International Monetary Review

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Research Review by IMI members

Research Report and Working Paper

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

The Effects of Monetary Policy on Input Inventories by Dai Tiantian and Liu Xiangbo

Regulatory Arbitrage and Window-Dressing in the Shadow Banking Activities: Evidence from China's Wealth Management Products by Cai Jinghan, Alicia Garcia-Herrero and Xia Le

Special Column

China Pakistan Economic Corridor(CPEC) by Yaseen Anwar

A Closer Asia-Africa Partnership is an Opportunity for All by Ben Shenglin

A Tale of Two Markets for the Redback by Xia Le and Dong Jinyue

Revive the IMF SDR Substitution Fund by Ousmène Mandeng

Introduction to the International Monetary Institute (IMI)

Established on December 20, 2009, IMI is a non-profit academic institution affiliated to China Financial Policy Research Center and the School of Finance of Renmin University.

Following the "general theory of macro-finance", IMI aims to become a world-class think tank, focusing on the studies of international finance, in particular the international monetary system and RMB internationalization. Despite its relatively short history so far, IMI has established itself as a leading research institution and important forum, where industry leaders, policy makers and academic experts from home and abroad share their insights and expertise.

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Executive Vice President of the China Society for Finance and Banking
Former Chief Executive of Hong Kong Monetary Authority
Member of IMI Advisory Board

Mr. Joseph Yam is currently Executive Vice President of the China Society for Finance and Banking, a society managed by the People's Bank of China. He was appointed in December 2009 with a responsibility to promote the financial development of the Mainland, serving as an advisor to the People's Bank of China.

Mr. Yam graduated from the University of Hong Kong in 1970 with first class honours. He started his civil service career in 1971, serving the public for over 38 years. His involvement in monetary affairs in Hong Kong started in 1982. He helped put together Hong Kong's Linked Exchange Rate system in 1983. During the sensitive period before the handover of sovereignty, he introduced many strategic and proactive reform measures that helped to ensure monetary and financial stability in Hong Kong. Mr. Yam was instrumental in the establishment of the Hong Kong Monetary Authority in 1993 when he left the Civil Service to head the new organization as its Chief Executive until his retirement at the end of September 2009.

In recognition of his contribution to Hong Kong, Mr. Yam was awarded the highest honour of the Grand Bauhinia Medal by the Hong Kong Special Administrative Region Government in 2009. In 2001 he had already been awarded the Gold Bauhinia Star.

Over the years Mr. Yam has been conferred with a number of honorary doctorate degrees from local and overseas universities, including his alma mater, the University of Hong Kong. Besides, he is also an honorary professor of a number of universities.

This issue is proud to present

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In Brief

Editor's Note:

Up to April 2016, members of IMI advisory board and academic committee have been expressing their research opinions on finance and economics through published articles and public speeches. This column reviews their opinions.

Research Review by IMI Advisory Board

According to **STEVE H. HANKE** in the article of "***The Hong Kong dollar, rock solid***", as many currency speculators bet on a devaluation of the HKD, it is fascinating how so many experienced currency speculators can be so ill-informed about Hong Kong's monetary setup and why is there so much confusion about exchange rates — particularly fixed exchange rates delivered by currency board systems. To answer that question, he developed a taxonomy of exchange-rate regimes and their characteristics. He pointed out that floating and fixed-rate regimes are inherently equilibrium systems in which market forces act to automatically rebalance financial flows and avert balance-of-payments crises, while pegged-rate systems are inherently disequilibrium systems, lacking an automatic adjustment mechanism. China's RMB falls into the pegged regime category, but that's not the case with the HKD, which is linked to the USD via a currency board. The currency board "backing (or 'stock') rule"—that the board's monetary base (reserve money) must be backed by foreign reserves — 100%, or slightly more, and the "flow rule" — that reserve money must change in a one-to-one relationship with changes in the currency board's foreign exchange reserves — are two rules strictly followed in Hong Kong. So there has never been a system that followed currency board rules — like Hong Kong's — that has been broken by a speculative attack. Indeed, its currency board is operating exactly as it should, which is why it can't be broken. When the U.S. Fed embraced quantitative easing, USDs flowed into Hong Kong. Now that the Fed has started to notch up the Fed funds rate, the flows have reversed. In consequence, the currency board is automatically tightening up, and both broad money and credit to the private sector are decelerating and are below their trend

rates. In the future, we should expect a slow-down in the Hong Kong economy. But, the HKD will remain rock solid.

As **LI YANG** pointed out in the article ***"In the internet age, a crucial part of macro-regulation is stating the truth"***, effective macro-regulation requires accurate judgments on China's economic fluctuations.There exist 3 factors causing economic fluctuations: short-term shocks, cyclical movements, and long-term trend.If the economic fluctuations are caused by short-term shocks, for example, a surge or slump in the price of oil or commodities, macro-regulation should conform to the principle of "not overreacting".If the economic fluctuations are caused by economic cyclical movements, regulatory measures on cyclical movements should be applied.If it is certain that the economic fluctuations are becoming a long-term trend, potential economic growth rate and resource utilization are not likely to be stabilized to their current equilibrium points for a long time, or even generate new equilibrium points. In this case, strong macro-regulation should step in. In monetary policies, both the price tool and quantitative tool can take the advantage of market and administrative forces. When market economy is normal, quantity and price always move in opposite directions. In this financial crisis, regulatory measures on quantity and price can be implemented separately under some extreme circumstances, which are very rare. In the Internet Age, a key part of macro-regulation is stating the truth. Internet economy has matured to a large extent; information can be obtained and transferred instantly; and different markets are interconnected with more uniformity. Against this backdrop, a key part of macro-regulation is stating the truth to gain public trust and cooperation. With markets' integration, uniformity, and high degree of transparency, regulators and the regulated are playing a cooperative game where they keep "communicating" and "negotiating". Thus, such regulation is realized by both parties.

PAN GONGSHENG mentioned in ***"The reform and development of China's bond market"***, in recent years, China's bond market achieved significant progress. The bond market play an increasingly important role in support macro-regulation, promoting reform and opening-up, improving social financing structure, and cutting the costs for corporate financing. Looking back, China's bond market experienced fluctuations and gained valuable experience. Based on the development experience of more matured international bond markets and the general principle of market development, the development of China's bond market is promoted through qualified institutional investors and OTC markets between banks. The bond market adheres to marketization reform and reduces administrative supervision for bond

markets while strengthening the regulating power of the market and invigorating market forces. The development of China's bond market started late, so forward-looking institutional arrangements for bond markets and financial market infrastructure construction are needed. There are still a series of potential problems and challenges for the development of bond market. Under economic downturn, the credit risks for micro entities become obvious. Price distortion is triggered by implicit guarantee and rigid payments. Lack of coordination influences the market's overall risk identification and control. As the financial market is opening up at a faster pace, the coordination and efficient universal regulation are needed for financial market infrastructure construction. Facing opportunities and challenges, problem-based approached should be adopted to tackle potential problems, remove institutional barriers, highlight top-down design, and to promote the development reform of the bond market. Maintain the stable general landscape while developing the bond market mainly through qualified institutional investors and OTC markets. Strengthen the prevention of risks, improve market regulation and the risk sharing mechanism, and build an efficient, fair and standardized bond market. Further enhance regulation and coordination, facilitate the marketization reform of bond issuing system and legal construction. Actively and steadily promote the opening-up of the bond market.

As **WANG ZHAOXING** put forward in ***"The revolution of the capital regulation system"***, the revolution of the system is the central task for this round of international financial regulation reform. Being different from the financial regulation enforced nationwide in the 30s of last century, this round of international financial regulation reform identifies and calculates risks more accurately via a new set of standards and mechanism, and offsets risks through capital on a more targeted basis. Promote financial stability through rising capital requirements is one major task for the capital regulation reform. The new capital system largely improve the quality of capital and rises the requirements, which enhances the financial institution's capacity in absorbing losses, withstanding risks and self-recovery and increases the resilience of the financial system. From a macro-prudential perspective, the new capital system increases the requirements for systemically important capital surcharge and countercyclical capital buffer to prevent systemic risks. Understand why this round of regulatory reform still attaches great importance to strengthen and improve the capital regulation from the perspective of historical evolution and central work of the latest round of reform. Basel Accord I (Basel I) applied a stifle weighing method for risk evaluation, which was not scientific and

accurate. While the capital requirement is insensible, banks also lack incentives to improve the risk management; and the risk coverage is too narrow including only the credit risk. Basel Ⅱ is a great leap forward from the historical evolution of the capital regulation system. But based on pragmatic demands, Basel II still failed to meet expectations, and had deficiencies in the systemic level and execution level. Based on the systemic level and execution level deficiencies of Basel Ⅱ, Basel Ⅲ made relevant amendments.

The new capital system influences all nations. The implementation of the new capital system brings deleveraging shocks for developed countries, as well as pressure on capital supply. The new system does not bring shocks to emerging markets such as China in the short term, but still exerts influences in the long term. The new capital system sets higher requirements for regulation agencies of all countries in terms of risk identification, measurement, management, offset and handling. Basel Ⅲ will not be the final version for the capital regulation system, and can be improved at least from the following aspects: what is the proper level for capital adequacy ratio, the capital regulation should balance simple comparability and risk sensitivity, deal with universality and difference, the long term influences of the new capital system on economic growth are to be closely observed.

Although the capital regulation reform is crucial for the international financial regulation reform, it is not only task. Therefore, the capital regulation reform is better understood when being put under the holistic framework. A comprehensive reform plan is needed for reducing moral hazards, maintaining financial stability, enabling the financial sector better serve the real economy, and promoting the long term steady economic growth.

According to "***A four-step plan of financial reform in the SFTZ***" by **XIA BIN,** Shanghai Free-Trade Zone (SFTZ) has a profound meaning. It marks the third milestone of China's reform and opening up, but at the same time faces many problems, especially in financial reform.He pointed out that the SFTZ differs from other overseas free-trade zones. The major difference is that the SFTZ needs financial reform, which will exert an overwhelming influence on the whole economy. If the financial reform is not well regulated, it will disrupt the necessary balance of domestic investment environment. Also, the entry point of the financial reform is to set up "special bank accounts", and to stick to the principle of "complete deregulation of the first tier, effective regulation of the second tier".

He put forward a four-step plan of financial reform in the SFTZ. Firstly, the government will establish "special bank accounts", which will act as an "iron fence".

After the implementation of financial marketization and the channel of "special bank accounts" in the SFTZ, capital inflows may exceed outflows. By this time, the government should extend the system of "special bank accounts" as soon as possible to non-resident financial institutions and enterprises in the whole Lujiazui area. The government should also allow money in the "special bank accounts" free access to the financial market in the SFTZ. According to the conditions in which the international financial market and domestic economy are operating then, the government will consider implementing the "special bank accounts" system simultaneously in cities such as Tianjin, Guangzhou and Shenzhen, and promoting capital controls and free RMB convertibility. After the exploration of the steps above, China has accumulated experience in gradually opening capital accountand the testing ground will come to an end. This means that China is then ready for capital account liberalization and full convertibility of RMB.

Research Review by IMI Academic Committee

CHEN YULU put forward ***five challenges for China's green financial reform*** including an enormous demand for green financing, insufficient supply of China's green finance, the lack of law protection system for the development of China's green finance, the lack of coordination mechanism for promoting China's green finance at the national level, and the lack of a clear strategic blueprint for the China's green financial reform and development. To implement the roadmap for green financial reform, China's future development should be divided into three phases in the upcoming 15 years. The first stage is the initiating stage where relevant mechanism should be improved, financial policies and tools should be innovated, and major strategic development areas should be identified. During the second phase, the capitalization and financialization of natural resources should be achieved, pilot projects should be expanded, and low-carbon development should be promoted. The third stage is the comprehensive implementation phase of China's green financial reform. We should set priorities in three sectors, vigorously promote the development of a green bond market, launch Green Development Funds and set up pilot projects for national strategic green reform.

BEN SHENGLIN and his research team constructed the Chinese Banks Internationalization Index (CBII) to dynamically measure and capture the progress of internationalization process of different Chinese banks overtime. Based on the index, they find that Bank of China is the most international among the "Big 5"

state-owned banks, China CITIC Bank is in the lead among shareholding commercial banks, contributions from oversea business to Chinese banks' overall results are still low, Chinese banks' oversea business is growing fast, almost half of the oversea branches of "Big 5" banks are located in Asia. He also gave some advices for Chinese banks. First, Chinese banks should be more prudent, when developing their global strategies, which should reflect banks' own capabilities and business priorities. Second, Chinese banks should follow the trend of (Chinese) government policies and strategic priorities more closely when they pursue international expansions. Third, Chinese banks should pay more attention to the financial regulations in different countries. Fourth, different forms of foreign presence should be considered at different development stages.

According to **CAO TONG** in ***"Self-finance based on blockchain entirely possible"***, blockchain technology has great influence on banking industry. Currency may return to physical currency. The history of credit currency is very short. Physical currency is used in most of human history. When the scarcity and self-invention problems of physical currency are addressed, we may go back to physical currency time. Finance can be divided in to direct finance which creates currency and indirect finance which does not. Self-finance may emerge when third-party applications of blockchain and financial management technologies are realized. Some functions of bank are being deconstructed with the advance of time. Multi-functional banks in the future will replace all-round banks. New changes call for new financial regulation and management system. From the macro finance perspective, the advent of self-finance age, currency creation and changes in central bank's functions call for new system. From the micro finance perspective, in the age of commercial finance, commerce and finance are inseparable and the ideas about regulation have also changed.

DING ZHIJIE stated in ***"China should improve management of capital inflows"*** that as the Federal Reserve enters the cycle of interest rate rises, global policy-makers are facing a new round of challenges concerning monetary strategies. The situation of China's foreign exchange has been reversed. Capital outflows have caused pressure on RMB's depreciation. The reduction of foreign exchange reserves in China has become the trickiest question facing China. China should take steps to tackle this problem. Cross-border capital flows have caused severe loss. Excess capital inflows resulted in appreciation of the currency, inflation of asset prices and surge of foreign exchange reserves. All these bode ill for emerging market economies. China should improve management of capital inflows. It is suggested

that the government announce that it will implement necessary regulatory measures on capital inflows when necessary so as to curb speculation, restore market confidence and avoid panicked capital flight. It is not advisable to take temporary measures on restricting capital outflows. We should take measures to guide, rather than prohibit, outflows of capital. We should improve management of capital inflows. When implementing policies concerning the use of foreign capital, we should pay more attention to China's own benefits. RMB exchange rate policies should prioritize stability. There is no basis for further yuan depreciation. Stability of RMB exchange rate policies means that the exchange rate and the fluctuation should be kept within the regulatory range. We should enhance our capacity of guiding market expectations. We should have a good mastery of market signals and use them to improve policy guidance and appease market sentiment. Gradual reduction of foreign exchange reserve should be continued. Since China still has a relatively large foreign exchange reserve, there is large room for reduction. Misinterpretations concerning the reduction of foreign exchange reserves still exist. In fact, the reduction of foreign exchange reserves should be seen as a reduction of burden. At present, exchange rate loss is non-existent. Reduction of foreign exchange reserves should be processed in a gradual approach and one-way decline of reserves should be prevented.

According to **JIAO JINPU** in the article ***"The role of digital finance in the development of inclusive finance"***, there are several theoretical base of digital currency's support for inclusive finance. First, digital currency promotes the development of inclusive finance in three ways. First, it broadens the coverage and facilitates access to financial services. Second, it lowers the transaction cost and time cost of financial services. Third, it improves the quality of financial services and customer satisfaction. Second, currency moves towards digital currency by undergoing three stages, which may happen simultaneously. Third, mobile currency becomes the symbol of digital currency. As mobile currency services are increasingly popular around the globe, regulatory framework has also been improved.

In Europe and Japan, regulatory regime focuses on the currency issuance. This regime sees the issuance of digital currency as an independent industry and imposes prudent regulation on currency issuance institutions. In Hong Kong and Taiwan, regulatory regime is similar to that of banks. This regime sees digital currency as depository services provided by banks and grant the rights of issuing digital currency only to commercial banks or deposit-taking companies. In the United

States, regulatory regime focuses on the services of the currency. This regime sees digital currency as non-depository currency services, and allows for the participation of both financial institutions and non-financial institutions. Regulatory focus is given to the products and services. As for China, we should press ahead with the development of legal system and confirm the legitimacy of digital currency with clear legislation, improve the protection mechanism for consumer rights and benefits, improve regulatory system and ensure the relevant markets are secure and stable while at the same encourage innovation and competition, establish unified technical standards so as ensure the connectivity between different platforms.

As **LIU JUN** pointed out in "***China should avoid getting into two predicaments",*** the rationale for Basel Accord can be concluded in four parts. Firstly, Basel accords are developed in response to financial crisis while inducing systematic risks for the next round of financial crisis. Secondly, the controversy and compromise over Basel accords reflect the competition for national interests. The new Basel accord is the product of previous round of compromise over national interests. Thirdly, Every Basel accord improves internationally active banks' business performance and regulation; promotes international finance and economic development under fair competition and prudential regulation. Fourthly, Basel accords are designed for internationally active banks since the endorsement of Basel I. Up to now, Basel accords have become a set of principles for countries' (including developing countries) banking supervision, which will impose a heavy burden on small-and-medium-sized banks' capital regulation.

As for the salient features of Basel Accords with Chinese characteristics, he thinks that if the capital requirement of Basel III is higher than that of China's existing requirement, then comply with the requirement of Basel III, otherwise China's existing capital requirement should be complied with. He also put forward approaches for China's Banking Industry to Cope with the Challenges of Implementing Basel Ⅲ. Firstly, take an active attitude and have a clear understanding of Basel Ⅲ. Secondly, improve the localization of Basel Ⅲ's institutional arrangements and incentive measures. Thirdly, encourage diversified competition and regulation. Last but not least, have a clear understanding of the development situation of China's banking industry; proactively regulate and supervise the uncertainties brought by the implementation of Basel Ⅲ.

LU LEI, in his article "***Liquidity shocks are the primary concern in the near***

future", mentioned that market fluctuations had been going on and liquidity risks were one of them since the beginning of this year. He suggested that macro-control needed improved epistemology. If China takes a counter-cyclical approach in implementing its macro-control policies, the premise should be that the current economic problems are caused by cyclical factors rather than structural problems. Moreover, independence of macro-control policies may not be ensured, and there might be some problems in total amount control polices. What's more, macro-control needs improved methodology. Firstly, expectation management should be a crucial part of macro-control policies. Secondly, focus should shift from micro-prudential regulation to macro-prudential regulation. Thirdly, more guidance and tolerance should be given to more capital account convertibility, informal finance and the newly-emerged internet finance.

As **DAVID MARSH** put forward in the article "***How the Federal Reserve could prevent a currency war with China***", it is time that the world's two largest economies filled this lacuna by negotiating a Federal Reserve-People's Bank of China swap agreement in each other's currencies, with the aim of supplying dollar and yuan liquidity on international financial markets. A Sino-American swap line would not only emphasize steadying the yuan against its main trading partners, with a major potential effect in calming financial markets, but also strengthen the U.S. Treasury's bid to regain ground in international financial diplomacy. In line with these ambitious goals, a Fed-PBoC accord would probably have to exceed the 350 billion yuan ($52 billion) swap lines in force between China and the Bank of England and the European Central Bank.

But the symbolic effect in shoring up the Chinese authorities' exchange commitment would be unmistakable. Factors helping calm the political environment for such an accord are that such an agreement would be similar to standing arrangements between the Fed and other major foreign central banks, which in this case swap agreements are decided at the operational and policy levels between individual central banks, and do not require legislative approval; and that it would lower the probability that Chinese depreciation would spark further "currency wars" between major trading partners, harming U.S. exporters in a U.S. election year. The accord would help calm nerves in Japan about undue depreciation of the yuan against the yen. It would pave the way too for more constructive engagement between the U.S. and China extending beyond present dollar strength, preparing for the inevitable time when the greenback starts to weaken again.

According to **TU YONGHONG** in the article ***"How to carry out macro-prudential financial management in the opening of capital account"***, joining SDR is a milestone event for RMB internationalization, and it must promote the opening of capital projects in China which will raise new challenges to the macro prudential management of our country. For tackling those new challenges, we need to conduct scientific top-level design, taking advantage of management tools for the flow of capital comprehensively. The opening of capital project is an inevitable choice at the moment. Firstly, for modern economy, the financial resource is the core for allocating other resources. Optimizing the allocation of financial resources is an effective way to accelerate the adjustment of economic structure. Secondly, at the background that the major developed countries like the United States, Europe and Japan continue conducting the implementation of quantitative easing policy, the financing difficulties for companies in our country have been eased, the financial environment is also improved and the opening of capital project is beneficial for accelerating the long-term transfer of productivity of our country and the industrial upgrading. Thirdly, RMB joined the SDR means that the Chinese government has to take the obligation to provide public goods globally; the opening of capital projects is a rational choice to suit the situation both at home and abroad.

Macro-prudential financial management encounters new challenges. Firstly, the influence of capital flow towards the formation mechanism of the exchanging rate of RMB rises, making it more difficult to manage the exchange rate of RMB. Secondly, continuing to build the effective management mechanism of risk for financial market, and reducing the risks. Thirdly, the development of offshore market increases the difficulty coefficient of financial management, the capabilities of managing the macro economy of Chinese government faces new challenges. Regarding the principles of financial management under the opening up of capital projects, firstly, insist the gist that the financial structures have to serve the real economy. Carrying out the financial innovation actively and guiding the financial resources to flow into the real economy. Secondly, take timely and effective policies and measures to keep the basic balance of International payments, protecting the potential financial risks and even the social unrest. Thirdly, use economic and market method primarily to carry out the macro prudential management. We should also coordinate the use of management tools for capital flow. Firstly, make the adjustment policies for international payments scientifically, comprehensively using the monetary, fiscal, income, industrial policies to stabilize the surplus. Secondly, maintain the flexibility of the exchange rate of RMB and keeping the necessary intervening mechanism. Maintain the relatively stable exchange rate of RMB. Thirdly, learn the experience

from international community, create a number of special adjustment methods that are in accordance with China's national condition and the developing characteristics of the status quo.

According to **WANG YONGLI**, since the end of 2008, which was marked with the eruption of global financial crisis, the scale of the asset for the Federal Reserve has rapidly enlarged (increasing by around 5 times from a little more than 0.9 trillion dollars to 4.5 trillion dollars since 2012). This phenomenon was once widely criticized by the citizens as irresponsible of printing money in full swing. But the amount of money is actually not increased that rapid as people imagined. And the quantity of the asset of Chinese central bank is not expanded as fast as the Fed. (Compare to the end of 2007, the quantity of the asset enlarged around 70 percent at the end of 2014. And the quantity of the asset for central bank even decreased in 2015) However, the speed of the enlargement of the amount of money in China is the fastest among the major economic entities.(Increasing for 40 trillion RMB at the end of 2007 to 139 trillion RMB by the end of 2015, enlarging for more than 3 times). However, the huge contrast between China and the US for their central bank assets and the total amount of money has not been considered, researched seriously and learned a lesson from the problem for a long time.

Many people has rigidly considered the enlargement of the quantity of the assets for central bank (the release of the base money) as a stimulation to necessarily push the total amount of money multiply, and forgot that between the base money and the total amount of money, there is also a index called the monetary multiplier. After the financial crisis, the Fed has conducted quantity ease policy. The policy was actually based on the post-crisis phenomenon that a huge number of international capital has flowed from the commercial bank to the central bank or the national debt (risk off). And the commercial banks decreased the quantity of loan and enlarged their currency reserve. The phenomenon drained the liquidity of market and push the assets of the central bank expand passively. In this situation, if the central bank didn't enlarge the amount of base money to the market. The financial market may completely collapse. And in this situation, despite that the central bank released the liquidity in full swing, the monetary multiplier didn't increase, thus the total amount of money won't increase as fast as people imagined. But it is not the same situation for China at that time. Massive amount of International capital flowed into China after the crisis. For the sake of restricting the currency appreciation of RMB, the Chinese central bank bought the foreign exchange passively, released the base money. And at the background that Chinese government implemented the

stimulating policy vigorously; the banks were trying their best to lend to the public. Therefore, the monetary multiplier was increased significantly and so that the total amount of money was necessarily expanding rapidly. The huge contrasts of the consequence of the monetary policies conducted by China and the US after the crisis imply a profound philosophy theory. As a matter of fact, it is worth of being pondered prudently.

As **ZHAO XIJUN** put forward in the article ***"Speed up comprehensive reform on financial regulation"***, China's financial industry is in a stage of fast development and changes. The ever-increasing financial innovations have made financial activities more complicated than ever. But as new situations and changes keep springing up in the fast development of financial industry, the existing financial regulation system is hard to adapt to the financial industry now and deepening reforms on regulation becomes necessary. There are some new developments in products, institutions, trading markets and technologies in financial industry. New changes in financial industry are mainly seen in financial products, institutions and technologies. Some financial institutions are making equity investments in other business fields and became holding financial institutions that own more and more financial licenses. Markets and platforms for trading financial products keep springing up; more and more ordinary residents now get involved. Development in technology, especially the Internet technology enables more institutions to do financial business even when they used not to. Financial regulation reform should be designed both on the micro and the macro levels. Financial institutions should meet regulatory demand. As for the regulation of local financial institutions, responsibilities of central and local regulatory agencies should be spelt out. Industries engaging in financial activities should develop their own professional management capacity, including external regulation and self-discipline.

IMI International Monetary Review

Research Report

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

By Gang Jianhua, Qian Zongxin, Zhang Chao, and Zhang Jiarui*

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

*****Joint research project by IMI and Korea Institute for International Economic Policy (KIEP). This report is published on December 30, 2015 in Korea by KIEP.
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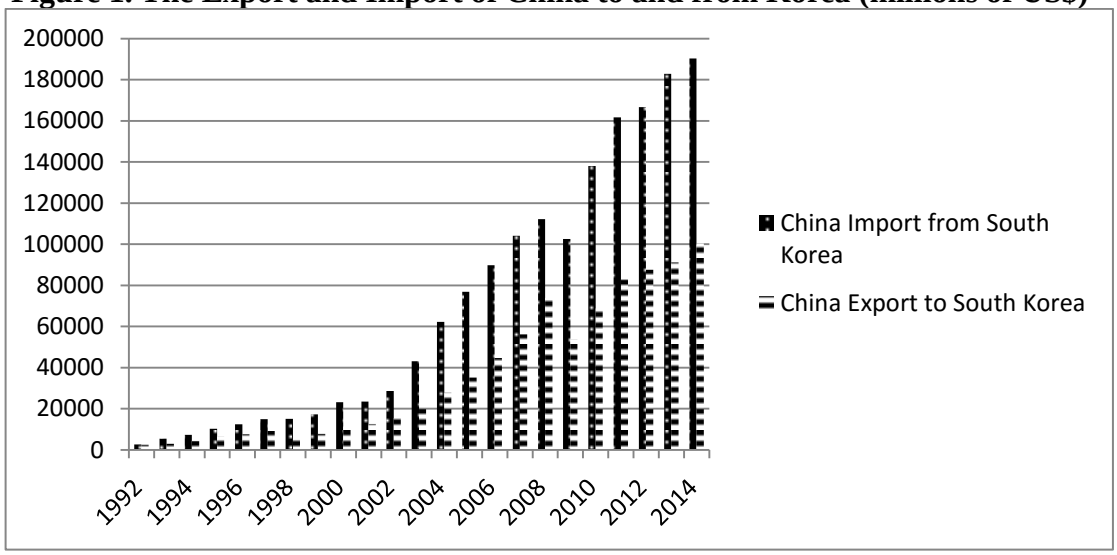
trade and capital market stability.

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$)

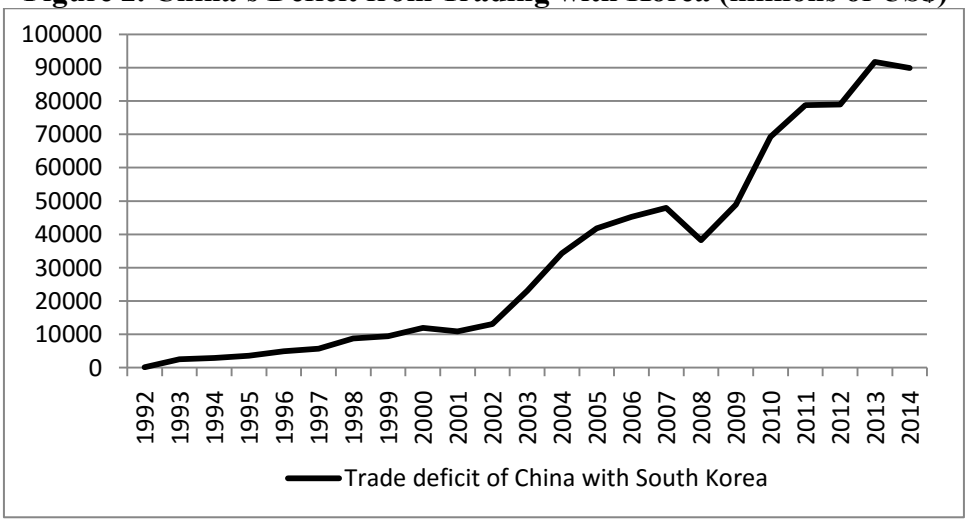


Source: CEIC data base.

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.

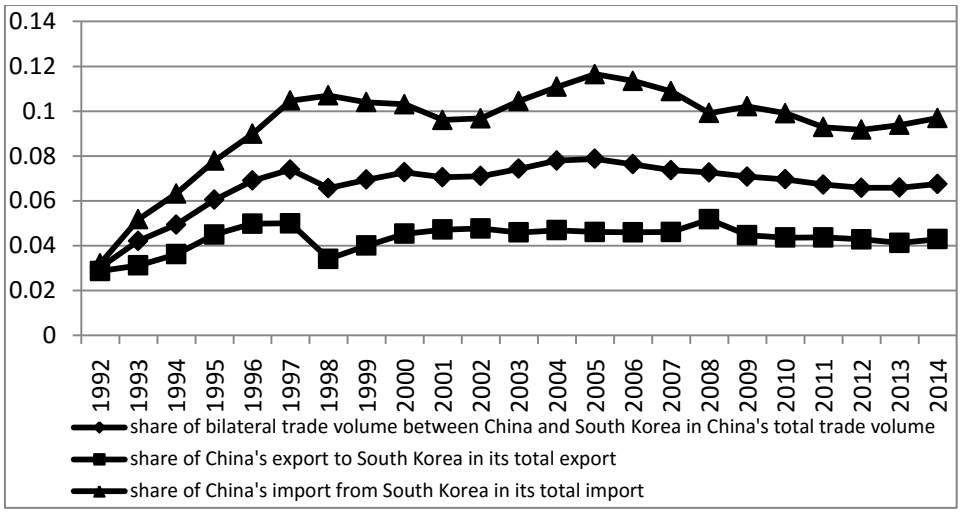
Figure 2. China's Deficit from Trading with Korea (millions of US$)



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

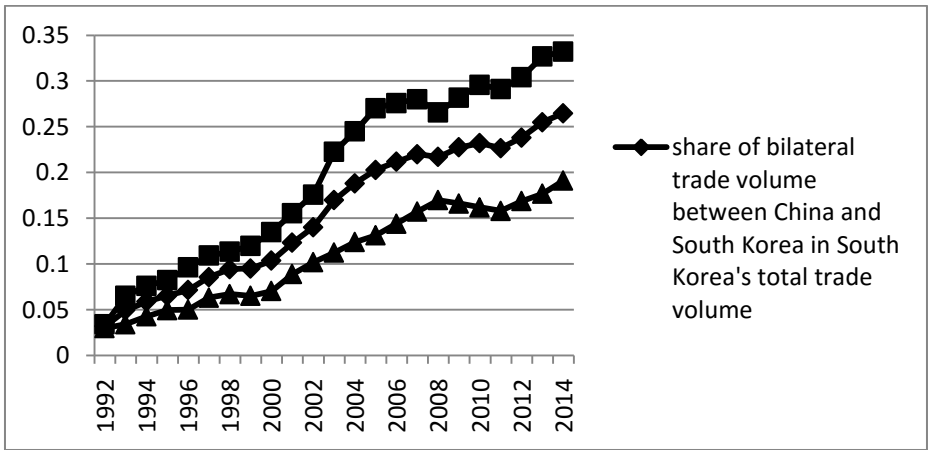


Source: CEIC data base

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

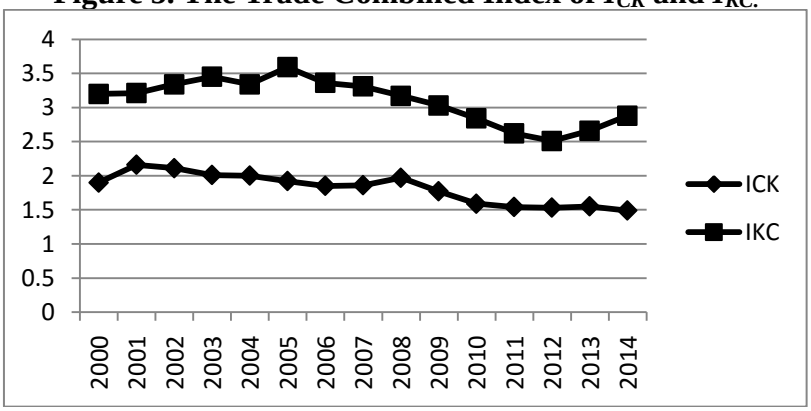
The Trade Combined Index is an index to feature the integration of two trading countries in international trade activities. This index is defined as follows: suppose two trading counties: China and Korea. Denote X_{CK} as the export from China to Korea, and X_C as China's total export. Also denote M_K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

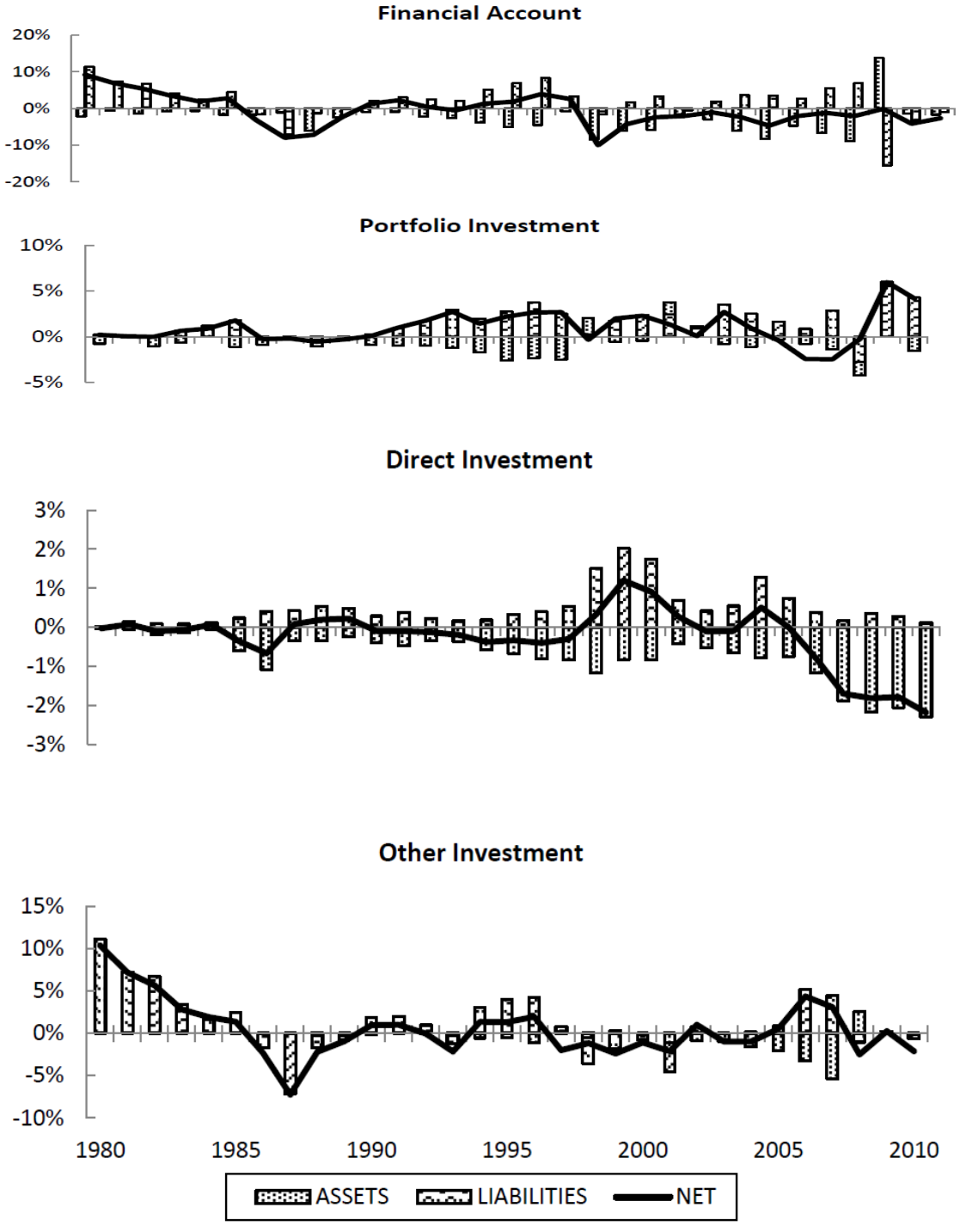
Our expectation is that, GDP is positively correlated with FDI, as better macro-economy may increase the sourcing countries' return on FDI. IRS is positively correlated with SCF, because short-term capital can gain higher return if interest rate in China is higher. However, IRS is negatively correlated 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.

