the existence of mean spillover effect from $Equity$ to UIP represents that domestic market plummets would cause sharply increase of uncovered interesting rate premium indicating domestic credit risk for a country, in which investors prefer tohold US dollars rather than CNY.

Market structure in Korea is quite different from the one in China. In Korea, the lagged net inflows has negative impacts on uncovered interest rate premium, indicating that positive inflows can reduce the uncovered interest rate premium, in reason that net inflows increase the demand of KRW in foreign exchange market as well as the supply in Korea local monetary market and then lower the exchange rate and interest rate.

Panel C and Panel D examine residuals in both VAR model via Ljung-Q statistics. The rejection of null hypothesis indicates the existence of autocorrelation of the residuals. The probability of accepting the null hypothesis for lag 5 is greater than 0.05 for all four variables and for lag 10 expect the residual of $Equity$ in the model of China. The multivariate residual test also indicates that there is no autocorrelation in residuals. Conversely, Ljung-Box Q statistics of the squared residuals for lag 5 and lag 10, with the exception of UIP in the model of China, are nearly all significant at 0.001 level. Moreover, in the multivariate case, null hypothesis of the existence of non-autocorrelation of standardized residual vector for lag 5 and lag 10 are neither rejected, In general, the Ljung-Box statistics present merely little evidence of autocorrelation in the standardized residuals, but great confidence on volatility interaction in the VAR models. VAR models are inadequate and identification of $Flow$, $Spread$, $Equity$ and UIP requires VARM-GARCH models which are possible to correctly specify the dynamic relationships.

2.5 Extended model

The VAR models explain the mean relationships via conditional mean equations. However, according to Panel C and Panel D in table 5 and 6, the residuals are not independent with their lags. Specifically, the square of residuals have autocorrelation, both for any univariate residual and multivariate residual, implying the existence of a potential conditional volatility interaction. This article presents a VAR-MGARCH-DCC model in order to identify such conditional volatility relationships.

2.5.1 Methodology

In the extended model, a VAR-MGARCH-DCC model proposed by Engle (2002) is presented:

$$
\begin{aligned}
&Y_t = \gamma + \sum_{k=1}^{p} B_k Y_{t-k} + \varepsilon_t \\
&\varepsilon_t = H_t^{1/2} \upsilon_t \\
&H_t = D_t^{1/2} R_t D_t^{1/2} \\
&R_t = diag(Q_t)^{-1/2} Q_t diag(Q_t)^{-1/2} \\
&Q_t = (1-\lambda_1-\lambda_2)R + \lambda_1 \varepsilon_{t-1}\varepsilon_{t-1}^T + \lambda_2 Q_{t-1} \\
&Y_t = \begin{bmatrix} Flow_t \\ Spread_t \\ Equity_t \\ UIP_t \end{bmatrix}
\end{aligned} \tag{6}
$$

ε_t is the random error vector at time t, and H_t is a 4×4 conditional covariance matrix of random error vector. H_t is a variance-covariance matrix and it equals $D_t^{1/2} R_t D_t^{1/2}$. D_t is a diagonal matrix of conditional variance,

$$
D_t = \begin{pmatrix} \sigma_{1,t}^2 & 0 & \cdots & 0 \\ 0 & \sigma_{2,t}^2 & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & \sigma_{n,t}^2 \end{pmatrix}
$$

in which each $\sigma_{i,t}^2$ follows a univariate GARCH model:

$$
\sigma_{i,t}^2 = s_i + \sum_{j=1}^{p_i} \alpha_j \varepsilon_{i,t-j}^2 + \sum_{j=1}^{q_i} \beta_j \sigma_{i,t-j}^2
$$

R_t is a symmetric matrix of conditional quasi correlations,

$$
R_t = \begin{pmatrix} 1 & \rho_{21,t} & \cdots & \rho_{n1,t} \\ \rho_{21,t} & 1 & \cdots & \rho_{n2,t} \\ \vdots & \vdots & \ddots & \vdots \\ \rho_{n1,t} & \rho_{n2,t} & \cdots & 1 \end{pmatrix}
$$

λ_1 and λ_2 are parameters representing the dynamics of conditional quasi correlations and satisfy $\lambda_1 \geq 0, \lambda_2 \geq 0, \lambda_1 + \lambda_2 < 1$.

