THE GREAT DELEVERAGING: ESSAYS ON CHINA'S FINANCIAL REFORMS OF
2016 AND 2017

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The Chinese Central Government introduced economic and financial reforms (“Supply-side Structural Reform (SSR)”) in Dec. 2015 to reducing the systematic default risk in China’s economy by de-capacity (removing excessive production capacity), de-stocking (removing excessive inventories) as well as deleveraging. The achievement of deleveraging involves removing high leverage ratios in both firms and financial institutions. Shadow banking, developed since 2009 and became an important financing channel besides the traditional approach, equipped with the same “bank-centric” feature as the financial sector received a lot attention during deleveraging. Policymakers together with financial regulators working cooperatively toward deleveraging by regulating financing channels connecting banking system and the real economy and urging the reduction of leverage ratios of firms. A variety of methods were involved in the process, such as banning of shadow banking, regulating the banking system, urging bank loan repayment in targeted industries, and discouraging the issuance of new loans to these firms and industries. The retraction of bank loans, the restrictions placed on issuing new loans and fund source of banks changed financial condition for firms. This change led firms to seek financing from alternative channels which affect risk of investment in stock market.

To address the change in financial conditions and its effect on stock market during deleveraging, this research discusses the issues in 3 chapters. Chapter 1 surveys the back-
ground and implementation of deleveraging policies. “Financialization”, which support overleverage ratio in real economy, was used by firms to hedge risks from uncertainty in goods market. Deleveraging has different effect on firms with different types of ownership, and operating liabilities also increased while financial debt fell due to changes in financial conditions. Updated regulations for deleveraging in financial sector (especially in banking system) designed to remove overleverage in financial system via discouraging funds into asset and firms overleveraged, reforming internal management based on macro prudent principles, and encourage funds into firms with real financing needs to develop their business. Chapter 2 discusses the choice of measuring stock market volatility risk in studying financial condition changes’ effect on stock market volatility. Among the 9 listed models for calculating volatility, Truncated Realized Volatility (TRV) is selected for volatility risk measurement. And the statistic shows mid-to-small capital sized stocks was not such volatile as large capital sized stocks before deleveraging, and it became more volatile than large capital sized stocks after deleveraging. Chapter 3 tests the dynamic relationships among the stock market volatility risk, the economy’s demand of money and the use of leverage in stock market (alternative financing approach) represented by margin trading balance using Vector Error Correction Model (VECM) during deleveraging. Deleveraging caused changes offer an opportunity of studying volatility risk in stock market through the perspective of leveraged trading and related financing conditions. Margin trading contributed to stabilize stock market volatility after the reforms were imposed, while it destabilized stock market before deleveraging. This result indicates firms’ alternative financing approach’s effect on volatility. Furthermore, tight financing conditions limited funds from the banking system (interbank market) to access the stock market directly. This reduced speculation in the stock market which further reduced volatility.
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CHAPTER 1
A SURVEY ON DELEVERAGING POLICY AND ITS IMPLEMENTATION

1.1 Background on Deleveraging Policy

Deleveraging was brought up in October 2015 as to remove the systematic risk from both financial system and real economy. It is one of China’s supply-side reform “de-capacity, de-stocking (reducing inventories) and deleveraging” in China starting from November 2015 and its target can be categorized into 1) removing massive leverage associated with multilayer-leverage financing, investment activities and maturity-mismatch in financing system 2) and to remove leverage supporting projects with high risk of default due to poor operation performance in non-financing firms, which usually have stable connections with banks relative to their peers, in real economy.

The motivation of deleveraging comes from the sluggish recovery from overseas’ market after 2008 financial crisis. With export’s fraction in GDP dropped from the historical highest level 35.4% in 2006 to 17.4% in 2017 (the year in this research sample), the continuous rise in production of export was no longer supported by its oversea markets. Meanwhile, the large 4 trillion CNY stimulus plan implemented after 2008 extended the life of firms whose oversea markets were affected and shrunk during and after the 2008 crisis.\footnote{The exchange rate CNY/USD is approximately 6.3.} Without orders from oversea markets, the firms with primary oversea business were stuck in the cycle living on both lower expectation of revenue from business and loans from banks with low rates to payback old debts. Those firms are called “zombie firms” as they (or some of their projects) cannot live on their own if loans from banks were cut off. From banks’ perspective, those zombie firms, which used to be customers with steady income flow, were less attractive given their business’ prospect. Hence, banks were forced to seek
for new loan and investment opportunities to replace that fraction of old customers.

Investment into real estate, asset markets were the obvious answers to the financial system. Real estate related loans guaranteed banks with interest rate ranging from 10% up to as high as 55% in 2013.\(^2\) Banks can realize their investment with a fixed income into asset markets by tunneling their funds into asset markets through non-banking institutions, such as trust funds, investment funds or brokers. Moreover, non-banking institutions with banks’ funds had no better option other than investing into stock and bond markets since returns there were higher. Brokers were also one of the beneficiaries along the chain of fund tunneling as they can benefit greatly from supplying investors margin trading opportunities to collect commission fees. Thus, margin trading became the engine driving up stock prices and causing later crash in stock market in 2015.

The forces that made it possible to sustain the credit chain and prosperity of stock market originated from low interbank market rate: the rate started with range between 2.5% to 3.8% in 2014, dropped to 1.5% in early 2015 and remained at relative low levels around 2% until August 2016. Low cost of funds from money market, the prosperity of both real estate and asset markets and loans to industries with high risk of default collectively contributed to high leverage in financial system, especially in stock market and banking sector. Market-wide high leverage levered margin trading raised the attention of regulators since it has the potential to cripple the whole finance system and spread its influence across other sectors of the economy resulting a systemic economic crisis. With the target of stabilizing financial system, regulators started to deal with overly raised leverage in margin trading of stock market in June 2015. It is worth to point out that the June 2015 stock market crash is also part of deleveraging. It can be seen as the overture of deleveraging policy determined in October 2015 since it was the results of the existence of excessive producing capacity without enough market and the direct exposure of the danger to financial system.

\(^2\)Estimated based on benchmark interest rate for loan in 2013, mid-to-long term interest rate are 6.15% (1 year – 3 years), 6.4% (3–5 years), 6.55% (5 years and above), short term loan interest rate are 5.6% (6 months and below) and 6% (6 months - 1 year). Banks loans to real estate developers can have interest rates floating up by 5% 50%.
and economy with overly high leverage.

1.2 Leverage Ratio Change after Deleveraging

Policies targeting Deleveraging are implemented differently across residential, non-financial corporate, government and financial sectors. The differences in policy implementation across sectors suggest the principle of structural deleverage. The structural-deleverage principle makes deleveraging in non-financial corporate and financial sectors the primary targets, not the residential sector. The leverage ratio in the residential sector was considered not as risky as in financial and non-financial corporate sectors. Research done by Zhang, Chang and Liu in 2018 ([39]) suggests the residential sector can fully cover down payment and interest of their debt with their income, deposit and financial assets held. The different risk bearing capacities across sectors indicates structural deleveraging to be the appropriate routine to follow while maintaining stable economic growth, controlling the overall leverage ratio. This deleveraging principle separates the series of deleveraging policies into two directions.

One direction is to lower leverage in non-financial corporate sector (as showed in Figure 1.1). The leverage ratio in the non-financial corporate sector was rose from 119.6% in 2011 to 151.2% in 2015 at an average rate of 6.32% per year. With the impact from deleveraging policies, the annual increasing rate dropped to 0.5% in 2016. The leverage ratio was further declined in 2017 from the first quarter of 160.4% to the last quarter of 156.6%.

The other direction of deleveraging is to lower the leverage ratio in the financial sector. The leverage ratio of the financial sector is measured from both asset side and liability side of financial institutions’ balance sheet. Figure 1.2 clearly shows the tendency of the leverage ratio before and after deleveraging in the financial sector. The leverage ratios measured from asset side of the balance sheet is close to the values measured from the liability side in 2011 and the asset side leverage ratio even equals the liability side leverage ratio in the
fourth quarter of 2011. Then the gap between the two measurements begins to enlarge after 2011 until 2016 where it reaches its highest level and shrinks afterwards. The trend suggests the start of initiating deleveraging policies from 2016 (late 2015). Liability-side and asset-side measured leverage ratios both rise from 2011 to 2015, and the average annual increasing rates are 5.16% and 5.84% respectively. The 0.68% difference between the annual increasing rates of the two leverage ratio measurements suggests a strong motivation for expanding business out of balance sheet through adding leverage to circumvent regulations and raise revenue. The above 5% annual rise in the leverage ratio disappears in 2016 and starts to decline in 2017, showing deleveraging policies’ effort in reducing the leverage ratio in the financial sector. Both the decline in trend and diminish in gap of the two leverage ratio measurements in 2017 imply the imposition of new regulation and the consequent leverage ratio drop in the financial sector.
1.3 Deleveraging’s influence in the Real Economy

1.3.1 Before Deleveraging

The purpose of deleveraging policies and actions is to reduce the overall economic risk accumulated. Apart from leverage in money market and asset market directly added by financial institutions, non-financial corporations also have strong incentives to add leverage for higher earnings in the financial and real estate markets. The 2008 Financial Crisis greatly changed the environment for international trade. As an important member in international trade, China was significantly affected. The fall in demand of the international market (together with low cost in money market, and the stimulus plan after 2008) helped to reshape the investment pattern of firms in China. This decline in demand after 2008 not only lowered the amount of exports, but shrunk the profit size of the real economy.

The less attractive profit margin from the real economy discouraged investment in industries producing tradeable products, and diverted attention to investment in financial asset and real estate. Such investment contributed to a rise in leverage and prices in both markets. Both central and local government’s stimulus plans counteracted the influence of the
2008 global financial crisis, helping sustained the production of firms hit during the crisis and heating the investment in infrastructure and real estate constructions at the same time. In addition, the counter cycle investment initiated by the stimulus plan also became the beginning of high leverage in the economy (non-financial corporate and financial sectors). The uncertain prospect and slackness of international demand made the profit margin fall which lowered investment efficiency. Meanwhile, the heated transactions that raised prices in the real estate and financial markets significantly helped firms to maintain a proper profit growth.

Some research studied the incentives of non-financial corporations to invest more financial assets. Li (2020) ([24]) used data from firms listed in China’s A-share stock market from 2007-2018 to explain how product competition is a factor other than drop in product demand contributing to the increase in the size of financial asset allocation. The more intensive the competition, the less earnings firms can get from activities of production. Thus investment in financial assets, unlike investment in production, can produce asset returns in less time and with less of the income uncertainty brought by selling competition so that firms can expect a more stable revenue.

Dou and Zhang (2021) ([13]) empirically studied non-financial corporations in the A-share market from 2012-2019, demonstrating that investment allocated in financial asset was higher than investment in R&D before deleveraging. Hu, Wang and Zhang (2017) ([19]) selected non-financial corporations in A-share market during 2002-2014 (prior to deleveraging) to test whether firms’ allocation of financial asset was based on consideration of precautionary saving or a pure substitution effect (i.e. larger size of financial asset allocation is out of firms’ consideration of raising profits). Their results show both effects affect financial asset allocation. And the above mentioned research represents most of the works studying the reason for non-financial corporations’ “financialization”. Their focus are on the substitution effect of earnings from financial investment for earnings from production activities.
Unlike them, theoretical research on the behavior of non-financial corporations’ investment in financial asset reveals another easily ignored factor affecting their investment decisions: the uncertainty of earnings from fixed capital investment, which contributes to producing activities. Zhang and Zheng (2018) ([36]) thinks the active financial and real estate markets, together with average shorter period of maturity, almost guaranteed a risk free environment for firms’ financial and real estate investment. However, variance of earnings from fixed assets (the uncertainty of earnings from fixed capital investment) is also a factor underpinning firms’ decision on allocation of financial and real estate investment. This result expands the scope of explaining the incentives of financial investment and emphasizes the importance of products’ demand for firms. In sum, non-financial firms preferred to allocate more investment in financial assets to reduce uncertainty in product selling, whereas non-financial firms’ “financialization” results from both uncertainty in product-sell earnings and relative higher and predictable returns from financial and real estate investment.