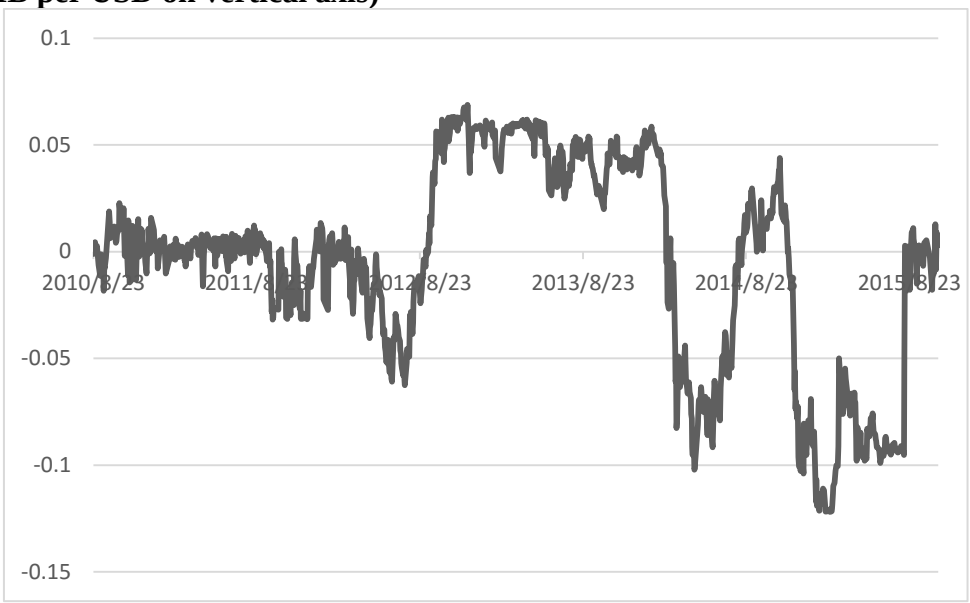
2.3 Data and description

• 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

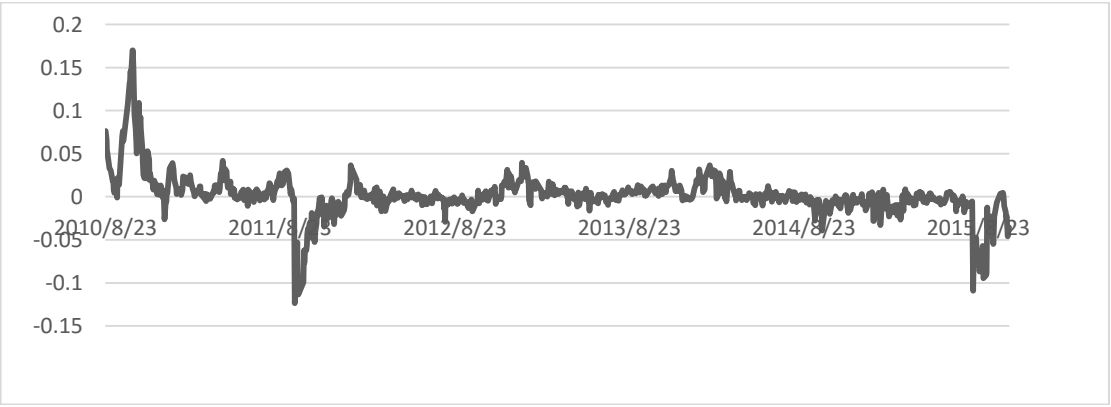


Table 2. Augmented Dickey-Fuller Test Results

	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.

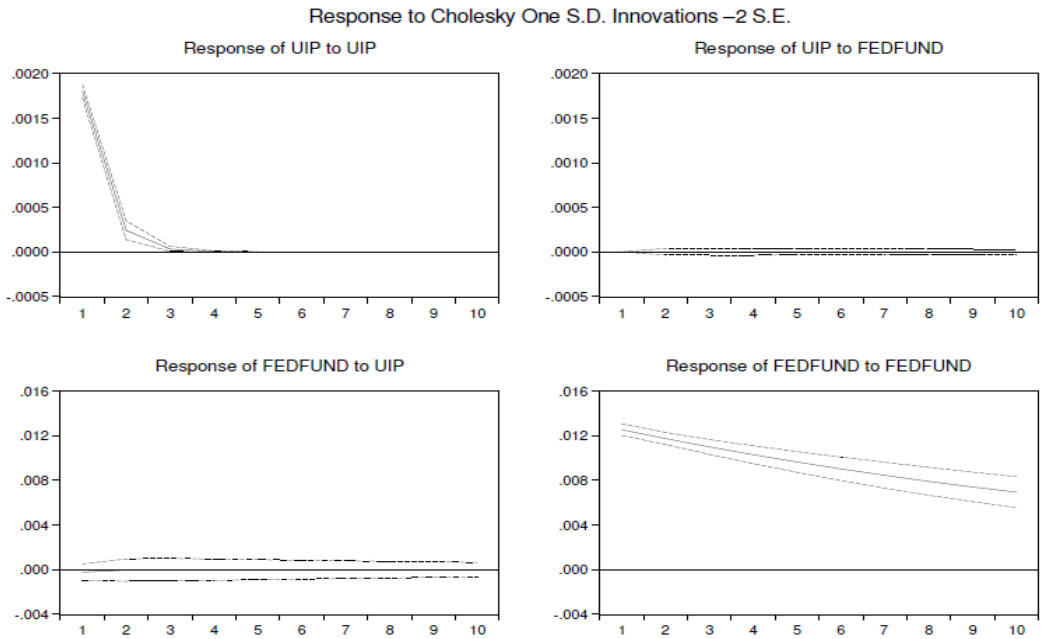
Table 3. Basic AR(1) Model of Federal Fund Rate and UIP

	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

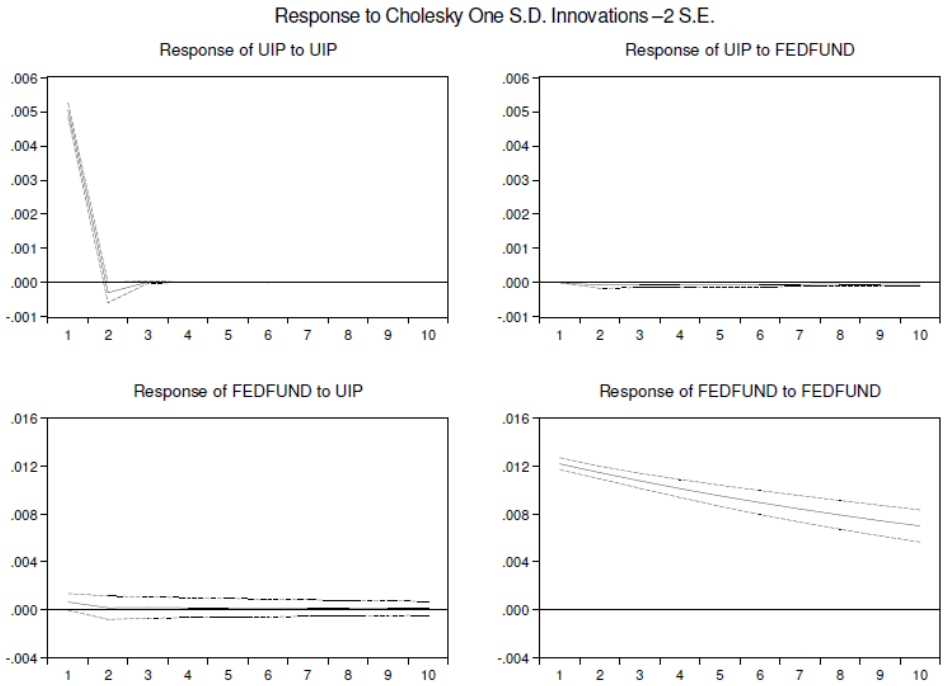


Table 4. Estimates of VAR Model of China

	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†
	(−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 seen from 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, offshore RMB 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 to hold 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:

$$\ln L = \sum_{t=1}^{T} \ln L_t$$

$$\ln L_t = \frac{n}{2} \ln 2\pi - \frac{1}{2} \ln |R_t| - \ln |D_t^{1/2}| - \frac{1}{2} \varepsilon_t R_t^{-1} \varepsilon_t^T$$

$\varepsilon_t = H_t^{1/2} \upsilon_t$, 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:

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

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:

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

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†	−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

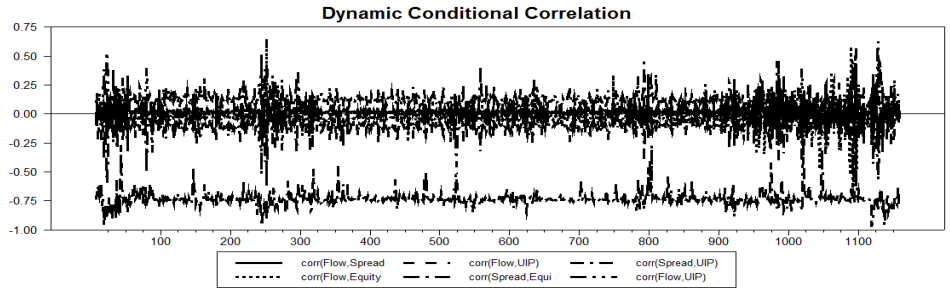
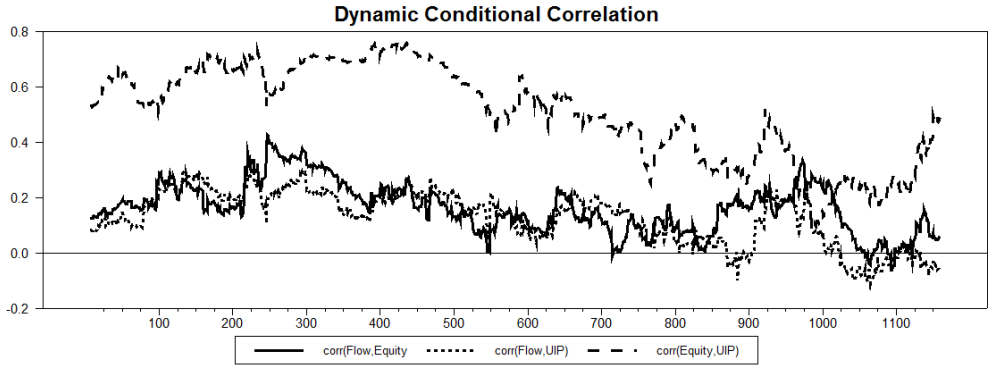


Figure 12. Dynamic Conditional Correlation of Korea



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:

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

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:

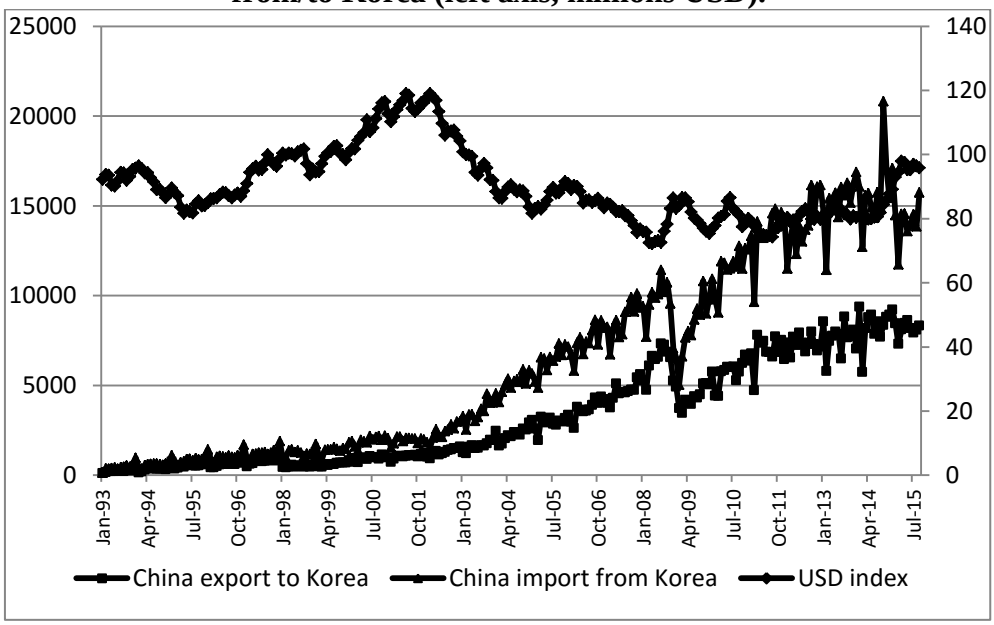
$$M_D = f\left(e^n \frac{P^{**}}{P}, Y\right) (7)$$

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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Working Paper

The Effects of Monetary Policy on Input Inventories*

By DAI TIANTIAN and LIU XIANGBO*

This paper explores the long-run and short-run effects of monetary policy on input inventories in a search model with monetary prorogation and two-stage production. Inventories arise endogenously due to search frictions. In the long run, monetary policy has hump-shaped real effects on steady-state input inventory investment, inventory-to-sales ratio as well as sales. We show that the effect of an increase in the money growth rate is driven by both the extensive and intensive margin in the finished goods market. The model is then calibrated to the U.S. data to study the short-run effect of monetary policy. We find that our model can reproduce the stylized facts of input inventories well and input inventories can amplify aggregate fluctuations.

Keywords: monetary shock; input inventories; business cycles; monetary search
JEL Classification: E32, E52, G31 D83

1. Introduction

The importance of studying inventory behavior in understanding the propagation mechanism of the business cycle has been widely acknowledged in the literature. The importance of inventories can be implied by a set of stylized facts. Using quarterly U.S. private nonfarm inventory data from 1953:1-2002:1, Khan and Thomas (2007a) establish: (1) the volatility of inventory investment is large, accounting for, on average, 29.5% of the volatility of GDP; (2) net inventory investment is procyclical; (3) net inventory investment is positively correlated with

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final sales, and its respective correlation coefficients with GDP and final sales are 0.67 and 0.41, which implies that output is more volatile than sales; (4) the inventory-to-sales ratio is countercyclical. The third empirical finding is often viewed as evidence that inventories can play a destabilizing role over business cycles. In other words, inventories may amplify aggregate fluctuations over the business cycle.

In fact, such amplification effects are mainly attributed to input instead of output inventories. Blinder and Maccini (1991) first point out the importance of input inventories. By decomposing the monthly U.S. manufacturing data by sector from 1959-1986, they found that, investment in input inventories is larger and more volatile than investment in out-put inventories and concluded that "most researchers seem to have barked up the wrong tree." This finding is robust to the narrowest definition of input inventories. Humphreys, Maccini and Schuh (2001), who examined longer time series from 1959-1994, also confirmed this finding. They found that manufacturing firms hold on average more than twice the amount of input inventories than output inventories, and input inventories are three times more volatile than output inventories. Recent evidence also shows different cyclical behavior between input and output inventories. As presented by Iacoviello, Schiantarelli and Schuh (2011), the input inventory to sales ratio is countercyclical, and the output inventory-sales ratio is "mildly procyclical".

Existing models,[1] (see, among others, Blinder and Maccini (1991), Khan and Thomas (2007a,b) and Fisher and Hornstein (2000)) in the inventory literature can match the stylized facts of inventories with technology shocks in many dimensions. However, some of those models fail to match the behavior of inventory investment, inventory-to-sales ratio and more cyclical production relative to sales. Compared to technology shocks, the importance of demand shocks for explaining inventory behaviors are far from conclusive. To name but a few, Kahn (1987) shows that the excess velocity of production relative to sales can be reproduced only by shocks to demand. Maccini, Moore and Schaller (2004) reinforce the puzzle that observed by Blinder and Maccini (1991): interest rate has no significant effect on inventories; and suggests that "…the long-run relationship between the inventories and the real interest rate may be fruitful". Jung and Yun (2006) show that output inventory behavior can be reproduced by a sticky price model with shocks to federal funds rate. Nevertheless, to the best of our knowledge, no paper in the literature has studied the effect of monetary shocks on input inventory behavior. To fill the gap, we employ Shi (1998), a search model with monetary prorogation, and extend the model from single-stage production to two-stage production by endogenizing the choice of material inputs, to study both the long-run and short-run effects of monetary policy on input inventories. Inventories arise naturally in our model

[1] Blinder and Maccini (1991) use production smoothing model, whereas Khan and Thomas (2007b) and Fisher and Hornstein (2000) use (S, s) model to rationalize inventories. Khan and Thomas (2007a) reviewed and evaluated stockout avoidance model and the (S, s) model. Also see Ramey and West (1999) for a comprehensive review on production smoothing model.

because of a search friction in the finished goods market. To highlight the unique feature of input inventories, we exclude output inventories. Thus, unmatched finished goods producers hold unused intermediate goods at the end of each period.

We find that monetary shocks have long run real effects on input inventories. Comparative statics show that monetary policy has hump-shaped real effects on steady state output per match, final sales, input net inventory investment (NII) and inventory-to-sales ratio. In particular, NII first increases with the growth rate of money, before falling for large growth rates. Intuitively, NII depends on the quantity of intermediate goods held by each output producer and the number of unmatched producers. When the money growth rate is low, a positive monetary shock reduces the real money balance, and buyers search more intensively, which generates a positive effect on the total number of matches (extensive margin effect), and implies a negative effect on the number of unmatched producers. On the other hand, monetary shock has a positive effect on the output per match (intensive margin effect), which implies a positive effect on the intermediate goods held. For a sufficiently low level of money growth, the positive effect on NII dominates the negative effect. NII increases with the money growth rate. When the money growth rate becomes sufficiently high, the negative effect would dominate, and NII decreases with the money growth rate.

This positive intensive margin effect is novel and is due to the two-stage production structure. The intuition is as follows. Output per match depends on the real money balances, labor and intermediate goods. If the money growth rate is low, a higher money growth reduces the real money balances, and hence has a negative effect on firms' profits. On the other hand, reduced real money balances lower firms' costs of inputs, which have a positive effect on firms' profits. Therefore, the positive effect dominates the negative effect for low levels of money growth; firm’s profitability increases, and households hire more labor and produce more intermediate goods. With more inputs, output producers can produce more once matched.

Finally, the positive intensive and extensive margin effects also imply that final sales increase with the money growth rate when it is low. Since input inventories move with final sales in the same direction, our results suggest that input inventories amplify the effects of monetary shocks on GDP in the long run.

When we calibrate the model to match the quarterly U.S. data from 1967:Q1 to 2010:Q4, we find that our model can reproduce the stylized facts of input inventories quite well. Specifically, our model predicts procyclical inventory investment, a countercyclical inventory-to-sales ratio, more volatile output relative to final sales and a positive correlation between NII and final sales. We also revisit the debate about the role of inventories over business cycles, and show that input inventories amplify aggregate fluctuations.

To model input inventories, researchers also consider a multi-stage production, although they use different types of frictions to rationalize inventories. Nevertheless,

most papers rely on real shocks to capture inventory regularities. If there were demand shocks, there would be tradeoffs between inventory investment and final sales. Example include, but not limited to, Blinder and Maccini (1991), Khan and Thomas (2007a), Ramey and West (1999), and Wang and Shi (2006). As a result, these models, for example the production smoothing model and stockout avoidance model (see, among others, Bils (2004), Bils and Kahn (2000), Coen-Pirani (2004), and Wen (2011)), usually predict counterfactual results, in particular, countercyclical inventory investment and a negative correlation between final sales and inventory investment. Khan and Thomas (2007a) show that by introducing idiosyncratic shocks, the generalized stockout avoidance model without capital is able to reproduce procyclical inventory investment and a positive relationship between inventory investment and final sales under preference shocks. But such improvements have to severely sacrifice the ability to match the long-run average inventory-to-sales ratio.

The model developed in the current study is different from that in Shi (1998) and thus delivers contrasting implications in matching real data. In particular, Shi (1998) employs a single-stage production model with output inventories, whereas we construct a multi-stage production model with input inventories. Under his model, Shi found that output inventory investment decreases monotonically with the money growth rate. This is because the quantity of goods per match decreases with the money growth rate monotonically in his model. In this way, output inventories serve as buffer stocks and respond negatively to a positive monetary shock as shown by Shi (1998) and Menner (2006), and hence, output inventories decrease whenever sales increase. Thus, the single-stage production model with output inventories is like the production smoothing model, in which inventories smooth production. It is difficult to generate more volatile output relative to final sales and a positive correlation between NII and final sales. However, in our multi-stage production model, output per match increases with moderate inflation. Such positive responses are strong enough to cause input inventories to move with final sales in the same direction during the transition, which is essential for reproducing the positive correlation between NII and final sales and more volatile output. Thus, the multi-stage production model with input inventories is like the stockout avoidance model, in which inventories amplify aggregate fluctuations.

The remainder of this paper is organized as follows. In section I, we describe a benchmark search model with input inventories. In section II, we define equilibrium and show how that monetary policy has long-run effects on inventories. In section III, we study the short-run dynamics of input inventories. Results of sensitivity analysis are also provided. Finally, section IV concludes this paper.

2. A search model with multi-stage production

2.1 The environment

This is a large household model. Households are different in types, which set is denoted by H. The number of households in each type is large and normalized to

one. There are also many types of finished goods, which set is denoted by H^f with same measures as H. Each household can produce both intermediate goods and household specific finished goods, which means that the finished goods $h^f \in H^f$ produced by household *h* is desired only by some other types of households.

Each household consists of six groups of agents (with the accompanying measure in parentheses): intermediate goods producers (a^i_p), finished goods buyers (a^f_b) and entrepreneurs (a^f_p), leisure seekers (n_0), workers ($a^f_p n_t$), and unemployed agents (u). Each entrepreneur consists of a finished goods producer and a finished goods seller. The number of agents ($a^i_p; a^f_b; a^f_p; u$) remain constant, while the number of effective buyers is endogenous, because I allow households to choose search intensities every period. Meanwhile, the number of leisure seekers and workers (n_0, n_t) varies over time which captures employment fluctuations.

Time is discrete. Figure 1 depicts the timing of the model. In the first subperiod, intermediate goods producers produce intermediate goods (q_t^i) for their own finished goods production with disutility $\varphi(q_t^i)$. The function φ satisfies $\varphi' > 0$, $\varphi'' > 0$ for $q^i > 0$, and $\varphi'(0) = \varphi(0) = 0$. At the end of the first subperiod, newly produced intermediate goods, together with input inventories, are evenly shared among entrepreneurs. Households do not consume intermediate goods. Intermediate goods are storable across periods.

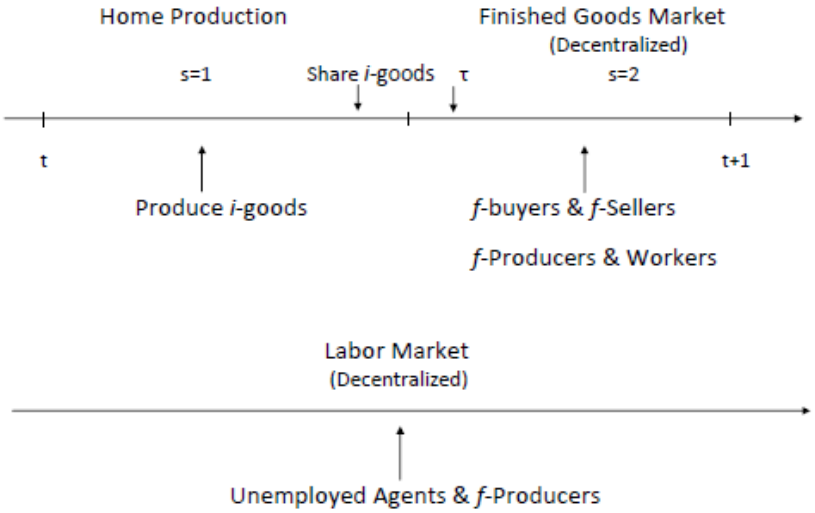

Figure 1: Timeline: Benchmark Model

In the second subperiod, finished goods market opens. Assume there are search frictions in the finished goods market. Once a buyer and a seller have been matched, the seller places the order for her customer. The corresponding finished goods producer then produces the product. As discussed in the introduction, this paper focuses on input instead of output inventories by assuming that finished goods producers produce if and only if they are matched. An intrinsically useless object, called fait money, can facilitate trades in this market. Furthermore, assume there is

no double coincidence of wants, so barter trades are excluded. At the beginning of each period, household divides the nominal money balance evenly among its finished goods buyers and chooses their search intensities (s^f_t). The terms of trade include the quantity of goods and the quantity of money $(\hat{q}^f_t, \hat{m}^f_t)$ are determined by Nash bargaining. Notice that the price level in the finished goods market is $P_t = m^f_t/q^f_t$. During the second subperiod, each household receives a lump-sum transfer (τ_t) which will be added to next period's nominal money balance. At the end of the period, finished goods buyers bring trade receipts, entrepreneurs bring profits and unused intermediate goods, and workers bring wage income back to the household. At the end, the household share consumption with its agents. Since agents regard the household's utility as a common objective and share consumption and inventories with each other, the idiosyncratic risk generated by search friction is smoothed within each household. The household carries the new nominal money balance (M_{t+1}) and input inventories which depreciate at a rate of δ_i over each period. Workers hired in the last period separate from current jobs at an exogenous rate r_n.

In the finished goods market, the total number of matches is determined by the following Cobb-Douglas matching function. Variables with a hat refer to an arbitrary household.

$$g(\hat{s}^f) = z_1^f (a_b^f \hat{s}^f)^{\xi} a_p^{f\,1-\xi}, \quad \xi \in (0,1), \tag{1}$$

where $z^f_1 > 0$ is a constant. Denote the ratio of buyers to sellers as $B^f = a^f_b/a_p{}^f$ and $z^f = z_1{}^f (B^f)^{\varepsilon-1}$. Then the matching rate for each unit of a buyer's search intensity is $g^f(\hat{s}^f)$ and the matching rate for each seller is $g^f(\hat{s}^f_s)$, where,

$$g^f_b \equiv z^f (\hat{s}^f)^{\xi-1}, \tag{2}$$

$$g^f_s \equiv z^f B^f (\hat{s}^f)^{\xi}. \tag{3}$$

Thus buyers and sellers get desirable matches at rates $s^f g^f_b$ and $g_s{}^f$ respectively.

In the labor market, each finished goods producer posts vacancies v_t. Unemployed agents search for jobs. Matched workers start to work in the next period and supply one unit of labor inelastically. Wages (W_t) are negotiated according to Nash bargaining and are paid in nominal terms, regardless of whether or not their employees formed a match. As in the standard labor search model (e.g., Blanchard and Diamond (1989)), the matching technology is: $\bar{\mu}(a^f_p \hat{v})^{\phi} u^{1-\phi}$, where $\varphi \in (0,1)$ and $\bar{\mu}$ is a constant; and the hat on variables refers to an arbitrary producer. The total number of matches for each firm is $\mu(\hat{v})v$, where $\mu(\hat{v}) = \bar{\mu}(a^f_p v/u)^{\phi-1}$ is the number of matches per vacancy. Hence, the number of matches per unemployed agent is $\mu(\hat{v})a^f_p \hat{v}/u$.

2.2 The household's decision problem

At the beginning of each period, the household divides the nominal money balance evenly among its finished goods buyers and chooses buyers' search intensities (s^f_t), consumption level (c_t), the number of vacancies for each firm (v_t), the next period's employment level (n_{t+1}), nominal money balance (M_{t+1}) and input inventory level (i_{t+1}) that carried over period, taking the terms of trade as given. Assume search intensities of both sellers and unemployed workers are inelastic with no cost to households.

The household's utility function, U(c), is strictly increasing and concave, and satisfies $\lim_{c\to 0} cU'(c) = \infty$ and $\lim_{c\to\infty} cU'(c) = 0$. $\varphi(q^i_t)$ is the disutility of producing intermediate goods. φ^f is the disutility of working in the finished goods market. $\phi^f(s^f_t)$ is the disutility of searching in the finished goods market. The function ϕ^f satisfies $\phi^f(s^f_t)$ and $\phi^{f"} > 0$ for s > 0 and $\phi^f(0) = \phi^{f'}(0) = 0$. Finally, $K(v_t)$ is the disutility of posting vacancies, which has the same properties as ϕ^f. Let F^*_{bt} (with measure $s^f_t g^f_{bt} a^f_b$) be the set of matched finished goods buyers in the period t. Similarly, F_{pt} (with measure $g^f_{st} a^f_p$) is the set of matched finished goods sellers in the current period.

Since we focus on input inventories, we assume the production function of the finished good is a Leontief production function:

$$q^f_t = \min\{a_t, n_t\}, \tag{4}$$

where a_t is the quantity of material inputs and n_t is labor inputs hired in the last period. A Leontief production function implies that intermediate goods and labor are not substitutable[2]. Moreover, this assumption gives us analytical results.

Then, the representative household's decision problem can be summarized as follows. The representative household taking the sequence $\{\hat{q}^f_t, \hat{m}^f_t, \hat{W}_t\}_{t\geq 0}$ and initial conditions $\{M_0, i_0, n_0\}$ as given, chooses $\{C_t, q^i_t, s^f_t, v_t, M_{t+1}, i_{t+1}, | n_{t+1}\}_{t\geq 0}$ to maximize its expected lifetime utility:

$$\max \sum_{t=0}^{\infty} \beta^t \mathbb{E}_{-1}[U(c_t) - \varphi(q^i_t) - a_p \hat{n}_t \varphi^f - a^f_b \Phi^f(s^f_t) - a^f_p K(v_t)] \tag{5}$$

subject to the following constraints for all $t \geq 0$

[2] A simple example would be to consider automobile manufacturers that cannot substitute labor for auto parts. But for the sake of comparison, we use a Cobb-Douglas production function for my quantitative analysis.

$$
\begin{aligned}
c_t &\leq s_t^f g_{bt}^f a_b^f \hat{q}_t^f, && (6)\\
\frac{M_t}{a_b^f} &\geq \hat{m}_t^f, \quad \forall F_{bt}^* && (7)\\
q_t^f &= \min\{a_t, n_t\}, && (8)\\
a_t &\leq i_t + q_t^i / a_p^f, \quad \forall F_{pt}^* && (9)\\
q_t^f &\geq \hat{q}_t^f, \quad \forall F_{pt}^* && (10)\\
M_{t+1} &\leq M_t + \tau_t + a_p^f \hat{n}_t \hat{P}_t^f \hat{W}_t - s_t^f g_{bt}^f a_b^f \hat{m}_t^f + g_{st}^f a_p^f \hat{m}_t^f - \hat{P}_t^f a_p^f \hat{W}_t n_t, && (11)\\
0 &\leq a_p^f [(1-\delta_n) n_t + v_t \mu_t - n_{t+1}], && (12)\\
a_p^f i_{t+1} &\leq (1-\delta_i)[a_p^f i_t + a_p^f q_t^i - g_{st}^f a_p^f a_t]. && (13)
\end{aligned}
$$

Constraint (6) and (7) are standard in a large household model. Constraint (6) is a budget constraint, which requires that the household's consumption does not exceed the total amount of finished goods obtained by its buyers. Constraint (7) states that in order to successfully trade with a matched seller, the buyer must have enough money. Constraint (8) implies that the usage of intermediate goods and labor are equal.

The intuition behind constraint (9) and constraint (10) is similar to the money constraint (7). Constraint (9) states that finished goods producer cannot use more intermediate goods than their holdings. Similarly, constraint (10) requires that matched finished goods producers should have enough workers and intermediate goods to produce.

Constraint (11) is the law of motion of money, which states that the nominal money balance at the beginning of next period will be no larger than the nominal money balance carried from last period plus changes in the nominal money balance. The changes in the nominal money balance come from the lump-sum transfer received in the second subperiod, the money spent by finished goods buyers, profits from entrepreneurs and wages earned by workers. Entrepreneurs obtain money if, and only if, their sellers can find desired matches, while wages have to be paid to workers at the end of the period, regardless of whether they matched or not.

Constraint (12) is the law of motion of employment, which states that at the beginning of next period, the number of workers in each firm is no larger than the number of workers who still stay with the current job, plus newly hired workers. The last constraint is the law of motion of inventories, which implies that the household's next period inventory level is no larger than unused intermediate goods depreciated at a rate of $\delta_i \in (0,1)$.

Denote the multipliers of money constraint (7) by Λ_t^f. Let Ω_{at} be the shadow price of (9) at the beginning of period t + 1. We are interested in equilibria with a positive inventory level, which requires that inventories have positive values in each period(ex. $\Omega_{at} > 0$). The multiplier of (10) is denoted by Ω_f. Since entrepreneurs

get positive surplus from trading finished goods, it is optimal for them to hire enough workers and have enough intermediate goods in hand. Let the shadow prices of (11), (12), and (13) at the beginning of period $t+1$ be Ω_{mt}, Ω_{nt} and Ω_{it} respectively, which are measured in terms of the household's period t utility.

Constraint (7) and (9) are restricted to be binding in equilibrium. By plugging c_t into the household's utility function, substituting a_t and q_t^f by n_t, and holding conditions (10), (11), (12) and (13) with equality, we can derive the first-order conditions with respect to $(M_{t+1}, i_{t+1}, n_{t+1}, s_t^f, v_t, q_t^i)$:

$$\begin{aligned}
\Omega_{Mt} &= \beta\mathbb{E}[\Omega_{Mt+1} + s_{t+1}^f g_{bt+1}^f \Lambda_{t+1}^f], && (14)\\
\Omega_{it} &= \beta\mathbb{E}[(1-\delta_i)\Omega_{it+1} + g_{st+1}^f \Omega_{at+1}], && (15)\\
\Omega_{nt} &= \beta\mathbb{E}[(1-\delta_n)\Omega_{nt+1} + g_{st+1}^f [\Omega_{ft+1} - \Omega_{at+1} && (16)\\
&- (1-\delta_i)\Omega_{it+1}] - \hat{P}_{t+1}^f \hat{W}_{t+1}\Omega_{Mt+1}],\\
\Phi^{f'}(s_t^f) &= g_{bt}^f [U'(C_t) - \omega_t^f] q_t^f, && (17)\\
\Omega_{nt} &= K'(v_t)/\mu(\hat{v}_t), && (18)\\
\varphi'(q_t^i) &= g_{st}^f \Omega_{at} + (1-\delta_i)\Omega_{it}. && (19)
\end{aligned}$$

Condition (14) equates the opportunity cost of obtaining one more unit of money and the expected benefits of carrying the money over to the next period. Such benefits include the shadow price of money and the shadow value of relaxing the money constraint in the finished goods market. Similarly, condition (15) equates the opportunity cost of obtaining an additional unit of input inventory and the expected benefits of carrying it over to the next period. Such benefits include the shadow value of inventories and the shadow value of relaxing the intermediate goods usage constraint.