MGARCH-DCC models are estimated by the full information maximum likelihood method to maximize the log likelihood function. The log likelihood function for all observations can be expressed as the sum of conditional log likelihood under each observation. Let $\ln L$ be the log likelihood of joint distribution, $\ln L_t$ be the log likelihood of observation t, n be the dimension of conditional mean equations. The joint likelihood function of DCC model is presented individually:

$$
\begin{aligned}
&\ln L = \sum_{t=1}^{T} \ln L_t \\
&\ln L_t = \frac{n}{2}\ln 2\pi - \frac{1}{2}\ln|R_t| - \ln|D_t^{1/2}| - \frac{1}{2}\varepsilon_t R_t^{-1} \varepsilon_t^T
\end{aligned}
$$

$\varepsilon_t = H_t^{1/2}\upsilon_t$, where υ_t indicates standardized residuals, which should follow white Gaussian white noise process with the variance-covariance matrix I (identity matrix). Suggested by Box (1970) and Ljung (1978), Ljung-Box Q statistics to examine whether υ_t is a (weakly) white noise process. The Ljung-Box Q statistic equals:

$$Q = T(T+2)\sum_{K=1}^{l}(\mathrm{T-k})^{-1}\sigma^2(k) \sim \chi^2_{l-p-q}$$

where T is the sample size, l is the lag to be tested, and $\sigma(k)$ is the sample autocorrelation at lag k. In addition, when testing residuals, the Ljung-Box Q statistic follows the chi-square distribution with $l-p-q$ freedom in which p is the order of the GARCH terms and q is the order of the ARCH terms.

Hosking (1980) expanded Ljung-Box Q statistic into multivariate cases. The multivariate Q statistic equals:

$$Q = T(T+2)\sum_{K=1}^{l}(\mathrm{T-k})^{-1}\sigma^2(k) \sim \chi^2_{n^2(l-p-q)}$$

where T is the sample size, n is the dimension of the conditional mean equations, l is the lag to be tested, and $\sigma(k)$ is the sample autocorrelation at lag k. Because of increased dimensions, the freedom degree of chi-square distribution changes into $n^2(l-p-q)$ in which p and q are the lag orders of GARCH terms and ARCH terms respectively.

2.5.2. Empirical results

BFGS (Broyden, Fletcher, Goldfrab and Shanno) algorithm is used to produce maximum likelihood parameter estimates in a VAR(5)-MGARCH(1,1) model. VAR lag order is selected based on Akaike information criterion. Table 6 and 7 shows the estimate results.

Mean equations shown in Panel A have similar results with VAR models, so Panel B is the focus point. Panel B indicates the coefficient estimates of the conditional variance equations. For each variable in both models, the coefficient $a_{i,i}$ and $b_{i,i}$ are statistically significant at 0.05 level, indicating time-varying variance characteristics and the presentence of ARCH and GARCH effects. In a DCC model, the dynamic relationships are presented by λ_1 and λ_2, which are 0.1238, 0.1965, 0.0176, and 0.9788, significantly differ from zero, respectively in the models of China and Korea, which proves that the conditional correlation is dynamic and reject constant conditional correlation assumption.