Besides the nature of earnings from products (related to fixed capital investment) and the higher interest of financial and real estate assets, state-owned enterprises and other firms with local government’s implicit guarantee are another source lifting the leverage level of the real economy. Loans issued to firms with such background can reduce bank loans’ default risk. This suggests banks can spend lower monitor cost if loans are issued to those firms since they have more predictable business operations with their steady market share. Furthermore, banks can also have guarantees over the return of loans given soft budget constraint of state-owned enterprises’ debt and debts of firms financing from local governments’ financing platform ensured by implicit government guarantees. Leverage added to those firms was thus sustained and even further scaled up by a continuous supply of funds from bank loans. State-owned firms and firms with the government’s implicit guarantee are usually located upstream in the supply chain.

The stimulus plan after the Global Financial Crisis also led to an increase of funds from bank loans flowing into those firms. Meanwhile, it’s worth pointing out, the demand shock
from overseas’ market did not have a direct effect on them. However, falling investment efficiency also threatened loans to those firms as insufficient demand of downstream firms’ products resulted in deteriorating demand for raw materials. High leverage ratio caused by overcapacity emerged out of this environment. Moreover, the structural mismatch between domestic production and domestic demand made it difficult to resolve this type of high leverage by solely relying on the domestic market’s purchasing capacity. The inefficiency of investment means the growth in profit was not commensurate with growth in investment, and one more unit of investment would slow down the profit growth. When internal finance cannot satisfy firms’ financing requirement under this condition, more bank loans or external financing is needed to maintain the firms’ normal operation and overcapacity would be the main force pushing up and sustaining a high level of leverage/debt (IMF, 2016 [27]; Zhang, Chang, Liu 2018 [39]).

It’s worth mentioning that the reason for high leverage in real estate industry is almost the same. Hu and Wu (2019) ([20]) analyzed the annual financial reports of non-financial corporations listed on the A-share market during 2001-2016. They found the pattern change in the difference in leverage ratios between state-owned enterprises and private-owned enterprises was due to the 2008 Global Financial Crisis. Their results showed the difference between average leverage ratio of private-owned firms and state-owned firms conversed from positive to negative. Furthermore, both private-owned and state-owned firms’ leverage ratios did not clearly relate to local GDP growth. Instead, that relationship became negative since 2008 as leverage ratios of both types of firms increased while local GDP growth rate fell. To stabilize the local economy and its subsequent objects such as employment and production, government officials would participate in the decision making process of state-owned firms’ bank loan application, and then bank loans could be used to maintain or even raise their producing capacities. Hu and Wu also suggested that bank loans to private-owned firms was not interfered by the 2008 crisis. So it’s obvious to conclude from their research that business of both types of firms were affected by global financial
crisis, but state-owned enterprises had higher level in debt and leverage ratios due to their soft budget constraint and local governments’ incentive to maintain local economic growth.

1.3.2 After Deleveraging

With the goal of reducing the overall risk of the high level of leverage accumulated since 2008, part of deleveraging policies’ focus was on the demand side of funds, i.e., the non-financial corporations. A case study of one steel company suggests overinvestment and overcapacity in production were the reasons for overleverage (Tian, 2019 [31]). As summarized in the previous subsection, uncertainty in returns of investment, soft budget constraint and the pressure to maintain local economic growth had driven leverage high among firms in nonfinancial sector. Zhang, Chang and Liu (2018) ([39]) recorded the achievement of deleveraging in the nonfinancial sector in 2016 and 2017. They demonstrates that the main contribution to deleveraging came from privately-owned firms: in the whole nonfinancial sector, the leverage ratio dropped from 158.2% to 156.9% by 1.3% in 2017, while the leverage ratio only dropped by 0.4% from 66.1% to 65.7% in state-owned firms in the same year.

The effectiveness of deleveraging policies was further investigated by examining firms with varying features. Xu, Zhou and Lu (2020) [33] found that firms with different levels of leverage ratios faced pressures from deleveraging differently: overleveraged firms with higher leverage ratios were more likely to be deleveraged, but this was not the case among state-owned firms. In addition, the deleveraging policy was effective in removing the overly high leverage in private-owned firms and state-owned firms controlled by the central government, while the effect was not significant in local government managed state-owned firms.

Yang and Wang (2020) [35] investigated the sources of firms’ external financing after deleveraging using A-share financial data from 2003-2016. Their results showed firms’ debt structure changed and operating liabilities (debts with upstream suppliers or clients
being the creditor) increased while financial debt (banks being the creditor) declined, although firms’ overall leverage ratio did fall after deleveraging. The structural change in firms’ debt resources suggested the tighter financing conditions from banking system after deleveraging.

Zhang and Pu (2018) ([40]) explained the changes of firms’ financing conditions in a theoretical work from the banks’ point of view since the start of deleveraging. They think the uncertainty of economic prospect, together with banks’ operating and profit-making modes made the financing environment harsh for firms with debt repaying abilities. A part of firms’ deleveraging pressure was from their banks who offered credits. The goal of banks shifted from finding valuable and reliable loan projects to reducing losses from earlier issued loans when the economic prospect was filled with uncertainty. With the judgement of future economic performance and change in operating objective, banks would urge the firms equipped with debt repayment capability to repay the loans, while extending the time of debt duration for firms without debt paying capability. Banks took action based on their own profit making pattern, because the opportunity cost of not repaying the debt would not be much worse in an environment with uncertain economic prospect, and the governments’ policy of stimulating economic activities might offer a chance for that firm to be able to repay the loans again.

In the meantime, debt repaid by firms with sound debt paying capacity could offer banks liquid asset or cash and maintain a resilient balance sheet in a relatively volatile environment. From the previous research, it is obvious that deleveraging policies targeting over-leverage were effective in reducing the excessive leverage in non-financial sector. Both state-owned and private-owned firms were affected, though the leverage ratio dropped more in private- than in state-owned firms because of the soft budget constraints of state-owned firms. Considering the banks’ goal of holding enough liquid assets and reducing potential losses during periods of uncertainty, deleveraging greatly reduced the risk of bankruptcy of overly leveraged firms while raising firms’ need of liquidity for operations
and their difficulty of financing from the banking system.

1.4 Deleveraging’s Influence in the Financial Sector

Apart from leverages added by non-financial firms, the rise of shadow banking was another force that fueled the leverage accumulation inside the financial sector. Shadow banking is a type of financial institutions outside the regular banking system doing financial intermediation while not subjecting to the current banking regulations. Unlike the typical shadow banking in US where the business was featured with securitization and financial engineering, the shadow banking in China was developed with its own features: first, their investment is essentially equipped with features of bank loans as banks are the ultimate providers of funds with collateral requirements; second, no matter how the credit chains of shadow banks evolved, the banking system remains the center of the credit chain network.

Other financial institutions, such as brokers, trust companies and fund companies would then help banks to find investment projects charging higher rates than those charged for bank loans. Also, the asset invested asset could be a construction real estate project, various types of securities or some loans to projects which don’t meet the banks’ normal collateral requirement. Thus, with the banking system being the center of the credit chain’s network providing fund for loans, other types of institutions in the financial sector cooperated by circumventing banking regulations to find investment opportunities. This formed the typical structure of China’s shadow banking (or simply “bank-centric, other financial institution on the peripheral” format).

This basic institutional structure of shadow banking shows the interlinkages among financial institutions and within commercial banks themselves. And that structure determines how the default risk is distributed among the institutions in the financial system:

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3 Deleveraging was also a requirement in the government, especially in local government. Local government usually borrowed from banks (primarily) or issued bond to provide local firms loans with implicit guarantee and loans from local governments’ financing platforms. As the local firms being the ultimate debtor, debts in government can be taken as the intermediate procedure of the whole lending process. Thus, the discussion of leverage in government is not included.
banks will undertake the majority loss if a shadow bank’ invested project defaults. The complicated network of mutually held funds among banks would easily spread the loss of one investment failure to other banks, especially when the invested asset was the focus of investors. The June 2015 stock market crash was a good example of the risk sharing in the shadow bank system. Funds from banks were funneled into the stock market through trust companies, security brokers, fund companies, and insurance companies and then became part of the leverage pushing up stock prices. The June 2015 market crash caused widespread losses not only among individual investors, but also among fund suppliers. Such large scale market crashes would easily destabilize the banking system, financial sector and even the whole economy.

1.4.1 Before Deleveraging

The rise of shadow banking in China originated from the stimulus plan China’s central government introduced to combat the influence of the 2008 Global Financial Crisis. Thus a sharp rise in M2 growth rate in 2008 (Figure 1.3) reflected the stimulus package and the expansionary monetary policy adopted. M2, adjusted quarterly according to the performance of the economy, is the intermediate target the People’s Bank of China (PBC, the central bank of China) follows to influence and guide the gross output and support employment. The central bank uses many approaches to control M2: open market operation, reserve requirement, interest rates for deposit and loan\(^4\), and short-term or mid-term liquidity facilities. Just as the shadow bank system is “bank-centric”, the financial system itself is also bank-centric. That bank-centric financial system structure can ensure the accuracy of M2 adjustment.

The most influential monetary policy instruments utilized by commercial banks are the reserve requirement and interest rates for deposits and loans. Both deposit-loan interest\(^4\)These deposit and loan rates are determined differently nowadays. PBC used to set an upper bound for deposit rates and banks’ actual deposit rates cannot be higher the upper bound limit. Starting from Oct. 23, 2015, the upper bound deposit rate limit was abolished and the lift of repression on deposit rate gives banks, especially for mid-to-small banks, more room to compete for deposits.
rates and reserve requirements determine the size of funds banks can use to make profits, particularly for mid-to-small banks. Banks, of any size, used to operate in a policy environment where the central bank determined the upper and lower bound of interest rates for deposits and loans respectively. The gap between loan rates and deposit rates (the loan-deposit difference) has traditionally been a reliable source of profit for banks issuing loans.\(^5\)

However, the difference between the ability of large banks and mid-to-small banks in absorbing deposits from the public is always an obstacle to business expansion and earnings for mid-to-small banks. The features of nation-wide branches and longer history of large banks make the public feel it is more convenient and reliable to deposit with them. Besides, the regulation of loan-to-deposit ratio (LDR) further limits mid-to-small banks’ ability to profit with their holding deposit (Chen et. al., 2018, [9]) even when the reserve requirement is considered. Thus, mid-to-small banks attract deposits from the public through higher

\(^5\)Like bank deposit rates, bank loan rates were also repressed under the guidance of PBC before Jul. 20, 2013, during which bank loan rates should not lower than 70% of the guided loan rates for varieties of maturities. The repression was removed after Jul. 20, 2013. The bank loan rates forming mechanism was further reformed from Aug. 12, 2020. The central bank no longer directly offer guidance for bank loan rates. Instead, PBC authorizes National Interbank Funding Center (China Foreign Exchange Trade System) to calculate and set the fundamental rates for bank loans’ reference.
deposit interest rates or other approaches, whether the economy is performing well or not. Lacking enough deposits to meet the borrowing request and expand their earning resources greatly compresses the profit margin of these banks. And the profit from loan-deposit difference becomes even thinner when one of the main drivers of the economy suffers a sudden drop in demand from overseas’ market.

Apart from relying on deposits to issue bank loans, central banks’ open market operations and central bank loans are also important liquidity resources for mid-to-small banks. Figure 1.3 shows the monthly year-over-year M2 growth from 2003 to 2018. The growth rate of M2 was relatively steady before 2008 around 18-20%, except for a temporary drop in mid-2004. The demand shock from the 2008 Global Financial Crisis triggered China’s domestic counter cyclical monetary policy of injecting more liquidity into the economy to sustain GDP growth and protect employment: the growth rate of M2 increased fast to 29.74% in Nov. 2009 from a low point of 14.8% the year prior. However, the massive investment after the 2008 crisis caused new problems, in addition to stabilizing the market’s expectation on economic growth. The continuous investment in infrastructure construction starting in 1999 began to show its effectiveness which improved the conditions for real estate development and contributed to a price-rise. Meanwhile other projects with government implicit guarantee or resources of financing platform also became more attractive in an environment without promising lending project due to the global financial crisis. More and more liquidity injected by PBC went to real estate and overcapacity firms with implicit guarantees, which pushed up the overall price level and interest rates, thereby hampering the recovery of private firms affected during the crisis. To correct the direction of fund flow and discourage investment and bank loans into those assets, the monetary authority PBC adopted an overall contractionary monetary policy from the end of 2009 to early 2015.6

This policy further compressed the profit margin on mid-to-small banks, already attenuated by their decreased ability to attract and absorb deposits, vis-à-vis larger banks.