Condition (16) equates the opportunity cost of hiring an additional worker and the expected benefits generated by this worker in the next period. This opportunity cost does not only include the shadow value of labor and the wage paid in terms of period t + 1 utilities $(\beta P_{t+1} W_{t+1} \Omega_{Mt+1})$, but also includes the expected cost of tightening the period t + 1 intermediate goods usage constraint and the expected shadow value of inventories discounted at the proper rate.

Condition (17) states that the opportunity cost of increasing the search intensity, which involves search costs and the real money balance, equals the marginal utility of consumption. Condition (18) equates the marginal cost of posting a vacancy and the expected benefits. The last condition equates the marginal cost of producing one more unit of intermediate goods and the marginal benefits which include the shadow value of inventories and the cost of relaxing the second subperiod intermediate goods usage constraint.

2.3 Terms of trade

Let us specify the terms of trade for the finished goods market and the labor market. Be-cause there are large households in this model, each agent in the representative household is negligible and can be viewed as an identity of a small measure (ε). Since each agent's contribution to the household is also negligible, we compute the terms of trade brought by each agent first, then take the limit $\varepsilon \to 0$. Variables with a bar refer to the buyer in the other household and are taken as a given by the representative household.

The terms of trade in the finished goods market are denoted by $(q_t^f \varepsilon, \overline{m}_t^f \varepsilon)$, where $q_t^f \varepsilon$ is the quantity of finished goods and $\overline{m}_t^f \varepsilon$ is the quantity of money. Thus, the trading surpluses of these two agents to their households are:

$$\text{seller's trade surplus:} \quad \Omega_{Mt} \bar{m}_t^f \varepsilon - \Omega_{ft} q_t^f \varepsilon, \tag{20}$$

$$\text{buyer's trade surplus:} \quad U(\bar{c}_t + q_t^f \varepsilon) - U(\bar{c}_t) - (\bar{\Lambda}_t^f + \bar{\Omega}_{Mt}) \bar{m}_t^f \varepsilon. \tag{21}$$

Normalizing surpluses by ε, the terms of trade are determined by Nash bargaining between buyer and seller with equal weights:

$$\max_{\bar{m}_t^f, q_t^f} \left[\Omega_{Mt} \bar{m}_t^f - \Omega_{ft} q_t^f \right]^{1/2} \times \left[\frac{U(\bar{c}_t + q_t^f \varepsilon) - U(\bar{c}_t)}{\varepsilon} - (\bar{\Lambda}_t^f + \bar{\Omega}_{Mt}) \bar{m}_t^f \right]^{1/2}. \tag{22}$$

By substituting $\overline{m}_t^f = P_t^f q_t^f$ solving for the first-order conditions and taking the limit,we can get the following equations:

$$(\bar{\Omega}_{Mt} + \bar{\Lambda}_t^f) P_t^f = U'(c_t), \tag{23}$$

$$P_t^f \Omega_{Mt} = \Omega_{ft}. \tag{24}$$

The first condition equates the marginal utility of consumption with the opportunity cost of spending money. The second condition states that the shadow value of real money balances equals the opportunity cost of obtaining money. Denote the shadow value of real money balance in the finished goods market by $\omega_t^f = P_t^f \Omega_{Mt}$

The wage $(W_{t+1} \varepsilon)$ is determined by Nash bargaining between the producer and the unemployed worker in the labor market. Assuming the producer's bargaining weight is σ, where $\sigma \in (0,1)$. Since the producer's surplus of hiring $\sigma\varepsilon$ more workers is $\{\Omega_{nt} - \beta E[(1-\delta_n)\Omega_{nt+1}\}\varepsilon$, by rearranging condition (16), we can reinterpret the producer's surplus in terms of real money balances:

$$\beta \mathbb{E}[\Omega_{ft+1} g_{st+1}^f - \omega_{t+1}^f W_{t+1} - a_p^f g_{st+1}^f \Omega_{at+1} - g_{st+1}^f \Omega_{it+1}(1-\delta_i)]\varepsilon. \tag{25}$$

Meanwhile, the unemployed agent contributes to his household's utility by $\beta(\overline{\omega}_{t+1}^f W_{t+1} - \varphi^f)\varepsilon$, where W_{t+1} is the expected wage income in terms of the real money balance. Normalizing surpluses $\beta\varepsilon$, the wage rate maximizes the weighted

Nash product of these two agent's surpluses: $\max_{W_{t+1}}[[\Omega_{ft+1}g^f_{st+1} - \omega^f_{t+1}W_{t+1} - a^f_p g^f_{st+1}\Omega_{at+1} - g^f_{st+1}\Omega_{it+1}(1-\delta_i)]^\sigma * [\bar{\omega}^f_{t+1}W_{t+1} - \varphi^f]^{1-\sigma}]$.

The wage rate can be obtained after taking the limit " ! 0 on the first-order condition:

$$\mathbb{E}\left[\omega^f_{t+1}W_{t+1}\right] = \mathbb{E}\left[(1-\sigma)g^f_{st+1}[\Omega_{ft+1} - \Omega_{at+1} - \Omega_{it+1}(1-\delta_i)] + \sigma\varphi^f\right]. \quad (26)$$

The wage rate equals the weighted sum of the expected future bene_t of hiring " more workers and the opportunity cost of working.

3. Equilibrium

3.1 Characterization

Although households produce and consume different types of goods, they are identical in the sense that they have the same utility function and production technologies. Given this, we define the symmetric search equilibrium as follows:

Definition 1 *A symmetric search equilibrium is a sequence of household's choices* $\{\Gamma_{ht}\}_{t\geq 0}$, $\Gamma_{ht} \equiv (c_t, q^i_t, s^f_t, v_t, M_{t+1}, i_{t+1}, n^f_{t+1})_h$, *expected quantities in trade* $\{\hat{X}_t\}_{t\geq 0}$, $\hat{X}_t \equiv (\hat{m}^f_t, \hat{q}^f_t, \hat{W}_t)$, *and the terms of trade* $\{X_t\}_{t\geq 0}$, *such that*

1. *all of these variables are identical across households and relevant individuals;*
2. *given* $\{\hat{X}_t\}_{t\geq 0}$ *and the initial conditions* (M_0, i_0, n_0), $\{\Gamma_{ht}\}_{t\geq 0}$ *solves the household's maximization problem, with* $(s^f, v) = (\hat{s}^f, \hat{v})$;
3. X_t *satisfies (25), (26) and (29);*
4. $\hat{X}_t = X_t \ \forall t \geq 0$.

As is standard, in order for money to play the role of a medium of exchange, we have to restrict the equilibrium to $\lambda^f > 0$. Similarly, we assume $\Omega_{at} > 0$, which requires that output producers prefer producing to hoarding intermediate goods in the second subperiod. Denote $k(v_t) = K'(v_t)/\mu(\hat{v}_t)$. Condition (11) and the Leontief production function imply that $i_t = q^f_t - q^i_t$. These three restrictions will be verified in the steady state. Then "hat" and "bar" are suppressed for a symmetric equilibrium. Condition (13) is reduced to $M_t + \tau_t = M_{t+1}$ under symmetry. Define the gross rate of money growth by $\gamma_t = M_{t+1}/M_t = (M_t + \tau_t)/M_t$. By substituting conditions (9), (11), (20), (21), (25), (26), (29) and $P^f_t = M^f_t / q^f_t$ into conditions (14) - (19), we can eliminate $(M, i, n, \lambda^f, \Omega_a, \Omega_f, \Omega_n, m^f, W)$, and the dynamic system is characterized in terms of (s^f, w^f, v, q^i, q^f) by the following conditions:

$$\mathbb{E}[\frac{\gamma_t \omega^f_t q^f_t}{q^f_{t+1}}] = \beta E\{\omega^f_{t+1} + z^f (s^f_{t+1})^\xi [U'(c_{t+1} - \omega^f_{t+1})]\}, \quad (27)$$

$$\Omega_{it} = \beta\mathbb{E}[\varphi'(q^i_{t+1})], \tag{28}$$

$$k(v_t) = \beta\mathbb{E}[(1-\delta_n)k(v_{t+1}) + \sigma z^f B^f (s^f_{t+1})^{\xi}\omega^f_{t+1} \tag{29}$$

$$+ \ (1 - z^f B^f (s^f_{t+1})^{\xi})\sigma(1-\delta_i)\Omega_{it+1} - \sigma\varphi'(q^i_{t+1}) - \sigma\varphi^f],$$

$$\Phi^{f\prime}(s^f_t) = z^f (s^f_t)^{\xi-1}[U'(c_t) - w^f_t]q^f_t, \tag{30}$$

$$\mathbb{E}[q^i_{t+1}] = \mathbb{E}\{q^f_{t+1} - (1-\delta_i)[1 - z^f B^f (s^f_t)^{\xi}]q^f_t\}, \tag{31}$$

$$\mathbb{E}[q^f_{t+1}] = (1-\delta_n)q^f_t + v_t\mu(v_t), \tag{32}$$

$$c_t = a^f_p B^f z^f (s^f_t)^{\xi} q^f_t. \tag{33}$$

Condition (32) of the dynamic system is of particular interest. It implies that if a monetary shock were to hit the economy, the corresponding effect would be propagated through the inventory channel. As shown by the right hand side of this equation, the quantity of next period home production (q^f_{t+1}) not only depends on the next period's quantity of finished goods (q^f_{t+1}), but also depends on the current period's quantities (q^f). Since condition (9) is restricted to being binding in equilibrium, the effects of a monetary shock would depend on the inventory level.

By rewriting $(s_t^{f*}, \Omega_t^*, v^*, q^{i*})$ as functions of (w^{f*}, q^{f*}), the steady state system can be reduced to two equations with two unknowns:

$$z^f[s^f(\omega^{f*}, q^{f*})]^{\xi} = \frac{\gamma-\beta}{\beta}\frac{\omega^{f*}}{U'(c(\omega^{f*}, q^{f*})) - w^{f*}}, \tag{34}$$

$$(1-\beta(1-\delta_n))k(v(q^{f*})) + \beta\sigma\varphi^f = \beta\{\sigma z^f B^f (s^f(\omega^{f*}, q^{f*}))^{\xi}\omega^{f*} \tag{35}$$
$$+[(1 - z^f B^f (s^f(\omega^{f*}, q^{f*}))^{\xi})\sigma(1-\delta_i)\beta - \sigma]\varphi'(q^i(\omega^{f*}, q^{f*}))\}.$$

We can see that the money growth rate has real effects on steady state variables. More-over, an unique steady state, which satisfies $\lambda^f > 0$; $\Omega_a > 0$, can be pinned down by these two equations (see Appendix A for a proof).

3.2 Long run effects of money growth

As shown in Appendix A, steady state equation (35) is independent of γ, and equation (36) is not monotonic in γ. This implies that the effects of monetary policy has nonmonotonic long run effects on the quantity of finished goods per match, or, the intensive margin effect. Particularly, for low levels of γ, q^f increases with γ, but q^f decreases with γ if γ is high. The possible positive intensive margin effect is novel and is due to the two-stage production structure. The intuition is the following. q^f depends on the real money balances, labor and intermediate goods. If γ is low, a higher γ reduces the real money balances. Reduced real money balances on the one hand have a negative effect on firms'

profits. On the other hand, they lower firms' costs of inputs, which have a positive effect on firms' profits. If γ is low, the positive effect dominates the negative effect; firm's profitability increases with γ; and hence households hire more labor and produce more intermediate goods.[3] Because there is a search friction in the finished goods market, households do not observe which output producers would get a match in the first sub-period and have to adjust the input levels for all output producers. In an extreme case of no substitutability between labor and intermediate goods, one more worker requires one more unit of intermediate goods as input; and output producer can produce one more unit once matched.[4]

Moreover, a higher money growth rate also has a positive extensive margin effect. As real money balances decreasing, buyers' surpluses from trade increase, and they search more intensively in order to spend money more quickly. As a result, final sales increases as both intensive and extensive margin effects are positive. In the opposite, when γ is high, firm's profitability decreases; and households hire less labor, produce less intermediate goods, and hence, q^f and final sales decrease with γ. The above analysis can be summarized in the following proposition:

PROPOSITION 1 *For sufficiently low levels of money growth, the steady state employment, quantity of finished goods traded in each match, the production of intermediate goods and final sales increase with the money growth rate, but they decrease with the money growth rate when the level of money growth is sufficiently high (See Appendix B for a proof.).*

The two-stage production model links the input responses in the upstream market to the final sales in the downstream market. To the contrary, in the one sector search model, the quantity of goods per match decreases with the money growth rate monotonically, or the intensive margin effect is always negative. This is because the quantity of goods per match depends only on real money balances. A higher γ reduces real money balances, and hence sellers' surpluses. Then, sellers produce less once matched.

The nonmonotonic response of quantities per match implies that, changes in the money growth rate also have nonmonotonic effects on input inventory investment (NII, as well as input inventories). By plugging the steady state equation of q^i into equation (15), we can see that NII depends on the quantity of intermediate goods held by each output producer (or output per match) and the number of unmatched

[3] When γ is low, the right-hand side of equation (36) is downward sloping, which equals firm's marginal profitability from hiring $(g_s^f[\Omega_f - a_p^f\Omega_a - \Omega_t(1-\delta_t)] - \omega W)$ and it decreases with ω^f (increases with γ).

[4] This result should hold for other production functions. See the example of Cobb-Douglas production function as shown in the quantitative analysis.

producers $(1-g_s^{f*})$:

$$NII^* = a_p^f \delta_i i^* = (1-\delta_i)\delta_i a_p^f [1-g_s^{f*}] q^{f*} \quad (36)$$

where, $q^{f*} = i^* + q^{i*}/a_p^f$ .Money growth aects the long run input inventory investment along two margins. If γ is low, both intensive margin effect and extensive margin effect are positive for a higher γ. First, positive intensive margin effect implies that each unmatched finished goods producer holds more intermediate goods. Second, positive extensive margin effect increases the total number of matches in the finished goods market, which has a negative effect on the total number of unmatched finished goods producers. If γ is low, the positive effect dominates the negative effect on NII and, as a result, NII increases with γ. But, if γ is high, households acquire less inputs, and NII decreases with γ. These results are summarized in the following proposition (see Appendix B for a proof):

PROPOSITION 2 *For sufficiently low levels of money growth, the steady state net in-put inventory investment (and input inventories) increases with the money growth rate, but decreases with the money growth rate for sufficiently high levels of money growth.*

According to the accounting identity GDP = Final Sales + NII, it is easy to show that GDP has similar nonmonotonic response as final sales and NII. There are hot debates in the literature on whether inventories have a destabilizing or stabilizing role over business cycles. Our model supports the view that inventories amplify the response of output in both long run and short run. This is because search friction forces inventories move with finals sales in the same direction in response to monetary shocks. Our model will also predict positive relationship between final sales and NII during the transitions. Therefore, we provide a microfoundation to the destabilizing role of inventories by introducing search frictions. We summarize the results in the following proposition:

Finally, GDP volatility has substantially decreased since 1984, which leads to two decades of "great moderation".[5] At about the same time, the input inventory-to-sales ratio started to show a significant downward trend.[6] Declining inventory-to-sales ratio is one of the explanations of "great moderation" in the literature, because GDP fluctuations could be amplified by inventories. Iacoviello, Schiantarelli and Schuh (2011) show the empirical evidence that the long run inventory-to-sales ratio decreases as the money growth rate decreases for that two decades. Our model predicts that the calibrated money growth rate is below the critical value. Thus our finds are consistent with theirs and suggest that changes in the money growth rate would be one of the reasons for the decline of the inventory-to-sales ratio and GDP volatility since the mid-1980. In the quantitative

[5] See McConnell and Perez-Quiros (2000) and Ramey and Vine (2004) for identifying the structural break.
[6] Kahn, McConnell and Perez-Quiros (2002) show a similar trend for durable goods

analysis, we give numerical examples to illustrate these propositions.

PROPOSITION 3 *For sufficiently low levels of money growth, the steady state input inventory-to-sales ratio increases with the money growth rate. To the contrary, it decreases with the money growth rate for sufficiently high levels of money growth. (see Appendix B for a proof)*

3.3 Comparisons between input and output inventories

The model developed in the current study is different from that in Shi (1998) and thus delivers contrasting implications in matching real data. In particular, Shi (1998) employs a single-stage production model with output inventories, whereas we construct a multi-stage production model with input inventories. Under his model, Shi found that output inventory investment decreases monotonically with the money growth rate. This is because the quantity of goods per match decreases with the money growth rate monotonically in his model. The corresponding condition in Shi (1998) is $i^* = q^* - f(n^*)$, where i^* is the output inventories, $f(n^*)$ is the firm's production function and q^* is the quantity of goods per match. Since production can be substituted by output inventories, output inventories serve as buffer stocks and respond negatively to a positive money shock as shown by Shi (1998) and Menner (2006), and hence, output inventories decrease whenever sales increase. Thus, the single-stage production model with output inventories is like the production smoothing model, in which inventories decrease with output and sales. It is hard for his model to generate more volatile output relative to final sales and a positive correlation between NII and final sales.

However, in our multi-stage production model, output per match increases with moderate inflation. By plugging condition (9) into condition (10), the equation $n^* = i^* + q^{i*} / a_p^f = q^{f*}$ holds in equilibrium. It is clear that both n^* and q^{i*} have to be adjusted to match q^{f*}. Thus, given search friction, NII increases with output and sales. Such positive responses are strong enough to cause input inventories to move with final sales in the same direction. Thus the multi-stage production model with input inventories is like the stockout avoidance model, in which inventories amplify aggregate fluctuations.

4. Quantitative analysis

For the sake of comparing results with related papers, we use a Cobb-Douglas production function instead of the Leontief production function and assume the gross rate of money growth and productivity jointly follow a VAR process as in Wang and Shi (2006). We also include search frictions in the intermediate goods market.

4.1 Full model

The detailed differences are the following. First, as the features of the finished goods market, there are search frictions in the intermediate goods market. Accordingly, there are also many types of intermediate goods, which are denoted by H^i. The measures of H, H^i and H^f are the same. Each household can produce the household specific intermediate goods. Trade occurs in the intermediate goods market, because the type $h \in H$ household cannot use its own specific intermediate goods as input to produce its specific finished goods. Let $\Phi^f(s_t^f)$ be a intermediate buyer's disutility of searching in the intermediate goods market, which has the same properties as $\Phi^f(s_t^f)$ in the baseline model.

Second, each household has one more group of agents, namely the intermediate goods buyers (a_b^i). Third, each household has to make two more decisions in each period: (1) How to divide money between markets, with the proportion Δ_{t+1} for intermediate goods buyers. Then, at the beginning of each period, she divides each market's nominal money balance evenly among each type of buyers. (2) Intermediate goods buyers' search intensities (s_t^i).

Once a buyer and seller are matched, the seller produces intermediate goods for his partner on the spot with disutility, $\varphi(\hat{q}_t^i)$, where $\hat{q}_t^i$ denotes the quantities of goods. The input buyer pays the amount of money, $\hat{m}_t^i$, to the intermediate goods seller. Denote the price level in the intermediate goods market by $P_t^i = m_t^i / q_i^t$. The function φ satisfies $\varphi' > 0$ and $\varphi'' > 0$ for $q > 0$, and $\varphi'(0) = \varphi(0) = 0$. Variables with a hat refer to an arbitrary household. At the end of the first sub period, the intermediate goods market closes. Input buyers bring trade receipts back to the household. The household adds traded intermediate goods to the input inventories carried from the last period, and then divides the intermediate goods evenly among entrepreneurs.[7]

Similarly to the benchmark model, the total number of matches in the intermediate goods market is determined by the following matching function: $g(\hat{s}^i) = z_1^i (a_p^f \hat{s}^i)^{\xi} a_p^{i\,1-\xi}, \xi \in (0,1)$ .As such, the matching rate for each unit of a buyer's search intensity is $g_b^i = z^i (\hat{s}^i)^{\xi-1}$ and the matching rate per seller is $g_s^i = z^i B^i (\hat{s}^i)^{\xi}$, where $B^i = a_b^i / a_p^i$ and $z^i = z_1^i (B^i)^{\xi-1}$. Finally, a buyer and a seller get desirable matches at rates $s^i g_b^i$ and g_s^i respectively.

The last dierence from the benchmark model is the Cobb-Douglas production function used in this model:

$$q_t^f = A_t a_t^{\alpha} n_t^{1-\alpha}, \tag{37}$$

where a_t is the quantity of material inputs and n_t is labor inputs that are hired in the

[7] Assume intermediate goods sellers would not bring their money holdings back to the household until the end of the period. This assumption simplifies the model in the sense that the equilibrium conditions do not involve the intertemporal price ratio of one good market relative to the other

last period. A_t is total factor productivity. The VAR process has the following form:

$$(\gamma)_{t+1} lnA_{t+1} = N_1 + N_2 (\gamma)_t lnA_t + (\epsilon)_{m,t+1} \epsilon_{A,t+1} \quad (38)$$

where N_1 is a 2*1 vector and N2 is a 2*2 matrix. ε_m is the shock to the money growth and ε_A is the productivity shock. The household's new decision problem, bargaining solutions for the intermediate goods market and the new dynamic system is described in Appendix C.

4.2 Calibration

The model is log-linearized and calibrated to match the quarterly US data. The sample period is from 1967:Q1 to 2010:Q4. The data is from the Bureau of Economic Analysis, the Bureau of Labor Statistics and the Federal Reserve Bank of St. Louis on inventories for the manufacturing sector, final sales, employment, money stock and the velocity of money to compute my calibration targets. All of the variables are in real terms. The input inventories include inventories of materials and supplies and inventories of work-in-process. Final sales are manufacturing sales. GDP is calculated according to the accounting identity, which equals final sales plus net inventory investment.

My calibration strategy is summarized as follows. The parameters in my model can be grouped into three categories. The first set of parameters $(\gamma^*, \hat{N}1, \hat{N}2, \sigma_m, \sigma_A \sigma_{mA}, \rho, \sigma_g)$ is calculated directly from data. The second set of parameters $(\phi, \sigma, \delta_n, z_1^f, a_p^f, a_b^f, FI, b, K_0, \varphi^i, \varphi_0^i, \varphi^f)$ is pinned down by jointly matching a set of targets. Most of my targets are calculated from my samples, while some of them are taken from other work in the literature. The last set of parameters $(\eta, \varepsilon_i, \varepsilon_f, B^i)$ is hard to determine, and is pinned down by jointly minimizing the difference between the simulated second moments and the observed ones.

The discount factor is set at β = 0:995, which implifies that the annual interest rate is 2%. In order to calibrate the model, we assume the utility function, the disutility functions of searching in the goods markets, the disutility function of producing intermediate goods, and the disutility function of posting vacancies have the following functional forms:

$$U(c_t) = \frac{c_t^{1-\eta} - 1}{1-\eta}; \quad (39)$$

$$\Phi^i(s_t^i) = \varphi^i(\varphi_0^i s_t^i)^{1+1/\epsilon_i}; \quad (40)$$
$$\Phi^f(s_t^f) = \varphi^f(\varphi_0^f s_t^f)^{1+1/\epsilon_f}; \quad (41)$$
$$\varphi(q_t^i) = \frac{b}{2}(q_t^i)^2; \quad (42)$$
$$K(v_t) = K_0 v_t^2; \quad (43)$$

where $\eta, \varphi^i, \varphi_0^i, \varphi^f, \varphi_0^f, \varepsilon_f, b, K_0$ are constants. The gross rate of money growth and productivity jointly follow a VAR(1) process. And, the estimated coefficients and the standard error of both shocks are the following:

$$\hat{N}1 = (0).738$$
$$\vdash 0.958$$

, $\hat{N}2 = (0).274 - 0.0773$
0.8450.942,

$\sigma_m = 0.0064, \quad \sigma_A = 0.0138, \quad \sigma_{mA} = 0.0045.$

The time series of total factor productivity are calculated as the Solow residual. Since the production function is in the individual level, it has to be aggregated in order to match the data. The expression for the log of productivity is the following:

$$\begin{aligned} lnA &= ln(c^f) - ln(a_b^f v_c^f B^f) - \alpha ln(inputs/P_i) \\ &+ \alpha ln(a_b^f v_c^f B^f/(1-FI)) - (1-\alpha) ln(empl/a_p^f), \end{aligned} \quad (44)$$

where v_c^f is the velocity of money. The variable inputs are the total cost of material inputs. P_i is the price deflator for material costs. The variable *empl* is the aggregate employment in the manufacturing sector. These series come from NBER databases.

We use M2 as the money stock since it is stable within the sample period.
The steady state money growth rate is calculated as the sample average. We also need to determine the following parameters:

$$(\phi, \eta, \sigma, \delta_n, \xi, u, \delta_i, z_i^f, z_1^f, a_p^i, a_p^f, a_b^f, FI, b, K_0, \varphi^i, \varphi_0^i, \varphi^f, \varphi_0^f, \varepsilon_i, \varepsilon_f, \alpha, B_i, \bar{\mu})$$

Parameters $(\phi, \sigma, \delta_n, u, \delta_i, z_1^f, a_p^f, a_b^f, FI, b, K_0, \varphi^i, \varphi_0^i, \varphi^f, \varphi_0^f, \alpha, \bar{\mu})$ are jointly calibrated to match the following targets: (1) the average labor participation rate is 0.6445 over the same sample period. (2) The average unemployment rate is 0.061. (3) The average velocity of M2 money stock is 1.8236. (4) The average input inventory to final sales ratio is 0.984. (5) The intermediate inputs to final sales ratio is 0.549. (6) The inventory to output ratio is 0.981 and the inventory investment to output ratio is 0.0038. (7) The shopping time of the population is 11.17% of the working time and the working time is 30% of agents' discretionary time. (8) The vacancy posting cost is 3.72 *10^{-4}. (10) The average quarterly separation rate from employment to unemployment is 0.102. (11) The average markup is 70%.

The first six targets are calculated from my samples. The seventh target is used to compute the goods markets' search intensities and is taken from Shi (1998).[8] The target value for the vacancy posting cost is taken from Berentsen, Menzio and Wright (2011). The target value for the average quarterly separation rate is taken from Shimer (2005). Since the markup is difficult to determine, we do sensitivity analysis for this value.

The finished good producers' bargaining power (σ), in the labor market, is set to the same value as the elasticity of the labor market matching function (ϕ) to give workers 72% of the rent, as such the Hosios condition holds.[9] The elasticity of the labor market matching function (ϕ) and the associate constant are estimated by the ordinary least squares, regressing the log of the job-finding rate on the log of market tightness. For the sake of comparison, FI is set to 0.269 as outlined in Shi (1998) and Wang and Shi (2006).[10]

Table 1: Parameter Values and Calibration Targets

Parameters	Values	Targets
β	0.995	Annual interest rate: 4%
A^*	1	Normalization
Unemployment u	0.0393	Avg. LP: 0.6445
i-sellers a_p^i	0.2010	Avg. UR: 0.061
f-sellers a_p^f	0.2010	Avg. Velocity of M2: 1.8236
i-buyers a_b^i	0.1005	Avg. ISR: 0.984
f-buyers a_b^f	0.0515	Avg. IPS: 0.549
δ_i	0.0038	Avg. INV/GDP: 0.981
z_1^i	0.0934	Avg. NII/GDP: 0.0038
z_1^f	3.0524	Shopping time/Working time: 11.17%
b	0.6706	Working time/Discretionary time: 30%
K_0	0.0006	Vacancy posting cost: 3.72×10^{-4}
B_f	0.1947	Avg. markup: 70%
α	0.4156	
φ^i	14.2091	
φ_0^i	0.1104	
φ^f	1.6025	
φ_0^f	1.8043	
ϕ	0.28	OLS estimation
$\bar{\mu}$	0.364	OLS estimation
σ	0.28	Give workers 72% of the rent
δ_n	0.105	Avg. monthly separation rate: 0.034
FI	0.269	Shi (1998)

To pin down the parameters (a_p^i, a_b^i, z_1^f) in the intermediate goods market, first,

[8] Wang and Shi (2006) match the same target.
[9] Also see Hosios (1990); Shi (2006); Shimer (2005) and Rogerson and Shimer (2011)..
[10] Also see Christiano (1988)

we assume (1) the intermediate goods market tightness equals B_f; (2) the time spent on searching intermediate goods is also 11.17% of the working time; (3) the numbers of sellers in both goods markets are equal; (4) the velocity of the money stock in the intermediate goods market is 0.2. This velocity seems very low, but it fits the data best.

Table 2: Parameter Values and Targets (cont'd)

Parameters	Benchmark Values
ξ	0.8
ϵ_i	0.4
ϵ_f	0.01
η	0.8
B_i	0.2

Finally, we set the benchmark value of $(\eta, \varepsilon_i, \varepsilon_f, \xi, B_i)$ to best fit the data, then do sensitivity analysis on these parameters. We set the elasticity of goods market matching functions ξ to be 0.8, the elasticities of the disutility functions of searching ε_i and ε_f to be 0.4 and 0.01 respectively. Let the relative risk aversion η = 0:8 and the markup to be 70%. We normalize the number of workers hired by each firm to n = 1. The parameter values and corresponding targets are summarized in Table 1. The benchmark values for assumed parameters are summarized in Table 2. The strategy of calibration is described in detail in Appendix D.

4.3 Model predictions

By using the calibrated parameter values, we give a numerical example in Figure 2 to il-lustrate Proposition 1-3 which shows that, for a low level of money growth, GDP, the net inventory investment, the inventory-to-sales ratio and the quantity of finished goods per match increase with the money growth rate, but decrease with the money growth rate if it reaches a high growth threshold. The critical money growth rate for each variable is slightly different, ranging from 5.68 percent to 7.98 percent.

Now let us look at the quantitative performance of the multi-stage production model. Table 3 reports the model prediction for stylized facts of input inventories. By assuming the economy is hit by a positive shock to the money growth rate, the stylized facts of input inventories can be quantitatively well reproduced, such as procyclical inventory investment, countercyclical inventory-to-sales ratio, negative correlation between final sales and inventory-to-sales ratio and more volatile output relative to final sales.

The most striking result is that the model predicts a positive correlation between

final sales and net input inventory investment. As tested in Khan and Thomas (2007b), neither the (S, s) model nor the basic stockout avoidance model can reproduce the positive relationship between final sales and net inventory investment under a preference shock. Even after introducing idiosyncratic shocks, the generalized stockout avoidance model still can only generate a very weak positive correlation, and this slight improvement comes as a result of severely sacrificing the ability to match the long run average inventory-to-sales ratio. Furthermore, unlike the models of Kryvtsov and Midrigan (2010a,b) and Jung and Yun (2006), which require unrealistic high depreciation rate to match the data. Our model can replicate the stylized facts of input inventories with calibrated depreciation rate that is as low as the empirical one.

The positive response of q^f, as shown in the next section is essential for being able to match the stylized facts, because it induces positive responses of employment and production of intermediate goods. Although the total number of matched finished goods producers increases, their unmatched counterparts hold more unused intermediate goods. As a result, the positive effect dominates the negative effect on inventories and input inventories increase with final sales during the transition. While as showed in Menner (2006), output inventories decrease with sales in response to a positive money growth shock, because the number of matched buyers increases, and the quantity of goods per match decreases.

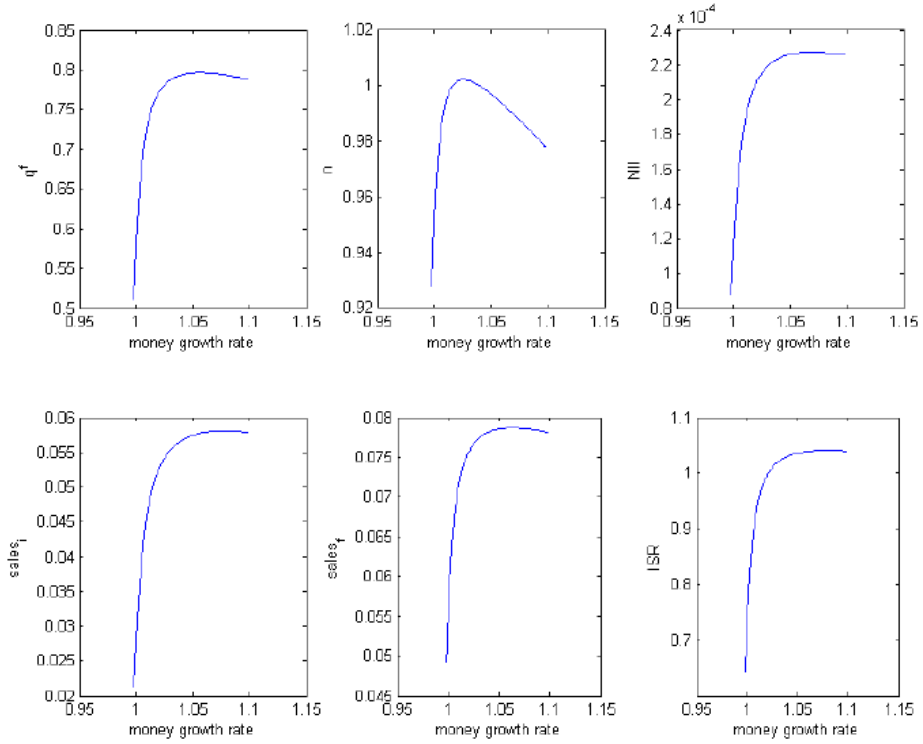

Figure 2: Long Run Effects of Money Growth

The model predicts a higher standard deviation of inventory investment relative to GDP, since there is no adjustment cost in my model. By introducing adjustment cost, the response of inventory investment will be smoother. Of course, it may sacrifice the accurateness of the stylized facts in other dimensions. Nevertheless, the results suggest that monetary policy is important for explaining inventory behaviors and replicating inventory stylized facts.

4.4 Impulse responses

Figure 3 depicts the impulse response functions to a one positive standard deviation shock to the money growth rate. Particularly, the responses of quantity of finished goods per match, inventories and employment are hump-shaped, and that they stay above the steady state during the entire transition.

The details of the propagation mechanism are as follows. First, when the shock hits the economy, the money growth rate increases and real money balances fall immediately, which stimulates buyers to search more intensively in both goods markets. Since inventories depreciate each period and households are eager to consume, households allocate proportionally more money to the finished goods market, as demonstrated by the fact that Δ_t drops immediately. Given the low money growth rate, households anticipate higher final sales and immediately increase intermediate goods buyers' search intensities in order to obtain more intermediate goods. But households do not know which finished goods producers would get a match in the second sub-period, thus they have to increase the level of intermediate goods for all finished goods producers, as demonstrated by the fact that a_t jumps immediately. With more intermediate goods, finished goods producers produce more if they matched and q_t^f jumps immediately.

Table 3: Model Predictions

	Data	Model	Standard Deviations
corr(GDP, IS)	-0.756	-0.798	(0.011)
corr(GDP, NII)	0.789	0.882	(0.008)
corr(FS, IS)	-0.756	-0.665	(0.018)
corr(FS, GDP)	0.987	0.957	(0.001)
corr(FS, NII)	0.680	0.708	(0.014)
$\sigma(FS)/\sigma(GDP)$	0.837	0.666	(0.008)
$\sigma(NII)/\sigma(GDP)$	0.220	0.411	(0.005)
$\sigma(IS)/\sigma(GDP)$	0.843	0.794	(0.011)

Numbers in parentheses are standard deviations over 1000 simulations. GDP: real GDP;GDP; IS: inventory-to-sales ratio; NII: net inventory investment; FS: final sales. All data are real series, end of period, seasonally adjusted and chained in 2005 dollars for the period 1967:Q1 to 2010:Q4. Net inventory investment is detrended as a share of GDP. Other series are detrended using a HP filter (λ = 1600). NII are calculated as a share of GDP in order to compare the results with that in Khan and Thomas (2007b).

Second, the money growth shock also induces a positive response of productivity, because we assume that monetary shocks affect productivity contemporarily and past money growth has a positive correlation with current productivity. Since the effects on productivity are very persistent, final sales keep above the steady state for more than twelve quarters. Such effects on final sales transfer back to the intermediate market and keep intermediate sales above the steady state. The positive response of final sales also increases future revenues. Since revenues stay above the steady state from the second period, households post more vacancies immediately, and n_{t+1} stays above the steady state for more than ten periods. As a result, q_t^f continues to rise before slowly going back to the steady state as the effects of technology shock diminishing. The multi-stage production enables q_t^f to synchronize with the responses of employment and material inputs during the transition. Thus the positive response of q^f arises from the interaction between different production stages which is different from the standard search model.

