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**China's Foreign Exchange Reserve Accumulation and Its
Currency Composition Management**

中国の外貨準備の蓄積と通貨構成管理

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Abstract

In the past two decades, the foreign exchange reserve holdings of East Asia and Petroleum Exporting Countries have increased dramatically. After a temporary suspension following the global financial crisis, the uptrend resumed at an accelerated pace. In particular, China's foreign exchange reserves have experienced a rapid growth since 1990, reaching 3.84 trillion dollars by the end of 2014, with an average annual growth rate exceeding 13% since 1988. The ratio of foreign exchange reserves to GDP also increased from 8% to 38%. As the world's biggest foreign exchange reserve holding country, analyzing the management behavior for China's foreign exchange reserves may shed some light for other reserve management entities. Investigating the macroeconomic impacts of China's foreign exchange reserve accumulation not only links the external economy with the domestic economy but also helps us more thoroughly understand its foreign exchange interventions. As for China, the rapid accumulation of foreign exchange reserves is a double-edge sword. Compared to the underlying positive effects, holding large-scale foreign exchange reserves is not a blessing but more like a burden.

Furthermore, the weakening of U.S. dollar against a basket of currencies since 2002 has brought great attention to the loss of China's foreign exchange reserves caused by the devaluation of primary currencies. The rising current account deficits and growing external debts of the United States in recent years also motivate the monetary authorities to avoid the U.S. dollar assets, especially after the introduction of the euro. The currency composition adjustment seems to be a powerful instrument for China's huge foreign exchange reserve management. Moreover, exploring determinants of currency composition decision is conducive to understanding the management of China's foreign exchange reserves.

Thus, there are three themes in this thesis answering such following questions: what are the effects of foreign exchange reserve accumulation on domestic economy? What is the currency

composition of China's foreign exchange reserves and how does China adjust it? Does China diversify its foreign exchange reserves out of the U.S. dollar? Does China effectively manage the currency composition of foreign exchange reserves? What influences the currency composition decision of China's foreign exchange reserves? All these answers not only help us further understand the management behaviors of the world's biggest foreign exchange reserve management entity but also provide references for other countries, and thus contribute to the existing literature.

After the introduction of this thesis in Chapter 1 and a detailed literature review in Chapter 2, Chapter 3 empirically analyzes the macroeconomic impacts of China's foreign exchange reserve accumulation. In addition to satisfying the temporary external financing need and defending the state from external shocks, foreign exchange reserve hoarding also brings financial and policy challenges to the monetary authorities. As for China, along with the accumulation of foreign exchange reserves, funds outstanding for foreign exchange have grown rapidly. The proportion of funds outstanding for foreign exchange to base money continues to grow from 45.7% in 1999Q1 to 102.3% in 2014Q4, exceeding 100% since 2005. Thus, the underlying inflation pressure is likely to be aroused by these excessive monetary base. As a significant symptom of external imbalance, the rapidly accumulated foreign exchange reserves may influence a country's macro-economy in various ways. However, none of these transmission channels could be indisputably agreed. In order to avoid these theoretical disagreements and more accurately analyzing the impacts of foreign exchange reserve accumulation, a newly proposed Pure-sign-restriction Approach within a Vector Autoregression framework is utilized. The key issue in applying VAR methodology is to identify the foreign exchange reserve accumulation shock. This is usually done by appealing to some certain informational orderings about the transmission mechanism of reserve accumulation to the real economy. Without being explicit about the a priori theorizing, it is difficult to distinguish between assumptions and conclusions. In terms of impacts of foreign exchange reserve accumulation, there is no broadly accepted a priori theorizing in the literature. What is therefore desirable in this case is to find a way to make the a priori theorizing explicit and to use as little of it as possible, while at the same time leaving the question of interest open. Inspired by Uhlig (2005) on monetary policy shocks, this thesis proposes to push this idea all the way, and to identify the effects of foreign exchange reserve accumulation by directly imposing sign restrictions on the impulse responses. The only assumptions are that foreign exchange reserve accumulation leads to the increases in foreign exchange reserves and in funds outstanding for foreign exchange. However, no restrictions on the responses of other variables are exerted.