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6The general direction of monetary policy was contractionary during 2009-2015, but with some expansionary policy intermittently due to discretionary principle while enforcing the monetary policy.
However, the rising demand of funds from real estate markets and other projects without qualified collateral did become investment projects with promising returns for mid-to-small banks. And the contractionary monetary policy was a crucial factor pushing banks, especially mid-to-small banks, into working on shadow banking to increase their revenue (Chen, et. al. 2018, [9]).

Although contractionary monetary policy was followed most of the time during the post-crisis period before the introduction of deleveraging policies in Nov. 2015, the demand of funds from the market reminded policy-makers of the essential task of sustaining economic growth and employment. The efforts and work of stabilizing economic growth in the post-crisis era made policy-makers de facto encourage the banking system to innovate and expand credit support to facilitate the recovery of the economy, and they even took developing shadow banking as an opportunity to expand and diversify banks’ business and an opportunity of explore ways of financial innovation. Innovating and expanding business usually requires banks to circumvent regulations on restrictions on credit scale (for example, 75% Loan-to-Deposit Ratio i.e. LDR) and reserve requirement (Ji, Li 2018, [21]).

It’s worth mentioning that the detailed texture of shadow banking had evolved from earlier bank-entrust cooperation, bank-insurance cooperation or reverse repo type of business before 2013 to interbank or loan-entrust type business after 2013, but the basic structure remains bank-centric (Wang, Zhang and Liu, 2017, [32]). The only difference between the two periods is that the invested asset was non-standard before 2013 and standard after 2013. The main driver of the shift in shadow banking cooperation pattern was a combination of the downward trend in GDP growth rate from 2013 and a new regulation imposed on non-standard asset investment of shadow banking in 2013. Meanwhile, standard assets such as bonds and stocks had higher returns than usual (Wang, Zhang and Liu, 2017 [32]) .

In order to circumvent the regulation requirement, the shadow banking business would search for fund that don’t contribute to calculating the regulation criteria, such as capital requirement, reserve requirement and LDR requirement. For example, wealth manage-
ment product (WMP) is a non-deposit type of fund with expected higher returns directly absorbed from the public so that no reserve is needed. And unlike the traditional bank deposit, WMP doesn’t promise a definite return, or at times even the principle. As a matter of fact, customers can choose from three types of WMP designs: guaranteed return, principle protected and floating return, non-principle protected and floating return with share of 11.1%, 21.7% and 67.2% respectively in 2014 (Ehlers, Kong and Zhu, 2018, [14]). However, these shadow banking business can still be traced from the asset-side of banks’ balance-sheet.

Generally speaking, the asset shadow banking invested is usually concealed under the item Account-Receivable Investment (ARI), which is not considered a traditional type of bank loans, on the asset-side of banks’ balance sheet (Wang, Zhang and Liu, 2017 [32]; Chen, Ren and Zha 2018 [9]). Before the decline in 2017 due to the implementation of financial system deleveraging policies, the monthly year-over-year growth rate of the banking system had a relatively steady level of 15% (Figure 1.4).

As mentioned in the previous paragraph, shadow banking pattern had a major shift from investing in non-standard assets to standard assets. Apart from the higher return of standard
assets and regulation imposed on the overall scale of non-standard asset invested, the newly released use of Negotiated Certificate of Deposits (NCDs) became an important foundation for this transition from non-standard asset investment into standard asset investment. NCDs were first announced in the NO.20 announcement of PBC in 2013 named “Provisional Measure of NCDs Management”.

It is an important investment instrument traded in interbank market that PBC can use to improve the reliability, transparency and competitiveness of interbank deposit/loan deals, which is traditionally an over-the-counter deal with a negotiated interest rate and can be redeemed any time after an agreement is reached. Meanwhile, the issued amount of NCDs can also be easily monitored as issuers need to submit applications to PBC with the planned issuing amount included at the beginning of every year. And the issued amount of NCDs cannot exceed the limit stated in the approved application. Due to insufficient deposit, borrowing from their large-sized peers is one of many approaches mid-to-small banks usually take to supplement their liquidity. Hence, the issued NCDs amount increased quickly starting in 2014, reaching RMB 13 trillion in 2016, which is 145% more than the amount in 2015, and 98% of the unexpired amount by the end of 2016 was issued by mid-to-small banks (Zhang and Chen, 2017 [37]; Wang, Zhang and Liu, 2017 [32]).

Besides a reliable financing approach without the hazard of early redemption and the transparent interest rate brought by NCDs, the benefit of not counting as an “Interbank Liability” on the balance-sheet gave mid-to-small banks more room to finance with NCDs.7

Using NCDs, mid-to-small banks lacking liquidity can borrow at a more transparent rate from their large-sized peers. Moreover, as a standard investment instrument for banks,

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7No. 127 announcement of CBRC (China Banking Regulatory Commission) named “Notice on Regulating Interbank Business of Financial Institutions” in 2014 published by the coalition of PBC, CBRC, CSRS (China Securities Regulatory Commission), CIRC (China Insurance Regulatory Commission) and SAFE (State Administration of Foreign Exchange) defines interbank business (interbank assets and interbank liabilities) as Interbank Offers, Interbank Deposits, Interbank Loans, Interbank Payment and Repurchase (Reverse Repo) etc.. It further regulates that a financial institution’s “Interbank Liabilities” cannot exceed 1/3 of the total liability of the same institution (or the “no bigger than one-third” rule). NCDs were not recorded as part of the item “Interbank Liabilities” hence don’t follow the “no bigger than one-third” rule. Instead, NCDs were recorded under the item “Bond Issued”.

NCDs greatly advance the liquidity of banks’ debt. Banks or financial institutions who purchase NCDs in its first round of transaction can sell them or enter a repurchase agreement on interbank market for liquidity. Thus, the credit chain would be extended and complicated as many financial institutions can be tied together with NCDs issued by a same bank (or other financial institution). NCDs became a tool that quickly pumped up leverage ratios and leverage connections inside financial institutions when PBC adopted a relatively expansionary monetary policy in a lax regulatory environment, which is exactly the situation during 2014-2015 before the deleveraging.

1.4.2 Deleveraging Policies in Financial System

The June 2015 stock market crisis alerted policymakers to the dangerous consequences of high leverage with its long and complicated credit chains. Funds from the financial system accumulated in the real estate market. Overcapacity industries, firms with implicit government guarantees and asset markets experienced over-leverage due to an overall sluggish demand recovery from the overseas market. This caused a cascade-like decay in the economy given the bank-centric structure of the financial system. Almost all sectors of non-financial firms, the financial system, residential sector, and government suffered great losses from the unexpected shock, when supply-side or demand-side or even monetary policy changes hit the above-mentioned “overly invested areas”. Deleveraging policies in the financial system were designed to cooperate with the deleveraging in the non-financial sector. Hence, the policies’ principles are 1) Discouragement: discourage the financial sector from continuously investing into the “overly invested areas”; 2) Reform: reform and update the existing regulations and propose macro prudent principles to better monitor and control the financial system risks; 3) Encouragement: encourage the financial system to redirect their funds to invest non-financial firms with real financing demand.

More specifically, “Discouragement” compresses banks’ profiting potential from shadow banking by extending the maturity of funds and raising the overall interest rate through open
market operation. “Reform” redefines items and assets/liabilities on the balance-sheet in calculating regulation indices and initiated Macro Prudent Assessment (MPA) with newly modified regulation rules. “Encouragement” aims to lower the cost of bank loans for non-financial firms, lower the difficulty of financing for firms with financing needs and provide debt-repay capability to maintain the economic growth rate at a reasonable pace.

**Discouragement**

The strategy of removing excessive leverage in the financial system is essentially weakens the backstop of the shadow banking business, and as such can be summarized as “Discouragement”. The previous subsection discussed the higher cost of deposit and limited asset choices that mid-to-small banks face. Matching loans with longer maturity and short-term funds (“Borrow Short-term, Lend Long-term”) also contribute to shadow banking, because banks can get profit earnings from the difference between the higher long-term investment loan interest payment and lower short-term fund cost.

In this process, the newly financed short term funds can be used to replace the borrowed funds that reach expiration. For example, one of banks’ funding resources is from their customers who are traditionally the deposit providers. Now they are offered Wealth Management Product (WMP) which works the same as traditional deposits but with higher interest rates. To keep a steady expectation of customers who invest banks’ WMP, banks had implicitly guaranteed their customers could bill out their losses from the investment and get a full refund of their principle and even at times interest as well, when loss actually occurs.

This implicit guarantee is ultimately insured by the short-term funds from the interbank market. Hence, to compress the foundation for shadow banking to survive, PBC injected liquidity with average longer maturity and higher interest rate into the interbank market (or banks most influential in banking system) starting in 2016 in order to raise both the interest level and the overall expectation of it. PBC’s open market operation raised the interest
rate in various funds with maturities varying from overnight to 1 year through the Midterm Lending Facility (MLF), Short-term Lending Facility (SLF) and Central Bank Repo.

Figure 1.5 shows the fraction of funds with longer terms (maturity over 9 months) in the total transacted amount in medium-term funds (funds with maturity over 3 months) in the interbank market from 2014 to 2018. Although longer termed funds might also have had higher weights at times before 2016, it came with large fluctuations as the most distanced two adjacent points can be as wide as 0.8. Starting in 2016, especially during 2016-2017, weights of longer-termed funds stayed around 49% except when the point troughed to about 10% in February 2017 (which was the Chinese New Year when shorter termed liquidity is required). The relatively stable weight of funds with 9-month and above maturities during 2016-2017 reflected PBC’s efforts to prolong the overall maturity through the newly injected liquidity. Meanwhile, the overall interest rate in the interbank market was raised by the end of 2016 and remained high in both 2017 and 2018, where the rate was higher and more stable than that in the pre-deleveraging period i.e. from late 2014 to Oct. 2015 (Figure 1.6).

Figure 1.6 shows the interest rates of funds with two representative maturities: overnight
interest rates and interest rates of funds maturing in 1 year. The one-year interest rate level jumped from 3.3% in Nov. 2016 to 4.5% in Dec., and slowly climbed during the whole year of 2017, and by the end of 2017 had reached 5.3%. The overnight interest rate started on an upward trend in July 2016 and stayed around 2.8% during 2017. Thus, both the foundation of “Borrow Short, Lend Long” and the banks’ motivation for developing a shadow banking business were weakened through the combination of raising overall fund interests and maturities.

*Reforms and Encouragement*

In addition to discouragement policies, correcting and modifying regulation standards were other approaches introduced to control the overall leverage size attributed to shadow banking. To support economic growth while suppressing rapid fund accumulation in the real estate market, the central bank and regulators adopted a contractionary monetary policy and encouraged the banking system to innovate business at the same time. The building blocks of business innovation are off-balance-sheet assets and fund funneling through peer banks and other financial institutions, which contributed to shadow banking at the same time.
time. By extending supervision over these assets and normalizing activities between banks and their cooperated peers/other financial institutions, they contributed to removing the foundation of shadow banking and the accompanying unnecessarily long and complicated credit chains supporting the high leverage ratio.

Table 1.1 lists a series of policies introduced for deleveraging in the banking system. The underlying logic of these policies can be categorized as the follows: First step, inspecting and investigating all business, especially innovated and shadow banking business, to reveal risky assets (on-balance-sheet or off-balance-sheet) and to clear out their funding resources to manifest the connection among financial institutions; Second, updating the existing regulation to include information from the innovated and shadow banking business (concluded from the previous step), which was not part of the original regulation criteria (variety of risk measurements), to reflect the real risky assets the banking sector held; Third, urging banks to reduce their leverage ratio to conform to the liquidity requirement and capital adequacy ratio etc. based on updated calculation methods and regulations. Fourth, applying flexible measures upon loan-retrieving (third step) from overcapacity firms and real estate projects with debt-repaying capability to avoid unnecessary bankruptcies; Finally, offering subsidies to encourage banks to redirect their loans to mid-to-small and even micro enterprises’ financing needs and poverty lifting projects.