Finally, inventories stay above the steady state since unmatched finished goods producers hold more intermediate goods during the transition, which is shown by the decreased shadow value of inventories.

Figure 4 depicts the short run dynamic responses of the equilibrium to one positive standard deviation shock to productivity. The same qualitative responses were obtained as in the former case, except for the responses related to employment and qf, which decrease monotonically toward the steady state instead of hump-shaped responses. Intuitively speaking, this is because the technology shock decreases monotonically during the transition. The positive technology shock induces a negative response of the money growth, because current money growth is negatively correlated with past productity. Therefore, the responses of both shocks are qualitatively the same as those in Figure 4 from the second period. Quantitatively speaking, the responses are stronger in the current case, since the magnitude of the shock to productivity is bigger.

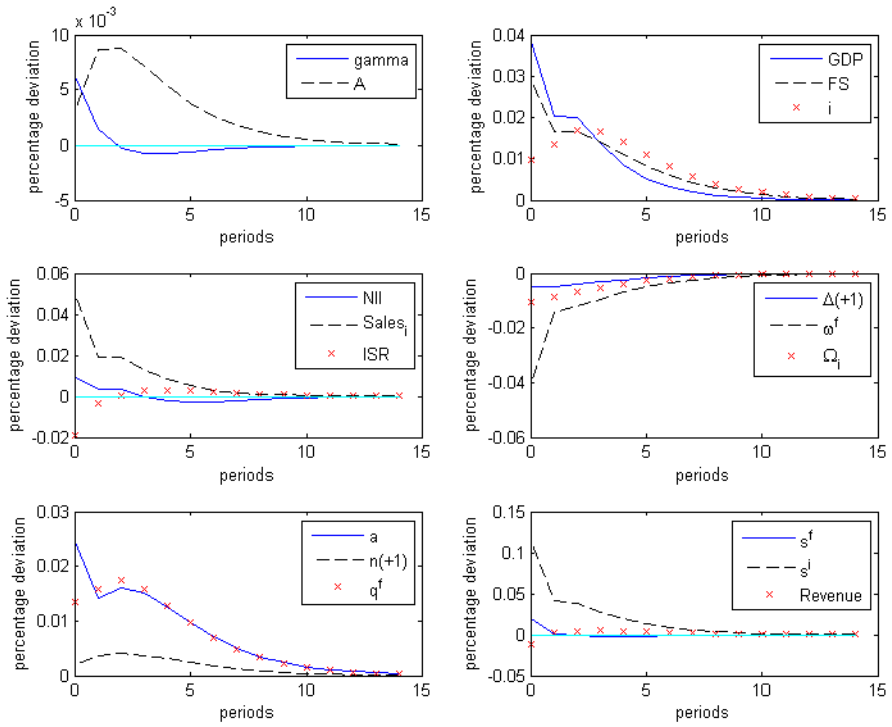

Figure 3: Impulse Response Functions to a Positive Money Growth Shock

The short run responses of input inventories in our model and that of output inventories in Menner (2006) and Shi (1998) are very different. The single-stage production model is similar to the production smoothing model, which always has a tradeo between the inventory and sales (and hence output). Thus, inventories decrease whenever sales increases during the transition, and it is difficult to reproduce the stylized facts of inventories without technology shocks.

Building on Shi's (1998) model, Wang and Shi (2006) also predict a positive response of inventories with the shock to money growth rate.[11] But, in our model, employment responds positively to both shocks. Input inventories are a part of the next period's material inputs in the multi-stage production model, thus higher input inventories have positive effects on final sales and revenues. As a result, households hire more labor if future revenues increase. In contrast, employment responds negatively to both shocks in Wang and Shi (2006), because abundant goods reduce households' profitability to hire labor. And, in their paper, inventories are important because output inventories induce a shortage of future goods supply, which can keep buyers' search intensities above the steady state. Therefore, input and output inventories work differently through the propagation mechanism in these two

[11] Our findings are consistent with Chang, Hornstein and Sarte (2006) in which employment (and inventories) increases in response to a permanent and positive shock to productivity in a model with inventories, if the costs of holding inventories are sufficiently low.

models.[12]

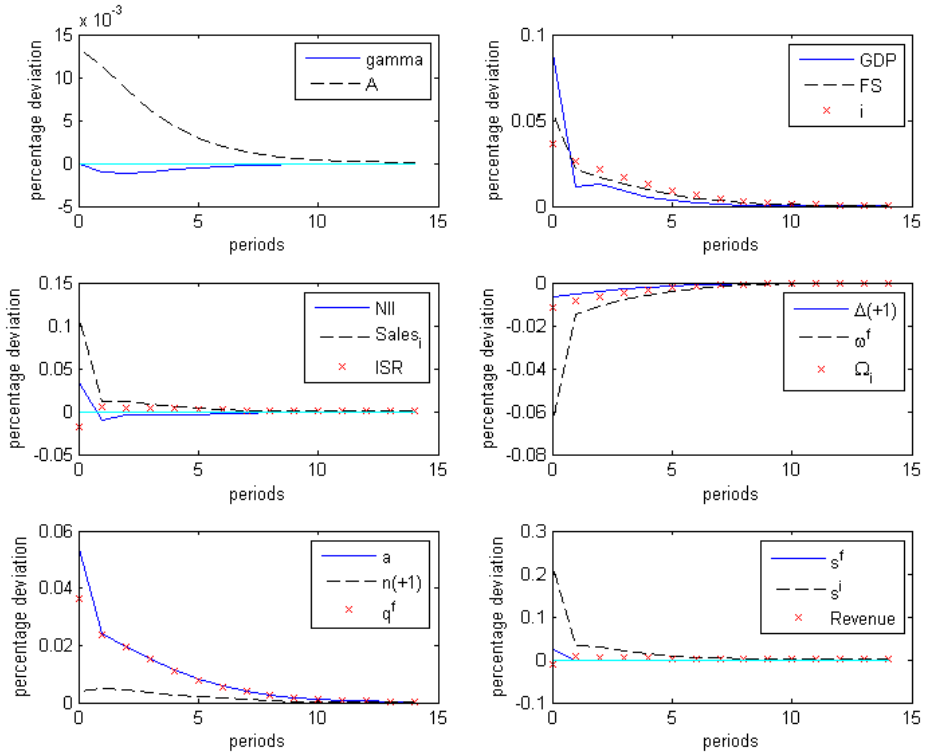

Figure 4: Impulse Response Functions to a Positive Productivity Shock

4.5 The role of input inventories over business cycles

There has long been a debate within the inventory literature about the role of inventories over business cycles. Since GDP is more volatile than final sales in the data, most researchers believe that inventories amplify aggregate fluctuations over business cycles. Others argue that inventories smooth business cycles because they smooth productions. In this section, we revisit this debate and show that input inventories play a decentralizing role over business cycles.

We compare two pairs of results by targeting different inventory-to-sales ratios and re-calibrating the model to each ratio. We divide the sample period into two sub periods. The first inventory-to-sales ratio is 1.0402, which is calculated from the first sub period:1967:I-1983:IV, and the second inventory-to-sales ratio is 0.9499, which is calculated from the second sub period: 1984:I-2010:IV. We choose the year 1984 as a break point for my sample because the input inventory-to-sales ratio experiences a declining trend beginning in 1984.[13] Some researchers argue that this declining trend is one of the reasons for "Great Moderation". Our results support this argument.

[12] All of these papers do not distinguish between input and output inventories when calibrate to data.
[13] The output inventory-to-sales ratio exhibits an opposite trend. See Iacoviello, Schiantarelli and Schuh (2011) for details

The calibration results are reported in Table 4. The stylized facts calculated from these two sub samples are similar except for the relative standard deviations of the inventory investment and the inventory-to-sales ratio relative to GDP. The most striking results are that the standard deviations of GDP, the input inventory investment, the inventory-to-sales ratio and final sales are lower in the second sub sample. Thus, our results show that, in the second sub sample, aggregate fluctuations are smoothed by holding lower input inventory levels.

Table 4: Role of Inventories

	$ISR = 1.0402$		$ISR = 0.9499$		$Data$
corr(GDP, IS)	-0.774	(0.014)	-0.801	(0.011)	-0.756
corr(GDP, NII)	0.896	(0.007)	0.874	(0.008)	0.789
corr(FS, IS)	-0.599	(0.023)	-0.690	(0.017)	-0.756
corr(FS, GDP)	0.940	(0.001)	0.965	(0.001)	0.987
corr(FS, NII)	0.693	(0.014)	0.717	(0.014)	0.680
$\sigma(FS)/\sigma(GDP)$	0.613	(0.008)	0.696	(0.007)	0.837
$\sigma(NII)/\sigma(GDP)$	0.473	(0.005)	0.376	(0.004)	0.220
$\sigma(IS)/\sigma(GDP)$	0.670	(0.009)	0.860	(0.013)	0.843
$\sigma(GDP)$	0.112	(0.003)	0.088	(0.002)	-
$\sigma(NII)$	0.053	(0.001)	0.033	(0.001)	-
$\sigma(INV)$	0.016	(0.001)	0.012	(0.001)	-
$\sigma(FS)$	0.069	(0.002)	0.061	(0.002)	-

Numbers in parentheses are standard deviations over 1000 simulations. GDP: real GDP; IS: inventory-to-sales ratio; NII: net inventory investment; FS: final sales; n: employment level of each output producer. The model is calibrated to two different ISR targets while keeping all the other parameters unchanged. ISR = 1:0402 is calculated from the first sub-sample: 1967:I-1983:IV and ISR = 0:9499 is calculated from the second sub-sample: 1984:I - 2010:IV.

Herrera and Pesavento (2005) argue that the better inventory management technology cannot account for most of the decline in volatility of output, because both the volatility of sales and inventories decreased since mid-1980s and most of the decline is due to the decline in that of input inventories.[14] Consistent with the empirical findings in Stock and Watson (2002), our model suggests that besides the better inventory management technology, reduction in volatility of money growth shocks may be another promising reason for explaining the “Great Moderation".

4.6 Sensitivity analysis

In the preceding sections, we have seen that the search model with shocks to the money growth rate can reproduce stylized facts of inventories. The model also suggests that input inventories amplify aggregate fluctuations over business cycles. Since parameters $\varepsilon_i, \varepsilon_f, \alpha, \eta, B_i$ and markup are hard calibrated from the data, we assumed their values for the best _t to data in the benchmark model. In this section,

[14] Herrera, Murtazashvili and Pesavento (2008) show that the cross-section correlation among manufactur-ing inventories and sales increased since the "Great Modaration"

we will examine the sensitivity of the quantitative results to different values of these parameters. Each parameter will be analyzed separately, and the model is recalibrated to the data for each analysis. The results of sensitivity analysis are reported in Table 5 - 10.

Table 5: Sensitivity analysis: ϵ_i

ϵ_i	0.1	0.4*	1	4	8	Data
corr(GDP, IS)	-0.745	-0.798	-0.413	0.631	0.733	-0.756
	(0.006)	(0.011)	(0.028)	(0.011)	(0.009)	
corr(GDP, NII)	0.507	0.882	0.917	0.937	0.940	0.789
	(0.020)	(0.008)	(0.006)	(0.004)	(0.004)	
corr(FS, IS)	-0.858	-0.665	-0.157	0.821	0.891	-0.756
	(0.006)	(0.018)	(0.038)	(0.010)	(0.007)	
corr(FS, GDP)	0.940	0.957	0.908	0.872	0.866	0.987
	(0.004)	(0.001)	(0.002)	(0.003)	(0.003)	
corr(FS, NII)	0.184	0.708	0.667	0.655	0.654	0.680
	(0.031)	(0.014)	(0.014)	(0.014)	(0.013)	
$\sigma(FS)/\sigma(GDP)$	0.877	0.666	0.532	0.444	0.427	0.837
	(0.007)	(0.008)	(0.009)	(0.008)	(0.007)	
$\sigma(NII)/\sigma(GDP)$	0.346	0.411	0.566	0.663	0.681	0.220
	(0.010)	(0.005)	(0.005)	(0.005)	(0.006)	
$\sigma(IS)/\sigma(GDP)$	2.321	0.794	0.300	0.265	0.294	0.843
	(0.049)	(0.011)	(0.008)	(0.008)	(0.007)	
$\sigma(GDP)$	0.043	0.096	0.161	0.247	0.270	-
	(0.002)	(0.002)	(0.004)	(0.006)	(0.007)	
$\sigma(NII)$	0.015	0.039	0.091	0.164	0.184	-
	(0.000)	(0.001)	(0.002)	(0.005)	(0.005)	
$\sigma(INV)$	0.005	0.013	0.023	0.035	0.039	-
	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	
$\sigma(FS)$	0.038	0.064	0.086	0.110	0.116	-
	(0.001)	(0.002)	(0.002)	(0.003)	(0.003)	

Numbers in parentheses are standard deviations over 1000 simulations. GDP: real GDP; IS: inventory-to-sales ratio; NII: net inventory investment; FS: final sales; n: employment level of each output producer. Parameter values with a star are benchmark parameter values.

Table 5 shows that the correlations predicted by this model are sensitive to changes in the value of ε_i, except for the correlation between final sales and GDP. Other correlations match the data more effectively with low value of ε_i. In particular, if ε_i were large, (for example, ten times larger than the benchmark value,) the correlation between inventory-to-sales ratio and GDP (or FS) would turn positive which is not consistent with data.

Table 6: Sensitivity analysis: ϵ_f

ϵ_f	0.01*	0.03	0.1	1	2	Data
corr(GDP, IS)	-0.798	-0.749	-0.576	-0.304	-0.280	-0.756
	(0.011)	(0.014)	(0.020)	(0.021)	(0.020)	
corr(GDP, NII)	0.882	0.889	0.888	0.939	0.943	0.789
	(0.008)	(0.006)	(0.006)	(0.003)	(0.003)	
corr(FS, IS)	-0.666	-0.716	-0.591	-0.352	-0.331	-0.756
	(0.018)	(0.020)	(0.027)	(0.030)	(0.028)	
corr(FS, GDP)	0.957	0.978	0.966	0.950	0.949	0.987
	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	
corr(FS, NII)	0.709	0.774	0.739	0.784	0.790	0.680
	(0.014)	(0.012)	(0.013)	(0.010)	(0.010)	
$\sigma(FS)/\sigma(GDP)$	0.666	0.722	0.683	0.556	0.542	0.837
	(0.008)	(0.005)	(0.005)	(0.005)	(0.005)	
$\sigma(NII)/\sigma(GDP)$	0.412	0.331	0.383	0.503	0.516	0.220
	(0.005)	(0.004)	(0.004)	(0.005)	(0.005)	
$\sigma(IS)/\sigma(GDP)$	0.794	1.454	1.796	2.128	2.174	0.843
	(0.011)	(0.019)	(0.020)	(0.049)	(0.052)	
$\sigma(GDP)$	0.096	0.096	0.087	0.074	0.073	-
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	
$\sigma(NII)$	0.039	0.032	0.033	0.037	0.038	-
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	
$\sigma(INV)$	0.013	0.013	0.014	0.016	0.016	-
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	
$\sigma(FS)$	0.064	0.069	0.059	0.041	0.040	-
	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	

Numbers in parentheses are standard deviations over 1000 simulations. GDP: real GDP; IS: inventory-to-sales ratio; NII: net inventory investment; FS: final sales; n: employment level of each output producer. Parameter values with a star are benchmark parameter values.

The intuitions of these results are as follows. A higher value of ε_i implies that intermediate goods buyers are more responsive to both shocks, which is demonstrated by larger standard deviations of aggregate variables. Intermediate goods buyers search more intensively, while the effect on finished goods buyers' search intensities is limited because ε_f is unchanged. Therefore, the increase in intermediate goods is larger than the increase in final sales, so households accumulate more inventories, which drives the inventory-to-sales ratio up and generates counterfactual results.

Table 6 shows that the model matches the data effectively with low ε_f. A higher value of ε_f implies that finished goods producers are more responsive to both shocks. Since finished goods buyers search more intensively in this case, q^f responds at a lower magnitude to the shocks and GDP and final sales become less volatile. Despite the decreasing volatilities of GDP and final sales, the inventory investment responds more strongly to the shocks. Therefore, the relative standard

deviation of the inventory-to-sales ratio (relative to GDP) increases with ε_f, and the correlation between inventory-to-sales ratio and GDP (or FS) are underestimated.

Table 7: Sensitivity analysis: ξ

ξ	0.2	0.4	0.6	0.8*	0.9	Data
corr(GDP, IS)	-0.901	-0.874	-0.833	-0.798	-0.780	-0.756
	(0.005)	(0.004)	(0.008)	(0.011)	(0.013)	
corr(GDP, NII)	0.663	0.809	0.855	0.882	0.892	0.789
	(0.015)	(0.011)	(0.010)	(0.008)	(0.007)	
corr(FS, IS)	-0.912	-0.804	-0.722	-0.665	-0.639	-0.756
	(0.002)	(0.006)	(0.012)	(0.018)	(0.020)	
corr(FS, GDP)	0.981	0.975	0.965	0.957	0.953	0.987
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	
corr(FS, NII)	0.504	0.659	0.690	0.708	0.714	0.680
	(0.018)	(0.016)	(0.015)	(0.014)	(0.013)	
$\sigma(FS)/\sigma(GDP)$	0.867	0.782	0.716	0.666	0.645	0.837
	(0.006)	(0.007)	(0.008)	(0.008)	(0.008)	
$\sigma(NII)/\sigma(GDP)$	0.226	0.294	0.362	0.411	0.432	0.220
	(0.006)	(0.005)	(0.005)	(0.005)	(0.004)	
$\sigma(IS)/\sigma(GDP)$	1.731	1.148	0.927	0.794	0.741	0.843
	(0.020)	(0.018)	(0.013)	(0.011)	(0.010)	
$\sigma(GDP)$	0.035	0.054	0.075	0.096	0.107	-
	(0.001)	(0.002)	(0.002)	(0.002)	(0.003)	
$\sigma(NII)$	0.008	0.016	0.027	0.039	0.046	-
	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	
$\sigma(INV)$	0.004	0.007	0.010	0.013	0.015	-
	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	
$\sigma(FS)$	0.030	0.042	0.053	0.064	0.069	-
	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	

Numbers in parentheses are standard deviations over 1000 simulations. GDP: real GDP; IS: inventory-to-sales ratio; NII: net inventory investment; FS: final sales; n: employment level of each output producer. Parameter values with a star are benchmark parameter values.

An interesting result is that the value of ε_f should be relatively lower than the value of ε_i in order to match the data. This result implies that intermediate goods buyers are more responsive than finished goods buyers. This is consistent with the empirical facts that most downstream firms sign long term contracts with upstream firms instead of searching for suppliers every period.

Table 7 shows that the predicted correlations are relatively stable in response to a wide range of ξ. The model tends to overestimate the correlations with a low value of ξ, except for the correlation between final sales and the inventory investment, which is underestimated. Moreover, the relative standard deviation of inventory investment is overshot by the model with a large value of ξ, and the relative standard deviation of the inventory-to-sales ratio is overshot with a low value of ξ.

Intuitively speaking, as ξ decreases, the matching rates decrease for both sellers and buyers in both goods markets. Because of input inventory the negative effects on final sales is stronger than those on intermediate goods sales; as a result, inventories become too volatile to match the data.

Table 8: Sensitivity analysis: η

η	0.2	0.4	0.8*	2	3	Data
corr(GDP, IS)	-0.857	-0.855	-0.798	0.520	0.685	-0.756
	(0.005)	(0.006)	(0.011)	(0.009)	(0.007)	
corr(GDP, NII)	0.825	0.845	0.882	0.954	0.974	0.789
	(0.012)	(0.011)	(0.008)	(0.003)	(0.002)	
corr(FS, IS)	-0.785	-0.770	-0.666	0.798	0.943	-0.756
	(0.009)	(0.010)	(0.018)	(0.010)	(0.004)	
corr(FS, GDP)	0.978	0.974	0.957	0.871	0.826	0.987
	(0.001)	(0.001)	(0.001)	(0.004)	(0.006)	
corr(FS, NII)	0.691	0.703	0.709	0.686	0.682	0.680
	(0.017)	(0.017)	(0.014)	(0.013)	(0.013)	
$\sigma(FS)/\sigma(GDP)$	0.781	0.752	0.666	0.408	0.299	0.837
	(0.007)	(0.007)	(0.008)	(0.007)	(0.005)	
$\sigma(NII)/\sigma(GDP)$	0.286	0.317	0.412	0.678	0.776	0.220
	(0.004)	(0.004)	(0.005)	(0.004)	(0.003)	
$\sigma(IS)/\sigma(GDP)$	1.210	1.102	0.794	0.606	0.965	0.843
	(0.022)	(0.018)	(0.011)	(0.019)	(0.023)	
$\sigma(GDP)$	0.082	0.087	0.096	0.111	0.117	-
	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	
$\sigma(NII)$	0.023	0.027	0.039	0.075	0.091	-
	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	
$\sigma(INV)$	0.011	0.012	0.013	0.018	0.021	-
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	
$\sigma(FS)$	0.064	0.065	0.064	0.045	0.035	-
	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	

Numbers in parentheses are standard deviations over 1000 simulations. GDP: real GDP; IS: inventory-to-sales ratio; NII: net inventory investment; FS: final sales; n: employment level of each output producer. Parameter values with a star are benchmark parameter values.

Table 8 shows that the quantitative results are sensitive to changes in the value of relative risk aversion. The model matches the data well with low η. If η were high, (for example, greater than one), both the correlation between inventory-to-sales ratio and GDP (or final sales) and the relative standard deviations would be mismatched. For the cyclical behavior, the model becomes more volatile to shocks with higher η. These results are due to the fact that the motivation for smoothing consumption is strong with high η, therefore final sales respond to the shocks at a lower magnitude. Thus, the relative standard deviation of final sales is much lower than the value observed in the data. Moreover, in order to smooth consumption, households use more material inputs during the transition and hold more inventories at the end of each period. As a result, the response of inventories

is too volatile such that the inventory-to-sales ratio is positively correlated with GDP (or final sales) and the relative standard deviation of inventory investment is overestimated.

Table 9: Sensitivity analysis: B_i

B_i	0.1	0.2*	0.4	0.6	0.8	Data
corr(GDP, IS)	-0.797	-0.798	-0.798	-0.798	-0.798	-0.756
	(0.011)	(0.011)	(0.012)	(0.011)	(0.011)	
corr(GDP, NII)	0.882	0.882	0.882	0.882	0.882	0.789
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	
corr(FS, IS)	-0.664	-0.665	-0.665	-0.665	-0.665	-0.756
	(0.018)	(0.018)	(0.019)	(0.018)	(0.018)	
corr(FS, GDP)	0.957	0.957	0.957	0.957	0.957	0.987
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	
corr(FS, NII)	0.708	0.708	0.709	0.708	0.709	0.680
	(0.014)	(0.014)	(0.015)	(0.015)	(0.014)	
$\sigma(FS)/\sigma(GDP)$	0.666	0.666	0.665	0.666	0.666	0.837
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	
$\sigma(NII)/\sigma(GDP)$	0.412	0.411	0.411	0.411	0.411	0.220
	(0.004)	(0.005)	(0.005)	(0.005)	(0.005)	
$\sigma(IS)/\sigma(GDP)$	0.794	0.794	0.794	0.794	0.794	0.843
	(0.011)	(0.011)	(0.010)	(0.011)	(0.011)	
$\sigma(GDP)$	0.096	0.096	0.096	0.096	0.096	-
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	
$\sigma(NII)$	0.040	0.039	0.040	0.040	0.040	-
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	
$\sigma(INV)$	0.013	0.013	0.013	0.013	0.013	-
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	
$\sigma(FS)$	0.064	0.064	0.064	0.064	0.064	-
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	

Numbers in parentheses are standard deviations over 1000 simulations. GDP: real GDP; IS: inventory-to-sales ratio; NII: net inventory investment; FS: final sales; n: employment level of each output producer. Parameter values with a star are benchmark parameter values.

Similar to the findings of Wang and Shi (2006), table 9 shows that the inventory regularities are insensitive to changes in B_i, the intermediate goods market's buyer/seller ratio. The intuition is the following. Increased market tightness on one hand generates negative externalities, hence has a negative effect, on buyers' matching probabilities and, on the other hand, it also generates positive externalities, hence has a positive effect, on sellers' matching probabilities. Since positive effects cancel out negative effects, the overall results are insensitive to market tightness.

Table 10 shows that the predicted results are sensitive to the changes in markups, and the model would _t the data more effectively with high markups. If the markup is low, households can consume more in the long run and final sales would respond more strongly to the shocks. More final sales require more material inputs, as a result of which inventories become too volatile and the inventory-to-sales ratio

is positively correlated with GDP (or final sales). Moreover, since the effects on GDP are bigger than the effects on inventories, the relative standard deviation of the inventory-to-sales ratio stays within an acceptable region.

Table 10: Sensitivity analysis: *markup*

markup	0.2	0.4	0.5	0.6	0.7*	Data
corr(GDP, IS)	0.7692	-0.183	-0.648	-0.766	-0.798	-0.756
	(0.005)	(0.029)	(0.021)	(0.015)	(0.011)	
corr(GDP, NII)	0.931	0.921	0.905	0.892	0.882	0.789
	(0.005)	(0.005)	(0.006)	(0.007)	(0.008)	
corr(FS, IS)	0.981	0.171	-0.403	-0.591	-0.666	-0.756
	(0.001)	(0.035)	(0.031)	(0.023)	(0.018)	
corr(FS, GDP)	0.855	0.902	0.924	0.943	0.957	0.987
	(0.005)	(0.002)	(0.002)	(0.001)	(0.001)	
corr(FS, NII)	0.664	0.665	0.675	0.691	0.709	0.680
	(0.014)	(0.014)	(0.014)	(0.015)	(0.014)	
$\sigma(FS)/\sigma(GDP)$	0.365	0.516	0.575	0.624	0.666	0.837
	(0.006)	(0.008)	(0.008)	(0.009)	(0.008)	
$\sigma(NII)/\sigma(GDP)$	0.797	0.584	0.519	0.462	0.412	0.220
	(0.014)	(0.004)	(0.005)	(0.005)	(0.005)	
$\sigma(IS)/\sigma(GDP)$	0.527	0.262	0.402	0.596	0.794	0.843
	(0.012)	(0.008)	(0.006)	(0.008)	(0.011)	
$\sigma(GDP)$	0.549	0.174	0.134	0.111	0.096	-
	(0.014)	(0.004)	(0.003)	(0.003)	(0.002)	
$\sigma(NII)$	0.437	0.102	0.070	0.051	0.039	-
	(0.016)	(0.003)	(0.002)	(0.001)	(0.001)	
$\sigma(INV)$	0.058	0.020	0.016	0.014	0.013	-
	(0.002)	(0.006)	(0.001)	(0.001)	(0.001)	
$\sigma(FS)$	0.200	0.090	0.077	0.069	0.064	-
	(0.005)	(0.002)	(0.001)	(0.002)	(0.002)	

Numbers in parentheses are standard deviations over 1000 simulations. GDP: real GDP; IS: inventory-to-sales ratio; NII: net inventory investment; FS: final sales; n: employment level of each output producer. Parameter values with a star are benchmark parameter values.

But, the inventory investment is much more volatile than the inventories because it is a flow concept, thus the relative standard deviation of inventory investment is overestimated by the model.

5. Conclusion

In this paper, we study both the long run and the short run effects of monetary policy on input inventories. In particular, money growth has nonmonotonic real effects on the steady state input inventory investment, inventory-to-sales ratio and final sales. By calibrating to quarterly US data, we showed that the model is able to replicate the stylized facts on input inventory movements well over the business cycle. And it predicted that input inventories are procyclical, which are different from output inventories. Such procyclical input inventories induce positive responses of

employment, since input inventories have positive effects on revenues.

Finally, our model shows that input inventories amplify aggregate fluctuations. This destabilizing role of input inventories attributes to the positive intensive effect. We also conducted a sensitivity analysis of some parameters relative to the baseline calibration. In order to match the data, the model requires that finished goods buyers are less responsive to the shock in comparison to intermediate goods buyers in order to keep the relative standard deviation of the inventory-to-sales ratio (relative to GDP) within a reasonable range. Nevertheless, search frictions in the labor market and the goods markets matter both qualitatively and quantitatively for matching the data.

To conclude, our paper sheds light on the importance of monetary policy to inventories.

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A. Appendix A

In this section, we prove that the model economy exists at least one steady state, which satisfie $(\lambda^f;\Omega_a)>0$. Denote the steady state values with an asterisk, which can be rewritten by the dynamic system:

$$
\begin{aligned}
z^f(s^{f*})^{\xi} &= \frac{\gamma-\beta}{\beta}\frac{\omega^{f*}}{U'(c^*)-w^{f*}}, && (45)\\
\Omega_i^* &= \beta\varphi'(q^{i*}), && (46)\\
\frac{(1-\beta(1-\delta_n))}{\beta}k(v^*) &= \{\sigma z^f B^f(s^{f*})^{\xi}\omega^{f*}-\sigma\varphi^f && (47)\\
&+ [(1-z^f B^f(s^{f*})^{\xi})\sigma(1-\delta_i)\beta-\sigma]\varphi'(q^{i*})\},\\
\Phi^{f\prime}(s^{f*}) &= z^f(s^{f*})^{\xi-1}[U'(c^*)-\omega^{f*}]q^{f*}, && (48)\\
v^*\mu(v^*) &= \delta_n q^{f*}, && (49)\\
q^{i*} &= \{1-(1-\delta_i)[1-z^f B^f(s^{f*})^{\xi}]\}q^{f*}, && (50)\\
c^* &= a_p^f B^f z^f(s^{f*})^{\xi}q^{f*}. && (51)
\end{aligned}
$$

As demonstrated in section II, the steady state system can be reduced to two equations which are repeated here for future use:

$$
z^f[s^f(\omega^{f*},q^{f*})]^{\xi}=\frac{\gamma-\beta}{\beta}\frac{\omega^{f*}}{U'(c(\omega^{f*},q^{f*}))-w^{f*}},
$$

$$
\begin{aligned}
(1-\beta(1-\delta_n))k(v(q^{f*}))+\beta\sigma\varphi^f &= \beta\{\sigma z^f B^f(s^f(\omega^{f*},q^{f*}))^{\xi}\omega^{f*}\\
&+[(1-z^f B^f(s^f(\omega^{f*},q^{f*}))^{\xi})\sigma(1-\delta_i)\beta-\sigma]\varphi'(q^i(\omega^{f*},q^{f*}))\}.
\end{aligned}
$$

Similarly to Shi (1998), above two equations give a relationship between ω^f and q^f, denote $q^{f*}=q^f 1(\omega^{f*})$ and $q^{f*}=q^f 2(\omega^{f*})$. The steady state value ω^{f*} is a solution to $Q^f 1(\omega^{f*})=Q^f 2(\omega^{f*})$. To ensure $\lambda^f>0$, the solution must satisfy

$U'(c^*) \geq \omega^{f*} + \Delta$, where $\Delta > 0$ is an arbitrarily small number. That is, we require $q^{f*} \leq q^f(\omega^{f*}, \Delta)$ [15], where $q^f(\omega^{f*}, \Delta)$ is defined by:

$$U'(c(\omega_f, q^f(\omega^f, \Delta))) = \omega^f + \Delta. \tag{52}$$

Using Lemma 3.2 as explained in Shi (1998), we can prove that the function $Q^f(!^f; \_)$ is well defined and has the following properties for sufficiently small $\Delta > 0$: $Q^f_{wf}(\omega^f, \Delta) < 0, Q^f(\infty, \Delta) = 0$; and $\lim_{\Delta \to 0} Q^f(0, \Delta) = \infty$ .The function $q^f 1(\omega^f)$ satisfies $q^f 1'(\omega^f) < 0$; $q^f 1(0) = \infty$ and $q^f 1(\infty) = 0$. Furthermore, the two curves $q^f 1(\omega^f)$ and $Q^f(\omega^f, \Delta) < 0$ have a unique intersection at a level denoted $\omega_1^f(\Delta)$ which satisfies $\lim_{\Delta \to 0} \omega_1^f(\Delta) = 0$ [16]

In order to prove the uniqueness, we also need to know the properties of $q^f 2$. Although the properties of $q^f 2$ are the same as what is described in Lemma 3.3 in Shi (1998), the proof is not the same due to different function forms.

We are going to prove that $q^f 2$ has the following properties: $q^f 2(0) = 0, q^f 2(\infty) = 0$, and $q^f 2'(\omega^f) < 0$ for sufficiently large ω^f . The two curves $q^f 2(\omega^f)$ and $Q^f(\omega^f, \Delta)$ have a unique intersection at a level denoted $\omega^f 2(\Delta)$ which approaches infinity when Δ approaches zero.

First, let us show $q^f 2(0) = 0$ by rearranging equation (36):

$$\begin{aligned}
\varphi'(q^i(\omega^{f*}, q^{f*})) &= \frac{\beta[\sigma z^f B^f(s^f(\omega^{f*}, q^{f*}))^\xi \omega^{f*} - \sigma\varphi^f] - (1 - \beta(1 - \delta_n))k(v(q^{f*}))}{\beta[1 - (1 - z^f B^f(s^f(\omega^{f*}, q^{f*}))^\xi)\sigma(1 - \delta_i)\beta]\sigma} \\
&\leq \frac{\sigma z^f B^f(s^f(\omega^{f*}, q^{f*}))^\xi \omega^{f*}}{1 - (1 - z^f B^f(s^f(\omega^{f*}, q^{f*}))^\xi)\sigma(1 - \delta_i)\beta]\sigma} \\
&\leq \frac{\sigma z^f B^f \omega^{f*}}{\{[1 - \sigma(1 - \delta_i)\beta]/(s^f(\omega^{f*}, q^{f*}))^\xi + z^f B^f \sigma(1 - \delta_i)\beta\}\sigma}
\end{aligned} \tag{53}$$

The right-hand side of (A9) approaches zero as ω^f approaches zero, becuase $\lim_{\omega^f \to 0} numerator = 0$ and $\lim_{\omega^f \to 0} deno\min ator = z^f B^f \sigma(1 - \delta_i)\beta$. Since $\varphi(') > 0$, equation (A9) implies $\lim_{\omega^f \to 0} q^i(\omega^{f*}, q^{f*}) = 0$. Finally $\lim_{\omega^f \to 0} q^f 2(\omega) = 0$, is implied by the steady state equation $q^{i*} = \{1 - (1 - \delta_i)[1 - z^f B^f(s^{f*})^\xi]\}q^{f*}$

Second, let us prove that the two curves $q^f 2(\omega^f)$ and $Q^f(\omega^f, \Delta)$ have a unique intersection. By plugging the equation of c– into the fourth equation of the steady state system, we can get a useful equation:

$$\Phi^{f'}(s^{f*})s^{f*} = [U'(c^*) - \omega^{f*}]\frac{c^*}{a_p^f B^f}. \tag{54}$$

---

[15] First, positive nominal interest rate implies $\gamma > \beta$ and is enough to ensure $\lambda > 0$. If $q^f{}_- > Q^f(!^f{}_-; \_)$, $U^{00}(c) < 0$ implies $U^0(c(!^f{}_-; q^f{}_-)) < U^0(c(!^f{}_-; Q^f(!^f{}_-; \_)))$, which violates $U^0(c_-) \_ !^f{}_- + \_$.

[16] Since equation (35) is identical to the steady state equation (3.4) in Shi (1998), we omit the proof here.

As the definition of $Q^f(\omega^f,\Delta)$, set $\omega^f = u'(c)-\Delta$. Then equation (A10) implies that s^f is a function of (c,Δ): $\Phi^{f'}(s^{f*})s^{f*} = \Delta c^*/(a_p^f B^f)$. Denote the solution for s^f as $s^f(c,\Delta)$. Because $\Phi^{f'}(0)=0, \Phi^{f'}(.)>0$ and $\Phi^{f''}(.)>0$, we can get $s^f(c,0)=0$, $s^f(c,\infty)=\infty$, $s^f(0,\Delta)=0$ and $s^f(c,\Delta)>0$. By rearranging equation (A10), we can prove that $c/(s(c,\Delta))^{\xi}$ is an increasing function of c.