The empirical results present a mixed picture of the diversification debate. An important

finding is that the effects of foreign exchange reserve accumulation on all variables are ambiguous initially, but then the impact on base money becomes significant and increases approximately in the same proportion as foreign exchange reserve accumulation under the sign restriction methodology even after isolating the business cycle shock, monetary policy shock and external shock. However, foreign exchange reserve accumulation has no significant influence on the inflation and the real effective exchange rate. In terms of sterilization interventions, it is found that the Chinese monetary authority efficiently offsets the influences of foreign exchange reserve accumulation on the monetary base through central bank bill issuance and reserve deposit ratio adjustment, though these policies become less efficient over time. Consequently, the base money caused by foreign exchange reserve accumulation is moderate rather than excessive. On the contrary, foreign exchange reserve accumulation has significant impacts on all variables from the beginning under the traditional impulse response analysis with the confirmed order of variables. It is therefore suggested that the assumption for variable orders in the VAR system can potentially influence the empirical results. As the sign restriction approach does not suffer from the order problem, thus our findings much better reflect the real world conditions of China's sterilization policy.

The second theme of this thesis analyzed in Chapter 4 is to estimate the currency composition of China's foreign exchange reserves and to assess its effectiveness of management. Compared with the continuously inflated scale, the currency composition of foreign exchange reserves and its change not only reveal differentiated asset management strategies but also can be employed to infer possible influences of dynamic asset adjustment behaviors on the future asset prices. It is the strictly confidential currency composition of official foreign exchange reserves for individual country that constitutes a critical obstacle for further investigations on the management of foreign exchange reserves. As far as China, although no convincing public information on the currency composition of foreign exchange reserves could be found, it is widely believed that the share of dollar denominated assets is extremely high. Although the State of Administration of Foreign Exchange has more than once expressed the views that the appreciation of renminbi will not directly cause the loss of foreign exchange reserves and the book profit of foreign exchange reserves is far more than its book loss, the loss related to exchange rate fluctuation and interest rate variation does exist. Adjusting the currency composition of foreign exchange reserves is supposed to be a powerful risk management tool for China. Many researchers have reported a dramatic reserve currency shift from the U.S. dollar to the euro between 2001 and 2003 (Papaioannou *et al.*, 2006; Zhang *et al.*, 2010; Sheng, 2013). However, the European sovereign debt crisis seems to severely hinder the internationalization of the euro.

The biggest obstacle in previous studies is the lack of convincing data that could be used to

estimate the currency composition. Based on basic portfolio accounting identities, the change of foreign exchange reserves is decomposed into two parts: the net purchase change and the non-purchase change, by virtue of the Balance of Payments and the International Investment Position. Based on the newly constructed data, we estimate the latent currency composition of China's foreign exchange reserves within the framework of Constrained Least Squares only imposing some generally accepted bound constraints. Among a large number of literatures, Sheng (2013) is supposed to be the first attempt to precisely estimate the currency composition of China's foreign exchange reserves. In order to build the State-space Gaussian Mixture Model, Sheng (2013) assumes that the value shares of foreign assets follow random walk processes. However, many previous literatures report that the shares of major currencies in global reserve holdings are quite stable (Eichengreen and Mathieson, 2000; Chinn and Frankel, 2007). Considering the bearing capacity of financial markets, it is impossible for the monetary authorities to randomly adjust the currency composition. Thus, the assumption seems unreasonable. Instead, we only assume that the value shares of different currencies fluctuate slightly in a commonly accepted range. As Sheng (2013) points out, the estimated currency composition is the *ex post* realized currency portfolio, rather than the *ex ante* one estimated through the traditional mean-variance optimality analysis.

In addition to this, we also discuss the impacts of currency composition adjustment on the portfolio risk of foreign exchange reserves. The Variance Sensitive Analysis proposed by Manganelli (2004) provides an easy to use way for asset allocation management, which not only reveals the risk sources but also points out the direction of optimization. As highly risk-averse investors, most central banks are more inclined to diversify their foreign exchange reserves so as to decrease their reserve portfolio risk. In other words, reserve asset portfolios tend to be risk-averse, with priority for liquidity and security before profit or carrying cost considerations. Thus, we mainly focus on the nexus between portfolio risk and currency composition management here. The effective management behaviors should be any actions that would reduce the portfolio risk of foreign exchange reserves. Thus, the variance sensitive analysis is appropriate to assess the management behavior of China's foreign exchange reserves and to determine its future directions.