The “discouragement” of raising interest rate and prolonging maturities that PBC adopted in 2016 was intended to prevent the further expansion of shadow banking prior to the implementations of deleveraging measures. To estimate the size of leverage and risky investment, CBRC published three documents on March 29 and April 6, 2017 to urge banks to self-inspect the bottom assets of their investment (through interbank channel, WMP and other approaches), and reveal investments that could not be penetrated to identify their bottom assets. As the unpenetrated bottom assets are the results of leverage added, it strongly implies that many institutions and individuals are involved along one credit chain. If one credit default occurs, it may cause a cascade loss or even bankruptcy along the credit chain.
and spread further to other sectors of the economy. Then the self-inspection on internal management and external investment was followed up on April 7, 2017 by a request banks to correct their activities violating laws, rules and regulations on ten aspects: share-holdings and investment, high-rank managers, rules and regulations, business, products, staff, corruption risk, internal supervision activities, collusion risk and illegal financial activities.

The second step, regulation updates can be divided into two sections: 1) Incorporating risks from shadow banking (innovated business) into the existing risk control categories, such as liquidity risk, financial product risk and internet financing risk, while improving the ability to bear losses through strengthening regulation and systematically normalizing collateral management. 2) Regulating operations along the credit chain supporting the existing shadow banking business (innovated business).

The risk from shadow banking was closely related to the bottom assets invested. Real estate realm risk, local government debt default risk, financial product risk and across-held financial product risk are the major risks of shadow banking investment. They are also equipped with both traditional risk features, such as liquidity risk and credit risk, and non-traditional risks, such as internet financing services and external shocks due to closer linkage among financial institutions. The risk control guidance published on April 10, 2017 requested banks to penetrate the bottom assets of shadow banking to include their risks into risk control management, while reducing their reliance on interbank financing which was the foundation for long credit chain due to lower funding cost. Besides revealing the previously hidden shadow banking risks for risk control, the document on May 8, 2017 took the further step of normalizing the collateral related issues through collateral management and valuation methods, risk monitor and rules on managers’ behaviors to strengthen the banks’ ability to bear investment losses.

Because shadow banking structures were typically equipped with features of bank-trust cooperation, and acquiring funds from WMP or interbank financing led to regulation circumvention (or regulation arbitrage), the regulations on deleveraging published from Aug.
30, 2017 began to normalize operations in shadow banking along the credit chain and to prepare the shift of regulation from sector-wise to product-wise given the shadow banking shaped investment patterns. Documents published on Aug. 30 and Dec. 22, 2017 both mentioned the operation regulations in bank-trust cooperation. Documents on Aug. 30 stated more detailed rules normalizing the issuance of trust products, so that the whole process of trust issuance ranging from types of trust products, to their application and registration time to beneficiaries of product and related transaction were all subject to increased supervision. Thus, the room for regulation arbitrage through bank-trust cooperation was further suppressed. Documents on Dec. 22 cleared the classification of bank-trust cooperated products, regulated the activities of commercial banks and trust companies involved in the bank-trust cooperation and requested that banks take asset accrual based on the bottom asset in the cooperation so that the overall shadow banking business was under supervision.

Apart from regulating a particular form of shadow banking, opinion-solicitation versions of regulating asset management business, banking books’ interest rate risk and liquidity management of commercial banks were also published. Although they were in their suggestion-requesting version and not implemented in 2017, the indication of new and widely changed regulatory rules did convince banks to limit their activities in expanding innovated operations. The Nov. 17 issued document (usually called “New Rules of Asset Management”, referred to as the “New Rules” thereafter) enjoyed the most attention in 2017, as it was the first policy to systematically regulate all asset management products, which contribute to the shadow banking business. The “New Rules” defines non-standard-debt investment and its unique features as compared to standard-debt investment, and generalizes and extends regulations over all non-standard-debt investments via requirement of risk provision, size control and liquidity risk control.

This new restriction theoretically includes all types of shadow banking business with bank-centric feature under supervision besides the bank-trust cooperation type. And hidden fund funneling of shadow banking business is clearly forbidden by the “New Rules”.
The “New Rules” further regulates the liquidity risk control on the financing procedure of WMPs, cash pool operations and rigid billing out investment. This action emphasized the riskiness of asset management products’ investment to alert both the public and the financial system, and committed to limiting the overall amount of funds invested in shadow banking projects. To avoid the formation of shadow banking business in the future, rules on design and classification of asset management products were also included to normalize the usage of these products.

The bank-centric feature of shadow banking and massive fund interlinkage among banks due to the imbalance in attracting public deposits or funds demonstrate the importance of interest rate risk to banks, especially banks with systematic influence. They are capable of transmitting interest rate risk to other banks and result in losses from systematic transmission. The opinion-solicitation version of the guidance on Nov. 26 stated clearer rules for categorizing interest rate risk type, interest rate risk measurement and daily monitoring, while paying closer attention to banks involved heavily in interbank business. The opinion-solicitation version of “Rules of Liquidity Risk Management of Commercial Banks” on Dec. 6 extended regulation on liquidity risk control to banks with capital size below 0.2 trillion CNY where effective supervision was not covered previously. And more importantly, it updated measurements on liquidity risk control, and added more detailed liquidity risk control request into the policy system, including daytime liquidity management, financing management etc.

The third step of urging banks to conform to the existing and the updated regulations has been performed since deleveraging in the financial system started in 2016. Two important issues emerged to be solved during the banking deleveraging: unnecessary bankruptcies of firms due to loans and debt repaying, and encouraging new loans to small or micro firms with financing needs to support the real economy. And this led to two further actions to reduce unnecessary deleveraging cost and more efficiently use loans or other funding resources from banks. Given the ongoing activities of deleveraging in overcapacity firms
and the real estate market, deleveraging from the financial system, especially from the banking sector, would lead to greater financing pressure on the real economy.

To alleviate such pressure, the file on Aug. 7, 2017 required commercial banks to set up internal groups for handling the debt-to-equity swap projects. This policy was designed to reduce the debt repaying pressure of the deleveraging policy targeting firms with surviving ability and to reduce firms’ liquidity pressure. Banks can swap their creditors’ right with these firms into equity, but this debt-to-equity swap project doesn’t apply to firms that lose their surviving ability once funding support from banks is cut-off, or allow them to intentionally escape the liability of repaying their debt. Directing banks’ loan support into small-to-micro firms’ and rural areas’ financing needs was an early deleveraging measure that remains an ongoing effort of policymakers. Commercial banks were required to offer differentiated loans to match rural areas’ and small-to-micro firms’ financing needs starting April 7, 2017.

Commercial banks were required to set up an interal Inclusive Financing Department to implement support for the micro-lending policies issued on May 26. Due to the lower profit margin and higher default risk of micro-lending, this strand of policies was further strengthened by a notice published on Aug. 26, 2017, which encouraged banks with fiscal subsidized interest and county built loan default compensation to be willing to offer micro-loans (amount under 50 thousand CNY and repay in 3 years) to rural areas and small-to-micro firms with no warranty or collateral requirement and base level interest rate.

In summary, the main idea connecting the published policies of the five steps is to reduce banks’ reliance on short-term finance and loans/investment, such as WMP and interbank business, and to increase the ability in risk control and the amount of mid-to-long term loans. Thus, the foundation of shadow banking is weakened and funds can be used more efficiently in the real economy. Figure 1.7 shows the change (growth rate) of bank loans to nonfinancial firms from the third quarter of 2012 to the last quarter of 2019. The growth rate of short-term bank loans to nonfinancial firms declined from 25% in Sep. 2012
Figure 1.7: Year over Year Growth Rate of Bank Loans to Non-Financial Firms: 2012 – 2019 (Quarterly)

to 10% in Sep. 2014, while mid-to-long term loans showed a slight and gradual rise from 6.9% to 11.2%. Although some ups and downs exist in both types of loans growth rates during 2014-09 to 2015-12, the growth rates were steady around the level of 11.2%.

Comparing the shape of both types of loans to nonfinancial firms with the shape of total bank loans (Figure 1.8 and Figure 1.9) during 2014-09 to 2015-12, the sharp rise in the banks’ loan balance was not attributable to loans to nonfinancial firms. Instead, it was the result of heavy investment in financial and real estate assets while expansionary monetary policy was adopted for a short period of time. During the financial system deleveraging in 2016 and 2017, growth rates of short-term and mid-to-long term loans diverged so that mid-to-long term loans reached its highest growth rate of 16.7% in the third quarter of 2017, while short-term growth rate hit its lowest point of -0.9%.

This change of pattern is also apparent in the measurement of loan balance. Figure 1.8 and Figure 1.9 show the loan balance of large banks and mid-to-small banks. Apart from the expansionary monetary policy period where both types of banks had a sharp rise in size, loan balances in large banks exhibited different features than those in mid-to-small banks: the monthly growth rate of loan balance of large banks stayed stable around 10.4% after
Jan. 2016 which is lower than its level before 2014-10 (an expansionary monetary policy was adopted during 2014-10 to 2015-07). Whereas mid-to-small banks had a growth rate of loan balance higher in level after 2016-01 than that before 2014-10. Looking deeper into the component of loan balance, the loan balance of mid-to-small banks can be further divided into mid-to-long term loans and short-term loans.

Just as the policymakers expected, mid-to-long term loans rose faster during 2016 and 2017 than during 2014-10, and the monthly year-over-year growth rate once reached 34% in 2017 (Figure 1.10). However, the growth rate of short-term loans was quite stable after 2016 and it remained below 10% during 2016 and 2017 where the rate was lower than their performance before 2014-10. So the micro-lending encouragement policies and reducing banks’ reliance on interbank business financing did help in directing more mid-to-long term loans into the real economy after deleveraging.
Figure 1.9: Loan Balance of National Mid-to-Small Banks
Figure 1.10: Short-term and Mid-to-Long term Loans of National Mid-to-Small Banks
Table 1.1: A list of policies regulating off-balance-sheet business and cooperation between banks and other financial institutions