Table 6. Estimates of VAR-MGARCH-DCC Model of China

	Flow (i=1)	Spread (i=2)	Equity (i=3)	UIP (i=4)
Panel A: Mean equation coefficient (t-statistics)				
$\beta_{i1,1}$	0.1078^{***}	0.0000	0.0020^{*}	−0.0001
	(4.675)	(0.3036)	(2.3615)	(−0.6052)
$\beta_{i1,2}$	$0.0607^{\dagger}$	−0.0001	−0.001	−0.0001
	(1.7153)	(−1.0351)	(−1.4522)	(−0.4661)
$\beta_{i1,3}$	0.0446	0.0000	-0.0028^{**}	0.0005^{*}
	(1.3851)	(0.3104)	(−2.9754)	(1.9965)
$\beta_{i1,4}$	0.0477	0.0003	0.0016	0.0004
	(1.4267)	(1.4121)	(1.3131)	(1.2965)
$\beta_{i1,5}$	0.0528	0.0000	0.0026	−0.0002
	(0.66)	(0.0477)	(1.4312)	(−0.4875)
$\beta_{i2,1}$	8.8949	-0.0286^{**}	−0.6147	-0.0453^{**}
	(0.3755)	(−2.6842)	(−1.0075)	(−2.6646)
$\beta_{i2,2}$	−0.1821	-0.0389^{**}	−0.9363	-0.0523^{*}
	(−0.0056)	(−2.9016)	(−1.1932)	(−2.2132)
$\beta_{i2,3}$	25.9608	−0.0569	−0.4962	$0.1143^{\dagger}$
	(0.6899)	(−1.5101)	(−0.5837)	(1.8838)
$\beta_{i2,4}$	28.9329	0.0004	−0.5821	$-0.0712^{\dagger}$
	(0.7606)	(0.0141)	(−0.7689)	(−1.7757)
$\beta_{i2,5}$	36.4382	0.007	0.641	0.0255
	(0.9852)	(0.2504)	(0.6826)	(0.5854)
$\beta_{i3,1}$	0.473	0.003	0.0301	−0.0059
	(0.4545)	(1.4813)	(1.1544)	(−1.3476)
$\beta_{i3,2}$	−0.3522	−0.0008	-0.0646^{**}	−0.0054
	(−0.4382)	(−0.4825)	(−2.5939)	(−1.2777)
$\beta_{i3,3}$	$1.9601^{\dagger}$	−0.0005	−0.0255	−0.0023
	(1.9337)	(−0.2234)	(−0.7175)	(−0.5192)
$\beta_{i3,4}$	0.5417	0.0007	0.0584^{*}	−0.0011
	(0.3061)	(0.4052)	(2.2473)	(−0.2562)
$\beta_{i3,5}$	0.1595	0.0028	$0.0717^{\dagger}$	−0.0036
	(0.1196)	(0.9572)	(1.8902)	(−0.7332)
$\beta_{i4,1}$	−1.1949	0.0076	0.2365	0.0186^{*}
	(−0.0669)	(1.4204)	(0.4425)	(1.9793)
$\beta_{i4,2}$	0.9023	0.0152^{*}	−0.0929	$0.0235^{\dagger}$
	(0.0349)	(2.428)	(−0.1455)	(1.8697)
$\beta_{i4,3}$	14.7385	0.0251	1.0639	−0.0539
	(0.6225)	(0.8188)	(1.435)	(−1.1041)
$\beta_{i4,4}$	3.605	-0.0679^{*}	−0.0956	0.0454
	(0.1637)	(−2.1913)	(−0.2252)	(1.1408)
$\beta_{i4,5}$	6.2373	−0.0101	−0.4589	0.0078
	(0.3008)	(−0.424)	(−0.6903)	(0.1945)
γ_i	0.0256	$-0.0001^{\dagger}$	−0.0002	0.0001
	(0.532)	(−1.8879)	(−0.1541)	(0.5156)
Panel B: Variance equation coefficient (t-statistics)				
c_{i1}	0.0532^{**}			
	(2.9093)			
c_{i2}		0.0000^{***}		
		(17.4814)		
c_{i3}			0.0003^{***}	
			(19.6159)	

c_{i4}				0.0000^{***}
				(17.534)
a_{i1}	0.0557^{***}			
	(23.3756)			
a_{i2}		0.0676^{***}		
		(15.5989)		
a_{i3}			0.1317^{***}	
			(13.5398)	
a_{i4}				0.0003^{***}
				(16.3947)
b_{i1}	0.2336^{***}			
	(15.5994)			
b_{i2}		0.2035^{***}		
		(11.5801)		
b_{i3}			-0.1753^{***}	
			(-9.0536)	
b_{i4}				0.28^{***}
				(21.9431)
λ_1		0.1238^{***}		
		(11.8559)		
λ_2		0.1965^{***}		
		(12.071)		