Rearranging the steady state equation of c*, it is easy to see that $q^f(c,\Delta)$ is also an increasing function of $c: q^f(c,\Delta) = c/a_p^f B^f z^f [s^f(c,\Delta))^{\xi}]\}q^f(c,\Delta)$. Similarly, q^i can be rewritten as a function of $c: q^f(c,\Delta) = c/a_p^f B^f z^f [s^f(c,\Delta))^{\xi}]\}q^f(c,\Delta)$. Since both $s^f(c,\Delta)$ and $q^f(c,\Delta)$ are increasing in $c, q^i(c,\Delta)$ is an increasing function of c.

Now we are ready to prove that the two curves $q^f 2(\omega^f)$ and $Q(\omega^f,\Delta)$ have a unique intersection. Rewrite equation (36) in terms of (c,Δ):

$$\begin{aligned} \text{LHS(36)} &= (1-\beta(1-\delta_n))k(v(q^f(c,\Delta))) + \beta\sigma\varphi^f \qquad (55)\\ \text{RHS(36)} &= \beta\{\sigma z^f B^f (s^f(c,\Delta))^{\xi}\omega^{f*} \\ &+ [(1-z^f B^f (s^f(c,\Delta))^{\xi})\sigma(1-\delta_i)\beta-\sigma]\varphi'(q^i(c,\Delta))\} \qquad (56)\end{aligned}$$

The left-hand side of (36) is an increasing function of c, and the right-hand side of (36) is a decreasing function of c, because $s^f(c,\Delta)$, $q^f(c,\Delta)$ and $q^i(c,\Delta)$ are increasing in c, $k'(v)>0$ and $\varphi'(q^i)>0$. Moreover, since $q^f(0,\Delta)=0$, $k(v(q^f(0,\Delta)))=0$, $q^f(\infty,\Delta)=\infty$ and $k(v(q^f(\infty,\Delta)))=\infty$ it is easy to see that $\lim_{c\to 0} RHS(36)=\infty$ and $\lim_{c\to\infty} RHS(36)=-\infty$. Similarly, the right-hand side has the following properties. $\lim_{c\to 0} RHS(36)=\infty$, because $q^f(0,\Delta)=0$, $s^f(\infty,\Delta)=\infty$ and $\lim_{c\to 0} cu'(c)=\infty$. And $\lim_{c\to\infty} RHS(36)=-\infty$. because $q^i(\infty,\Delta)=\infty$, $q^f(\infty,\Delta)=\infty$ and $\lim_{c\to\infty} cu'(c)=0$.

Given these properties of (36), there is a unique solution for c to (36). Denote this solution by $c(\Delta)$, then $\omega^f 2(\Delta) = u'(c(\Delta))-\Delta$ is unique. Thus there must be a unique intersection between the two curves $q^f 2(\omega^f)$ and $Q^f(\omega^f,\Delta)$.

Third, we are going to prove that $\lim_{\Delta\to 0}\omega^f 2(\Delta)=0$, $q^f 2'(\omega^f)<0$ and $q^f 2(\infty)=0$. For fixed c, $\lim_{\Delta\to 0} LHS(36)=\infty$ and $\lim_{\Delta\to 0} RHS(36)=-\infty$, because $\lim_{\Delta\to 0} s(c,\Delta)=0$ and $\lim_{\Delta\to 0} q^f(c,\Delta)=\infty$. Thus (36) is satisfied only when $\lim_{\Delta\to 0} c(\Delta)=0$ and $\lim_{\Delta\to 0}\omega^f 2(\Delta)=0$. Next, $q^f 2'(\omega^f)<0$ since $q^f 2(c,\Delta)$ is an increasing function of c and $\omega^f 2'(c(\Delta))<0$. This can be proved by plugging $\omega^f 2'(c(\Delta))$ into $q^f 2(\omega^f)$ and analyzing $q^f 2(\omega^f 2(c(\Delta)))$.

Now, we are going to prove $q^f 2(\infty) = 0$. Because $Q^f(0,\Delta)$ is a positive constant and $q^f 2(0) = 0$ is proven, $q^f 2(0) < Q^f(0,\Delta)$ and the curve $q^f 2(\omega^f)$ must cross the curve $Q^f(\omega^f,\Delta)$ from below if the two have a unique intersection. Moreover, because $Q^f(\infty,\Delta) = 0$ is proven in Lemma 1 and $0 \le q^f 2(\omega^f) \le Q^f(\omega^f,\Delta)$ for $\omega^f < \omega^f 2(\Delta)$, $0 \le q^f 2(\infty) < 0$ or $\omega^f < \omega^f 2(\Delta)$. Then $q^f 2(\infty) = 0$ since $q^f 2(\omega^f)$ is continuous and only has one intersection with $Q^f(\omega^f,\Delta)$.

Finally, given the properties of equations (35) and (36) proven, there exists at least one steady state for the model.

B. Appendix B

B.1. Proof of proposition 1

Now we are going to prove that the long run effect of money growth on q^f is not monotonic. Since Equation (36) is independent of γ, while equation (35) will be shifted to the right as $\gamma \to \beta$ and to the left as $\gamma \to \infty$. Since $q^f 2(0) = 0$, $q^f 2(\infty) = 0$ and $q^f 2'(\omega^f) < 0$ for sufficiently large ω^f, equation (36) is hump-shaped. Thus steady state q^f decreases with if γ is high, but increases with γ if it γ is low.

To prove the production of intermediate goods $a_b^i q^i$ is nonmonotonic, we take derivative of that:

$$\frac{\partial i}{\partial \gamma} = \frac{\partial i(q^f(\omega^f))}{\partial q^f} \frac{\partial q^f}{\partial \omega^f} \frac{\partial \omega^f}{\partial \gamma}, \tag{57}$$

where $\partial \omega^f / \partial \gamma < 0$, and $\partial q^f / \partial \omega^f$ first increases with γ then decreases with large value of γ. $\partial i / \partial q^f > 0$ will be proved in the next proposition. Since $n = q^i$ with Leontief production function, employment also increases with γ if it is low, but decreases with γ if it is high.

Take derivative of the final sales $(s^{f\zeta} a_b^f q^f)$: f

$$\frac{\partial FS}{\partial \gamma} = z^f \xi a_b^f q^f s^{f\xi - 1} \frac{\partial s^f}{\partial \gamma} + z^f a_b^f s^{f\xi} \frac{\partial q^f}{\partial \gamma}. \tag{58}$$

Since $\partial s^f / \partial \gamma > 0$, final sales are not monotonic in γ as q^f does.

B.2. Proof of proposition 2

Since the difference between steady state net inventory investment and steady state inventory level is just a constant multiplier $a_p^f \delta_i$, we only prove the long run response of inventory investment. Equation (37) implies that the steady state net inventory investment is the difference between the quantity of goods per match

and the final sales discounted at a proper rate, namely,

$$NII^* = a_p^f \delta_i i = (1-\delta_i)\delta_i a_p^f q^f [1 - z^f B^f (s^f)^\xi]. \tag{59}$$

The derivative of i with respect to q^f can be derived from this equation:

$$\begin{aligned} \frac{\partial i}{\partial q^f} &= (1-\delta_i)[1 - z^f B^f (s^f)^\xi] - (1-\delta_i) q^f \xi z^f B^f (s^f)^{\xi-1} \frac{\partial s^f}{\partial q^f} \\ &> 0. \end{aligned} \tag{60}$$

$\partial i / \partial q^f > 0$ because $\partial s^f / \partial q^f > 0$. Since i is a function of $q^f(\omega^f)$, the effects of money growth on input inventory investment can be studied by taking the derivative of $a_p^f \delta_i i(q^f(\omega^f))$ with respect to γ :

$$\begin{aligned} a_p^f \delta_i \frac{\partial i(q^f(\omega^f))}{\partial \gamma} &= \frac{\partial i}{\partial q^f} \frac{\partial q^f}{\partial \omega^f} \frac{\partial \omega^f}{\partial \gamma} \\ &> 0, \quad \text{if } \gamma \text{ if low;} \\ &< 0, \quad \text{if } \gamma \text{ if high.} \end{aligned} \tag{61}$$

We can conclude that $\partial NII^* / \partial \gamma > 0$ if γ is low and $\partial NII^* / \partial \gamma < 0$ if γ is high. This is because that $\partial q^f / \partial \omega^f < 0$ when γ is low, $\partial q^f / \partial \omega^f > 0$ when γ is high as implied by proposition 1. Moreover, $\partial i / \partial q^f > 0$ and $\partial \omega^f / \gamma < 0$.

Since both final sales and NII are nonmonotonic in , it is clear that GDP is also increases with γ if it is low, and decreases with γ if it is high.

B.3. Proof of proposition 4

By rearranging equation (39), we can get a expression for steady state inventory-to-sales ratio:

$$\begin{aligned} IS &= \frac{a_p^f i^*}{a_p^f B^f z^f (s^{f*})^\xi q^{f*}} \\ &= (1-\delta_i)[\frac{a_p^f (q^{f*})}{a_p^f B^f z^f (s^{f*})^\xi q^{f*}} - 1], \\ &= (1-\delta_i)[\frac{1}{B^f z^f (s^{f*})^\xi} - 1] \end{aligned} \tag{62}$$

The effects of money growth on the inventory-to-sales ratio can be studied by taking the derivative with respect to:

$$\begin{aligned} \frac{\partial IS^*}{\partial \gamma} &= -(1-\delta_i) \frac{B^f z^f \xi s^{f\xi-1}}{[B^f z^f (s^{f*})^\xi]^2} \frac{\partial s^f}{\partial q^f} \frac{\partial q^f}{\partial \omega^f} \frac{\partial \omega^f}{\partial \gamma}, \\ &> 0, \quad \text{if } \gamma \text{ if low;} \\ &< 0, \quad \text{if } \gamma \text{ if high.} \end{aligned} \tag{63}$$

Evaluating at $\omega = \omega^*(\gamma)$, the inventory-to-sales ratio has a hump-shaped long run response to the money growth rate across steady states, because $\partial q^f / \partial \omega^f < 0$

when γ is low; and $\partial q^f / \partial \omega^f > 0$ when γ is high as implied by proposition 1. Moreover, $\partial \omega^f / \gamma < 0$ and $\partial s^f / \partial q^f > 0$.

C. Appendix C

The household's new decision problem is altered as follows. The representative house-hold taking the sequence $\{\hat{q}_t^i, \hat{m}_t^i, \hat{q}_t^f, \hat{m}_t^f, \hat{W}_t\}_{t\geq 0}$ and initial conditions $\{M_0, i_0, n_0\}$ as given,

chooses $\{C_t, a_t, s_t^i, s_t^f, \Delta_{t+1}, M_{t+1}, i_{t+1}, v_t, n_{t+1}\}_{t\geq 0}$ to maximize its expected lifetime utility:

$$\max \sum_{t=0}^{\infty} \beta^t \mathbb{E}_{-1}[U(c_t) - g_{st}^i a_p^i \varphi(\hat{q}_t^i) - a_p \hat{n}_t \varphi^f - a_b^i \Phi^i(s_t^i) - a_b^f \Phi^f(s_t^f) - a_p^f K(v_t)] \quad (64)$$

subject to the following constraints for all $t \geq 0$:

$$\begin{aligned}
c_t &\leq (1-FI) s_t^f g_{bt}^f a_b^f \hat{q}_t^f, && (65)\\
\frac{(1-\Delta_{t+1})M_{t+1}}{a_b^f} &\geq \hat{m}_{t+1}^f, \quad \forall {F_{bt+1}}^* && (66)\\
q_t^f &= A_t a_t^{\alpha} n_t^{1-\alpha}, && (67)\\
a_t &\leq i_t + \frac{1}{a_p^f} s_t^i g_{bt}^i a_b^i \hat{q}_t^i, \quad \forall {F_{pt}}^* && (68)\\
q_t^f &\geq \hat{q}_t^f, \quad \forall {F_{pt}}^* && (69)
\end{aligned}$$

$$\begin{aligned}
\frac{\Delta_{t+1} M_{t+1}}{a_b^i} &\geq \hat{m}_{t+1}^i, \quad \forall {I_{bt}}^* && (70)\\
M_{t+1} &\leq M_t + \tau_t - s_t^i g_{bt}^i a_b^i \hat{m}_t^i + g_{st}^i a_p^i \hat{m}_t^i + a_p^f \hat{n}_t \hat{P}_t \hat{W}_t && (71)\\
&\quad - s_t^f g_{bt}^f a_b^f \hat{m}_t^f + g_{st}^f a_p^f \hat{m}_t^f - \hat{P}_t a_p^f \hat{W}_t n_t,\\
0 &\leq a_p^f [(1-\delta_n) n_t + v_t \mu_t - n_{t+1}], && (72)\\
a_p^f i_{t+1} &\leq (1-\delta_i)[a_p^f i_t + s_t^i g_{bt}^i a_b^i \hat{q}_t^i - g_{st}^f a_p^f a_t]. && (73)
\end{aligned}$$

Functions $U(\cdot), \Phi^f(\cdot)$ and $K(\cdot)$ have the same properties as in the benchmark model. $\Phi^i(s_t^i)$ is a buyer's disutility of searching in the intermediate goods market. The function Φ^i satisfies $\Phi^{i'} > 0$ and $\Phi^{i''} > 0$ for $s^i > 0$, and $\Phi^i(0) = \Phi^{i'}(0) = 0$. I_{bt}^* (with measure $s_t^i g_{bt}^i a_b^i$) is the set of matched intermediate goods buyers in period t. Moreover, as discussed in Shi (1998)[17]. We modify the model to incorporate fixed investment which is a constant fraction of aggregate sales.

Denote the multipliers of money constraint (C3) and (C7) by Λ_t^f and Λ_t^i respectively. All of the multipliers of the rest conditions are the same as in the benchmark model.

The terms of trade in the intermediate goods market are determined by Nash

[17] Also see Wang and Shi(2006)

bargaining. As in the benchmark model, we assume the intermediate goods buyers and sellers have the same bargaining powers, and the terms of trade can be pinned down by the following two equations:

$$P_t^i(\bar{\Omega}_{Mt}+\bar{\Lambda}_t^i) = \bar{\Omega}_{at}+(1-\delta_i)\bar{\Omega}_{it}, \quad (74)$$

$$\varphi'(q_t^i) = P_t^i\Omega_{Mt}. \quad (75)$$

Then, we can write the dynamic system

$$n_{t+1} = (1-\delta_n)n_t + v_t\mu(v_t), \quad (76)$$

$$a_p^f i_{t+1} = (1-\delta_i)[a_p^f i_t + s_t^i g_{bt}^i a_b^i q_t^i - g_{st}^f a_p^f a_t], \quad (77)$$

$$i_t = a_t - s_t^i g_{bt}^i a_b^i q_t^i/a_p^f, \quad (78)$$

$$\mathbb{E}[\frac{1-\Delta_{t+1}}{\Delta_{t+1}}] = \mathbb{E}[\frac{\omega_{t+1}^f q_{t+1}^f a_b^f}{\varphi'(q_{t+1}^i)q_{t+1}^i a_b^i}], \quad (79)$$

$$0 = \beta\mathbb{E}\Big[\{\omega_{t+1}^f + z^f(s_{t+1}^f)^{\xi}[(1-FI)U'(c_{t+1}-\omega_{t+1}^f)]\}\Big] \quad (80)$$

$$- \mathbb{E}\Big[\frac{(1-\Delta_{t+1})\gamma_t\omega_t^f q_t^f}{(1-\Delta_t)q_{t+1}^f}\Big],$$

$$\Omega_{it} = \beta\mathbb{E}\{(1-\delta_i)\Omega_{it+1} + g_{st+1}^f a_p^f[\varphi'(q_{t+1}^i) \quad (81)$$

$$+ \lambda_{t+1}^i - (1-\delta_i)\Omega_{it+1}]\},$$

$$k(v_t) = \beta\mathbb{E}[\sigma g_{st+1}^f A_{t+1}a_{t+1}^{\alpha}n_{t+1}^{-\alpha}\omega_{t+1}^f(1-\alpha) \quad (82)$$

$$- \sigma\varphi^f + (1-\delta_n)\Omega_{nt+1}],$$

$$\Phi^{i'}(s_t^i) = g_{bt}^i[g_{st}^f a_p^f\lambda_t^i - (1-g_{st}^f a_p^f)\varphi'(q_t^i) \quad (83)$$

$$+ (1-g_{st}^f a_p^f)(1-\delta_i)\Omega_{it}]q_t^i,$$

$$\Phi^{f'}(s_t^f) = z^f(s_t^f)^{\xi-1}[(1-FI)U'(c_t) - w_t^f]q_t^f, \quad (84)$$

$$c_t = (1-FI)a_p^f B^f z^f(s_t^f)^{\xi}q_t^f, \quad (85)$$

$$A_t\alpha(\frac{n_t}{a_t})^{1-\alpha}\omega_t^f = a_p^f[\varphi'(q_t^i)+\lambda_t^i] + (1-a_p^f)(1-\delta_i)\Omega_{it}. \quad (86)$$

D. Appendix D

Now, we are going to describe the calibration procedures. Derive the steady state equations from the dynamic system:

$$
\begin{aligned}
v^*\mu(v^*) &= \delta_n n^*, && (87)\\
\delta_i a_p^f i^* &= (1-\delta_i)[z^i a_b^i (s^{i*})^{\xi} q^{i*} - z^f B^f (s^{f*})^{\xi} a_p^f a^*], && (88)\\
a^* &= i^* + z^i a_b^i (s^{i*})^{\xi} q^{i*}/a_p^f, && (89)\\
z^f (s^{f*})^{\xi} &= \frac{\gamma-\beta}{\beta}\frac{\omega^{f\star}}{(1-FI)U'(c^*) - w^{f\star}}, && (90)\\
\Omega_i^* &= \frac{\beta z^f B^f (s^{f*})^{\xi} a_p^f [\lambda^{i*} + \varphi'(q^{i*})]}{1-\beta(1-\delta_i)(1-z^f B^f (s^{f*})^{\xi} a_p^f)} && (91)\\
k(v^*) &= \beta[(1-\alpha)\sigma z^f B^f (s^{f*})^{\xi} A^* (a^*)^{\alpha} (n^*)^{-\alpha} \omega^{f*} - \sigma\varphi^f] && (92)\\
&+ \beta(1-\delta_n)k(v^*),\\
\Phi^{i'}(s^{i*}) &= g_b^{i*}\{[g_s^{f*} a_p^f \lambda^{i*} - (1-g_s^{f*} a_p^f)[\varphi'(q^{i*}) && (93)\\
&- (1-\delta_i)\Omega_i^*]\}q^{i*},\\
\Phi^{f'}(s^{f*}) &= z^f (s^{f*})^{\xi-1}[(1-FI)U'(c^*) - \omega^{f*}]q^{f*}, && (94)\\
A^*\alpha(\frac{n^*}{a^*})^{1-\alpha}\omega^{f*} &= a_p^f[\varphi'(q^{i*}) + \lambda^{i*}] + (1-a_p^f)(1-\delta_i)\Omega_i^*, && (95)\\
c^* &= (1-FI)a_p^f B^f z^f (s^{f*})^{\xi} q^{f*}. && (96)
\end{aligned}
$$

The average labor participation rate (LP = 0:6445), the average unemployment rate (UR = 0:061) and the assumption $a_p^i = a_p^f$ can be used to pin down parameters (u, a_p^i, a_p^f) :

$$u = LP \cdot UR = 0.0393. \quad (97)$$

Since the households have measure one, the labor participation rate equals $u + a_p^f(1+n) + a_p^i$. Using the assumption $a_p^i = a_p^f$, the number of sellers in the intermediate goods market a_p^i is equate to its counterparts in the finished goods market a_p^f, and the steady state vacancies can be calculated as the following:

$$
\begin{aligned}
a_p^f &= (LP-u)/(2+n) = 0.2017, && (98)\\
a_p^i &= LP - u - a_p^f(1+n) = 0.2017, && (99)\\
v^* &= \Big[\frac{\delta_n \cdot n}{\bar{\mu}(a_p^f/u)^{\phi-1}}\Big]^{1/\phi}. && (100)
\end{aligned}
$$

The depreciation rate of input inventory can be pinned down by matching the average inventory to output ratio and the average inventory investment to output ratio, which are $a_p^i i^* / GDP$ and $a_p^i \delta_i i^* / GDP$ respectively in the model.

$$\delta_i = \frac{NII/GDP}{INV/GDP} = 0.0038, \quad (101)$$

where GDP=NII+FS.

By matching the average velocity of M2 money stock (v_c^{f*} = 1:836), we can get

$z^f(s^{f*})^{\zeta}$ = 2:4947 which can be used later:

$$\begin{aligned} v_c^{f*} &= p^f c^{f*}/m^f \\ &= c^{f*}/(a_b^f q^{f*}) \\ &= (1-FI)z^f(s^{f*})^{\xi} \end{aligned} \tag{102}$$

Similarly, $v_c^{i*} = z^f(s^{i*})^{\zeta}$. We need two more targets to pin down B^f: the average input inventory to final sales ratio (ISR) and the intermediate inputs to final sales ratio (IPS). In this model:

$$ISR = a_p^i i^*/c^{f*}, \tag{103}$$

$$IPS = \frac{z^f B^f (s^{f*})^{\xi} a_p^f a^*}{B^f v_c^f a_p^f q^f} \frac{P_i}{P^f}, \tag{104}$$

$$\Rightarrow \frac{z^f B^f (s^{f*})^{\xi} a_p^f a^*}{B^f v_c^f a_p^f q^{f*}} = IPS(1+markup). \tag{105}$$

By plugging equation (D3) into equation (D2), We can get $i^*/a^* = (1-\delta_i)[1-z^f B^f (s^{f*})^{\zeta}]$. We also can rewrite i^*/a^* in terms of ISR and IPS:

$$\begin{aligned} \frac{i^*}{a^*} &= \frac{a_p^i i^*}{c^f} \frac{B^f v_c^{f*} a_p^f q^{f*}}{z^f B^f (s^{f*})^{\xi} a_p^f a^*} z^f B^f (s^{f*})^{\xi}, \\ &= \frac{ISR \cdot B^f v_c^f}{(1-FI)IPS(1+markup)} \quad . \end{aligned} \tag{106}$$

After equalizing the two equations of i^*/a^*, B^f can be calculated in terms of ISP, IPS, v_c^{i*} and the markup:

$$\begin{aligned} B^f &= \frac{(1-\delta_i)}{\{(1-\delta_i) + ISR/[IPS(1+markup)]\} v_c^{f*}/(1-FI)} \quad , \\ &= 0.1947. \end{aligned} \tag{107}$$

Next, equations (D4)-(D6) are plugged into equation (D9) to get rid of ω^f; λ^i and $\Omega_{i\,i}$; we can then pin down the parameter . Rearranging equations (D1)-(D10), we can get:

$$\omega^{f*} = \frac{\beta v_c^{f*}}{\gamma^* - \beta + \beta v_c^{f*}/(1-FI)} U'(c^*), \tag{108}$$

$$\begin{aligned} &\equiv E{\cdot}U'(c^*), \\ \lambda^i &= \frac{\gamma^* - \beta}{\beta z^i (s^{i*})^{\xi}} \frac{\omega^{f*}}{1+markup}, \\ &= \frac{\gamma^* - \beta}{\beta v_c^{i*}(1+markup)} E{\cdot}U'(c^*), \\ &\equiv F{\cdot}U'(c^*), \end{aligned}$$

Where,

$$\frac{\omega^{f*}}{\omega^{i*}} = \frac{P^{f*}\Omega_M^*}{P^{i*}\Omega_M^*} \quad \Rightarrow \omega^{i*} = \frac{\omega^{f*}}{1+markup} \quad , \tag{109}$$

and,

$$\begin{aligned} \Omega_i^* &= \frac{\beta B^f v_c^{f*} a_p^f/(1-FI)}{1-\beta(1-B^f v_c^{f*} a_p^f/(1-FI))(1-\delta_i)} [\frac{\omega^{f*}}{1+markup} + \lambda^{i*}], \\ &= \frac{\beta B^f v_c^{f*} a_p^f/(1-FI)}{1-\beta(1-B^f v_c^{f*} a_p^f/(1-FI))(1-\delta_i)} [\frac{E}{1+markup} + F] U'(c^*), \\ &\equiv G{\cdot}U'(c^*). \end{aligned} \tag{110}$$

Then α can be calculated by plugging the above equations into equation (D9):

$$\begin{aligned} \alpha &= \frac{a_p^f[E/(1+markup)+F] + (1-a_p^f)(1-\delta^i)G}{E} \frac{a^*}{q^*} \quad , \\ &\equiv H\frac{a^*}{q^{f*}} \quad , \\ &= 0.4156, \end{aligned} \tag{111}$$

where $a^*/q^{f*} = 0.6822$ can be calculated by rearranging $i^*/a^* = (1-\delta_i)[1-z^f B^f (s^{f*})^{\zeta}]$:

$$\begin{aligned} a_p^f i^* &= (1-\delta_i)[1-z^f B^f (s^{f*})^{\xi}] a_p^f a^*, \\ \Rightarrow \frac{a_p^f i^*}{B^f v_c^{f*} a_p^f (q^{f*})} &= (1-\delta_i)[1-z^f B^f (s^{f*})^{\xi}] \frac{a_p^f a^*}{B^f v_c^{f*} a_p^f q^{f*}}, \\ \Rightarrow ISR &= (1-\delta_i)\frac{1}{B^f v_c^{f*}} \frac{a^*}{q^{f*}} - (1-\delta_i) z^f B^f (s^{f*})^{\xi} \frac{a_p^f a^*}{B^f v_c^{f*} a_p^f q^{f*}}, \\ \Rightarrow a^*/q^{f*} &= [ISR + (1-\delta_i) IPS(1+markup)] B^f v_c^{f*}/(1-\delta_i). \end{aligned} \tag{112}$$

Since α is known, we can calculate $a^* = 0{:}5198$ by rearranging the production function $q^{f*} = A^* a^{*\alpha} n^{*(1-\alpha)}$:

$$\begin{aligned} \frac{q^{f*}}{a^*} &= A^* a^{*(\alpha-1)} n^{*(1-\alpha)}, \\ \Rightarrow a^* &= [\frac{q^{f*}}{a^*} A^* n^{*(1-\alpha)}]^{1/(\alpha-1)}. \end{aligned} \tag{113}$$

Then q^{f*}; c^{f*}; i^* and a_b^f can be calculated:

$$\begin{aligned} q^{f*} &= A^*(a^*)^\alpha(n^\alpha)^{1-\alpha} = 0.7619, \\ c^{f*} &= (1-FI)a_p^f B^f v_c^{f*} q^{f*} = 0.0546, \\ i^* &= i^*/a^* \cdot a^* = 0.2662, \\ a_b^f &= B^f a_p^f = 0.0393. \end{aligned}$$

Now, we can calculate ω^f; λ^i and Ω_i using the value of c^{f*}:

$$\begin{aligned} \omega^{f*} &\equiv E \cdot U'(c^*) = 7.4215, \\ \lambda^i &\equiv F \cdot U'(c^*) = 0.4760, \\ \Omega_i^* &\equiv G \cdot U'(c^*) = 4.4572. \end{aligned}$$

Using the seventh target, which is that the shopping time of the population is 11:17% of the working time and the working time is 30% of agents discretionary time, we can calculate the buyer's search intensity in the finished goods market s^{f*}. Once s^{f*} is known, z^f and z_1^f can be determined as follows:

$$\begin{aligned} s^{f*} &= 0.1117 * 0.3(a_p^f(1+n) + a_p^i)/a_b^f = 0.5162, \\ z^f &= z^f(s^f)^\xi/((1-FI)(s^{f*})^\xi), \\ z_1^f &= z^f * (B^f)^{1-\xi} = 3.0524. \end{aligned}$$

Since we assume the intermediate goods market and the finished goods market are sym-metric, a_b^i; s^{i*}, and z_i^i can be determined in a similar way:

$$\begin{aligned} a_b^i &= B^i a_p^i = 0.0393, \\ s^{i*} &= 0.1117 * 0.3(a_p^f(1+n) + a_p^i)/a_b^i = 1.7207, \\ z^i &= z^i(s^i)^\xi/(s^i)^\xi = v_c^i/(s^i)^\xi, \\ z_1^i &= z^i(B^i)^{1-\xi} = 0.0934. \end{aligned}$$

Now the quantity of intermediate goods per trade (q^i), the constant in the disutility function of producing intermediate goods (b) and the constant in the disutility of posting vacancies (K_0) can be calculated by using equation (D3), the function of $\varphi^i(q^i)$ and the last target ($K = 3.72 * 10^{-4}$):

$$\begin{aligned} q^{i*} &= \frac{a^* - i^*}{v_c^{i*} a_b^i} = 6.5096, \\ b &= \varphi^{i\prime}(q^{i*})/q^{i*}, \\ &= \omega^{i*}/q^{i*} = 0.6706, \\ K_0 &= K/v^{*2} = 5.9501e-004. \end{aligned}$$

Finally, the parameters $(\varphi^i, \varphi_0^i, \varphi^f, \varphi_0^f)$ can be determined by using the steady state relations:

$$\varphi^i = \frac{b}{2}(q^i)^2 = 14.2091,$$

$$\begin{aligned}
\varphi^f &= [\beta(1-\alpha)\sigma B^f v_c^{f*}\omega^{f*}q^{f*}/((1-FI)n^*) - [1-\beta(1-\delta_n)]\Omega_n]/(\beta\sigma), \\
&= 1.6025, \\
\varphi_0^i &= \left\{\frac{z^i(s^{i*})^{\xi-1}[B^f a_p^f v_c^{f*}\lambda_i^*/(1-FI) + (1-B^f a_p^f v_c^{f*}/(1-FI))[(1-\delta_i^*)\Omega_i^* - bq^{i*}]]q^{i*}}{\varphi^i(1+1/\epsilon_i)(s^{i*})^{1/\epsilon_i}}\right\}^{\frac{\epsilon_i}{1+\epsilon_i}} \\
&= 0.1104, \\
\varphi_0^f &= \left(\frac{z^f(s^{f*})^{\xi-1}((1-FI)(c^{f*})^{-\eta} - \omega^{f*})q^{f*}}{(\varphi^f(1+1/\epsilon_f)(s^{f*})^{1/\epsilon_f})}\right)^{\epsilon_f/(1+\epsilon_f)} \\
&= 1.8043.
\end{aligned}$$

E. Appendix E: Data Sources

1. Underlying Detail - NIPA Tables, The Bureau of Economic Analysis

- Table 1AU. Real Manufacturing and Trade Inventories, Seasonally Adjusted, End of Period [Chained 1996 dollars, 1967-96, SIC] (Q)
- Table 1AU2. Real Manufacturing and Trade Inventories, Seasonally Adjusted, End of Period [Chained 2005 dollars, 1967-97, SIC] (Q)
- Table 1BU. Real Manufacturing and Trade Inventories, Seasonally Adjusted, End of Period [Chained 2005 dollars, 1997 forward, NAICS] (Q)
- Table 2AU. Real Manufacturing and Trade Sales, Seasonally Adjusted at Monthly Rate [Chained 1996 dollars, 1967-96, SIC] (Q)
- Table 2AUI. Implicit Price Deflators for Manufacturing and Trade Sales [Index base 1996, 1967-96, SIC] (Q)
- Table 2BU. Real Manufacturing and Trade Sales, Seasonally Adjusted at Monthly Rate [Chained 2005 dollars, 1997 forward, NAICS] (Q)
- Table 2BUI. Implicit Price Deflators for Manufacturing and Trade Sales [Index base 2005, 1997 forward, NAICS] (Q)
- Table 4AU1. Real Manufacturing Inventories, by Stage of Fabrication (Materials and supplies), Seasonally Adjusted, End of Period [Chained 2005 dollars, 1967-97, SIC] (Q)
- Table 4AU2. Real Manufacturing Inventories, by Stage of Fabrication, Seasonally Adjusted (Work-in-process), End of Period [Chained 2005 dollars, 1967-97, SIC] (Q)
- Table 4BU1. Real Manufacturing Inventories, by Stage of Fabrication (Materials and supplies), Seasonally Adjusted, End of Period [Chained 2005 dollars, 1997 forward, NAICS] (Q)
- Table 4BU2. Real Manufacturing Inventories, by Stage of Fabrication (Work-in-process), Seasonally Adjusted, End of Period [Chained 2005 dollars, 1997 forward, NAICS] (Q)

2. Databases, the Federal Reserve Bank of St. Louis

- M2 Money Stock, seasonally adjusted, end of period, quarterly
- Velocity of M2 Money Stock, seasonally adjusted, end of period, quarterly

3. Databases, Bureau of Labor Statistics

- Civilian Labor Force (Seasonally Adjusted) - LNS11000000
- Civilian Employment (Seasonally Adjusted) - LNS12000000
- Civilian Unemployment (Seasonally Adjusted) - LNS13000000
- Manufacturing Employment - CES3000000001

4. Manufacturing Industry Productivity Database, The National Bureau of Economic Research

- emp: Total employment in 1000s, 1987 SIC version
- matcost: Total cost of materials in $1,000,000, 1987 SIC version
- pimat: Deflator for MATCOST 1987=1.000, 1987 SIC version

IMI International Monetary Review

Regulatory Arbitrage and Window-Dressing in the Shadow Banking Activities: Evidence from China's Wealth Management Products*

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We examine wealth management products (WMP) issued by Chinese commercial banks, which are an important part of China's fast growing shadow banking sector. We document that the WMPs' maturity dates cluster toward the end of a month and then decrease significantly at the beginning of the following month.Our empirical work detectsa negative relationship between a bank's loan-to-deposit ratio (LDR) at the end of a quarter and the number of its issued WMPs expiringwithin several days of the quarter-end. Our findings suggest that banks are using WMPs as vehicles for their regulatory arbitrage or window-dressing behaviors.

1. Introduction

The outburst of the sweepingGlobal Financial Crisis (GFC) in 2008-2009 put the shadow banking systems in advanced economies under the spotlight. Many scholars and policymakers concluded that the unregulated activities of shadow banks had greatly increased the vulnerabilities of the global financial system and led to the contagion of financial crisis across borders. (Bernanke, 2012; Gorton and Metrick, 2012)

In the aftermath of the GFC, the regulators around the world set out to overhaul their regulatory frameworks and, as one of important objectives, have been attempting to include the shadow banking system under the new regulatory umbrella. In the meantime, both academia and policymakers started to enhance their research on the shadow banking activities.

The relevant literature has prospered after the GFC, especially about the shadow banks in advanced economies such as US. Claessens et al. (2012) has made a concise survey of the existing academic studies about the US shadow banks.Claessens et al. (2012) point out that regulatory arbitrage is one of key

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motives for banks to engage in shadow banking activities (particularly securitization). Acharya et al. (2013, a) provide empirical evidence of how US banks utilized commercial paper conduits to reduce regulatory capital charge.

Financial Stability Board (FSB, 2012) finds that the shadow banking systems are prevalent globally, even in many emerging economies. International Monetary Fund (IMF, 2014)avers that the growth of shadow banking system in emerging markets even outpaced their traditional banking system. In particular, China has a large-sized and fast-growing shadow banking sector. As estimated by FSB (2014), the aggregate size of China's shadow banking sector has approached to around USD 3 trillion as of end-2013, increasing by more than 37% from the previous year.

It is noted that the shadow banks in emerging markets could have different characteristics from their peers in advanced economies.Acharya et al. (2013, b) find that an important part of India's shadow banking system, non-bank financial corporations (NBFCs), perform as a substitute for banks' direct lending in the country's rural areas, which is in contrast to the role of shadow banks in advanced economies. Dang et al. (2014) make a comprehensive comparison between the shadow banking system in China and that in US, concluding that China's shadow banking is much more reliant on banks to perform many basic functions of credit intermediation while the US shadow banking system is more market-oriented and being operated in parallel to banks.