<table>
<thead>
<tr>
<th>Date</th>
<th>No.</th>
<th>A Brief Summary on the Policy's Purpose Related to Deleveraging</th>
<th>List of Policies Related to Deleveraging</th>
<th>Issued by</th>
<th>File Code</th>
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<td></td>
<td>2</td>
<td>Investigating risk hidden in off-balance-sheet business through circumventing supervision criteria, changing credit funds into trust funds, funneling and offering funds through other financial institutions</td>
<td>&quot;Notice on Managing Regulation Arbitrage, Inside Circulating Arbitrage, Related Arbitrage in Banking Sector&quot;</td>
<td>CBRC</td>
<td>[2017] No. 46</td>
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<td>4/6/2017</td>
<td>3</td>
<td>Urging banks to self-inspect the bottom assets of inter-bank business, wealth management business, repo and trust business. And whether financial assets traded in interbank business and its process conformed to the regulation.</td>
<td>&quot;Notice on Inspecting Inappropriate Innovation, Transactions, Motivation and Services Charges in Banking Sector&quot;</td>
<td>[2017] No. 53</td>
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<tr>
<td>4/7/2017</td>
<td>4</td>
<td>Encouraging banks to differentiate loan policies to support rural area development and small-to-micro sized firms' financing needs while preventing supervision arbitrage, overly long credit chain and over investment into real estate market.</td>
<td>&quot;Guidance on Improving the Quality and Effectiveness of Banking Sector Serving the Real Economy&quot;</td>
<td>CBRC</td>
<td>[2017] No. 4</td>
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<td></td>
<td>5</td>
<td>Requesting banks to self-inspect from ten aspects varying from internal management to external investment to correct activities violating laws, rules and regulations.</td>
<td>&quot;Notice on Correcting the Activities Violating Laws, Rules and Regulations in Banking Sector&quot;</td>
<td>CBRC</td>
<td>[2017] No. 5</td>
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<td>4/10/2017</td>
<td>6</td>
<td>Reducing banking system’s reliance on interbank financing and emphasized the risk prevention from ten areas: varying from traditional risks (credit risk, liquidity risk, real estate related risk, local government debt) to non-traditional risks (finance product risk, internet financing risk etc.).</td>
<td>&quot;Guidance on Risk Control in Banking Sector&quot;</td>
<td>CBRC</td>
<td>[2017] No. 6</td>
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<td>4/12/2017</td>
<td>7</td>
<td>Strengthen on-site and off-site supervision and supervision on information disclosure.</td>
<td>&quot;Notice on Completing and Improving Supervision Shortage and Effectiveness&quot;</td>
<td>CBRC</td>
<td>[2017] No. 7</td>
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<td>5/26/2017</td>
<td>9</td>
<td>Setting up Inclusive Finance Department in large and middle sized commercial banks to differentiate finance products to divert bank loans to small business and poverty lifting areas</td>
<td>&quot;The Implementing Project of Setting up Inclusive Financing Department in Large Commercial Banks&quot;</td>
<td>CBRC</td>
<td>[2017] No. 25</td>
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<td>8/7/2017</td>
<td>10</td>
<td>To promote the progress and control liquidity risks during deleveraging in firms, commercial banks are required to set up internal institutions to handle the work of &quot;debt converting (debt-to-equity swap)&quot;. Firms with overcapacity, incapable of salvage losses, intentionally escaping from repaying debt and firms don’t conform to the industrial policy are not included in this project</td>
<td>&quot;Regulations on Commercial Banks’ Newly Established Institution for ‘Debt-to-Equity Swap’ (Trial Version)”</td>
<td>CBRC</td>
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<td>8/16/2017</td>
<td>11</td>
<td>To encourage issuing bank loans to poverty lifting individuals and projects while assisting deleveraging, cost burden is reduced for both creditors and debtors via: no collateral requirement, base level interest rate, fiscal subsidized interest and county built loan default compensation.</td>
<td>“Notice on Development of Micro-lending Business Supporting the Poverty Lifting Plans”</td>
<td>CBRC</td>
<td>[2017] No. 42</td>
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<td>8/30/2017</td>
<td>12</td>
<td>To suppress the room of bank-trust type regulation arbitrage, time of trust products registration and product differences are cleared and added into the Rules, so that the whole trust product issuing process is under supervision. Trust product invested asset and transactions related to the trust product are also newly included in the supervision.</td>
<td>“Rules of Managing Trust Registration”</td>
<td>CBRC</td>
<td>[2017] No. 47</td>
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<td>11/17/2017</td>
<td>13</td>
<td>Reshape the supervision structure from sector-wise (banking system, insurance system etc.) separate regulation into a combination of sector-wise and product-wise regulation. Thus the room of regulation arbitrage can be further suppressed.</td>
<td>“Guidance on Normalizing Asset Management Business in Financial Institutions (Suggestions Requesting Version)”</td>
<td>PBC</td>
<td></td>
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<td>11/26/2017</td>
<td>14</td>
<td>State the requirement in managing banking book’s interest rate risk, and further categorized and standardized the measurement of risks. The construction of risk measuring system offers a more detailed and accurate data recorded for future regulation.</td>
<td>“Guidance on Interest Rate Risk Management of Commercial Banks’ Banking Book (Suggestions Requesting Version, Updated)”</td>
<td>CBRC</td>
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<td>12/6/2017</td>
<td>Three new indices are introduced to liquidity risk management: Net Stable Funding Ratio (NSFR), High quality Liquid Asset Adequacy Ratio, Liquidity Matching Rate. And refined day time liquidity risk and financing management. The updated regulation offers measures on regulating mid-to-small banks under RMB 0.2 trillion scale who were deeply involved in and relied on interbank financing.</td>
<td>&quot;Rules of Liquidity Risk Management of Commercial Banks (Suggestions Requesting Version, Updated)&quot; CBRC</td>
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<tr>
<td>12/22/2017</td>
<td>Refined the definition of bank-trust funneling business so that behaviors of both banks and trust companies involved are normalized. And the supervision of bank-trust cooperation business is expanded to off-balance-sheet activities.</td>
<td>&quot;Notice on Normalizing Bank-Trust Cooperation Business&quot; CBRC [2017] No. 55</td>
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1.5 Conclusion

Deleveraging policy starting from Nov. 2015 was not solely focusing on high leverage reduction in financial system. The sluggish recovery of overseas economy weakened the survival of firms who rely on demand from overseas’ market. Firms with implicit guarantees and industries like real estate and financial system equipped with investable assets were considered as safe assets before 2016 given this background. The systematic risk of high leverage ratio in both real economy and financial system led policymakers to adopt the deleveraging policy in Nov. 2015. A series of policies are designed to stop the trend of harmful leverage rising and cultivate “good” leverage in supporting real economy’s financing needs in both real economy sector and financial sector. Deleveraging on reducing leverage and related overcapacity in real economy starts from Nov. 2015, while the actual
move of deleveraging in financial system did not start until July, 2016. The five steps took
for financial system deleveraging in 2017 should be taken as the subsequent activities of
contractionary monetary policy in late 2016, and their ultimate goal was to gradually re-
move the foundation of shadow banking while kept the overall economic activate. This
adjustment led to a shift in loan pattern as mid-to-long term bank loans grows faster than
short-term loans, which even as negative growth rate in some months.
CHAPTER 2
INTRODUCTION TO THE CONSTRUCTION OF MARKET VOLATILITY MEASURES FOR CHINA’S STOCK MARKET

2.1 Background for Selection of Measure

Deleveraging, a pivotal step in Supply-side Structural Reform, started in Nov. 2015. Its implementation covered overcapacity firms in the real economy, real estate industry and financial sector. Because of the properties of value storage and rapidly rising property prices, real estate was largely considered one of the many investable financial assets in China. Deleveraging put a direct stop to the shadow banking development that started in 2009 in the financial system and overcapacity firms which live off implicit guaranteed bank loans. The effects of the series of deleveraging policies was not limited to business patterns in the financial system and overcapacity firms, but extended as well to overall financing conditions and asset investments. Unlike the shadow banking structural pattern in the US where financial institutions compete with each other to issue financial products, China’s shadow banking structure places “commercial banks in the center with credit chain connecting peer banks and other financial institutions;” in short, it is “bank-centric.”

The bank-centric shadow banking business and firms, overcapacity or not, chose to diversify their investment in financial assets. The sluggish recovery of the overseas’ market and the Reform of Interest Rate Liberalization starting in 2013 became the foundation and engine for both shadow banking and firms’ bank loans with implicit government guarantees to expand their sizes. Unlike the gradually declining earnings from product selling and the uncertainty of the overseas market, financial asset investment was relatively safer and brought firms higher earnings. Financial institutions, especially banks, also benefit from investing in financial assets. The development and expansion of the shadow banking business
offered banks more effective tools to participate in financial asset investments by circum-
venting supervision from regulators. High leverage thus accumulated in firms in the real
economy, real estate market, stock market, bond market and financial institutions. Shadow
banking pushed up actual lending rates, and the high leverage that existed in the real estate
industry, financial sector and selective firms combined to create an environment that led to
a cascade loss to the economy when an expected negative shock hit. The June 2015 stock
market crisis motivated policymakers to make the final decision on deleveraging, when
almost all financial institutions were affected.

Although the goal of deleveraging is to remove risky factors from the economy and
improve the financing environment, changing the existing financing business and operation
patterns did result in some frictions in financing. This friction was due to 1) pressure from
repaying the bank loans of overcapacity firms and real estate projects, and 2) pressure from
self-inspection, transforming illegal and unregulated bank operations to conform to the
updated rules and regulations, and making banks reluctant to accept applications and offer
new loans (except policy encouraged loans, such as micro-lending to small-to-micro firms).
Thus, exchange listed firms and other firms not in the small-to-micro category were widely
affected by the various changes in financing conditions brought about by deleveraging in
2016 and 2017.

The tighter financing conditions and series of policies removing shadow banking through
eliminating rooms of regulatory arbitrage certainly influenced the stock market, as stocks
were important assets both in shadow banking’s diversified investment and in shareholders’
(or listed firms’) property. The great change in overall financing conditions and investment
participants showed different sensitivity to stock market risks. To capture the market’s risk
sensitivity to changes in bank activity and market participant investment before and after
deleveraging, the volatility of two market indices are used to describe the difference in risk
sensitivity between large capital sized stocks and mid-to-small capital sized stock.

Market participants’ perspective on stock investment is captured by the margin trading
balance, as margin trading was one of the important tools shadow bankers used to invest in the stock market which broadly affected other investors’ views before deleveraging. The share-pledging broadly used in 2016 and 2017 by listed firms with financing needs was due to a rise in financing difficulties, in contrast to the reasons for share-pledging before deleveraging. However, the emergence of firms’ internal risk management, caused by massive pledged shares, resulted in an increase in the market’s sensitivity to information and large price fluctuations. Firms then cooperated with brokers to hide share-pledging through margin trading, as it helped firms suppress information from the public and brought brokers another source of revenue when stock market investment was inactive during deleveraging. The margin trading balance is a good way to measure the consistency of stock market investors’ views/activities in the two periods and to reflect the change of usage brought about by financing condition shifts during deleveraging.

The central position of banks inside the financial system explains their pivotal role in influencing financing conditions and the extension of the shadow banking business. Interest Rate Liberalization (IRL) introduced in 2013 provided banks with additional room to innovate and develop business, such as the rapid growth of shadow banking. But the financing ability imbalances which emerged as IRL progressed caused some mid-to-small banks to increase their reliance on interbank business to sustain their own operations. Different types of banks were thus connected to each together. This connection was further strengthened by the expansion of shadow banking as its “borrow short and lend long” profiting pattern required banks to continuously acquire short-term funds to replace the earlier matured funds. Interbank business certainly can provide banks with a more reliable source of funds when they lack the ability to continuously absorb funds from the public. The significance of interbank business continued during deleveraging and reform of IRL made the interbank market another important monetary policy tool of PBC in implementing policies. By injecting Mid-term Liquidity Facility (MLF) into the interbank market in 2016, for example, both the interest rate and maturity were raised and motivation for extending
shadow banking discouraged, particularly for banks that rely more on interbank business. Hence, a measurement that could capture overall interbank activity in both periods is desired. Although some interbank business takes place over the counter, transactions in the open market offer an in-time track of banks activity. Thus, interbank transaction volume is used to the interbank market activities.

2.2 Variable Construction

The availability of high frequency data at the intraday level has brought tremendous theoretical advances to variable estimations. Estimation of stock price volatility using intraday data can better capture the detailed sensitivity of the market during transaction time. More detailed information on the market's attitude, instead of general descriptive measures based on low frequency data, gives investors, researchers and policymakers insight into how the market reacts to certain changes so that sources of investment risk can be tracked and the interactions better understood. Volatility is an important but latent variable measuring risk of investment. Hence, specific techniques of measurement estimation vary from parametric models to non-parametric models. Parametric models for volatility estimation are based on past estimations of the same variable. The basic ARCH and GARCH models, and other models transformed from these basic forms, are equipped with the same feature, where estimations of volatility are conditioned on earlier estimations. The difference between their variations and prototypes can be the assumptions on returns with different signs, such as the T-GARCH model. Although improvements in model variations keep updating and extending the applicability of these models, they are routinely criticized for not including factors essential to their estimation, such as implied volatility and other financial return related factors, that can easily return misspecified volatility estimates.