The most important finding is that, although the primary currency composition was stable, China had paid more and more attention to the emerging international currencies, such as the Canadian dollar and the Australian dollar. The U.S. dollar, the euro, the pound sterling and the Japanese yen were still four dominant currencies in China's foreign exchange reserves. However, the total share of these four currencies significantly decreased from 2008 to 2012. In particular, China may have tried to introduce the Canadian dollar and the Australian dollar as alternatives to the pound sterling and the Japanese yen, respectively, since 2012Q4. In the whole sample period,

China did not significantly diversify its foreign exchange reserves out of the U.S. dollar to other international currencies. However, a downtrend of the U.S. dollar share during the subprime crisis and an uptrend of it since 2011 were also found, which means that China tries to alternatively take the portfolio diversification strategy and portfolio rebalance strategy rather than stick to either one of them. In addition, the European sovereign debt crisis did have prominent influence on China's foreign exchange reserve management and caused China to decrease the shares of the euro and the pound sterling since 2010. Nevertheless, by the end of 2015Q1, China held about 63.6% of its foreign exchange reserves in the U.S. dollar, 19.6% in the euro, 3.09% in the Japanese yen, 4.89% in the pound sterling, 2.22% in the Canadian dollar, 2.03% in the Australian dollar and 0.09% in the Swiss franc.

Another important finding is that the currency composition management of China's foreign exchange reserves was relatively effective. Before 2014Q3, the first derivative of the U.S. dollar was always positive while those of other currencies were always negative and vice versa after 2014Q4. With respect to the absolute values of derivatives, all of them rapidly declined in 2012. These findings show that, although diversifying out of the U.S. dollar was not always decreasing the portfolio risk of foreign exchange reserves, the portfolio diversification strategy during the subprime crisis was indeed a smart move; on the contrary, the reduction of the euro during the European sovereign debt crisis may not be a good choice. Nevertheless, the portfolio rebalance since the end of 2014 did contribute to the management of China's foreign exchange reserves. In the meantime, the introduction of the Canadian dollar and the Australian dollar may effectively improve the management of China's foreign exchange reserves due to the fact that they had larger derivatives in absolute values.

According to previous studies, some traditional factors, such as the *country size*, *inertia*, *confidence in the value of reserve currency*, have significant influences on the decision of currency composition. Yet most of these researches, especially for those on determinants of the currency composition of individual country's foreign exchange reserves, are controversial, because they all build on analyses about the aggregate data of global level or country groups due to the reluctance of the monetary authorities to release data on foreign exchange reserve composition. In other words, whether the currency composition of individual country's foreign exchange reserves will change with the alterations of its own trade structure, foreign debt composition or the domestic economic development and foreign economic situations has not been investigated. Thus, the third purpose of this thesis is to figure out what drives the currency composition decision of China's foreign exchange reserves. Based on the estimated currency composition, Chapter 5 analyzes possible determinants of the relative change of currency composition including China's differentiated import and export trade structures and the composition of foreign debts in addition

to many traditional factors found in previous literatures. In order to address these concerns, two-currency group (the U.S. dollar and the euro) and four-currency group (the U.S. dollar, the euro, the pound sterling and the Japanese yen) panel regressions with cross-section weighted standard errors are established, respectively.

Like previous studies, we find that the inertia and confidence in the value of reserve currency strongly affect the currency composition decision of China's foreign exchange reserves. In addition, as expected, the increase of export trade is conducive to enhancing the value share of that currency in total foreign exchange reserves. However, the influence of import trade is only statistically significant in the four-currency group regressions. These findings suggest that, when making the currency composition decision, China will emphasize the influence of export trade structure in the two-currency group while will also pay attention to the change of import trade structure in the four-currency group. Another interesting finding is that the composition of foreign debts is negatively related to the currency composition change of China's foreign exchange reserves, which is inconsistent with most previous studies. This probably means that China may try to seek for foreign debt composition arbitrage rather than asset-liability collaborative management due to the fact that foreign assets are significantly more than foreign debts. Furthermore, We find that additional variables, such as long term bond yields, inflation and exchange rate volatility, have little impact on the currency composition decision of China's foreign exchange reserves.