In this study, we analyze one important part of China's shadow banking system—wealth management products (WMPs) issued by banks. The bank issued WMPs in China are financial contracts which are sold to investors through banks' channels. The WMPs can offer higher interest rates than traditional deposits since the latter are capped by the authorities.[18]Generally, the WMPs have fixed maturities and can't be circulated before their expirations. To a certain extent, a WMP is like a fixed-term deposits contract offered by banks which strictly cannot be withdrawn before its maturity. However, WMPs are notbeingtreated as deposits by the regulator in calculating some important regulatory indicators such as the LDR and Required Reserve Ratio (RRR) for deposits.

Our investigation shows that the WMPs' maturity dates cluster toward the end of a month and then decrease significantly at the beginning of the following month. Such a pattern could be caused by banks' regulatory arbitrage and window-dressing, in particular for a lowerLDR at the end of a month (or quarter). With more WMPs maturing within several days of a month end, banks can manage to keep the proceeds of these WMPs in forms of deposits for a short period. As such, banks can boost their deposits at the end of the monthso as to meet the regulator's LDR requirement and window-dress their balance sheets.

We further examine the direct impact of WMPs' expiration on a bank's LDR.

[18]After several rounds of liberalization, China's deposit rates are currently capped at 30% above the benchmark deposit rates. Indeed, the cap on the interest rates constitutes one important form of financial repression in China (Wei and Tapsoba, 2014)

Toward this end, we build a novel dataset of Chinese small-and-medium sized banks by matching their financial information with the numbers of WMPs issued by them in the period of 2007-2013. Then we regress the numbers of WMPs which expired just ahead of the end of a quarter, on their bank issuers' LDRs at the quarter-end. Ourregression models detect a negative relationship between a bank's LDR and the number of its WMPs expiring ahead of the quarter-end. In summary, our results suggest that banks are using WMPs as vehicles for their regulatory arbitrage or window-dressing behaviors.

The remainder of this paper is organized as follows. Section 1 provides some background information about the WMPs issued by banks and the LDR regulation in China. Section 2 discusses the mechanism how banks' WMPs could affect their LDRs. Section 3 describes the data and presents our empirical results. Section 4 concludes.

2. Background information

2.1 TheWMPs issued by banks

In China WMPs can be issued by both banks and other non-banking financial institutions, such as trust companies, securities firms and insurance companies. In this paper, we only focus on the ones issued by banks.

Bank issued WMPs are distributed by banksto individual and institutional investors. A WMP could have a minimum subscription share. In August 2011, the China Banking Regulatory Commission (CBRC), China's banking regulator, circulated a directive[19](namely, "a directive of regulating bank's marketing and sales of wealth management products", the Directive afterward) which unified the minimum subscription share of a WMP for an individual investor at RMB 50,000 (equivalent to around USD 8,000), effective from January 2012. However, before the implementation of this directive, banks have the discretion to set the minimum subscription share for their issued WMPs. In some cases, the minimum subscription share could be as lower as RMB 1,000(equivalent to around USD 150).

Theoretically, a WMP is set up to purchase and hold financial assets which are expected to bring investment returns for its investors. The financial assets acquired by WMPs are diverse, ranging from loans, money market funds, commercial papers, bonds, stocks, and even private equity.[20]

In generally, a WMP has a fixed-term maturity. When a WMP expires, its originating bank needs to pay off both principals and interest rates. Before a WMP's maturity day, its holders have no right to ask banks to repay them in full or part of principals or interest rates. Moreover, there is no secondary market for the WMPs. In this sense, a WMP is like a closed-end fund without a secondary market.

[19] It Chinese version is available at http://www.cbrc.gov.cn/chinese/home/docDOC_ReadView/20111009E63FE2BF1B07CFCAFFB978A4C2F0DC00.html

[20] The dataset of WIND provides very broad classifications for WMPs in terms of their holding assets. Indeed, a WMP can hold different classes of financial assets. The information disclosure of the underlying assets is always inadequate. Evenmany buyers are not clear about the underlying assets of the WMPs they purchased.

The maturities of bank issued WMPs could range from 1 day to 5 years. Banks can establish their cash pools through issuing and rolling over WMPs while use the proceeds to extend normal loans or hold long-term financial assets, which could create serious risks of maturity mismatch. In concern of the increasingly maturity mismatch risks, the authorities reportedly halt the issuance of the WMPs with a maturity of less than 1 month in November 2011.[21]

One important reason of the WMPs being able to attractinvestors is that their interest rates are not subject to the authorities' interest rate cap. As such, the WMPs can offer an alternative way for households to park their savings other than bank deposits. In marketing aWMP to investors, banks generally provide its expected return for reference. As stipulated by the CBRC, the expected return is not a guaranteed one unless the bank manifest that it provides credit guarantees for the WMP's principal or even interest rates. But in that case, the WMPis required to be included in a bank's own balance sheet. On the other hand, a WMP without its originating bank's credit guarantee can be treated as the bank's off-balance-sheet business and doesn't need to be booked in its balance sheet.

Interestingly, the default cases of WMPs were very rare before 2014 no matter whether credit guarantees were provided by their originating banks (Zhu and Conrad, 2014). Dang et al. (2014) point out that the no-default phenomenon could strengthen individual investors' misperception that all the WMPsenjoy their originating banks' unconditionally backstop. It is possible that banks try to provide certain support to their issued WMPs in order to maintain their reputations in the WMP businesses.

Acharya et al. (2014) find that large banks tend to issue more WMPs, which in turn pose higher financial stability risks to them. They also find that the number of issued WMPs has a negative relationship with large banks' leverage (which is defined as the ratio of a bank's asset size to equity).Their draw the conclusion that large banks have larger capital buffers to withstand the related risks.

2.2 The importance of the loan-to-depositratio

The importance of the LDR, which is defined as a bank's unweighted loans to deposits, can hardly be overestimated. It constitutes a key building block of Chinese banking regulation framework and banks' own risk management systems, in particular for liquidity risk.

Both China's 1995 Commercial Banking Law and the 2003 Commercial Banking Law stipulate that "the ratio of the average balance of loans and the average balance of deposits shall not exceed 75 percent". Traditionally, the commercial bank's compliance with the regulatory LDR was evaluated on a quarterly basis, and the basis for computation was typically the balance of loans versus the balance of deposits at the end of each month. This traditional calculation of LDR based on the quarter-end balances of loans and deposits has created strong incentives for

[21] It was reported by China Daily, an official English newspaper in China. The report is available at http://www.chinadaily.com.cn/china/2011-11/18/content_14115785.htm

commercial banks to maneuver it to their favor, either by boosting deposits or contracting loans at the end of a month. The LDR is one of 13 core indictors of China's CARPALs rating system[22], a lower score of which could threaten to drag down the bank's overall regulatory rating and trigger the regulator's intervention.

Whereas the 75% cap of the LDR was written into the Commercial Banking Law since 1995, it was not until 2004 that the sector-wide LDR fell below this statutory requirement for the first time. The sector-wide LDR had been trending down for several years and hit its bottom of 66.9% in 2008. Since then, banks' LDR have rebounded due to China's credit binge aiming to coordinate a massive stimulus package to counter the global financial crisis (GFC). Starting from mid-2011, banks have been reportedly required by the CBRC to report their LDRs on a daily basis (Ma et al., 2011).

In the meantime, the LDR is alsoan important part of banks' internal risk management and performance assessment systems.Liu (2014) reports that almost all the banks use the LDR as an indicator in assessing their branches' performance. Moreover, the LDR is one of financial indicators which banks need to disclose to the investors of their equities or bonds. Generally, these financial indicators provided by banks are the quarter-end ones. The external investors rely on these indicators to assess the creditworthiness of the banks and then make their investment decisions.As such, the LDR, along with other financial indicators, becomes a signal which banks send to the public, which gives banks more incentive to do the window-dressing, in particular at the end of the quarter.

The banks' window-dressing motivation is so strong that the balances of banks' deposits still vary a lot within a month even after their LDR reporting was changed to be on a daily basis. In view of it, the CBRC had to unveil new rules in September 2014,requiring banks to keep the inter-day deviation of deposits below a certain level. [23]

2.3 Testable hypothesis

There is a widespread suspicion that Chinese banks use WMPs to manage down their LDRs at the end of a month or quarter, so as to comply with the regulatory requirement as well as to window dress their balance sheets. For example, the IMF (2012) conjecture that the maturity of the WMPs might be structured carefully to coincide with the timing at which they need to comply with the loan-to-deposit ratio (LDRs) although they don't provide relevant empirical evidence.

The way to manage WMPs for the LDR circumvention is straightforward. When a WMP expire, banks can wind down the financial assets[24] and keep the proceeds for

[22]CAPRALs is the Chinese equivalent to the CAMELS rating system in the US and the ARROW regulatory framework in the UK.

[23] Refer to the relevant report by Financial Times, available at http://www.ft.com/cms/s/0/bef1c4ce-4919-11e4-9d04-00144feab7de.html#axzz3QgUDNZK2.

[24]Given the serious maturity mismatch between the WMPs and their holding assets, banks can arrange some short-term transactions (for example, a repurchase agreement) and then issue new WMPs to ensure that they can continue hold the assets. In any case, banks will get the proceeds from the expired WMPs.

a short period before the investors ask for redemption. During the short holding period, the proceeds will be converted to time deposits on the issuing bank's balance sheet. As such, the bank can temporarily and effectively boost its balance of deposits to meet the regulatory LDR requirement as well as send a signal to the public that its liquidity situation is in good shape.

In doing so, banks don't necessarily make the maturity date of a WMP fall exactly on the end of a month as long as they can persuade their investors not to withdraw their money(which comes from the redemption ofthe WMPs) over the weekend. One common practice is that banks issue new WMPs at the beginning of the following month for investors' subscription. As such, many investors will tend to leave their money in banks for a short period in the form of time deposits. But the intermission should be brief enough to hook up the investors.

It is noted that such a manoeuvre works for both the guaranteed and the non-guaranteed WMPs.For a non-guaranteed WMP, it expiration will simultaneously augment the bank assets because it was off-balance-sheet. In regarding for a WMP with the banks' credit guarantee, its expiration can only lead to the changes of different accounting items on the bank's balance sheet. In particular, time deposits of the bank will increase at the expense of an equivalent-amount decline in other liabilities, which theoretically should not affect the aggregate size of the bank's balance sheet.

Based on the above descriptions, we can set up a couple of testable hypothesesfor our study.

Hypothesis I:if for any reason the banks deliberately manoeuvre the WMPs to boost their deposit balances at the end of a month or quarter, they shouldmake the WMPs mature at or close to the end of the month or quarter. It means that we should observe a clustering of the WMPs' maturities atthe month- and quarter-end.

Hypothesis II:banks' regulatory arbitrage and window-dressing behaviors should have significant impact on their LDRs. It suggest that there should exist a negatively relationship between a bank's LDR and its originated WMPs expiring atthe end of the same month or quarter. We are going to test these two hypotheses in the rest of the paper.

3. Empirical analysis

3.1 Data description and summary statistics

Our information of the bank issued WMPs is from the WIND dataset, from January 2007 to December 2013. For every WMP record, the WMP dataset in the WIND report its originating bank, its value date and maturity date.The dataset also reports whether WMP is guaranteed by the issue bank or not. One important shortcoming of the WMP dataset in the WIND is the lack of information about the amount of the WMPs. As a consequence, we can only use the number of WMPs issued by a bank as the proxy for the bank's exposure to the WMPs business.It looks like a reasonable proxy to reflect the activeness of a bank in this business.

The financial information of banks is from two sources. The WIND has a separate dataset which reports banks' disclosed financial information based on listed banks' regular financial reports and unlisted banks' prospectus for bond issuance in the interbank bond market. One advantage of the WIND bank-specific data is that they are reported on a quarterly basis, which enables us to maximally expand our sample. For banks whose financial information does notappear in the dataset of the WIND, we use the BANKSCOPE as supplement. The bank financial information in the BANKSCOPE is annually-based. Just like WMPs data, the selected period for bank information is from January 2007 to December 2013.

Figure 1 plots all the WMPs issued by banks from January 2007 to December 2013. During this reporting period, the number of bank issued WMPs had grown from 2,893 in 2007 to 54,761 in 2013, implying an average annual growth rate of 63.3%.

Figure 1: The number of WMPs issued by banks

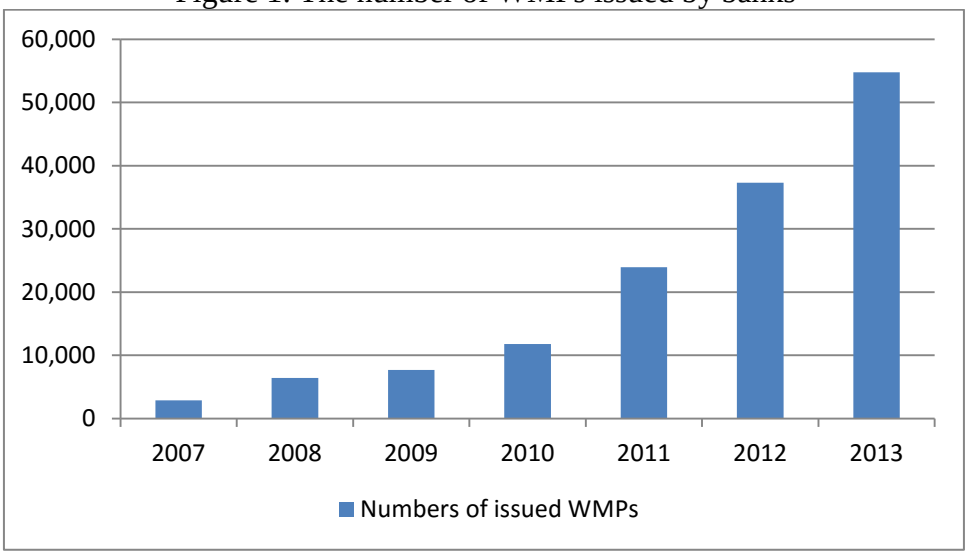


Figure 2 shows the maturities of the bank WMPs during the reported period. Except for 2007 and 2008, the WMPs with a maturity of longer than one year only accounts for a small fraction of all the WMPs. In most of years, the majority of WMPs have maturities below six months. Another significant change in the pattern is that the percentage of WMPs with a maturity of less than one month sharply shrunk to 3-4% after it peaked at around 29.3% in 2011. As we explained in the previous section, the authorities reportedly halt the issuance of the WMPs with a maturity of less than one month in November 2011.

Figure 2: The maturities of the WMPs

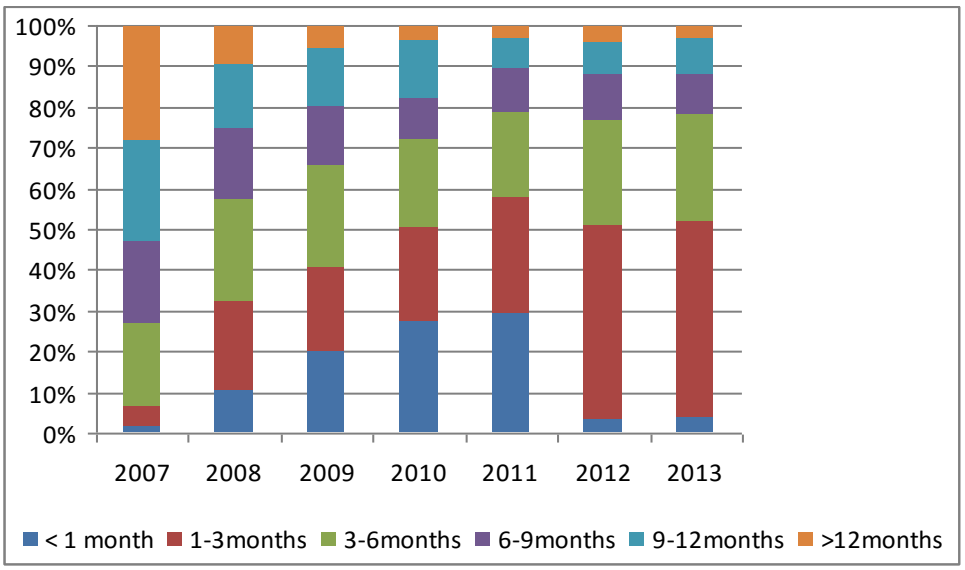
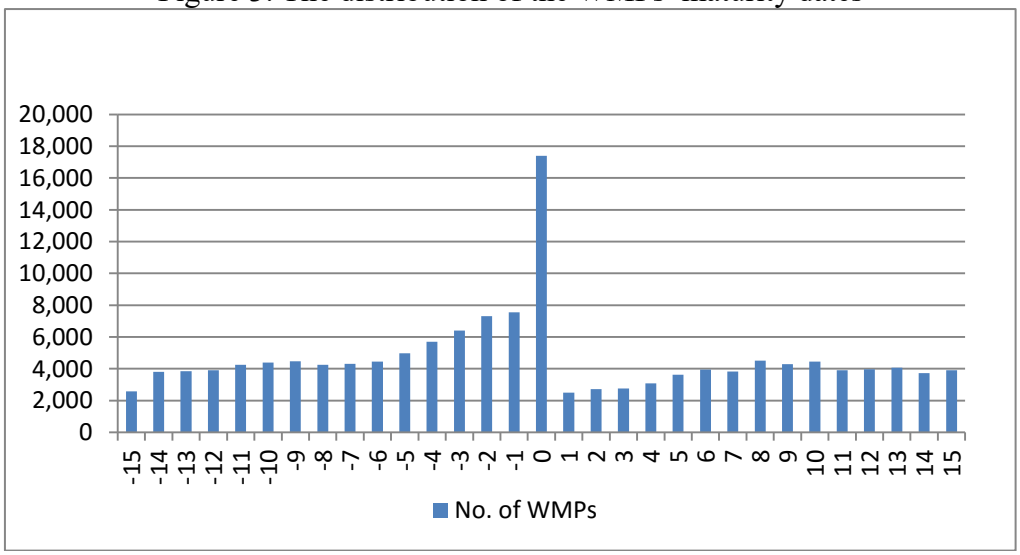


Figure 3 provides more information about banks' credit guarantees attached to their issued WMPs. The percentage of guaranteed WMPs steadily declined from 64.9% in 2007 to 28.2% in 2012 and then sharply plunged to 6.5% in 2013. The collapse of guaranteed WMPs is due to a series of the authorities' clampdown on the irregularity in the WMPs business in 2012 and early 2013. In particular, the Directive effective from January 2012 and a new set of rules announced in March 2013 (namely, "a notice of regulating WMPs business"[25]) have greatly restricted banks' guarantees for their issued WMPs.

[25]Its Chinese version is available at http://www.cbrc.gov.cn/govView_2B22741AFBC446CF890636DACAB71166.html.

Figure 3: The distribution of the WMPs' maturity dates



3.2 The pattern of WMPs' maturity dates

This section analyzes the pattern of the WMPs' maturity dates. We present graphical evidence that the maturity dates of the WMPs cluster on a few days at the end of a month. We further show whether such a pattern holds in different sub-samples. Such a pattern is consistent with our hypothesis I which is set up in the previous section.

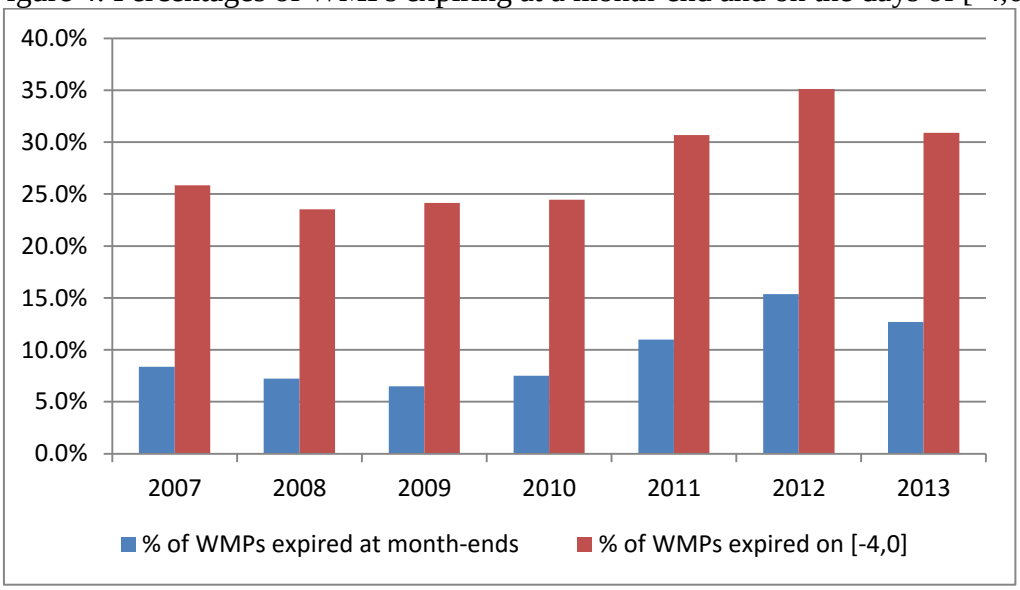
We group the WMPs based on the distance between their maturity dates and the month-ends. The below rules are followed in grouping:

- A WMP is to be classified into the group 0 if its maturity date exactly falls on the end of a month.
- If a WMP's maturity date is in two days after the end of a month, the WMP is to be classified into group 2.
- If a WMP's maturity date is on two days prior to the end of a month, it is to be classified into group -2.
- We ensure that every WMP only be classified into one group. For example, a WMP maturing on January 15th will be classified to the group 15 while a WMP maturing on January 16th will be in the group -15.

As such, there are in total 31 groups being formed, ranging from group -15 to 15 (afterwards we use groups of [i, j] to stand for all the groups from i to j where i and j are integrals between -15 and 15). Figure 4 plots the number of the WMPs in different groups. As shown, the number of the WMPs maturing on a month-end (the group 0) is pronouncedly higher than the ones maturing on other days. In terms of percentage, the WMPs in group 0 account for 12.0% of all the WMPs reported in our sample. Even within several days towarda month-end, the number of the maturing WMPs tends to be higher. For example, the WMPs in the groups of [-4,0] jointly account for 30.6% of the total WMPs. On the other hand, the percentage of

the WMPs in the groupsof [1,5] is significantly lower. In our sample, only 10.1% of the WMPs maturing on the first five days of every month (the groups of [1,5]).

Figure 4: Percentages of WMPs expiring at a month-end and on the days of [-4,0]

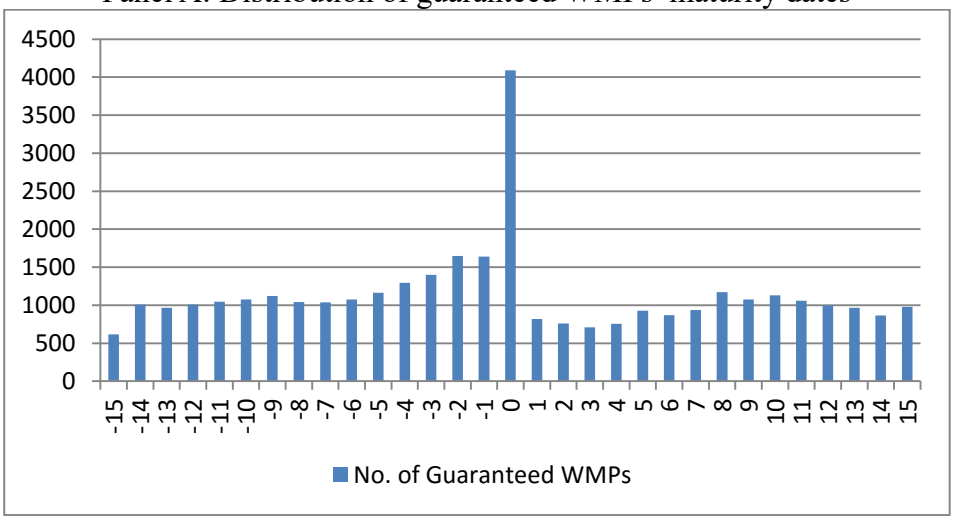


Such a pattern of WMPs' maturity dates could be due to banks' regulatory arbitrage and window-dressing of their LDRsatthe end of a month. By transferring the proceeds of unwinding the WMPs' assets into time deposit accounts, banks can effectively boost their LDRs over the month-end. Therefore, banks prefer to arrange the maturity dates of the WMPs at or very close to the end of a month so that they can manage to do regulatory arbitrage and window-dressing before the WMP investors ask for redemption.In the meantime, banks don't want to retain the proceeds of the WMPs for too long because it means they need to pay extra interest rates to the WMP investors.

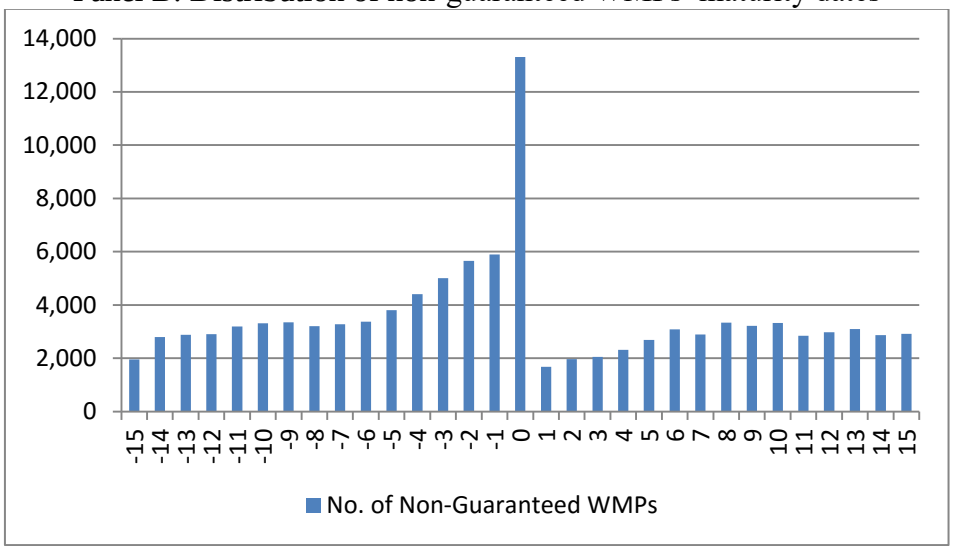
We further investigate the WMP maturity dates in different sub samples. First, we find that such a pattern holds in both guaranteed and non-guaranteed WMPs (Figure 5). It is a reasonable because, as we described, both guaranteed and non-guaranteed WMPs permit banks to do the regulatory arbitrage and window-dressing of temporarily boosting deposits.

Figure 5: Distribution of the maturity dates for guaranteed and non-guaranteed WMPs

Panel A: Distribution of guaranteed WMPs' maturity dates



Panel B: Distribution of non-guaranteed WMPs' maturity dates



Second, we investigate the WMP maturity dates at the end of a quarter and at a month-end which is not a quarter-end, which are plotted in panel A and B of Figure 7 respectively. The patterns shown in both Panel A and B are similar while the clustering of the WMP maturity dates appears to be more pronounced in Panel A. In particular, 11.4% of the WMPs maturing at a quarter-end compared to 10.% at a month-end which is not a quarter-end. Moreover, 32.6% of the WMPs expire within 5 days prior to a quarter-end (the groups of [-4, 0]) compared to 23.1% otherwise.

It is no surprise that the quarter-end clustering of the WMP maturity dates is stronger because many banks disclose their key financial information at a quarterly

basis. As a result, banks have a stronger motive to do the window-dressing of their LDRs at the end of a quarter on top of regulatory arbitrage.

3.3 Regression analysis

In this section, we directly examine whether banks can effectively lower their LDRs by temporally converting WMPs into deposits at the month-ends. As described in the previous section, we form a novel dataset by matching the number of WMPs with their issuer banks' financial fundamentals. As a result, the dataset is an unbalanced panel. The time series of the panel is on a quarterly basis due to the data availability. (The Wind only reports bank's quarterly information while the Bankscope only reported annually) It is that the clustering of the WMPs expiration is more pronounced at the quarter-ends, making it easier for us to detect its impact on the banks' LDRs.

The panel consists of 71 banks and 512 observations between March 2007 and December 2013. We in particular exclude the largest five commercial banks ("the Large Five") from the panel for two reasons. First, the WMPs issued by the "Large Five" accounts for almost one-third of total WMPs. In this sense, the Large Five are outliers in our sample. Second, the "Large Five" have been the major liquidity providers in China's interbank market. Sometimes even the central bank injects liquidity into the market via the Large Five. Therefore, they are much less constrained by liquidity compared to other banks.

Our strategy is simple. We directly regressa bank's reported LDRson the numbers of its WMPs expiring within several days at the end of the quarter. If the clustering of the WMP expiration ahead of a quarter-end is due to banks' regulatory arbitrage or window-dressing behaviors, the regression models should yield a significantly negative coefficient on the number of WMPs expired within several days (5 days of [-4,0] in our baseline specification) of the quarter-end. As a control, we further investigate the impact of the WMPs expiring on the rest of days in the same month other than the days of [-4, 0]. Given the fact that banks will can retaining funds for too long, the WMPs expiring on the daysother than [-4, 0] should have a very weak impact on the banks' LDR at a quarter-end.

Our baseline specification is

$$LDR_{it} = \alpha_i + \delta_t + \beta\, WMP_{it} + \varphi\, X_{it} + \varepsilon_{it}$$

where $LDR_{it}$is the LDR of a bank i at at the end of the quarter t, WMP_{it} is the log number of the bank I 's WMPs expiring within five days of the end of the quarter t ([-4,0]), X_{it} are control variables, α_i are bank-fixed effects, and $\delta_t$are time-fixed effects. The control variables including the log size of a bank's total assets, the bank I's leverage ratio which is defined as a bank's total assets to its equity as well as non-performance loan ratio (NPL) at the end of a quarter. Table 1 shows the summary statistics (Panel A) and correlations between variables (Panel B) that we use in our regression analysis.

Table 1: Summary statistics and correlations

Panel A: Summary Statistics

	Mean	Std.Dev	Median	Min	Max	N
LDR	65.497	9.762	67.951	27.366	94.487	512
log_num WMPs expiring on [-4,0]	1.673	1.184	1.609	0.000	4.905	512
log_num WMPs expiring on other days	2.621	1.274	2.708	0.000	5.081	465
Bank size (log total assets)	26.704	1.338	26.659	23.880	29.022	512
levevage	17.269	4.610	16.717	6.066	45.191	512
npl	0.928	0.609	0.830	0.090	9.560	475

Panel B: Correlations between variables

N=512	LDR	log_num WMPs expiring on [-4,0]	log_num WMPs expiring on other days	Bank size (log total assets)	levevage	NPL
LDR	1					
log_num WMPs expiring on [-4,0]	0.093	1				
log_num WMPs expiring on other days	0.259	0.678	1			
Bank size (log total assets)	0.455	0.591	0.700	1		
levevage	0.165	0.067	0.131	0.369	1	
NPL	-0.043	-0.136	-0.150	-0.174	0.016	1

Panel A of Table 2 presents the results for the WMPs expiring on days of [-4,0]. The column (1) and (2) reports the results of OLS pool regressions. The column (3) and (4) reports the results of two random effect models with and without the controls of bank characteristics (leverage and NPL). The column (5) and(6) report the results of two fixed effect models while the column (7) and(8) are for fixed effect models with first differences.

Table 2
Panel A:

Estimation	OLS	OLS	RE	RE	FE	FE	FE(FD)	FE(FD)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Log (No. of WMPs)	-1.412***	-1.272 ***	-1.084 ***	-1.055 ***	-0.836***	-0.772 ***	-1.130 ***	-0.958***
	(0.426)	(0.427)	(0.236)	(0.260)	(0.239)	(0.261)	(0.243)	(0.260)
Log (Assets)	3.598***	4.141 ***	-1.384 **	-1.099 *	-2.598 ***	-2.835 ***	-10.98 ***	-12.27***
	(0.389)	(0.411)	(0.542)	(0.580)	(0.596)	(0.666)	(1.668)	(1.885)
Leverage		-0.279***		0.068		0.046		0.167 **
		(0.094)		(0.064)		(0.064)		(0.068)
NPL		0.132		-0.230		-0.535		-0.060
		(0.654)		(0.385)		(0.384)		(0.391)
Time Fixed	Y	Y	N	N	N	N	Y	Y
Banks	71	70	71	70	71	70	71	70
Observations	512	475	512	475	512	475	512	475
R-squared	0.299	0.337	0.117	0.134	0.164	0.213	0.871	0.871

Panel B:

Estimation	OLS	OLS	RE	RE	FE	FE	FE(FD)	FE(FD)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Log (No. of WMPs)	0.118	-0.193	-0.413	-0.474	0.059	0.049	-0.073	0.115
	(0.420)	(0.436)	(0.296)	(0.321)	(0.307)	(0.330)	(0.313)	(0.337)
Log (Assets)	2.520***	3.287***	-2.559 ***	-2.213 ***	-4.624 ***	-4.714 ***	-9.264 ***	-9.84 ***
	(0.437)	(0.482)	(0.661)	(0.693)	(0.746)	(0.796)	(1.700)	(2.048)
Leverage		-0.392***		-0.199		-1.234		0.040
		(0.103)		(0.079)		(0.078)		(0.087)
NPL		-0.058		-0.147		-0.348		0.067
		(0.464)		(0.315)		(0.307)		(0.313)
Time Fixed	Y	Y	N	N	N	N	Y	Y
Banks	75	75	75	75	75	75	75	75
Observations	573	530	573	530	573	530	573	530
R-squared	0.233	0.266	0.145	0.160	0.153	0.171	0.814	0.813

In all eight regression results of Panel A, the (log) number of WMPs expiring on days of [-4,0] has a significantly negative coefficienton the LDR of the bank. It is consistent with our hypothesis that the WMPs are used by some banks as the vehicles for their regulatory arbitrage and window-dressing behaviors.

Panel B of Table 2 presents the results for the WMPs expiring on the daysother than [-4, 0] of the month. In all eight regression models, these WMPs don't appear to have any significant impact on their issuing banks' LDRs.

Table 3 exhibits some robustness checks. In Panel A of Table 3, we investigate the subsample of the period after the GFC (2009 onwards). In Panel B we focus on the WMPs which have a maturity less than a year. In both cases, the results are highly consistent with those in Table 2, meaning that the expiration of WMPs may be due to the consideration of LDR requirement.

Furthermore, it may be argued that the window choice of [-4,0] is purely arbitrary with no justification. For robustness, we further vary the lengths of windows and redo the exercise. The results are shown in Panels C and D of Table 3. In Panel C and D we examine the WMPs expiring on the days of [-3,0] and [-7,0] respectively. In all these new samples, a negatively significant relationship between a bank's LDR at a quarter-end and the number of its WMPs at and close to the quarter-end.