As noted in Mukherjee, Peng et al. in 2018 [28], the 12 most commonly used non-parametric models for volatility estimation with a stochastic assumption on the process of volatility can be seen as a combination of two processes: a continuous process (the diffu-
sion part) and a discontinuous process (the jump part). Then the integrated volatility \( [X, X]_t \), estimated at intraday basis would return an asymptotic and unbiased estimation of volatility, the continuous part of the integrated volatility \( [X, X]^c_t \), with assumptions on the discontinuous process \( [X, X]^d_t \) of following a Poisson distribution and finite occurrence (jump), where

\[
[X, X]_t = [X, X]^c_t + [X, X]^d_t. \tag{2.1}
\]

And the log price of \( X_t \) would follow an Ito process with a jump or a jump-diffusion process:

\[
dX_t = \mu_t dt + \sigma_t dB_t + \xi_t dN_t \tag{2.2}
\]

where \( \mu_t \) is a conditional drift part, and the very small \( dt \) would make \( dB_t \) (a Brownian Motion) dominate the drift part. The term \( dN_t \) follows a Poisson process with a mean of \( \lambda \Delta_n \), where \( \Delta_n \) is the length of one time interval. The time interval is so small that the Poisson distributed jump rarely occurs in several adjacent intervals. Taking two adjacent intervals as an example, \( \Delta^n_i N \) has a Poisson distribution with a mean of \( \lambda \Delta_n \). If a jump occurs in the first interval, then the probability of at least one jump occurring in the second interval is very small and close to zero, i.e.

\[
P(\Delta^n_i N \geq 1)P(\Delta^n_{i+1} N \geq 1) = o_p(\Delta_n).
\]

Hence,

\[
IV_t = [X, X]^c_t = \int_0^t \sigma_s^2 ds
\]

can be estimated as

\[
\hat{IV}_t = \sum_{i=1}^N (\Delta^n_i X)^2
\]

when \( N \) is large and the occurrence of jump is very rare. To find the most suitable method of estimating unbiased integrated volatility, the 9 out of 12 models for volatility construction and one model for jump are described in the following paragraphs.
2.2.1 Realized Volatility (RV)

Realized Volatility is a nonparametric volatility estimator invented by Andersen et al. in 2001. Its estimation returns a consistent volatility estimator if the sample is large enough and certain conditions are met so that the discontinuous part doesn’t cause biased estimation, such as jump absent or jumps rarely exist so that can be ignored. Thus $RV_t$ is a consistent estimator of $IV_t$. The expression for $RV_t$ is:

$$RV_t = \sum_{i=2}^{N} (\Delta t X)^2.$$  \hspace{1cm} (2.3)

In this case, $\hat{IV}_t = RV_t$.

2.2.2 Realized Bipower Variation (BPV) and Realized Tripower Variation (TPV)

As the earlier nonparametric measure of estimating volatility, RV’s definition didn’t provide ways of dealing with IV estimation when frequent jumps exist. This underestimation of jumps’ existence would then result in upward biased estimated RV as no less than one jump may exist in one time interval. Barndorff-Nielsen and Shephard (2004)[6] introduced BPV to solve this problem. With Poisson distribution assumed for the discontinuous part of Equation 2.2, the frequent but finite jumps can be excluded and get an asymptotic and unbiased estimation of $IV_t$ with $BPV_t$, where $BPV_t$ is:

$$BPV_t = m_1^{-2} \sum_{i=2}^{N} |\Delta t X||\Delta t^{-1} X|,$$  \hspace{1cm} (2.4)

where $m_1 = \sqrt{2\Gamma(1)/\Gamma(1/2)}$. The assumption that the probability of two adjacent time intervals having at least one jump is close to zero made BPV an improvement on RV in estimating volatilities.

The idea of Tripower Variation (TPV) is similar to BPV. With frequent but finite jumps, the influence of jumps can be eliminated by multiplying absolute value of three adjacent
log $X_t$ differences to get a consistent estimation of $IV_t$. So TRV is a generalized version of BPV and resolves similar issues. Hence the definition of TPV is:

$$TPV_t = m_{2/3}^{-3} \sum_{i=2}^{N-1} \left( |\Delta_t^{i+1}|X||\Delta_t^i X||\Delta_t^{i-1} X| \right)^{2/3}$$

(2.5)

where $m_{2/3} = 2^{1/3} \Gamma(5/6)/\Gamma(1/2)$. However, it is not as efficient as BPV since microstructure noise has stronger influence over TPV, which would also cause biased IV estimation.

2.2.3 Two Scale Realized Volatility (TSRV), Multiscale Realized Volatility (MSRV) and Modulated Bipower Variation (MBV)

In addition to the interference from jumps, microstructure noise is another factor which may unexpectedly weaken the consistency of IV estimators. This effect is more pronounced when the sample intervals get smaller as higher frequency data (“tick-by-tick data”) can acquire. This vast change of ultra-high frequency widely availability and usage in volatility estimation made every record contain the information of market participants’ decision making. This in turn is affected by many individual features such as microstructure noise due to consideration of inventory risks, and information asymmetry that are not meaningful to volatility estimation. Hence, including more neighborhood sample intervals and using their averaged modified forms can effectively reduce the influence of microstructure noise.

Zhang et al. [38] introduced TSRV and MSRV in 2006 to solve this common issue in instances of high frequency data usage.

To reduce the influence from microstructure noise, the authors adopt not only a subsample-average strategy in constructing TSRV, but equally a sampling-space strategy inside each subsample. Specifically, they define $TSRV_{t,N}$ as follows:

$$TSRV_{t,N} = [X, X]^{avg} - \frac{1}{K}[X, X]^N,$$

(2.6)
where \([X, X]^{avg}\) is:

\[
[X, X]^{avg} = \frac{1}{K} \sum_{i=1}^{K} [X, X]^{n_i},
\]

(2.7)

and \([X, X]^N\) is:

\[
[X, X]^N = \sum_{j=1}^{N-1} \left( \frac{X_{t+j+1}}{N} - X_{t+\frac{j}{N}} \right)^2.
\]

(2.8)

Here \(N\) is the total number of observations, \(\frac{1}{N}\) is the size of each time interval, \(K = C N^{2/3}\) is the number of subsamples and \(C\) is a constant. The number \(n_i = N/K\) is the number of observations in each sample and \(i\) in the subscript is the count number for subsamples and \(i = 1, 2, 3, \ldots, K\). It’s worth noting that subsamples don’t overlap with each other and that the calculation of \([X, X]^{n_i}\) requires asset returns of equi-spaced observations. Finally, \([X, X]^{n_i}\) is defined as:

\[
[X, X]^{n_i} = \sum_{j=1}^{n_i-1} \left( \frac{X_{t+j+1}}{N} - X_{t+i\frac{K}{N}} \right)^2.
\]

(2.9)

Hence, a microstructure-noise robust measure of IV is obtained in Equation 2.6 when jump is rare and finite or absent.

Like the relationship between BPV and TPV, MSRV has the similar goal of suppressing microstructure noise as TSRV but with a larger convergence rate of \(N^{1/4}\), which is higher than the convergence rate of \(N^{1/6}\) in TSRV, making MSRV more attractive. The major difference in MSRV is the \(T\) different time scales. Then the definition of \(MSRV_{t,N}\) is:

\[
MSRV_{t,N} = \sum_{\tau=1}^{T} a_{\tau}[X, X]^{(N,K_{\tau})},
\]

(2.10)

where \(\tau = 1, \ldots, T\) and \(a_{\tau}\) is:

\[
a_{\tau} = 12 \frac{\tau}{T^2} \frac{T - \frac{1}{2} - \frac{1}{2T}}{1 - 1/T^2}.
\]

(2.11)

Note that \(\sum_{\tau=1}^{T} a_{\tau} = 1\) and \(\sum_{\tau=1}^{T} a_{\tau}/\tau = 0\).
And $[X, X]^{(N, K_τ)}$ is similar to interpretation of Equation 2.9, except $K_τ$ has different time scales:

$$[X, X]^{(N, K_τ)} = \frac{1}{K_τ} \sum_{i=1}^{K_τ} \sum_{j=1}^{n_τ, l} \left( X_{t_i + \frac{(j+1)K_τ + l}{N}} - X_{t_i + \frac{(j+1)K_τ}{N}} \right)^2 \quad (2.12)$$

where $l = 1, \ldots, K_τ$ and $K_τ$ is the total number of subsamples in time scale $τ$, and $n_{(τ, l)} = N/K_τ$ is the size (number of observations) of each subsample in time scale $τ$.

Modulated Bipower Variation (MBV) developed by Podolskij et al. in 2009 [30], has the same essential idea as TSRV and MSRV: they all take subsamples and two observations with equispaced intervals ($B$ is the total number of subsamples selected, $R = c_1 N^{0.5}$ where $c_1$ and $c_2$ are both constants) to smooth out the frictions in IV estimation. The expression for MBV is:

$$MBV_{t, N} = \frac{\left( \frac{c_1 c_2}{\mu^2} \right) mbv_{t, N} - \theta_2 \hat{ω}^2}{\theta_1} \quad (2.13)$$

where

$$\theta_1 = \frac{c_1 (3c_2 - 4 + \max((2 - c_2)^3, 0)))}{3(c_2 - 1)^2}, \theta_2 = \frac{2 \min((c_2 - 1), 1)}{c_1 (c_2 - 1)^2} \quad (2.14)$$

$$mbv_{t, N} = \sum_{b=1}^{B} |X_{b}^{(R)}||X_{b+1}^{(R)}| \quad (2.15)$$

$$X_{b}^{(R)} = \frac{1}{N/B - R + 1} \sum_{j=\frac{(b-1)N}{B}}^{\frac{bN-R}{B} - 1} \left( X_{t_i + \frac{j+1}{N}} - X_{t_i + \frac{j}{N}} \right) \quad (2.16)$$

where $\mu_1$ is a constant and $\hat{ω}^2 = \frac{1}{2N} RV_{t, N}$ and $RV_{t, N}$ is the same as $RV_t$ in equation (3), $N$ here is still the number of total observations.

Although the design of averaging over equispaced observations and different time scales reduces microstructure noise and improves estimation efficiency, its shortcoming remains obvious: it requires the assumption of no jump or rare jumps, which does not apply to IV estimation when infinite jumps are present.
2.2.4 Realized Kernel (RK) and Subsampled Realized Kernel (SRK)

Realized Kernel (RK) and Subsampled Realized Kernel (SRK) are practically the same method for IV estimation, except that SRK adopts an additional subsampling procedure to smooth the market friction one more time in the final step of obtaining the realized kernel estimation. Barndorff-Nielsen et al. [5] developed RK in 2008 and its modified version (i.e. SRK) in 2011 [4]. RK is obtained by getting h-th realized autocovariance first, where \( h = 1, 2, 3, \ldots, H \) and \( H = cN^{1/2} \), then calculating the weighted average of \( h \)-th realized autocovariances by putting more weight on distanced observations and less weight on closer observations to smooth the market microstructure friction in small intervals. RK is defined as follows:

\[
RK_{t,N} = \gamma_0(X) + \sum_{h=1}^{H} \kappa(x) \left( \gamma_h(X) + \gamma_{-h}(X) \right)
\]  

(2.17)

where \( x \in [0, 1] \) so that letting \( x = \frac{h-1}{H} \), then \( \kappa(x) \) is a weighted function that weights more on the distanced realized autocovariance. And the realized autocovariance is defined as:

\[
\gamma_h(X) = \sum_{j=1}^{N-1} \left( X_{t+\frac{j+1}{N}} - X_{t+\frac{j}{N}} \right) \left( X_{t+\frac{j+1+h}{N}} - X_{t+\frac{j+h}{N}} \right)
\]  

(2.18)

The SRK estimator follows the same realized autocovariance calculation as in equation (18) and weighted sum calculation as in (17) inside each subsample (the total number of subsamples is \( S \)). The additional step taken for SRK estimators is

\[
RK_{t,N} = \frac{1}{S} \sum_{s=1}^{S} SRK_{t,N}^s
\]  

(2.19)

where \( SRK_{t,N}^s \) is \( RK_{t,N} \) in each subsample, and it has the same expression as equation (17). Kernels are assumed to smooth out market microstructure friction to include more neighborhood observations to dilute the influence of noise. This idea is the same as the 3 estimators reducing microstructure noise. The expression of realized autocovariance cal-
Calculation in equation (18) indicates both the estimators, RK and SRK, are not jump robust and consistent estimators are obtained only when jumps are rare or absent.

2.2.5 Truncated Realized Volatility (TRV) and Jump

The eight IV estimators are briefly summarized in the previous subsections. The development and modification of each estimation method aimed to weaken the influence of market microstructure noise and jumps as much as possible so that an efficient asymptotic unbiased estimator of IV could be obtained. However, with variance and covariance calculated using asset returns from very small intervals, the construction of quadratic variation for IV estimation is not robust to infinite jumps, even when neighborhood observations are added to control for market friction. Hence, techniques for dealing with IV estimation with infinite jumps were developed. TRV and Jump (Aït-Sahalia, 2009[2]) are two of such estimators and representing continuous component and discontinuous component of the IV estimation.