† significant at 0.001 level
* significant at 0.001 level
** significant at 0.001 level
*** significant at 0.001 level

Table 7. Estimates of VAR-MGARCH-DCC Model of Korea

	Flow (i=1)	Equity (i=2)	UIP (i=3)
Panel A: Mean equation coefficient (t-statistics)			
$\beta_{i1,1}$	0.1952^{***}	0.0024	0.0022
	(5.6825)	(0.9285)	(1.4642)
$\beta_{i1,2}$	0.1565^{***}	0.0017	−0.0015
	(4.6207)	(0.6441)	(−0.9675)
$\beta_{i1,3}$	$0.0623^{\dagger}$	0.0003	-0.0034^{*}
	(1.8258)	(0.1264)	(−2.1608)
$\beta_{i1,4}$	0.0987^{**}	0.0009	0.0022
	(3.0433)	(0.3661)	(1.5051)
$\beta_{i1,5}$	0.0869^{**}	-0.0063^{*}	−0.0004
	(2.7276)	(−2.4199)	(−0.2965)
$\beta_{i2,1}$	0.8807^{**}	−0.0263	0.0057
	(3.2492)	(−0.7401)	(0.3275)
$\beta_{i2,2}$	0.2796	0.0416	0.0088
	(1.0591)	(1.2516)	(0.5018)
$\beta_{i2,3}$	$0.4445^{\dagger}$	−0.0194	−0.0206
	(1.7002)	(−0.5611)	(−1.2163)
$\beta_{i2,4}$	0.1605	−0.0446	−0.0101
	(0.6289)	(−1.315)	(−0.5876)
$\beta_{i2,5}$	0.3632	−0.0517	0.0086
	(1.5161)	(−1.5576)	(0.501)
$\beta_{i3,1}$	1.2565^{*}	0.083	−0.0458
	(2.4106)	(1.4694)	(−1.3249)
$\beta_{i3,2}$	0.8294	−0.0267	0.0191
	(1.4587)	(−0.4675)	(0.5442)
$\beta_{i3,3}$	0.4078	−0.0723	0.0341
	(0.7652)	(−1.2587)	(0.9631)
$\beta_{i3,4}$	0.6118	−0.0442	−0.0054
	(1.1328)	(−0.7483)	(−0.1632)
$\beta_{i3,5}$	−0.6458	−0.003	−0.0072
	(−1.2536)	(−0.0506)	(−0.2037)
γ_i	0.0058^{*}	0.0003	0.0003^{*}
	(2.3015)	(1.1349)	(2.0805)
Panel B: Variance equation coefficient (t-statistics)			
c_{i1}	0.0001^{*}		
	(2.391)		
c_{i2}		0.0000^{**}	
		(2.8525)	
c_{i3}			0.0000^{**}
			(2.9653)
a_{i1}	0.0683^{***}		
	(4.141)		
a_{i2}		0.0618^{***}	
		(5.0502)	
a_{i3}			0.068^{***}
			(5.627)
b_{i1}	0.9288^{***}		
	(56.8918)		
b_{i2}		0.9185^{***}	
		(56.2668)	
b_{i3}			0.9163^{***}

		(69.1206)
λ_1	0.0176^{***}	
	(4.0802)	
λ_2	0.9788^{***}	
	(177.9505)	

† significant at 0.001 level
* significant at 0.001 level
** significant at 0.001 level
*** significant at 0.001 level

The dynamic conditional correlation is illustrated in figure 11 and 12. In figure 11, a significant dynamic interaction between exchange rate spread change and uncovered interest rate parity premium is presented with the evidence that the dynamic conditional correlation between *Spread* and *UIP* is always negative in China. As we have introduced, *Spread* reflects changes in the capital control while *UIP* reflects excess return of carry trade. The negative correlation between shocks to those variables suggest that when the onshore exchange rate is more undervalued than the offshore exchange rate due to some unexpected economic shocks, the UIP premium decreases. Since the UIP premium is positively associated with the expected future offshore RMB exchange rate by its definition, we can conclude that the offshore RMB is anticipated to depreciate in the future when the onshore exchange rate is more undervalued than the offshore exchange rate due to some unexpected economic shocks. This reveals that the pricing of the onshore RMB actually leads the pricing of the offshore RMB, rather than the other way around.