Table 3
Panel A:

Estimation	OLS	OLS	RE	RE	FE	FE	FE(FD)	FE(FD)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Log (No. of WMPs)	-1.124 **	-0.961 **	-1.080***	-1.042 ***	-0.753***	-0.671 **	-0.963 ***	-0.816 ***
	(0.463)	(0.458)	(0.254)	(0.272)	(0.256)	(0.271)	(0.259)	(0.272)
Log (Assets)	3.460 ***	4.123 ***	-1.649 ***	-1.083 *	-3.674 ***	-3.653***	-9.947 ***	-12.11***
	(0.417)	(0.434)	(0.627)	(0.636)	(0.718)	(0.766)	(1.857)	(2.145)
Leverage		-0.411 ***		0.120		0.087		0.223 **
		(0.116)		(0.077)		(0.077)		(0.088)
NPL		0.379		0.016		-0.089		-0.079
		(0.701)		(0.435)		(0.426)		(0.411)
Time Fixed	Y	Y	N	N	N	N	Y	Y
Banks	70	69	70	69	70	69	70	69
Observations	465	436	465	436	465	436	465	436
R-squared	0.272	0.322	0.142	0.151	0.182	0.230	0.878	0.879

Panel B:

Estimation	OLS	OLS	RE	RE	FE	FE	FE(FD)	FE(FD)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Log (No. of WMPs)	-1.346 ***	-1.228 ***	1.122***	-1.100 ***	-0.882***	-0.823 ***	-1.16 ***	-0.99***
	(0.424)	(0.425)	(0.235)	(0.258)	(0.238)	(0.260)	(0.242)	(0.258)
Log (Assets)	3.573***	4.130 ***	-1.314 **	-1.036 *	-2.499***	-2.740 ***	-11.03***	-12.29***
	(0.388)	(0.411)	(0.543)	(0.581)	(0.597)	(0.667)	(1.676)	(1.893)
Leverage		-0.274 ***		0.064		0.044		0.168 **
		(0.094)		(0.064)		(0.064)		(0.068)
NPL		0.162		-0.214		-0.514		-0.036
		(0.654)		(0.386)		(0.385)		(0.392)
Time Fixed	Y	Y	N	N	N	N	Y	Y
Banks	71	70	71	70	71	70	71	70
Observations	508	472	508	472	508	472	508	472
R-squared	0.300	0.340	0.113	0.128	0.161	0.211	0.871	0.872

Panel C:

Estimation	OLS	OLS	RE	RE	FE	FE	FE(FD)	FE(FD)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Log (No. of WMPs)	-1.252***	-1.175***	-0.720***	-0.755***	-0.471**	-0.484*	-0.706***	-0.611**
	(0.406)	(0.403)	(0.238)	(0.256)	(0.238)	(0.254)	(0.241)	(0.252)
Log (Assets)	3.613***	4.251***	-1.972***	-1.471***	-3.358***	-3.497***	-12.329***	-14.042***
	(0.364)	(0.384)	(0.537)	(0.571)	(0.587)	(0.658)	(1.773)	(2.047)
Leverage		-0.254***		0.107*		0.073		0.210***
		(0.093)		(0.065)		(0.065)		(0.070)
NPL		0.022		-0.504		-0.902**		-0.350
		(0.654)		(0.418)		(0.417)		(0.427)
Time Fixed	Y	Y	N	N	N	N	Y	Y
Banks	69	68	69	68	69	68	69	68
Observations	480	445	480	445	480	445	480	445
R-squared	0.326	0.371	0.178	0.195	0.210	0.265	0.868	0.870

Panel D:

Estimation	OLS	OLS	RE	RE	FE	FE	FE(FD)	FE(FD)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Log (No. of WMPs)	-1.118 ***	-1.056 **	-.943 ***	-.895 ***	-.652***	-.550 **	-.849 ***	-.696***
	(0.422)	(0.425)	(0.235)	(0.257)	(0.241)	(0.261)	(0.242)	(0.254)
Log (Assets)	3.411***	4.019***	-1.308**	-1.037 *	-2.615 ***	-2.759 ***	-9.419***	-12.13***
	(0.393)	(0.420)	(0.546)	(0.584)	(0.607)	(0.671)	(1.627)	(1.843)
Leverage		-.284***		0.077		0.068		.191 ***
		(0.091)		(0.062)		(0.062)		(0.066)
NPL		0.328		-0.114		-0.407		0.039
		(0.627)		(0.366)		(0.365)		(0.370)
Time Fixed	Y	Y	N	N	N	N	Y	Y
Banks	73	73	73	73	73	73	73	73
Observations	541	501	541	501	541	501	541	501
R-squared	0.291	0.331	0.124	0.141	0.170	0.218	0.866	0.870

4. Conclusion

We examine wealth management products (WMP) issued by Chinese commercial banks, which are an important part of China's fast growing shadow banking sector. We document that the WMPs' maturity dates cluster toward the end of a month and then decrease significantly at the beginning of the following month, implying that banks may maneuver the expiration dates of WMPs to meet the LDR requirements, among others. A direct test further detects a negative relationship between a bank's loan-to-deposit ratio (LDR) at the end of a quarter and the number of its issued WMPs expiring within several days of the quarter-end. Our findings suggest that banks are using WMPs as vehicles for their regulatory arbitrage or window-dressing behaviors.

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Special Column on One Belt One Road

CHINA PAKISTAN ECONOMIC CORRIDOR (CPEC)

By YASEEN ANWAR*

While the $1.8 Trillion One Belt One Road (OBOR) initiative captures global attention, the much smaller $46 Billion CPEC arm has somewhat less recognition. Notwithstanding, the unheralded CPEC is moving forward at a steady pace and carries with it, significant geopolitical advantages for both China and Pakistan. The initiative comprises the 5 parts of China's Vision Plan for Integration: 1) Connectivity, 2) Trade, 3) Financial Integration, 4) Policy implementation, and 5) People to People linkages. Nevertheless CPEC's success depends on managing apparent vulnerabilities, both economically and politically.

The CPEC represents the South Asian leg of OBOR's larger Central Asian arm of Economic strategy in support of China's macroeconomic dimension. It opens Central Asia, a geographically closed region lacking in infrastructure that will provide greater access to the sea and expand the global trade network. CPEC will also enhance energy and power shortage of Pakistan that currently reduces the country's economic growth by up to an estimated 3%.

The initial outlay of the $46 Billion CPEC initiative is already on its way. While the bulk of it is under the MOU status, approximately $5-6 Billion of it has achieved financial close and is being financed by the China Exim Bank and Industrial & Commercial Bank of China (ICBC). The early projects are in the Power sector, i.e. Coal, Solar, Hydro, and Wind.

For CPEC's success, Pakistan must maintain high corporate governance standards and build its Resource Capacity in all infrastructure related project entities in order to achieve the associated synergistic benefits and ensure CPEC's success. The prevailing debate within the country on priority for the Western, Central, and Eastern corridors is contentious with political overtones that diminish the economic value of the most cost effective and long term beneficial route to be taken. The Corridor from Gwadar seaport should be the shortest direct route to the north that involves SMEs that will generateconcurrent employment and with

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Exit linksleading to major urban centres to ensure cost benefits are realized short and long term for all countries impacted.

Secondly, to facilitate trade and implementation of CPEC, Pakistan should utilize its Currency Swap Agreement signed in 2011 with PBOC for trade purposes for which it was intended and reduce its dependency on Balance of Payments support as initially used and necessary in 2013. With the inclusion of RMB in the SDR basket of Reserve currencies on November 30, 2015, the RMB becomes even more desirable for CPEC related projects as an option that will not only save foreign exchange but also provide a cushion from prevailing currency volatility.

Thirdly, part of China's economic success is attributed to economic policy reforms that created 15 Special Economic Zones (SEZs) in key cities. Shenzen in 1996 is an excellent example of success in that it now ranks as the 4th largest in China. Gwadar seaport could follow suit as a designated SEZ whereby it would benefit from: 1) Special Tax incentives, 2) greater independence on International Trade activities, and 3) possess economic characteristics of a market driven economy that would attract foreign capital for construction, elicit wholly owned foreign companies &partnerships, and emphasizeexport oriented products that are much needed towards generating a Trade Surplus.

SEZs in China are listed in National Planning but have Provincial authority on economic administration. SEZs also have local government legislation authority with exports and FDI impacted positively as the pace of liberalization supports faster economic growth. Policy reforms of such a nature or a blend, could be initiated that would benefit Gwadar port area and the Province itself.

Finally, CPEC will also impact the trajectory of Urbanization in Pakistan and if prudently managed, will have favourable consequences for both China and Pakistan. Pakistan has the highest rate of urbanization in South Asia with a projected population of 335 Million by 2050, and an annual urbanization rate of 3.06%. In Sindh & Punjab, almost half of the population is already urbanized while in the KPK and Baluchistan provinces, the level is lower at 16.87% and 23.89% respectively. (Source: Hasan & Raza 2010).

Pakistan's overall urbanization is currently at 35%, with projections at 50% by 2030. New challenges are emerging in terms of infrastructure service delivery, particularly in urban areas. The rapid urbanization poses major challenges in three key areas which are interconnected: 1) urban governance, 2) urban poverty, and 3) infrastructure service delivery.

How can the CPEC enable positive urban development trajectories? There are obvious potentials for CPEC to contribute to infrastructural development and generate employment opportunities. But these are likely to occur only if alongside there are conscious government interventions at the Federal, Provincial, and District levels to manage urbanization. With depreciating quality and scale of municipal infrastructures in key areas and insufficient urban planning, Urbanization

and Infrastructure have not kept pace. Cities in Pakistan have accumulated huge deficits across public services including health, utilities, and transport which adversely affect each citizen's quality of life. Not giving appropriate attention to these areas will have long term adverse implications for CPEC. If leveraged properly, CPEC could provide ample employment opportunities, particularly in regions like Baluchistan, a key corridor necessary for CPEC's success.

As in all cases, infrastructure represents the engine of growth for an economy and is critical to support the planned growth rates. Infrastructure will trigger the SME sector that will provide employment and the opportunity to the banking sector to diversify its portfolio; the roads, bridges, and railroads to improve transportation and lower delivery costs; an elevated telecommunications network in today's technology era is a must; and investment in the Power sector is essential for manufacturing, both for domestic needs and exports to ensure a stable Trade and Current Account.

Underscoring again, CPEC's emphasis on infrastructure is a key positive development that provides Pakistan with an opportunity to integrate 'all' provinces economically and to build a unified, inter-dependent economy that will not only generate new employment, but also reduce potential urbanization pressures on already heavily urbanized centres by influencing migratory populations, thereby reducing domestic political tensions. The inclusion of disenfranchised populations into CPEC will also improve productivity and in turn GDP growth rates. However, ignoring these issues will potentially reduce the opportunity to realize long term growth rates. These key areas, if given the appropriate weightage, will certainly elevate the probability of CPEC's success as envisioned by the Chinese and Pakistan leadership.

IMI International Monetary Review

A Closer Asia-Africa Partnership is an Opportunity for All*

*By*BEN SHENGLIN*

In early March, Prof. Ben Shenglinwas invited to the inauguration ceremony and first conference of the Raisina Dialogue sponsored by Indian Ministry of Foreign Affairs and Observer Research Foundation at New Delhi. This article was published in the conference journal of the Observer Research Foundation.

Abstract

Asia and Africa are similar in many ways: big and growing populations, mostly developing countries, rich and diverse cultures, histories of foreign occupation …… However the similarities seem to end there. Their recent economic fortunes and growth trajectories have been as divergent as one can imagine, with Asia considered the poster child of development and Africa falling behind ever further. What are the key factors behind their divergence? Though peace and security are crucial factors that have set them apart, connectivity factors such as trade, finance and technology have played differentiating roles as well. Building a stronger Asia-Africa connectivity will benefit not just the development of Africa, but also that ofAsia and the rest of the world. China's recent rollout of the so-called One-Belt-And-One-Road strategy has further sharpened its traditional focus on African friendship and its intensified effort to play a leading role inAsia-Africa partnership has caused some international concern and stimulated some healthy competition for geopolitical alliances and African partnership, which is an opportunity the world should seize to make not just Africa but the whole world a better place.

Introduction

Why nations prosper and fail have fascinated people from all walks of life, from "development economists" to historians and cultural experts, from social and political scientists to political leaders. Various initiatives have been undertaken to unlock the growth potential of the developing countries, including the establishment of multilateral, both regional and global, institutions, with World Bank being probably the most prominent example and AIIB (Asia Infrastructure

*In early March, Prof. Ben Shenglinwas invited to the inauguration ceremony and first conference of Raisina Dialogue sponsored by Indian Ministry of Foreign Affairs and Observer Research Foundation at New Delhi. This article was published on the conference journal of Observer Research Foundation.

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Investment Bank) and NDB (NewDevelopment Bank) being the most recent endeavors.

In the world of "development economics", there has been increased and particular focus onAsia and Africa due to not just the importance of these two regions in terms ofpopulations (See Fig 1 below) and those in poverty, but also the Asia's perceived successes and strategies in contrast with Africa's pitfalls and potential, and the possible lessons for Africa to realize its untapped potential.

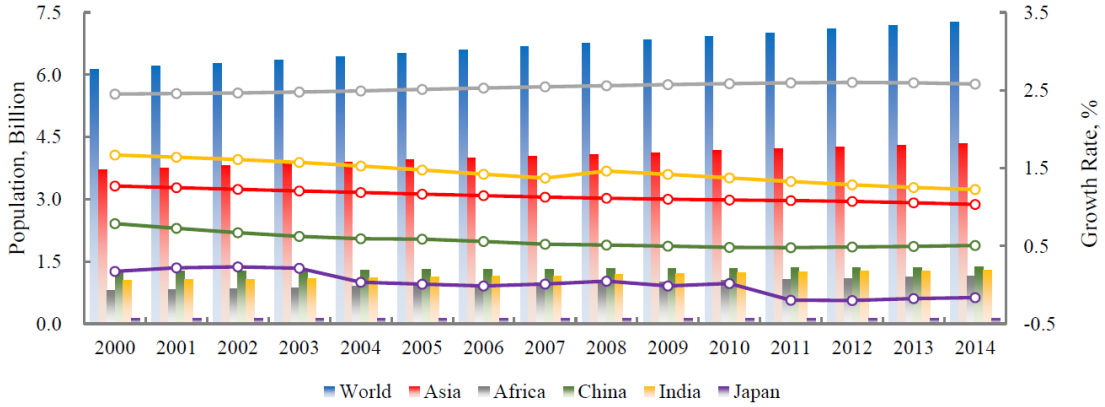

Fig 1 Asia& Africa's share of World Population

Source: (1) United Nations Population Division. World Population Prospects, (2) United Nations Statistical Division. Population and Vital Statistics Report (various years), (3) Census reports and other statistical publications from national statistical offices, (4) Eurostat:Demographic Statistics, (5) Secretariat of the Pacific Community: Statisticsand Demography Programme, and (6) U.S. Census Bureau: International Database

Asia and Africa account for 75% of the world's population and are expected to continue their leadership in the growth of population, due to the increasing availability of improving health care, positive demographic trends and recent relaxation of one-childpolicy restriction in China.

1. Asian Success and African Potential

While the vast diversity of Asian and African nations means the risk of generalising the analysis by simply focusing on the two aggregated regions to draw the broad conclusions, this over-generalisation is partially mitigated bythe inclusion of Asia'sBig Three (China, India and Japan), South Africa and Egypt in our analysisgiven their significance, diversity and data availability.

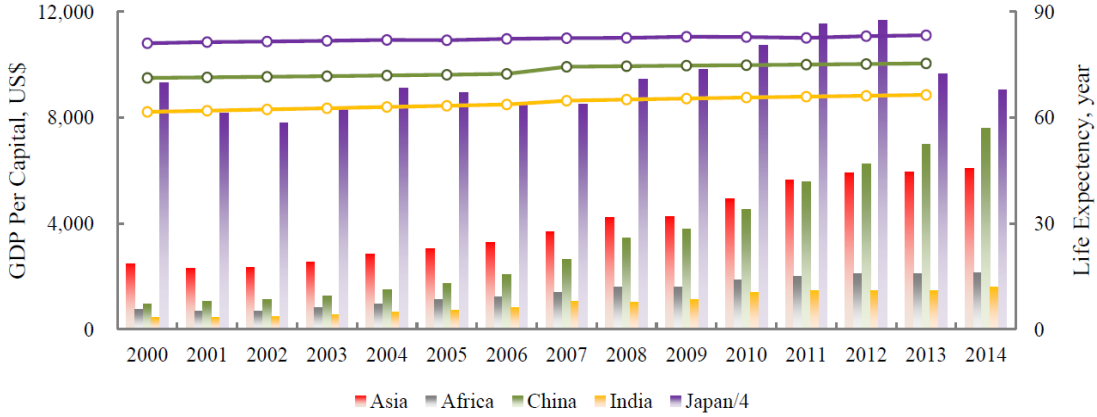

Fig 2 GDP Per Capita, Life Expectancy of Asia and Africa

Source:World Bank national accounts data, and OECD National Accounts data file

Note：Japan's GDP per capita in the graph is its actual divided by 4 forbetter illustration.

It must be hardfor many to believe the following salient points:

• In 1970,Asia was a bit more than five times of Africa in terms of nominal GDP, today their gap has doubled with Asia equal to 10 times of Africa

• In 1970,Africa's nominal GDP per capita was similar to Asia's and more than two times of China's; today African's average is less than 30 percent of China's; China and Africa were at par in terms of GDP in 1970, today China is five times of Africa.

• During the same period of time, India was able to narrow its gap with Africa from nearly 50 percent to about 20 percent today, in nominal GDP.

• In terms oflife expectancy, Egyptians and South Africans lived longer than Chinese and Indians in 1960; today a Chinese can expect to live nearly 5 years and 20 years longer than his Egyptian and South African counterpart respectively, while an Indian can expect to live 10 years longer than a South African. The gap betweena South African and Japanese in terms of life expectancy has also doubled since 1970. Considering South Africa is among the more developed nations of Africa, we can safely say that the gaps between some other African nations and Asia are even wider and discomforting.

2. The Three Dimensions of Connectivity

The Asia-Africa gaps reflect both, the huge progress that Asia has made in its development efforts and the significant opportunities for Africa. Various studies have been undertaken to identify the key success factors behind Asia's success and what can be replicated in Africa.

While there are important and non-economic factors behind the vastly divergent economic performances of the two regions, connectivity or the lack of it

seems toexplain a significant part of their divergence. Among the various elements of connectivity, trade, technology and financial appear to have played the pivotalroles.

2.1 Trade

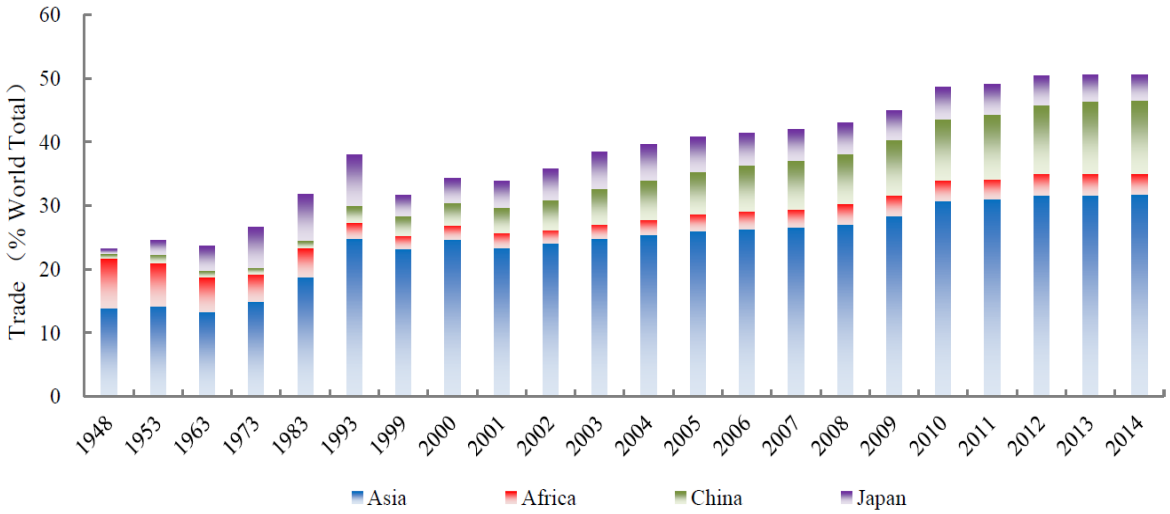

Fig 3 TradeConnects the World: Asia, Africa, China & Japan

Source: WTO Statistics Database

What is striking from Figure 3 is that Africa's role in world trade has declined significantly since 1948. Its share of world exports and imports fell from 7.3percent and 8.06 percent in 1948 to 3 percent and 3.44 percent in 2014, representing a sharp deterioration of its position in the global value chain oftrade and its "connectivity" with the rest of the world.

In contrast, Asia has expanded its role of world trade, taking 32 percent respectively of total global exports and imports today, from a more modest 13 percent and 8 percent in 1948. It is no wonder that Japan, the four Little Tigers of Asia, and China have all successfully pursued the export-led growth strategies, according to the World Trade Organisation data.

2.2 Technology

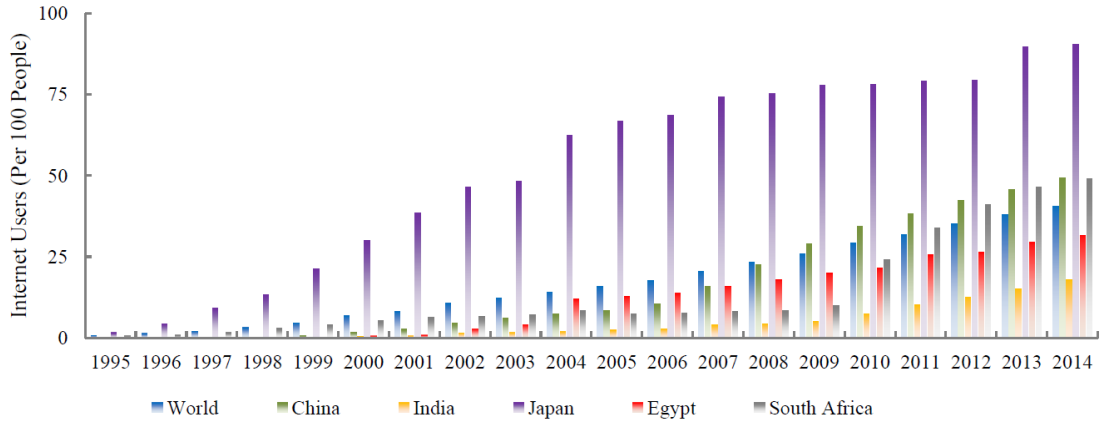

Fig 4 Technology Connects the World: Internet Penetration Ratio

Source:InternationalTelecommunication Union, World Telecommunication/ICT Development Report anddatabase, and World Bank estimates

Though data on the regional level and many individual African countries are not available, Fig4 shows the internet users as a percentage of total population in different countries and regions. It is noteworthy that China had a relatively late startand was not able to catch up with the world until 2009; today China is well above the world average, with over 50 percent of Chinese connected to internet.

What is equally striking is that South Africa has played an excellent catch-up game and its internet penetration ratio is now comparable to China's. Egypt has also improved fast and it is now ahead of India, though below the world average. The mobile technology probably represents an unprecedented opportunity for a "latecomer" Africa to leapfrog many of the now outdated technologies. The disruptive natureand equalizing effect of the new technologies means literally that the world is flat and Africa, for the first time, can be as easily accessible and visible on the world map as any other nation or region.

2.3 Finance

Technologyand finance are considered two pillars underpinning the development of countries and corporate successes alike. How inclusive is their financial system is an indicator of both the level of social development and how strongly finance empowers the people and thus their nation to achieve the economic success and social justice.

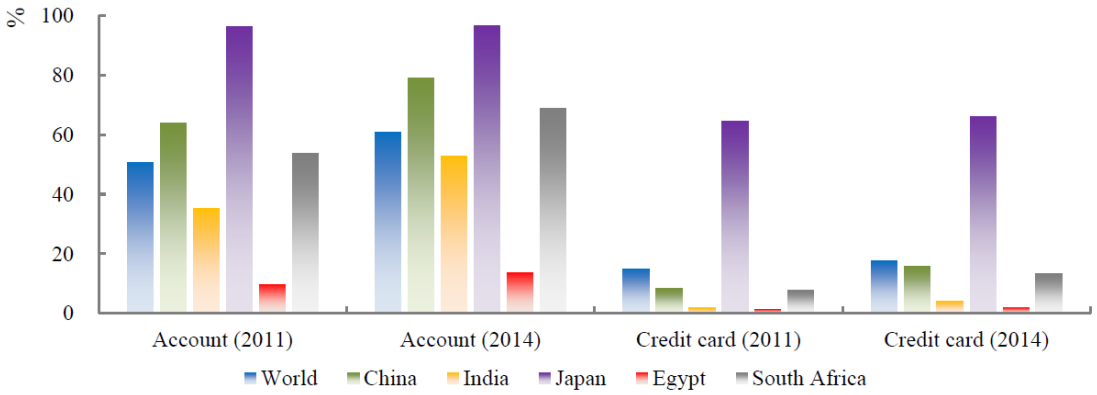

Fig 5 Financial Inclusiveness: Bank Account and Credit Card Penetration Ratio

Source: World Bank GlobalFinancial Inclusion Database

In terms of number of bank accounts and credit cards per 100 adults (age 15 or above), China and South Africa are leading the "financial inclusiveness" index, with India falling substantially behind the world average and Egypt failing miserably in the ranking. Those who are excluded from the formal financial system are missing out the opportunities for themselves, which also constrains the government's ability to facilitate entrepreneurship and cultivate broader base for taxation.

The cure to this problem may lie in "internet finance" in China (better known as FinTechoutside China), the combination of technology and finance thanks to the exciting progress made in the Big Data and cloud computing powers. The much talked-about developments in FinTech space such as blockchain promise to revolutionize the way financial services are provided and are probably the best bet for Asia and Africa to achieve financial inclusiveness and equality with the developed world. The mass market customers, or the so-called microfinance customer segments, have been unbanked or under-served by the traditional financial services firms due to efficiency constraints. They will now have access to similar, if not the same, level of financial services thanks to FinTech's cost-effectiveness and decentralized business model. Developing countries like China provide fertile ground for applying such innovative solutions without the powerful incumbency of traditional financial sector and some of them appear to be leading in this new area.

3. The Opportunities for Asia-Africa Partnership

After making strides over the past decades, China and many other countries in Asia are facing the challenge of "middle income trap". Politically, the much-needed intra-Asia cohesiveness is sorely missing; Asia is now home to some of the most dangerous hotspots of geopolitical tensions in the world. What has

helped Asia achieve economic growth includes the general peaceful environment and security arrangement in the region for the past few decades - a point that many people may have forgotten. The lesson that Africa must learn in order to achieve sustainable economic development is that security and stability are prerequisites for economic growth, even before technology, finance and trade.

Asia-Africa Partnership is flourishing and is expected to gain additional momentum given the shaper focus placed by Asia, in particular China, India and Japan. While Japan started investing in Africa earlier, it is China that has moved faster.Despite being a latecomer, China has so far invested USD 32 billion, three times of the total of Japanese investment in the region. In terms of trade, China has quadrupled its export to Africa over the past 20 years, exceeding $100 billioneach year in both 2014 and 2015, while imports from Africa saw a five-fold growth in the same period of time. Japan's trade with Africa is dwarfed byChina's, with exports and imports totaling $27 billion in 2014, according to data from World Bank and World Trade Organization.

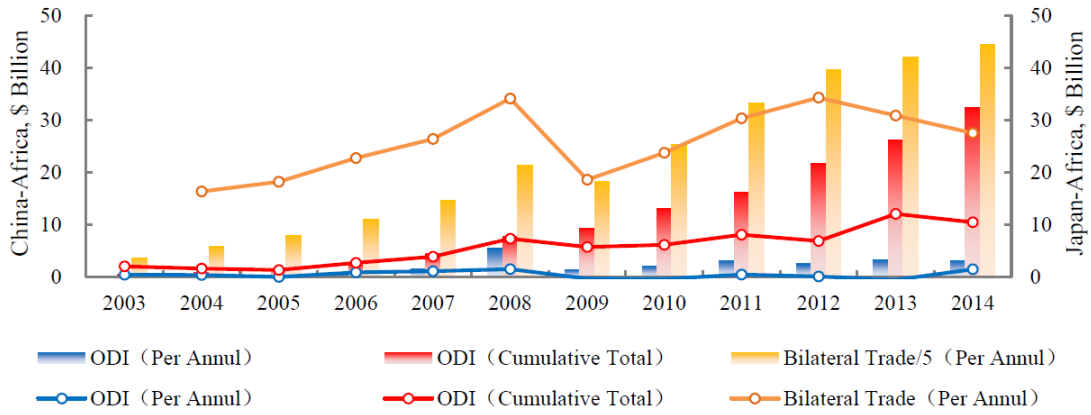

Fig 6 Asia-Africa Connectivity: Investment & Trade

Source: World Bank data, WTOSstatistics Database

China has launched "One Belt and One Road" (OBOR) initiative, which is expected to cover most of Asia, Europe and extend further into Africa. One of its particular focuses is "connectivity", in terms of trade and investment, infrastructure, technology and people. This means improving "Intra-Asia" cohesiveness as well as strengthening inter-regional connectivity such as Eurasia and Asia-Africa partnerships. To support these and encourage alternative development paths, China had led the launch of AIIB and NDB with a particular focus on infrastructure. NDB has even planned a regional office in South Africa, signaling its commitment to foster closer Asia-Africa partnership. China's proactive OBOR policy has attracted some international misunderstanding, closer scrutiny and even competition, the latter of which is probably unintended but is nevertheless good for Africa and

developing world in general. OBOR as China's vision for inter- and intra-regional partnership, and AIIB among the alternative funding vehicles to support OBOR, their roll-outs have helped the world, including India, Japan and the United States to sharpen their focus on closer inter-regional partnership with Africa. The world, and Africa in particular, should welcome and will benefit from more and closer partnerships.

(The author wishes to thank Jiamin (Jamie)Lu，EddieBrient, and SadarUsman PhD Students at Zhejiang University for their researchassistance to this article.)

IMI International Monetary Review

Special Column on RMB Internationalisation

A Tale of Two Markets for the Redback

*By*XIA LE* and DONG JINYUE

Summary

- Chinese financial turmoil has thrown the RMB exchange rate under the spotlight. In particular, the gap between the RMB exchange rates in its onshore (CNY) and offshore (CNH) markets reached the historical high. Thishas motivated us to introduce this uniquephenomenon of "one currency, two markets" of the RMB, and investigate the relationship between these two exchange rates.

- The development of RMB offshore markets took off after China embarked on its ambitious plan to increase the usage of the currency in cross-border trade settlements. A "CNH" market is taking shape as the volume of offshore RMB experienced a period of fast growth and became increasingly active since its inception.

- The segmentation between the CNY and CNH markets unavoidably led to a price differential, which cannot be fully eliminated as the currency's capital account inconvertibility limits the arbitrage behaviours across the borders. But for a while, two exchange rates tended to converge as China's on-going financial liberalization campaign has made the capital account increasingly porous.

- The gap widened significantly again after the PBoC's RMB exchange rate reform on August 11 2015. The pricing power of the RMB shifted to the offshore market as our Granger Causality test shows that CNH's price-guide impact on CNY becomes stronger after the August 11 RMB reform; while CNY's price-guide effect on the CNH offshore market turns insignificant.

- The authorities have prioritized the goal of stabilizing people's expectation for the RMB exchange rate and stemming capital outflows. They cut off the

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linkages between the two markets to impede the transmission of depreciation pressure across the border, which could lead to the stagnation of the offshore market.

- The dramatic change of the CNH market largely mirrors the conflict between the exchange rate reform and RMB internationalization under strong depreciation expectation and escalating global uncertainty. In our opinion, the right sequencing should be the exchange rate reform first, then capital account opening and RMB internationalization.

Introduction

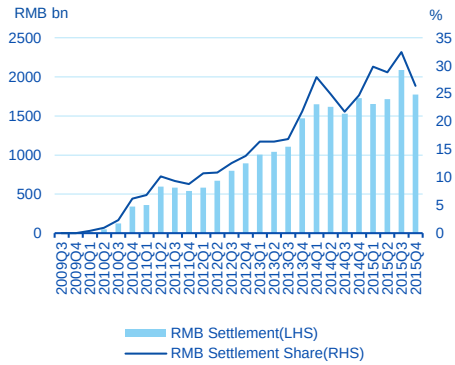
Recent financial turmoil has thrown the RMB exchange rate under the spotlight. More interesting is that the "redback" has two prices (CNY and CNH) quoted in its onshore and offshore markets with a significant and time-varying spread. On January 6, the gap between the CNY and CNH exchange rates reached 1,400 basis points. The pair of the RMB exchange rates has added difficulties for investors to understand this fast-rising currency and make their investment decisions. Thisreport seeks to introduce this uniquephenomenon of "one currency, two markets" for the RMB, and investigate the relationship between them.

The rise of the RMB offshore (CNH) market

The development of RMB offshore markets took off after China embarked on its ambitious plan to increase the usage of the currency in cross-border trade settlements in the aftermath of 2008-2009 Global Financial Crisis (GFC). The successful progress of the RMB usage in cross-border trade settlements (Figure1) gave rise to a growing pool of RMB funds outside China and fuelled the development of an offshore RMB market, even though the country hasn't fully opened its capital account.

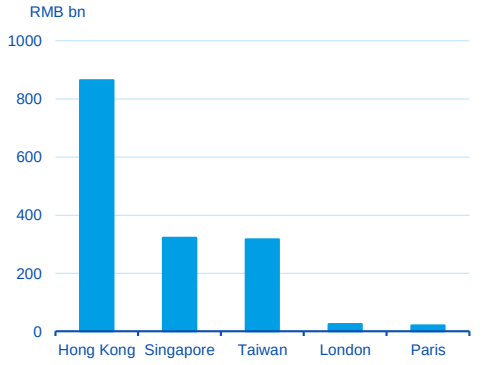
A "CNH" market is taking shape as the volume of offshore RMB experienced a period of fast growth. With its special relationship with China ("One Country, Two Systems") and excellent infrastructure as a well-established international financial centre, Hong Kong became the first offshore RMB business hub alongside the traditional onshore CNY market. In recognition of the RMB's rising power in the international arena, more global financial centres join the competition for offshore RMB business. (Figure 2)

Figure 1
Offshore RMB settlements have been increasing over time



Source: CEIC and BBVA Research

Figure 2
The rank of RMB offshore markets based on RMB offshore deposits (2014)



Source: CEIC and BBVA Research

The CNH market has become increasingly active since its inception. To date, the CNH market offers many types of RMB business and financial products including spot FX, deliverable forwards, swaps, deposits and CDs, Dim Sum bonds (RMB denominated bond issued in offshore market), RMB-denominated loans, etc. In its 2013 Triennial Central Bank Survey, the Bank of International Settlement (BIS) stated "…*Renminbi turnover soared from $34 billion to $120 billion. The renminbi has thus become the ninth most actively traded currency in 2013, with a share of 2.2% in global FX volumes, mostly driven by a significant expansion of offshore renminbi trading*".

One currency, two markets

In theory, the onshore (CNY) and offshore (CNH) RMB markets are segmented because China hasn't fully opened its capital account yet. There are various forms of restrictions limiting investors from transferring RMB funds between the CNY and CNH markets. The CNY market remains highly regulated by the People's Bank of China (PBoC). For example, access to the wholesale FX market is granted only to domestic banks, finance companies, and domestic subsidiaries of foreign banks. On the other hand, there isn't an official regulator in the CNH market. Local regulators can only apply their rules to financial institutions under their own jurisdictions. Indeed, these regulators have less appetite for imposing additional restrictions on offshore RMB business. Instead, they have been attempting to lobby China's authorities to relax their restrictions for cross-border RMB business because it could gain more business opportunities for their financial markets and institutions.

The segmentation between the CNY and CNH markets unavoidably led to a price differential (Figure 3). The gap between the CNY and CNH rates was wider at the early stage of the CNH market development (2010 August-2011 January). During that period, the CNH rate appreciated more than the CNY one because the currency was less available in overseas market. Due to the fact that China's still closed capital account limited the arbitrage behaviours between these two markets, the price differential cannot be fully eliminated.

There were also a few episodes when the CNH interbank rates spiked due to the liquidity shortage in the offshore market, for example in October 2011. This type of liquidity shortage can quickly be fixed when the Hong Kong Monetary Authority (HKMA), with the PBoC's support, injected RMB liquidity into the offshore market.

Over time the CNY and CNH rates tended to converge as the PBoC steadily stepped up their efforts to liberalize the capital account and push forward RMB internationalization. Moreover, to boost the international usage of the RMB, the authorities also increased their tolerance of arbitrage behaviours which exploited interest and exchange rate differentials between the CNY and CNH markets. These efforts have proved to be effective in the sense that they have substantially increased the usage of the RMB in overseas markets and thereby enabled the "redback" to meet the International Monetary Fund's "freely usable" requirement for its inclusion in the currency basket of the Special Drawing Rights (SDRs) last November.