There is one feature common to both measures: threshold adequately defined to filter out (log) price differences bigger (smaller) than the defined value, no matter how the quadratic form is obtained. This design of threshold weakens the influence of infinite jumps when realized volatility is estimated as TRV, so that estimators with this feature are generally robust to both finite and infinite jump. TRV is defined as:

\[
TRV_{t,N} = \sum_{j=1}^{N-1} |\Delta_j X|^2 1_{\{|\Delta_j X| \leq \alpha \Delta_n\}}
\]  

(2.20)

The threshold \(\alpha \Delta_n\) is defined as

\[
\alpha = \left( \frac{1}{t} \int_0^t \sigma^2 ds \right)^{1/2},
\]  

(2.21)

where \(\sigma\) has order \(O_p(\sqrt{\Delta_n})\), which is the order of the diffusion part \(dX_t\), and \(\alpha \Delta_n\) where
$\varpi \in (0, 1/2)$. This implies that

$$O_p \left( \sqrt{\Delta_n} \right) < \alpha \Delta_n^\varpi.$$  

Since the order of the jump component is $O_p(1)$ we get:

$$O_p \left( \sqrt{\Delta_n} \right) < \alpha \Delta_n^\varpi < O_p(1).$$  \hspace{1cm} (2.22)$$

Then the order of $\alpha \Delta_n^\varpi$ can be used to truncate absolute asset returns larger than it to remove jumps from the series of $\Delta_n^t X$.

Jump $[34]$ can be estimated with similar method estimating TRV as in equation (2.20).

$$Jump_{t,N} = \sum_{j=1}^{N-1} |\Delta_j X_j|^2 \mathbf{1}_{\{ |\Delta_j X_j| \geq \alpha \Delta_n^\varpi \}}$$  \hspace{1cm} (2.23)$$

Because of using the same truncation criteria $\alpha \Delta_n^\varpi$ as in TRV, this jump variation estimator exactly captures the unused information estimating TRV. This estimation of jump is consistent with the assumption of TRV, where $|\Delta_j X|$ less than $\alpha \Delta_n^\varpi$ is a continuous component of IV.

2.3 Construction of Realized Volatility Series for the CSI300 and CSI500 Stock Indices

The CSI300 and CSI500 indices are the two influential indices of China’s A-share Stock Market that measure the performance of 300 large capital sized stocks and 500 mid-to-small capital sized stocks respectively. The stocks selected for the indices construction have industry distribution consistent with the markets’ actual industry distribution. Hence, the performance of CSI300 and CSI500 represents the overall large capital stocks and mid-to-small capital stocks respectively. Besides showing the performance of stocks with different capital sizes, they usually function as criteria for investment valuation, and the underlying
assets for the investment on index and related financial derivatives. Thus to understand how
the changes in financial conditions during deleveraging influenced the volatility risk of the
two indices would provide investors with important information for decision making.

To better capture the market’s sensitivity to financing condition changes due to delever-
aging, data at intraday frequency is used for constructing the volatility of CSI300 and
CSI500. The data for volatility calculation is from CSMAR, a professional data provider
in China. Volatility is estimated using Truncated Realized Volatility (TRV) based on the
consideration of weakening the possible existence of infinite jumps so that the estimators
are robust to jumps. Given the 1-minute frequency of the data, \( TRV_{t,N} \) is constructed as:

\[
TRV_{t,N} = \sum_{j=1}^{N-1} |\Delta_j X|^2 1_{|\Delta_j X| \leq \alpha \Delta_n^\omega},
\]  

(2.24)

where \( N = 240 \) represents 240 minutes daily trading hours, \( t = 1, 2, \ldots, 250 \) and \( T = 1/250 \) where 250 is the number of trading days each year. Then \( ds = \Delta_n = T/N \) in the
\( TRV_{t,N} \) estimation and threshold \( \alpha \Delta_n^\omega \) estimation, where \( \omega = 0.49 \) so that \( \Delta_n^\omega \) is larger
than \( \Delta_n^{1/2} \) as in equation (2.22).

To be more specific, the estimation of \( \alpha \Delta_n^\omega \) can be described as the following. Let
\( \alpha_n = \alpha \Delta_n^\omega, \alpha_n^{(i)} \) be the estimation of \( \alpha_n \) in \( i \)-th round and \( \alpha_n^{(0)} \) be the initial value of \( \alpha_n \).
Initially, BPV (RV can also be used in the process) estimated by equation (2.4) is used to
estimate \( \alpha_n^{(0)} \). Because BPV is an unbiased estimator of IV with finite jumps. To make \( \alpha_n \)
satisfy the condition in equation (2.22), \( \alpha_n \) has the expression

\[
\alpha_n = C \left( \frac{1}{T} IV_t \right)^{1/2} \Delta_n^\omega
\]

(2.25)

where \( C \) is a constant, and the initial value of \( IV_t, IV_t^{(0)}, \) can be estimated as \( IV_t^{(0)} = \)
So the initial value of \( \alpha_n, \alpha_n^{(0)} \), is

\[
\alpha_n^{(i)} = C \left( \frac{1}{T} I_t V_t^{(i)} \right)^{1/2} \Delta_n \tag{2.26}
\]

where \( i = 0, 1, 2, 3, \ldots, K \) and \( K \) is a constant. Then reuse equation (2.24) to estimate \( TRV_{t,N}^{(1)} \) to replace \( \hat{IV}_t^{(0)} \) in equation (2.26) to get \( \alpha_n^{(1)} \).

After newer \( \alpha_n^{(i)} \) is estimated in (2.26), re-estimate \( TRV_{t,N}^{(i)} \) in equation (2.24) to replace \( TRV_{t,N}^{(i-1)} \) in previous round. This loop continues until \( |TRV_{t,N}^{(i)} - TRV_{t,N}^{(i-1)}| \) is less than a certain criteria defined, e.g., \( 0.05 \times TRV_{t,N}^{(i-1)} \). Then the TRV is achieved in the last round.

Figure 2.1 shows the calculated daily values for TRV and JUMP for the CSI300 and CSI500 from 2014 until 2017. Deleveraging started to be effective since the end of 2015. So dates before Nov. 2015 is the period before deleveraging and dates after Nov. 2015 is the period after (during) deleveraging. It’s worth noticing the implementation of deleveraging policies in real economy and financial sector was asynchronous. Deleveraging in real economy started from Jan. 2016, while no effective measures were taken until July 2016 in financial sector. Panel a) for TRV and Panel b) for Jump of indices CSI300 and CSI500 show more frequent and volatile fluctuations before Jan. 2016, and the decline in period Jul. 2015-Jan. 2016 in the magnitude of fluctuations was due to removing overleverage in stock market. The frequency and magnitude of fluctuations in TRV and Jump continues to decline after Jan. 2016 and the fluctuations were further mitigated starting from Jul. 2016, when systematic deleveraging in financial sector started.

Besides the general trend of the two series, large capital sized stock represented by CSI300 has relative more volatile TRV and jumps before deleveraging than that of CSI500. And CSI500, representing mid-to-small capital sized stocks, became the more volatile index than that of CSI300. This fact suggests mid-to-small capital sized stocks were more sensitive to changes during deleveraging.
Figure 2.1: TRV and Jump for CSI300 and CSI500 Indices: 2014 – 2017

2.4 Conclusion

Apparently the patterns of TRV and Jump in Figure 2.1 showed great changes after deleveraging. The deleveraging policies starting from Nov. 2015 was not limited to remove overleveraging and lower leverage ratios, the goal of reducing the economy’s systematic risk was approached by controlling risky investment and financing activities of both the real economy and financial sector. The pressure of debt repaying in the real economy and banning
of shadow banking reshaped the development of financial environment since 2009. The "bank-centric" shadow banking supported the credit chain of shadow banking and closely linked the interbank market activities with overinvested assets.

Margin trading was blamed as the primary cause of the stock market crash in June 2015. As it offered tools accumulating high leverage in stock investment and forming expectations of stock market before deleveraging, which is the usual function of margin trading. The deleveraging since Jan. 2016 changed financial conditions which greatly affected investors’ financing decisions. Instead of raising leverage in stock transactions, the margin trading was used as an alternative financing approach satisfying some shareholders’ share-pledging needs. This change of margin trading’s utilization, although occurs in stock market, still made the need of margin trading connect to interbank market activities through financing demand.

Thus, deleveraging changed financial conditions, altered patterns of investors’ behavior and banking activities. It’s necessary to compare the difference in the connections between stock market and interbank market to show how the financial condition changes affect the volatility risks in stock market.
CHAPTER 3
THE IMPACT ON STOCK MARKET VOLATILITY OF CHANGING FINANCING CONDITIONS IN CHINA

3.1 Motivation

Stock market volatility is an important measure quantifying market sentiment i.e. investors’ fear in investment and the stability of investment in stock market. Changing financing regulation lead firms to seek alternative financing approaches to substitute the ones they currently employ. With stocks serving as one of the main investment tools in China, changes in financial regulations will increase uncertainties in stock market. Once such regulation was the banning shadow banking in China. Such a ban blocks a channel through which the banking system can invest in the stock market while circumventing supervision.

Margin trading provides liquidity to the market, hence reducing volatility. Besides providing liquidity, margin trading also raises the leverage ratio because investors borrow to finance their investment. With investors’ own money put in the margin account as the collateral, margin trading investors can expand their investment capacity through borrowing. Volatility may increase when more investors’ price expectations converge thus leading to an expansion of their investment through leverage trading. Apart from margin trading’s traditional effect on volatility via liquidity provision, there were other technical changes to margin trading rules that had the potential to also affect market volatility. One such rule was “withdraw collateral’s market value above 300%” (“300% Rule” thereafter) that operates in margin account take advantage of the financing feature of margin trading to offer firms with financing needs an alternative financing approach in 2016-2017. This non-traditional financing channel avoided the need for firms to release their financing information to the public which stabilized volatility.
The widely existing over leverage or high leverage ratio issues in China originated from the real economy’s decline in earnings due to a sluggish recovery from overseas’ market. Lacking investment opportunities in the real economy, both firms and financial institutions sought other projects/areas to invest. With a 4 trillion RMB stimulus packages invested in 2009, infrastructure and construction investment provided an ideal environment for the development of real estate sector. The real estate industry grew rapidly since then with massive investment attracting entrepreneurs into the area. And real estate assets were thus considered as safer assets thus investment were attracted, including investment from firms with implicit government guarantees.

Shadow banking was developed and expanded in such environment to circumvent supervision requirements. More importantly, investors became more leveraged were thus accumulated along with the development of shadow banking. The amount of leverage began to accumulate quickly in industries with high tradability as revenue and profit from business could not cover financing expenses. More debt was therefore borrowed to repay the previous matured debt (Lu and Ge, 2016 [26]). With returns falling in businesses related to production which was the main type of bank loans (Lu and Ge, 2016 [26]), banks who are the primary financing resource for the whole economy diverted their focus to real estate and asset markets. The prosperity of the stock market in 2014 and 2015 is a good example of the results of such resource diversion.

Figure 3.1 displays the connection between the interbank market and margin trading. The massive scale of China’s financing activities originating from the banking system is reported yearly in Figure 3.2. The funds demanded (transacted amount) in the interbank market reflects the daily tightness of funds demanded in the real economy. Funds demanded before July 2015 was primarily driven by the bullish of stock market as showed in Figure 3.1. Activities in the interbank market is represented by the daily aggregate transaction amount in the interbank lending market and the interbank bond market, meanwhile the margin trading is the daily margin trading balance in the stock market. Both variables are
Figure 3.1: Daily Margin Trading Balance and Daily Interbank Transaction Amount 2014-2017

measured in units of 10 billion RMB. Daily interbank transaction volume increased along with the margin trading balance from July 2014 to July 2017, especially during period January- July of 2015. It is worth mentioning that the leverage added to financial system caused by shadow banking not only inflated asset prices but raised firms’ financing cost as well. For example, banks entrust funds with other financial institutions for a fixed income and entrusted financial institutions further channel funds through other financial institutions and so on. The funds eventually go to firms with financing needs paying a higher interest rate than that of bank loans. The credit chain of shadow banking (multi-layer nesting operation) is supported by both the high leverage of institutions and the low cost of funds from interbank market is the foundation for its existence.

The decrease in firms’ revenue and profit, and rise in leverage inside the financial system created systematic default risk inside the real economy since the in China’s financial system is “bank-centric”. Bank loans are the major resource for firms with financing needs and funds from the banking system are the major resource of the credit chain supporting shadow banking. The deleveraging that occurred was aimed at 1) reducing production capacity in firms with overcapacity or implicit government guarantees so that the high lever-
age ratio in less productive area can be reduced; 2) banning shadow banking and regulate interbank business to reduce leverage inside the financial system.