Besides, figure 12 presents that the dynamic conditional correlation between *Equity* and *UIP* is always positive in Korea. Since both the equity premium and UIP premium can be interpreted as risk factors. This finding indicates that both excess return from stock investment and carry trade are driven by common risk factors. Similar result is not found in China, which might reflect the difference between stock market and currency market in China. In China, the stock market is dominated by individual investors and the currency market participants are mainly institutions, therefore, the dynamics of the two markets are driven by very different risk factors. For example, in China's stock market individual investors prefer lottery-like stocks and as a result, the stock returns are affected by both systematic market risk and also by idiosyncratic stock risk. Similar phenomenon does not exist in the currency market.

Figure 11. Dynamic Conditional Correlation of China

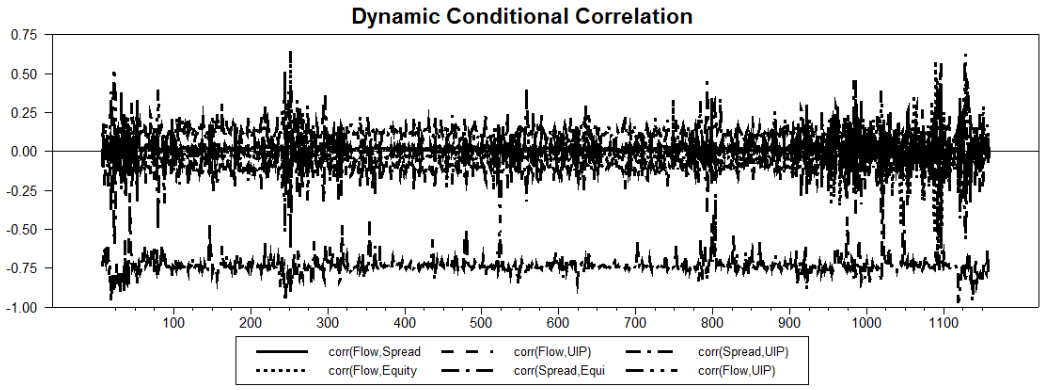
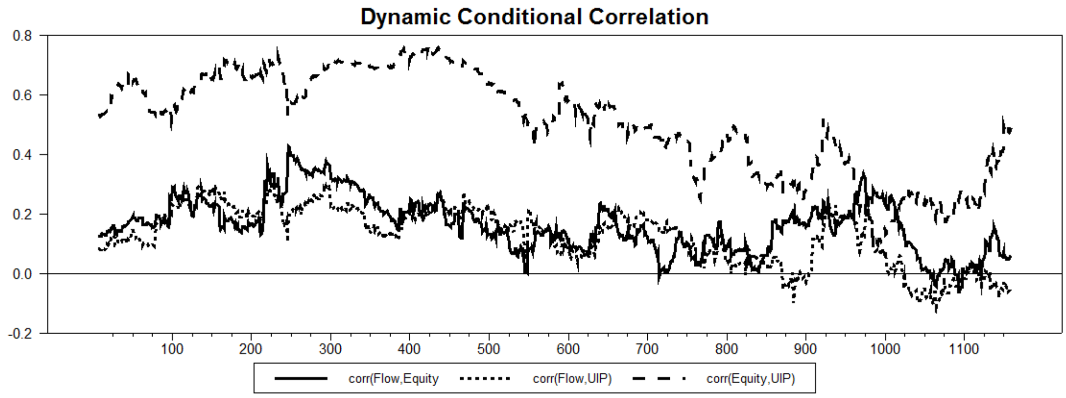