Pricing power shifted to the CNH market after the 2015 August devaluation

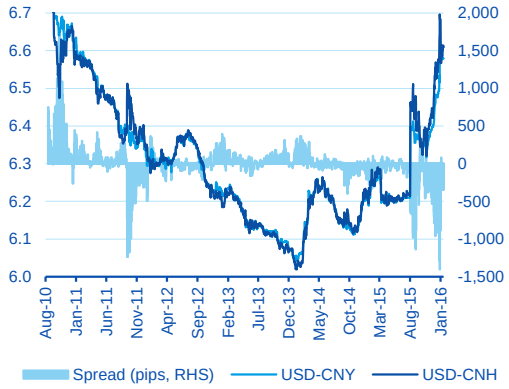
The gap between the CNH and CNY exchange rates started to widen again after the PBoC unexpectedly announced the reform of the RMB fixing price mechanism and devalued the currency by 1.9% on August 11 2015. (See ourChina Flash) In retrospect, the authorities seemingly intended to increase the flexibility of the RMB exchange rate. However, the timing of this move seems questionable as global financial markets were then surrounded by enormous uncertainties over the US Fed's monetary policy. As such, the unexpected RMB devaluation rattled investors and made the exchange rate anchorless. Panicked investors thought that China wanted to join the "currency war" and would depreciate the RMB much deeper to regain its competitiveness in exports. More pessimistic investors even interpreted that the devaluation itself was a signal of the economy implosion and scrambled to transfer their money out of the country. Policymakers' poor communication also hindered investors from learning the true policy intention at the first time.

To avoid too sharp depreciation and associated risk of accelerating capital flight, the authorities intervened into the CNY market again to stabilize investors' expectations. However, an unintended result is that the PBoC gave the pricing power of RMB to the offshore market because the CNH market was less affected

by the government's interventions. Our Granger Causality empirical results (Refer to the BOX at the end) demonstrate that in the aftermath of the August devaluation, the CNH price tends to have a guide impact on the CNY price, while the CNY price has no significant guide impact on the CNH price.

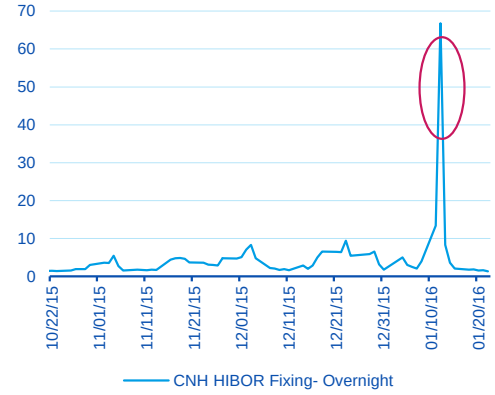
Since then, the CNH market has persistently priced a relatively lower value of the RMB than its onshore counterpart. The authorities thus faced a policy dilemma: the more interventions they did in the CNY market, the larger extent of depreciation was priced in the CNH market. In turn, the large depreciation pressure of the offshore market transmitted to the onshore market via cross-border arbitrage behaviors and consequently nullified the authorities' interventions.

Figure 3
The gap between onshore and offshore RMB became large again at the beginning of 2016



Source: CEIC and BBVA Research

Figure 4
Large discrepancy of CNY and CNH also leads to CNH inter-bank rate soaring in January



Source: CEIC and BBVA Research

The offshore market gave its way to the financial stability for the time being

Now the authorities have prioritized the goal of stabilizing people's expectation for the RMB exchange rate and stemming capital outflows. On top of introducing a basket currency index (CFETS) as the new anchor for the RMB exchange rate (see our recent China Flash), the authorities have also increased their interventions in the onshore market so as to establish their credibility of this new FX policy regime soon.

To solve the policy dilemma mentioned in the previous section, the authorities have adopted new approaches to deal with the offshore market as well. In particular, they cut off the linkages between the two markets to impede the transmission of depreciation pressure across the borders. In the meantime, the authorities deliberately reduced the RMB liquidity in the offshore market to raise

the CNH interest rates. High interest rate levels will not only increase the attractiveness of holding RMB but also add financing costs for the RMB short-sellers in the offshore market. It is also believed that China's authorities are attempting to intervene in the CNH market via some Chinese banks' overseas subsidiaries. (Table 1)

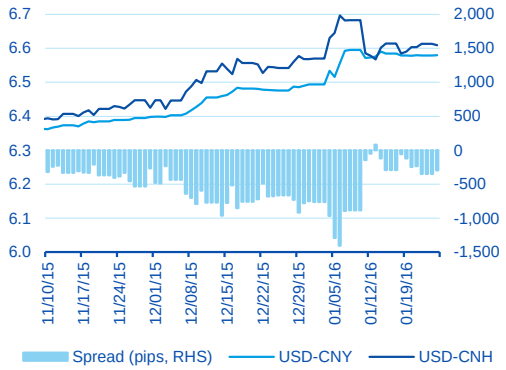
Table 1: The recent PBoC's interventions to the onshore and offshore RMB market

Time	The PBoC's interventions on offshore RMB market
September-15	The PBoC increased the transaction fee of foreign banks' spot RMB purchase and sale from the previous 0.0001%-0.0002% to 0.3%.
September-15	Some big Chinese banks started to buy offshore RMB and exchange them to USD at a high cost, which was deemed to be at instigation of the PBoC.
November-15	To tighten the RMB liquidity in the offshore market, the PBoC stopped to provide cross-border finance to the offshore banks' RMB account; also, the offshore RMB settlement banks' bond repurchase business are stopped as well.
December-15	The PBoC announced that starting from 2016, the interbank market FX trading time will be expanded till 23:30, to promote a more coincident exchange rate of onshore and offshore market.
December-15	The PBoC implemented window guidance to some foreign banks to temporarily stop their FX trading.
January-16	The PBoC announced that it will implement Reserve Required Ratio (RRR) on the RMB deposits by foreign financial institutions' mainland branches

Source: The PBoC website and BBVA Research

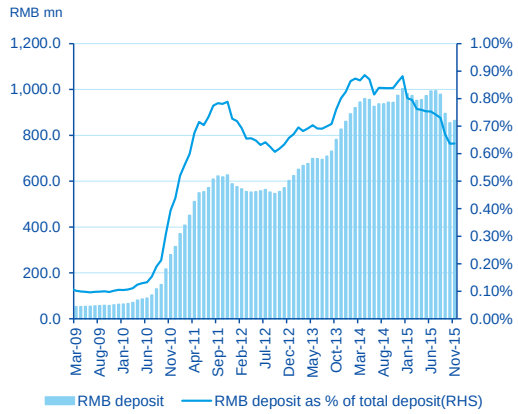
These new measures seem to be effective in the recent weeks as the authorities managed to align the CNH rate with the CNY. (Figure 5) However, these measures bear a high cost. They indeed have dampened foreign investors' interest in the RMB and have largely weakened the price discovery function of the CNH market. The depth of the offshore market is also adversely affected, which means that the CNH interest and exchange rates will inevitably become more fickle. All in all, these measures will sacrifice the development of the offshore market, which is a serious setback for RMB internationalization. (Figure 6)

Figure 5
The authorities managed to align the CNH rate with CNY through intervening offshore market…



Source: CEIC and BBVA Research

Figure 6
…but these measures might sacrifice the development of the offshore market



Source: CEIC and BBVA Research

When will the CNH market thrive again?

The dramatic change of the CNH market largely mirrors the conflict between the exchange rate reform and the RMB internationalization under strong depreciation expectation and escalating global uncertainty. Under such a circumstance, the *right sequencing* issue becomes more pronounced than before. Although China's authorities have been pushing forward a number of financial liberalization reforms on multiple fronts simultaneously, now it seems to be the right time to fine-tune the agenda and rearrange the order. In our opinion, the *right sequencing* should be the exchange rate reform first, then capital account opening and the RMB internationalization.

We believe that the authorities' priority is to link the RMB value to a basket of currencies in order to stabilize market expectations and avert large-scaled capital exodus. The CNH market could suffer a period of stagnation until China's authorities established its credibility of the new FX policy regime. That being said, the CNH market is likely to regain its prosperity in the next couple of years as capital account liberalization and RMB internationalization are back on the top of the authorities' reform agenda again.

Appendix 1. CNH's price-guide mechanism becomes stronger after the 2015 August 11 RMB reform based on Granger Causality test

We deploy Granger Causality test to illustrate that CNH's price-guide impact is increasing after the 2015 August 11 RMB exchange rate fixing price reform. Among many of the causality test methods in time series studies, Granger Causality test is the most widely used and intuitively straightforward.

The basic idea of Granger test is that*X* is said to *Granger-cause Y* if *Y* can be forecast better using past *Y* and past *X* than just past *Y*. To implement the idea, we normally do the regression from Y on the past X and past Y in the time t-1, t-2, etc. (lags are determined by some statistically optimal choice), and to test whether the F-test of all the past X's coefficients are jointly significant.

We basically test the mutual Granger causality relationship between CNY and CNH exchange rate in two regions: before and after the 2015 August 11 RMB reform. The first time window is from August 23, 2010 to August 10, 2015 and the second time window is from August 11 2015 to January 15, 2016.

Table 2 is the summary of significance level of the F-statistic of our Granger Test. (Table 2) Our results show that: (1) CNH to USD exchange rate could Granger-cause CNY to USD exchange rate both before and after the August 11 RMB exchange rate reform; (2) CNY to USD exchange rate can Granger-cause CNH to USD before the reform, however, it cannot Granger-cause CNH to USD after the reform.

The empirical results indicate that CNH's price-guide impact on CNY becomes stronger after the August 11 RMB exchange rate reform while CNY's price-guide effect on the CNH offshore market turns weaker after the reform. That said, the price-guide mechanism of CNH/USD was much amplified after the RMB exchange rate fixing price reform.

Table 2: Summary of Granger Causality test result

		Regress CNY on CNH (lag=8)	Regress CNH on CNY (lag=8)
BeforetheAugust 11 Reform	F-statistic	3.335	3.798
	Significancelevel	0.0008***	0.0002***
After theAugust 11 Reform	F-statistic	6.986	1.322
	Significancelevel	0.0000***	0.2279

Notes: *** means F-test is significant at 1% level; no * means it is not significant at 1%, 5% or 10% level.
Source: BBVA Research

IMI International Monetary Review

Revive the IMF SDR Substitution Fund

By OUSMÈNEMANDENG*

Introduction

The inclusion of the renminbi into the IMF Special Drawing Right (SDR) basket was an important but mostly symbolic step. The relevance of the renminbi inclusion will come with the proliferation of the SDR. This will rest largely on the amount of SDRs outstanding. While the IMF is unlikely to offer greater SDR allocations amid resistance from key IMF member countries, China should embark on promoting the SDR through an SDR substitution fund.It would likely define the actual future of the SDR and help inserting the renminbi into the international monetary system.

History of SDR

The SDR emerged amid perceived impending shortages of international reserves possibly disrupting or constraining orderly payments and settlement of international transactions. Concerns about the adequate supply of reserves are immediately related to the purpose and origins of the IMF itself. John Maynard Keynes stated as part of the objects of his 1942 proposal of an international clearing union:[1] "We need a *quantum* of international currency, which is neither determined in an unpredictable and irrelevant manner as, for example, by the technical progress of the gold industry, nor subject to large variations depending on the gold reserve policies of individual countries; […]." The SDR was based on a dual concern about inadequate reserve supply and undue dependence on countries issuing reserve assets.

The SDR was conceived during the 1960s amid mounting concerns about adequate international liquidity. Proposals to create international liquidity as per the Bernstein Plan through the Reserve Settlement Account or the Triffin Plan were still received with considerable hesitance. Triffin famously insisted that international liquidity should not be dependent on the balance of payments of the U.S. or the U.K. From 1964, the IMF became increasingly concerned about the slowing pace of reserve accumulation.[2]At the time, any rise in international reserve was mostly due to increased holdings of foreign exchange mainly dollarsandit was feared that the

*New Sparta Asset Management

[1] International Monetary Fund, The International Monetary Fund 1945-1965, Volume III: Documents, Washington, D.C., 1969. Italics as per original.

[2] International Monetary Fund, The outline of a new facility in the Fund, DM/67/58, 15 September 1967.

accretion of dollar international liquidity will soon dry up leading eventually to a significant weakening of the structure of international liquidity.[3]In 1965, the IMF included as part of its work programme the need for additional reserves.[4]In 1967, the IMF began deliberations in earnest about a reserve facility based on drawing rights in the Fund.[5] In 1968, the IMF Executive Board issued a report recommending modifications of the Articles of Agreement of the IMF to establish a facility for special drawing rights.[6] On 1 January 1970, the first SDR allocation was made.[7] In 1978, the second amendment of the IMF Articles of Agreement came into effect and provided for the SDR to become"the principal reserve asset in the international monetary system."[8]

In 1972, at the IMF Annual Meetings, then U.S. Treasury Secretary George Shultz offered the international community a bold plan to reform the international monetary system and end the special role of the dollar as a reserve currency. The U.S. proposal came after a complete disruption of the then existing monetary order and as key countries growing mistrust in the U.S. administration's willingness to make necessary economic policy adjustments to ensure the stability of the dollar. Shultz presented the outlines of a plan including: Substituting the dollar for the SDR to become the formal numeraire of the system, offering an exchange of existing reserve assets (dollars) into other reserve assets, eliminating the role of gold, transferring sovereignty to international institutions to manage the system.[9]

The idea of a substitution account to exchange foreign exchange for SDRs had emerged. It rested largely on the desire to substitute existing reserve assets and bring forward the amount of SDRs outstanding.In 1972-74, the Committee of Twenty analysed the possibility of a substitution account based on a compulsory exchange of foreign exchange assets for SDRs.[10]In 1975, the IMF debated a substitution account for gold to allow IMF member countries to obtain SDRs in exchange of gold.[11] In 1979 after different iterations, the IMF reconsidered a substitution account to

[3]International Monetary Fund, Gold and international liquidity, EBD/64/85, 10 July 1964.
[4] International Monetary Fund, Future work on international liquidity and related topics, EBD/65/168, 18 October 1965.
[5]International Monetary Fund, An outline of a reserve facility based on drawing rights in the Fund, SM/67/69, 29 May 1967.
[6] International Monetary Fund, Report of Executive Directors, SM/68/38, 1 March 1968; International Monetary Fund, Board of Governors Resolution 22-8, SM/67/78, 16 April 1968.
[7] International Monetary Fund, Allocation of Special Drawing Rights, EBD/70/4, 6 January 1970.
[8]International Monetary, Fund Articles of Agreement, Article VIII section 7, 1 April 1978.
[9]The New York Times, "Text of Shultz talk before International Monetary Fund and World Bank," 27 September 1972.
[10] James Boughton, Silent Revolution, The International Monetary Fund 1979-1989, Washington, D.C., 2001.
[11] International Monetary Fund, A Substitution account for gold, SM/75/94, 24 April 1975.

exchange dollars for SDRs. The idea attracted considerable interest and consisted of an account administered by the IMF that accepts deposits on a voluntary basis of eligible dollar-denominated securities in exchange for an equivalent amount of SDR-denominated claims. Considerations assumed that for such account to obtain broad participation, the costs and benefits should be fairly shared among all parties concerned and it should contain adequate provisions for liquidity, rate of interest and preservation of capital value. The account was seen to contribute significantly to promote the SDR as the principal reserve asset. Its proposal aimed to maintain stable the balance between assets and liabilities affected by differences in the interest rates between dollar and SDR-denominated claims and the exchange rate of the dollar against the SDR. A proposal was submitted to set aside IMF gold to support the operation of the account while the U.S. and other participants would share any residual profit or loss of the account.[12]

The SDR's favourable momentum though was short-lived.Conditions for reserve supply changed andsupport for the SDR declined precipitously. SDR allocations remained few and the substitution account ideas were abandoned in 1980. The idea failed largely amid disagreement about the distribution of the risks and costs involved.[13]

The 1970 SDR allocation was part of first general allocation in 1970-72 of SDR9.3 billion and the second general allocation in 1979-81 was of SDR 12.1 billion. For almost 30 years, no further SDR allocations were made. In 2009, amid some renewed interest, a third general allocation of SDR162.2 billion was distributed together with a special one-time allocation of SDR21.5 billion. There are SDR204.1 billion outstanding today.

The limited interest for SDRs rests in large part in the SDR's features and failure to adopt the substitution accounts. The SDR is a reserve asset issued by the IMF and used almost exclusively in transactions with the IMF. It is de facto a credit line allowing countries to exchange SDRs for foreign exchange. It is neither a currency nor a liability of the IMF. The SDR is for all practical purposes a pure form of internal money. Its valuation does not depend on market movements nor does it seemingly affect the market. As such the SDR value offers little indication about net demand for international liquidity. The SDR are held predominantly by central banks in their accounts in the IMF. The SDR is also a unit of account and all transactions of the IMF are accounted for in SDRs.Attempts to give rise to private sector use of

[12] International Monetary Fund, Report of the Executive Board to the Interim Committee on a Substitution Account SM/80/89 15 April 1980.
[13]Boughton idem.

SDRs were largely unsuccessful.

The SDR valuation is a weighted average of the exchange rates of the SDR basket currencies relative to the dollar. The currencies included in the SDR basket are the dollar, euro, sterling and yen and from October 2016 the renminbi. The weights are based on the share of each currency in world exports of goods and services and international reserves. The addition of the renminbi to the SDR basket represents some innovation—the SDR was made previously of many currencies—but does not address the fundamental limitations inherent in the SDR (Table).

The most limited feature of the SDR seems to be the small amount outstanding. The equivalent US$280 billion of SDRs pales against the US$11,400 billion in central bank foreign exchange reserves.

Future prospects

The reluctance to issue more SDRs has been based in large part on an assessment by the IMF that there is insufficient demand for additional reserve assets and subsequent opposition by key IMF member countries. General SDR allocations are performed on a needs basis, that is, whether there is a long-term global need to supplement existing reserve assets. Decisions on general allocations are normally taken for successive basic periods of up to five years. In 2001, in conclusion for the eighth basic period, one IMF Alternate Director stressed that "we cannot support the finding of a 'long-term global need.' The current slowdown of the world economy can be attributed to many factors—the lack of availability of SDRs is surely not one of them. [O]n a global scale, the system has been capable of generating the reserves it needs."[14] The view has been representative for the dominant attitude at the IMF Executive Board. In 2011, for the tenth basic period, the IMF Acting Managing Director concluded that there is no broad support for an SDR allocation.[15] The views expressed by some IMF Executive Directors that SDR allocations should also respond to mounting undue concentrations in reserve holdings and to serve to promote the SDR as a reserve asset have remained unheeded.

An SDR substitution account is considered to remain the most promising approach to promoting the SDR. The mechanism of such account remains relatively simple if and only if considerations of risk and cost sharing are discarded. The aim would be to use a substitution account to issue SDRs in large amounts to offer

[14] International Monetary Fund, Minutes of Executive Board Meeting EBM/01/128, 12 December 2001.
[15] International Monetary Fund, Report of the Acting Managing Director to the Board of Governors and to the Executive Board pursuant to Article XVIII, Section 4(c), 30 June 2011.

adequate liquidity and establish a private market for SDRs. Participation should be strictly voluntary and participants attracted by the properties of the SDR-denominated securities issued by the account. The proposition rests largely on the implicit diversification benefits of holding liquid SDR-denominated securities that have been significantly enhanced with the adoption of the renminbi in the SDR basket.The renminbiwould itself directly benefit by gaining access to a broad international investor base.Participants could include central banks but also private sector investors. One of the key lessons of previous attempts at a substitution account is that participants have to be willing to hold SDR risk.

China should give consideration to sponsor launching a substitution account. This could be done by seeding an SDR substitution fund. The fund would hold as assets, eligible securities deposited by participants in the fund andparticipants would receive SDR-denominated notes in exchange.The SDRs would be freely tradable with third parties and the price be strictly market determined as a function of the net asset value of the account, that is, the advantage of poolingdifferent reserve assets. The value of the SDRs would thus be the difference between the value of the deposited assets and the liquidity premium of the SDRs and the transaction costs of diversification. The SDR could trade at a discount or premium to the net asset value of the fund.

The SDR will remain mostly symbolic if SDRs outstanding remain small. The IMF is unlikely to support significant additional SDR allocations. China should therefore give consideration to initiating andlaunching an SDR substitution fund possibly as part of its G20 Presidency agenda.As in the past, a substitution fund will likely determine interest in and the future of the SDR. It will thus decide on the actual relevance of the renminbi SDR basket inclusion.

Table. SDR basket composition

Initial weights

	Jul 1969-Jun 1974	Jul 1974-Jun 1978	Jul 1978-Dec 1980	1981-85	1986-98	1999-2016*	from Oct 2016
Gold (grams)	0.8887						
U.S. dollar		0.330	0.330	0.420	0.420	0.419	0.417
Deutsche mark		0.125	0.125	0.190	0.190		
Pound sterling		0.090	0.075	0.130	0.120	0.113	0.081
Japanese yen		0.075	0.075	0.130	0.150	0.094	0.083
French franc		0.075	0.075	0.130	0.120		
Canadian dollar		0.060	0.050				
Italian lira		0.060	0.050				
Netherland guilder		0.045	0.050				
Belgian franc		0.035	0.040				
Swedish krona		0.025	0.020				
Australian dollar		0.015	0.015				
Danish krone		0.015					
Norwegian krone		0.015	0.015				
Spanish peseta		0.015	0.015				
Austrian shilling		0.010	0.015				
South African rand		0.010					
Saudi Arabia riyal			0.030				
Iranian rial			0.020				
Euro						0.374	0.309
Chinese renminbi							0.109

Source: Boughton, J. (2001), Silent Revolution: The IMF 1979-1989, IMF (corrected); IMF. *In January 1999, the Deutsche Mark and French franc were replaced by equivalent amounts of euro, weights with effect from January 2011.

IMI News

2015 IMI Annual Meeting

January 18, IMI welcomed the opening of its 2015 annual meeting in Culture Square. The meeting was attended by Cui Wenli, chairman of IMI council and general manager of Maida Investment and Consultancy Co., Ltd; PengXiaoguang, deputy chairman of IMI council and vice president of Global Business & Times; IMI Academic Committee members including Chen Weidong, Ding Zhijie, GuoQingwang, Hu Xuehao, Liu Jun, QuQiang, Zhang Jie, and altogether over 30 members of the Council and the Academic Committee. The conference is chaired by Ben Shenglin, executive director of IMI and founding dean of Academy of Internet Finance of Zhejiang University.

Prof. GuoQingwang delivered his opening speech on behalf of the School of Finance. He spoke highly of all the significant jobs accomplished by IMI in 2015.

Director Zhang Jie presented his summary of 2015 and expectations for 2016. He briefly reviewed major tasks finished in each month of 2015, including the Macro-Finance Salon, ASEAN+3 Macroeconomic Research Office (AMRO) meeting, and International Monetary Forum and press conference of the RMB Internationalization Internationalization Report. Meanwhile, He also discussed about the future opportunities and challenges that might appear in following tasks, such as the completing the Series of IMF History Project, building five scientific research teams, improving IMI research and report system, publishing the RMB Internationalization Report 2016 in China and abroad, etc.

Members of the Council and the Academic Committee, as well as research fellowshad a deep and broad communication based on their own consideration, and gave suggestions to the future development of IMI. Cui Wenli spoke highly of the newsletters and journals published by IMI. Chen Weidong looked forward to deeper researches, taking RMB internationalization as an opportunity, and providing feasible and proactive solutions for academic governance reform. Hu Xuehao pointed out that IMI should stick to RMB internationalization as the research topic, expand the scope of research, establish a sound operation mechanism for the future. Liu Jun provided a series of suggestions on how to expand the research scope,

promote the academic masterpieces, and enhance the cooperation and mutual trust with all parties.

Roundtable on Money and Finance·Winter 2015

On January 16, Roundtable on Money and Finance •Winter 2015 was held in Fuzhou, jointly organized by IMI, Minjiang University and RUC Fujian Alumni Association. The conference was themed cross-strait financial cooperation after RMB's inclusion into the SDR. The conference was attended by Wei Benhua, former deputy administrator-in-bureau of SAFE;E Zhihuan, deputy general manager of Economics & Strategic Planning Department of BoC (Hong Kong); Cai Yingyi, professor of National University of Kaohsiung; and more than 100 other guests from Beijing, Shanghai, Fujian, Taiwan and Hong Kong. The conference was chaired by Tu Yonghong, deputy director of IMI.

The conference was held on the day of Taiwan's presidential election. It is of great significance to discuss economic and financial cooperation on this day.

After opening remarks, on behalf of RUC-Taiwan Sinopac research team, Prof. He Qing and Prof. Cai Yingyidelivered the keynote speeches. Prof. He focused on the research on One Belt One Road and cooperation mechanism across the strait. He pointed out the fact that the economic cooperation between mainland and Taiwan was still restricted by various factors. Furthermore, he put forward profound suggestions on deepening cross-strait financial cooperation and promoting regional integration from five aspects. Prof. Cai analyzed cross-strait financial cooperation after RMB's inclusion into the SDR in three aspects. He emphasized the core issue of deepening cross-strait exchange and cooperation was transforming "China Threat" to "China Trust" in 2016.

In the panel discussion, the guests discussed in-depth on topics of SDR inclusion, cross-strait financial cooperation, RMB internationalization, etc. Wei Benhua explored the significance of RMB's inclusion in the SDR and theimpact on RMB internationalization. E Zhihuan emphasized issues of RMB exchange rate and RMB internationalization. Zhao Zhong, the founding partner of Murong Investment. Ltd., presented his insight about the capital market under the exchange rate reform. Pan Changfeng, director of Internet Financial Development Research Center, elaborated the effects of SDR inclusion on the development of Free Trade Zone.

Roundtable on Money and Finance·Spring 2016

On March 26, Roundtable on Money and Finance Spring 2016 was held in Renmin University. The conference was themed "financial support for the supply-side structural reform". Executives of financial regulation sectors and financial experts were present at the conference and delivered speeches, including Jiao Jinpu, the chairman of Shanghai Gold Exchange; Guan Tao, senior research fellow of China Finance 40 Forum and former director-general of the Department of International Balance of Payments of SAFE; Wang Yongli, senior vice president of LeTV and former vice president of Bank of China; E Zhihuan, deputy general manager of Economics & Strategic Planning Department, Bank of China (Hong Kong); Yan Xiandong, head of the Division of Census and Statistics of PBoC; Xi Hui, deputy director of the Research Institute of Financial Informatization of PBoC; Pan Changfeng, director of Haixi Reseach Center of Fiscal and Financial Development, Research Base of Humanities& Social Sciences in Universities in Fujian Province; Li Xin, professor of the Research Institute of Securities and Futures of Capital University of Economics and Business; Guo Qingwang, dean of the School of Finance, RUC; Zhao Xijun, associate dean of the School of Finance, RUC; Qu qiang, director of China Financial Policy Research Center, RUC; Ben Shenglin, executive director of IMI; Song Ke, deputy director of IMI. The conference was chaired by Tu Yonghong, deputy director of IMI.

Mr. Jiao Jinpu talked about the four key elements of the supply-side reform, i.e., cutting taxes, reducing costs, encouraging innovation and promoting the flexibility of labor market. He discussed how the Reaganomics and Thatcher's privatization reform of state-owned enterprises had helped western countries in relieving stagflation in the 1980s, and how their experience can be learnt by us to solve our problems. He also explained the supply-side reform thoroughly from 3 aspects: behavior regulation, inclusive finance and financial innovation.

The topic of Dr. Guan Tao's keynote speech was "increasing and improving financial supply is key to comprehensive supply-side reform". He pointed out that from both the global and domestic perspectives, finance could support the real economy not only through monetary stimulus, but also through other means. He also analyzed the 6 main parts of Chinese financial supply-side reform, including enriching the financial institution system, improving the financial market system, enhancing the financial innovation function, perfecting the financial macro-control, further opening up the financial system and improving the financial governance

system. Meanwhile, he mentioned that the reform should properly balance the relationships between adjusting structure and stabilizing growth, direct financing and indirect financing, supporting development and stabilizing finance, encouraging innovation and regulating in an appropriate manner, further opening up and preventing risks, learning from global experience and considering China's national conditions, using policy guidance and staying market-oriented.

Macro-Finance Salon (No. 29): Blockchain - the Basic Framework of Value Internet

On March 5, Macro-Finance Salon (No. 29) was held at Renmin University of China. Wu Zhifeng, senior research fellow of IMI and director of International Strategy Department, Research Institute of China Development Bank, was invited as the guest speaker. He delivered a speech on "blockchain: the basic framework of value internet".

In his speech, Mr. Wu Zhifeng first introduced the definition of blockchain—a shared distributed public ledger technology that makes decentralized trust possible for the first time. He analyzed the role blockchain plays in the internet protocol stack and emphasized the three core features of blockchain—consensus, security and openness. He also introduced blockchain's development trend, point-to-point value transaction and smart contract. As for how the blockchain works, Mr. Wu explored its decentralized mode, its logical structures in systems and businesses and the process of the new distributed public ledger.He pointed out that dynamic network, ledger structure and consensus mechanism isthe three key technologies for blockchainto establish decentralized trust.

Macro-Finance Salon (No. 30): Capital Account Management and Convertibility

On March 22, Macro-Finance Salon (No. 30) was held in Room 714, Mingde Main

Building. IMI senior research fellow, Sun Lujun, executive director of Guoxin International Investment Corporation Ltd. and the former director-general of the Capital Account Management Department of SAFE, was invited to deliver a speech on capital account management and convertibility. IMI research fellowZhang Chao chaired the meeting.

Sun introduced China's foreign exchange management of capital account transactions regarding its content and purposes. He also analyzed in detail the IMF's attitude towards managing capital flows. He believed that the main purpose of such management were to prevent rapid surges of cross-border capital flows, especially short-term capital flows, and to maintain the balance of payments, so that a country's financial system and economic development would not suffer severely from inflow surges or disruptive outflows. Sun pointed out that after the financial crisis IMF became more pragmatic on capital flow management, acknowledging its rationality under certain conditions. But IMF also noted that capital flow management was only a temporary measure because there were prerequisites.

Capital account convertibility, in Sun's view, was an important part of China's financial reform and opening up. Theoretically, less government interference in the financial system and market would help turn idle funds into productive investment outlays and channel funds to more productive sectors and regions. Therefore, financial development and economic growthcould mutually support each other. Generally, the changes in global economic landscape gave China favorable opportunities and environment for financial reform and opening up. Sun believed that China should seize the "window period"of such changes to step towards financial liberalization. Specific measures included ending any form of financial repression that still exited, forming a market-oriented financial system, further promoting market-based interest rate and exchange rate, and progressively realizing RMB capital account convertibility. These required reformers to be courageous and farsighted enough. Meanwhile, RMB capital account convertibility needed overall planning, gradual improvement, and space for adjustment.

Tao Xiang International Finance (No. 3): Lessons Learned from the 2008 Financial Crisis

On March 25, Tao Xiang International Finance Lectures (No. 3) was held in Renmin University. Geng Qun, the general manager of the asset management

department of Huaneng Trust, made a speech on "Insight and Inspiration – Lessons Learned from the 2008 Financial Crisis". Wei Benhua, former deputy administrator-in-bureau of SAFE; Wang Fang, assistant dean of the School of Finance; and Xu Yisheng, CEO of Hangzhou China Soft New Dynamic Asset Management Company attended the lecture and made comments accordingly. Prof. Tu Yonghong, deputy director of IMI, chaired the lecture.

The 2008 global financial crisis, though struck 8 years ago, provides lessons for China, argued Dr. Geng. He spelled out, in chronological sequence, how the crisis developed, why it happened, and how the governments around the world tried to tackle it. He also introduced how this crisis inspired China's development. He believed that America's subprime mortgage crisis was mainly attributed to the government's policies that encouraged home ownership and to the relatively easy monetary policy. China was not severely impacted by the crisis, which helped it demonstrate its capability to the world. The reason was that China hadn't implemented capital account liberalization at that time. After several years of reform and opening up, China now faces more challenging problems such as controlling the real estate bubbles, implementing supervision after capital account liberalization, developing the financial system, innovating financial products, and adjusting economic structure. He encouraged the students to fully utilize their knowledge in their work and play their part for China's future development.

IMI Research Team Visits Taiwan

On January 12 and 13, the Cross-Strait Financial Cooperation Forum co-hosted by IMI and BankSinoPac was held in Taipei. TuYonghong, deputy director of IMI;and He Qing, Wang Fang, and Qian Zongxin, researcher fellows of IMI, delivered keynote speeches.

Prof.TuYonghong centered on the mainland's marketization reform of interest rate, exchange rate and capital account and reviewed the entire process in which the mainland's marketization reform had been launched, promoted, and deepened during the past 37 years. She particularly explained why and howreform policies were made based on the macro situation and momentous events in each stage so asto accommodate the overall reform goals. She resumed to summarize historical experiences and put forward sensible suggestions for the future direction of China's marketization reform.

Prof. Wang Fang gave a keynote speech under the title of "New Triffin Dilemma and RMB Internationalization". She started with the US current account deficits, laid special stress on analyzing the causes of the exacerbation of the UScurrent accounts, and pointed out that there exists a long-term imbalance between economic imbalances and currency imbalances in the US. She mentioned that under the Jamaican currency system, the exacerbation of the US current accounts leads to the "New Triffin Dilemma", which gives rise to frequent occurrence of international financial crises, as well as a "balance of terror" in the global economic and financial systems.

Prof. He Qing delivered a keynote speech on the Belt and Road Initiative and mechanisms for cross-strait cooperation, in which he pointed out the advantages and opportunities for Taiwan to join the Belt and Road Initiative. He pointed out that cross-strait economic cooperation still faces many restrictions, and came up with five suggestions for enhancing the cross-strait economic cooperation and the regional integration.

Prof. Qian Zongxin centered on the determinants ofthe offshore financial center's core business and their reference for cross-strait financial cooperation.

FCEE Joins Hands with IMI as the First Partner in Latin America

School of Business Studies and Economics at University of Montevideo (FCEE) signed the Memorandum of Understanding with IMI on February 10, becoming the first partner of IMI in Latin America. Alejandro Cid, the head of FECC, signed the memorandum with Herbert Poenisch, member of the IMI academic committee and former senior economist of the Bank for International Settlements.

FCEE is an integral part of the University of Montevideo, specializing in tertiary education and research in the fields of business, finance and economics. It is considering the establishment of a research center focusing on economic ties between the Southern Cone of South America and Asia，building on the increased trade and financial relationships between these areas.

Further down the road, FCEE will conduct close cooperation with IMI in such areas as academic activities, talent exchanges, joint research, and information sharing.

Executive Director of IMI Attends the Inauguration of Raisina Dialogue in India

From March 1st to 4th, Ben Shenglin, executivedirector of IMI, was invited to the inauguration ceremony and first conference of Raisina Dialogue sponsored by Indian Ministry of Foreign Affairs and Observer Research Foundation.

Raisina Dialogue is established imitating Singapore's Shangri-La Dialogue. As a high-level forum, it aims at enhancing India's international and regional influence. The conference was attended by government officials and influential scholars around the world.

Prof. Ben made a speech entitled "the role of emerging Asia in global trade governance" on the Competing Globalization Forum. During the conference, he also discussed with Dr. Jaya Josie, member of IMI Academic Committee and Head of BRICS Research Center of Human Sciences Research Council, on the implementation of Memorandum of Understandingbetween IMI and HSRC.

During his visit in New Delhi, Prof. Ben was also invited to deliver a speech at the Chinese Embassy in India on thenew normal of globaleconomy and China's supply-side financial reform. He visited the School of Management at the University of Delhi and discussed with Professor Simrit Kaur on joint research and student exchangeopportunities.

Call for Papers

International Monetary Review

International Monetary Review is an internal academic magazine sponsored by International Monetary Institute. Following the principle of including both Chinese and western merits with precise and practical academic spirit, International Monetary Review focuses on the cutting-edge theoretical researches in internationalization of RMB, reform of international monetary system, regional monetary and financial cooperation, China's international financial strategies, and other macro-financial theories and policies.
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General rule: Submitted manuscripts should be double-spaced texts in 10.5 point font, and formatted for paper of standard size with margins of at least 20mm on all sides. Pages should be numbered, and an abstract (of no more than 200 words), as well as keywords and complete author affiliations, should be included in the paper in the title page. A regular article should not exceed 50 pages.
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