Figure 12. Dynamic Conditional Correlation of Korea



Summary of empirical results

This part of the paper decomposes the excess returns of international capitals into three components: capital controls, stock market risk premium, and currency risk premium. We base our study on the benchmark VAR models and extended VAR-MGARCH-DCC models and conclude that the stock market risk premium directly affect capital flows, but, surprisingly, capital controls will not affect capital flows. Conversely, equity market have direct impact on foreign exchange market, represented by uncovered interest rate premium. The dynamic conditional correlation of capital controls and currency risk premium in China is always significantly negative in China and the correlation of equity risk premium and currency risk premium is always positive in Korea. Moreover, unexpected federal fund rate will not influence uncovered interest rate premium in both China and Korea, indicating Federal Reserve policy will not directly affect capital flows in China and Korea via this channel.

Comparing estimation results of China and Korea, it is obvious that the market structure is quite different, especially the capital flows. In China, capital flows are highly controlled in order to prevent volatility. However, capital control in China seems triggered speculative trading and weakened the incentive of long-term investment based on fundamentals. Korea is a good example for China. Free capital flows can attract long-term investors, on the base of reasonable and effective market rules.

3. Effects of USD Appreciation on Bilateral Trade between China and Korea

Early studies about the impacts of exchange rate movement on international trade focus on bilateral trade. For example, Li and Xu (2011) study the impact of RMB appreciation on China and the U.S. bilateral trade. The research on the impact of a third currency exchange rate movement on another two countries bilateral trade is limited. In this section, we carry out this exercise. Particularly, as the market widely expected that the Federal Reserve will raise policy rate in December 2015, which further results to a stronger USD, we analyze the potential influence of the USD appreciation on the bilateral trade between China and Korea.

Currently, most of the trade between China and Korea is priced by USD. An appreciation of USD, if symmetrically against RMB and KRW, would therefore have little impact on the trading activities between China and Korea in the short time. In the long time, however, USD appreciation might cause this currency to flow back to the U.S. domestic market. In case of insufficient currency at hands, the trading willingness of both China and Korea might be dampened. In addition, the appreciation of USD might cause risk on local currencies (RMB and KRW), which further has negative impact on domestic economy. Therefore, the bilateral trade between China and Korea is affected through domestic economic fundamental changes. We illustrate this idea below.

Traditional theory argues for a causality relationship in which international trade is affected by exchange rate, domestic income, among other macro-economic variables. This theory is based on the Supply-Demand framework, where import volume is determined by the price of the imported goods (exchange rate) and domestic income (budget). Denote the price index of the imported goods as P^*, domestic price index as P, and the domestic income as Y, then the demand for imported goods can be written as:

$$M_D = f\left(P^*, P, Y\right)$$

And the theory predicts that:

$$\frac{\partial M_D}{\partial Y} > 0,\ \frac{\partial M_D}{\partial P^*} < 0,\ \text{and}\ \frac{\partial M_D}{\partial P} > 0$$

These conditions says that, the more of the domestic income (larger budget), the larger is the demand for foreign goods; the more expensive of the foreign goods, the less is its demand; and the higher is the price of domestic goods, the larger is the demand for foreign goods.

If we denote P^{**} as the price of imported goods measured by domestic currency, RP as the relative price of imported goods to domestic goods, e^n is the nominal exchange rate of the two currencies, then

$$RP = \frac{P^*}{P} = e^n \frac{P^{**}}{P}$$

Thus the demand for imported goods can be re-written as:

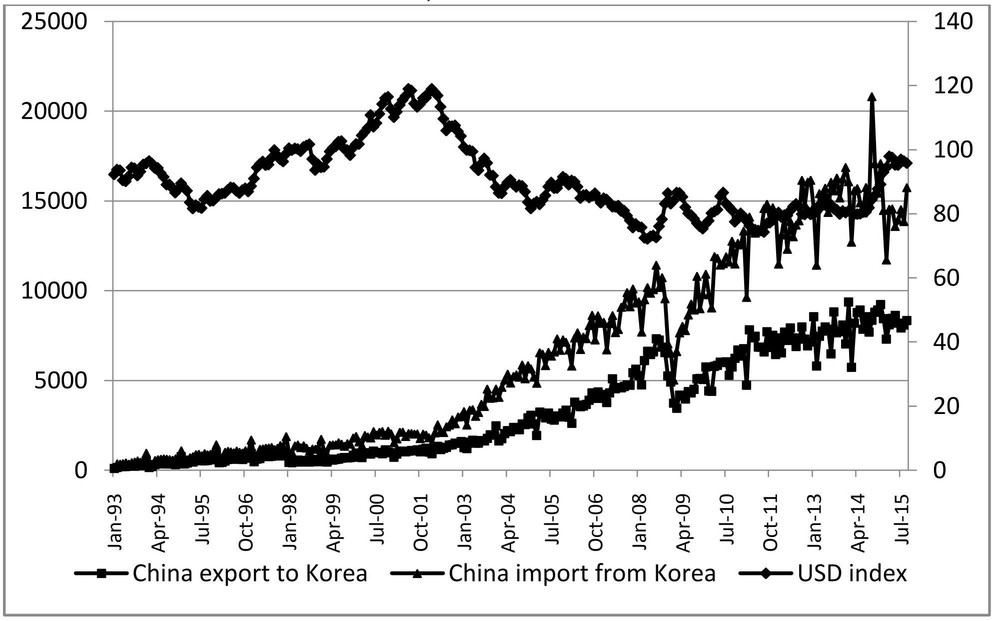
$$M_D = f\left(e^n \frac{P^{**}}{P}, Y\right) \tag{7}$$

The larger is the exchange rate, the higher price of the imported goods, thus the less demand is the imported goods.

The above classic model is limited to describe the multi-countries cases. However, when we use the above model to study the trade between China and Korea and we want to gauge the impact of USD appreciation on the trade, we need to investigate the impact of USD appreciation on the exchange rate between RMB and KRW and that on the domestic income respectively in China and Korea.

Figure 13 shows the USD index and China's export to Korea and import from Korea. From the figure we see that the USD experienced two major appreciation circles since 1993. The first one is between 1994 and 2001, while the second one just started in late 2014 when the market gradually formed the expectation of Feds to raise interest rate. For the appreciation period of USD, the bilateral trade between China and Korea exhibited no large fluctuations. The USD suffered a long and strong depreciation between 2001 and 2008, during which the bilateral trade between China and Korea showed a strong increase. However, we doubt that this is a result of the depreciation of USD. Rather, it is a result of China entering WTO in 2001.

Figure 13. The USD Index (right axis) and the Import and Export of China from/to Korea (left axis, millions USD).



Source: CEIC data base.

Although the bilateral trade between China and Korea seems to be only limitedly affected by the fluctuations of USD index, in the long time, as the trade is supported by the USD currency, appreciation of USD, or Fed' monetary policy changes, is always a risk for the stability of the trade. Due to limited space and lack of data, we cannot estimate the long run effect of using USD as intermediary for bilateral trade between China and Korea and quantify the risk mentioned above. However, potential risk lies in several aspects. For example, if Fed raises interest rate, international capital flows to the U.S. domestic financial market. This will have negative impact on China and Korea's domestic economy due to capital outflow. In addition, the USD currency becomes relatively rare, which increases the transaction cost of the bilateral trade between China and Korea. If such risk is significant, in the long time, China and Korea should promote their trade by pricing in local currencies.

RMB is on the journey to the internationalization. RMB has already been included in SDR currency basket. This justifies that it is beneficial to use RMB as the pricing currency for the bilateral trade between China and Korea. First of all, China and Korea have already used a significant amount of RMB as the intermediary currency for the trade. Secondly, the RMB index is much more stable than the USD index, showing a more consistent exchange rate regime. In the third place, after RMB become the base currency of SDR, the liquidity risk of holding RMB as foreign reserve largely disappears, as the central bank can always exchange the RMB for other currencies, either via SDR or directly. Last but not least, the best way to promote RMB as the intermediary for China and Korea's bilateral trade is through the bid-offer of commercial banks.

4. Effects of the U.S. Monetary Policy on China's Capital Market Stability

According to our study in section 2, we believe the U.S. monetary policy, particularly the current monetary tightening (rising policy rate), has limited impact on China's capital market stability.

First of all, the empirical results in section 2 shows that the even *unexpected* federal fund rate movement will not influence uncovered interest rate premium in both China and Korea, indicating that Federal Reserve policy will not directly affect capital flows in China and Korea. In fact, rising policy rate in the U.S. has been well expected for a long time (almost one year), and the world capital market has gone through the portfolio adjustment, if any.

Second of all, as the capital market expects and understands, rising policy rate in the U.S. is based on the improvement in the labor market and recovery of investment and economy. According to the data, however, both labor market and investment recover still slowly. Although the current unemployment rate is 4.8%, such official statistics ignored the fact that certain unemployed labor forces have given up searching for new jobs. Indeed, before the financial crisis in 2008, the share of potential labor force in the total population was 62.8%. This share is now 59.3%. The decreasing unemployment rate alone is insufficient to judge that the U.S. economy has recovered from the crisis. On the other hand, the manufactory industry in the U.S. is still under recession, far from being healthy. The Sales data of the U.S. manufactory industry has shown a slow down since January 2015, with the decrease in new order and increase of inventory. The latest ISM index (Institute for Supply Management) is 48.6, the lowest since 2014. The weak recovery of the U.S. economy implies that the Fed might not raise policy rate in a fast and unexpected way.

In the third place, typical after financial crisis, the financial sector and real sector in the U.S. went through fast deleveraging. At the time between 2008 and 2014, the risk of trading partner was high, and the U.S. financial market exhibited a clear liquidity dry up. The Fed carried out several rounds of quantitative easing (QE) to supply more liquidity, yet these liquidities immediately "flew to quality" and became cash asset in commercial banks' balance sheet. Such liquidities are important to prevent further financial turmoil, but contributed little to the U.S. economy recovery because these liquidities did not become credit to support investment. Although the Fed just raised interest rate modestly, its effect is withdrawing some excessive liquidity. The marginal effect of the previous monetary easing on the U.S. economy was small and the Fed was constrained by the zero interest rate bound, a signal of liquidity trap, thus the Fed's current monetary tightening will have little impact on the U.S. economy or financial market.

Last but not least, China's capital market is capable to absorb the shocks from the U.S. financial market. The marketizations of interest rate and exchange rate of RMB are deepening and scheduled. The total outstanding foreign debt is less than 10% of China's GDP, far less than the danger line of 20%. As our empirical study shows, the rising interest rate in the U.S. will not have significant impact on the international capital flow in China. We believe that it will not have significant impact on China's financial market either.

5. Policy Implications and Concluding Remarks

Our study shows that the Fed's monetary policy has limited impact on China and Korea's international capital flow and capital market. On one hand, unexpected policy rate change in the U.S. affects little on the uncovered interest rate premium in both China and Korea, while the latter is a significant factor in driving capital flows. On the other hand, the market has formed the expectation of raising policy rate in the U.S. for more than a year before the Fed actually does so. The marginal impact of raising interest rate in the U.S. on Asian economies has been diminishing. We argue that the "Pull factors", such as fundamentals of domestic economy, will play a more important role in shifting international capital flow of China and Korea.

As our review suggests that China and Korea are very important trading partners, we suggest that the two countries should promote more deepening bilateral trade under Free Trade Agreement. Moreover, both countries should enhance their own economic strength, thus weakening the impact of the U.S. monetary policy on their capital market. In particular, we suggest that the two countries, particularly China, should promote mutual financial account liberalization and integration. The two countries should also be more active in communications and cooperation in money market, debt market, stock market and so on. In doing so, China and Korea will defend the external financial shocks (such as shock by Fed) together rather than individually. We believe this is important to develop more stable financial markets in two countries.

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