The direct consequences of deleveraging for firms are 1) banks are reluctant to renew or issue new loans to firms since they need adjust their balance sheet to meet the requirement of updated regulation and to reduce leverage level at the same time; 2) pressure from paying back loans requires liquidation of asset which affects firms’ liquid assets that are available to use for other business needs, which led to additional financing needs; 3) Some firms who are not the deleveraging target but belong to industries like chemicals, iron and steel and non-ferrous alloy also had their production affected and hence their revenue declined during deleveraging; 4) Firms along the supply chain may experience a rise in cost and a higher amount of unpaid revenue from their customers. All the factors listed affect a firm’s decision making on financing since the common financing channels were greatly affected by policy from both the revenue end and banks’ side.

Alternative financing approaches would therefore be given a serious consideration given the reforms in 2016 and 2017. Obviously, listed firms on stock market have an additional commonly used financing choice than the non-listed firms: to finance through share-
pledging. However, with many listed firms’ taking advantage of a rise in their stock price in 2015 and pledging part of shares held by insiders, a continued pledging of shares would easily lead to a reaction by investors and large stock price fluctuations causing an agency problem. To avoid the negative effect share-pledging could cause, a rule of “withdraw collateral’s market value above 300%” (“300% Rule”) in margin trading account can be utilized to satisfy firms’ financing needs without raising the concerns of the market. The “300% Rule” allowed investors to withdraw the exceeded amount of money from their margin account if their collateral amount exceeds 300% of the market value of debt in margin account.

Besides avoiding overreactions of investors, brokers also benefited from offering listed firms the opportunity to finance through margin trading. With transaction amount continues to decline since late 2015, brokers found that offering margin trading based financing services brought commission fees and interest revenue at the same time. Their revenue from offering margin trading account-based financing services together with interest revenue from share-pledging were almost the same as revenue from commission fees.

This chapter aims to find out how margin trading after deleveraging in 2016-2017 affected stock market volatility (risk of investing in stock market) during deleveraging. The paper is divided into 4 parts: section 2 offers a background introduction on the reforms enacted; section 3 outlines the empirical model used to test the relationships among financing conditions, stock market volatility and margin trading and the construction of variables used in the model; section 4 is analysis of the empirical results, and the paper concludes in section five.

3.2 Background

3.2.1 Deleveraging and financial condition changes

Deleveraging was raised as part of “supply-side structural reform” in China in Nov. 2015 with the purposes of reducing default risk due to less efficient projects (low productivity,
overcapacity and obsolete producing capacity) and overleverage in the financial sector. It further aimed to regulate and improve risk control in the financial system with an emphasis on the banking system. The reforms were imposed because of the international market declined after the 2008 Financial Crisis making firms exposed to international markets weak in financing bank loans due to lower revenue and profits.

Traditionally, banks favored firms producing goods, but that preference gradually changed as international demand for Chinese goods fell. Banks shifted their focus to business inside the financial system and the real estate industry. The People’s Bank of China (PBC) eased monetary policy in 2013 to inject more liquidity into the banking system with the expectation that financing costs would be lowered for firms, especially for mid-to-small sized business. While the results of the expansionary monetary policy in 2014 and 2015 went to the opposite direction policymakers had expected: financing costs remained high and leverage was inflated inside the financial system which made no significant improvement over revenue and profit of firms.

The rise in the leverage ratio through a multilayer nesting approach not only raised overall financing cost, but also compressed the ability for firms to finance directly from banks (Lu and Ge, 2016 [26]). Meanwhile, because of partial state ownership and bank loans with implicit guarantees from local government, some high-risk firms were still able to get their bank loans renewed. Hence, contribution of deleveraging in 2016-2017 in real economy was mainly from firms of private ownership (Zhang, Chang, Liu 2018 [39]). In addition to the higher default risk in the real economy, higher priced asset and real estate markets that were attracting funds would make the “bank-centric” shadow banking work as a mechanism spreading default across the whole economy. In addition, the above-mentioned risks to the economy was exacerbated by low financing costs (such as repo rate) in the interbank market: the rate ranged between 2.5% to 3.8% in 2014, dropped to 1.5% in early 2015 and remained at relative low levels around 2% until Aug. 2016. It’s worth mentioning that although banks can also finance at low cost through issuing short-
term Wealth Management Products (WMPs), interbank market is a relatively more reliable source for banks short of funds.

Measures taken for the implementation of the deleveraging policy can be classified into three categories: 1) adding 14-days and above repos as additional open market operating tools besides the commonly used 7-days repos and overnight offerings starting from August 2016 to reduce the room for banks to profit from interest rate spread; 2) Starting from March 29, 2017 to the end of 2017, a series of policies focus on regulating banks’ internal management, bank-institution (bank) cooperation were announced by regulators. These policies focused on regulating banks’ asset management projects, regulating and improving banks’ liquidity management, penetrating banks’ investment chains, reducing loans to zombie firms and projects with excessive production capacities, and redirecting loans to business or industries with more efficiency. Those adopted regulations directly affected the supply of loans to the whole system since loans from banking system take 70.61% of the whole China society’s financing scale. 3) Removing leverage-supported excessive production capacity and inventories that led to zombie firms i.e. demand target firms or owners of investment with high leverage to repay their bank loans used to lever their projects.

These three approaches eventually influenced the supply and demand of loans or funds from the banking system. First, reopening 14-days and above repos reduced the ability for banks to entrust funds with other financial institutions to receive a fixed income, since mid-to-small sized banks are sensitive to fund cost. These banks relied more on NCDs and low-cost funds in the interbank market given the structural change in the liability’s side of their balance sheet in recent years (Liu, Zhang 2019 [25]). Second, the series of policies announced in 2017 forced banks to inspect their loans and investment and call in non-performing loans and investment that were highly leveraged in zombie firms, projects with overcapacity, and projects that were highly leverage in the financial system.

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The newly announced policies discouraged banks from issuing new loans to borrowers but also discouraged banks to maintain lending relationships with customers with already issued loans. Firms, even firms with normal financing needs, would find it more difficult to acquire loans from banks under this financing environment. Finally, the requirement for firms (especially state-owned firms or firms with shares state-owned) to reduce loans associated with overcapacity and inventories also limited their ability to acquire new loans for their policy targeted projects. For example, among 342 listed firms owned by State-owned Asset Supervision and Administration Commission of State Council in A-share stock market, 175 firms had their liability-to-asset ratio decreased in 2017 comparing with levels in 2015 (Zhang, Chang, Liu 2018 [39]).

With the liability structure in the banking system relying more on NCDs and low-cost funds from the interbank market, the interbank transaction volume is a good measure to describe the overall needs from the real economy and asset markets. The above-mentioned regulation pushed firms to finance through other avenues with the amount of share-pledging rising: the pledged share balance was 0.34 trillion CNY in 2014, then doubled to 0.71 trillion CNY in 2015. This amount continued to rise to 1.28 trillion CNY in 2016 and became 1.62 trillion CNY in 2017.

3.2.2 Margin account’s “withdraw asset value above 300%” rule

With the number of trades declining after deleveraging, brokers needed to seek revenue from other sources. The margin accounts’ “withdraw asset value above 300%” (“300% Rule” thereafter) benefited firms with financing needs and brokers at the same time. Furthermore, the amount of revenue generated from the “300% Rule” combined with the revenue from share-pledging almost equaled the amount of revenue from commission fees which was the primary resource of brokers before deleveraging.

Brokers were able to utilize margin trading to help listed firms to circumvent the requirement of making announcement, which would influence the market and cause un-
wanted fluctuations in individual stocks, when listed firms had already reached the 50% share-pledging limit. The “300% Rule” refers to the rule that an amount of money equaling the value of collateral greater than 300% of borrowed amount can be withdrawn from the margin account. To be more specific, a basic form of utilizing the “300% rule” works as the following: inside shareholders of a listed firm can use their marketable shares as collateral, say 100 CNY worth of shares, to open a credit account. Then they borrow Gold ETFs worth 33 CNY from brokers and short sell the 33 CNY Gold ETFs in the market. Then the inside shareholders of a listed firm can borrow money from brokers to buy 33 CNY worth of gold ETF to return the borrowed amount of security for short selling earlier. Now the inside holder had settled his short selling with the broker and 33 CNY plus 100 CNY worth of shares in margin account. Then the value of asset in margin account comparing with the borrowed amount has exceeded the 300% limit: (33 CNY + 100 CNY) / 33 CNY is about 403%. Then the borrowed 33 CNY can be withdrawn from the margin account and the referred financing process is complete. The interest brokers charge for margin account financing is about 8%, the same as share-pledging.

The exact amount of margin trading due to margin trading-based finance is uncertain since the operations are private information from over-the-counter agreements between brokers and their customers. However, the popular assets used for margin-trading based finance gives some indication on the usage of margin trading during deleveraging. Gold ETFs is one of such popular assets used for margin trading-based finance. Figure 3.3 shows the trend of margin trading balance in stock market and the fraction of margin trading of Gold ETFs in the total balance during Nov. 30, 2015 – Dec. 29, 2017. The total margin trading balance declined in the end of 2015 and January of 2016, and stabilized around 0.88 trillion CNY in 2016 and 2017. In the meantime, the fraction of margin trading on Gold ETFs rose quickly starting from July 2016, when the contractionary monetary policy was adopted in interbank market and reached 2% in March 2017 and stabilized around 2.14% during the rest of 2017. There were 1059 assets in the stock market included in margin
Figure 3.3: Weight of Margin Trading of Gold ETFs in Total Margin Trading Balance from Nov. 30, 2015 to Dec. 29, 2017

trading, and the margin trading on Gold ETFs rose fast and eventually took 2.14% of the total margin trading balance. This suggests the widely existence of utilizing margin trading to offer margin trading-based financing services in stock market during deleveraging.

3.3 Literature Review

The action of deleveraging in an economy can change the financing condition which influences the overall economic operation, especially with “de-capacity and de-stocking” in the real economy. A report from the World Bank by Feyen, Kibuuka and Otker-Robe (2012) [15] documented that synchronized deleveraging efforts across euro area banks induced illiquidity pressure in banking system and credit condition deterioration in euro area and regions with close financial links to euro area banks. The concerns over liquidity provision of banking system and credit deteriorated in real economy during deleveraging in China were similar to what it was like in Europe.

Meanwhile, shadow banking, which is the main target of deleveraging in financial system, had formed a business pattern providing liquidity to the economy. Shadow banking
acquired funds from interbank business and Wealth Management Products (WMP) and invested in assets with better returns such as real estate, bonds and stocks. The deleveraging activities affected credit from both traditional bank-financing activities and shadow banking activities, which motivated firms to search for alternative financing approaches. For example, financing from firms’ own suppliers on the upper-stream supply chain, such as delaying the payment of business or directly borrowing from their suppliers. Besides, firms can also finance from their down-stream firms by advance charges.

Margin trading-based finance is one of those alternative financing methods for listed firms during deleveraging. But margin trading-based finance was taken as a substitution for share-pledging. This was due to the shortcomings of share-pledging. Financing through share-pledging is always associated with an agency problem, such as managerial incentives and contingency risks, which would lead to market overreactions causing a rise in volatility (Anderson and Puleo, 2020 [3]). The occurrence of agency problem would make public shareholders doubt firms’ future operations that it may devaluate firms’ cash holdings (Chou, Wang and Yang, 2021 [10]).

To reduce such risk of share-pledging, listed firms carefully control and manipulate account records such as discretionary accruals, increase real income and non-recurrent items during share-pledging to give the public a positive impression on operating status (Dejong, Liao and Xie, 2020 [11]). Listed firms or their inside shareholders with share-pledging intentions may employ other approaches to make up for the shortcomings of the selected financing method. Margin trading-based finance is one of such alternative financing approaches that shares can be pledged without publicly announcing the sensitive financing information utilizing “300% Rule” of margin account.

Margin trading is an instrument expanding investors’ investment capacity. And it was also an important investment project through which funds were provided with shadow banking. For example, the June 2015 stock market crash was well-known as the cascade spread of volatile asset prices across the market, which was the result of too much
leverage (about 3 trillion CNY by June 2015) added through margin trading via brokers, entrusted funds and other channels related to shadow banking during market expansion. Hence, research on margin trading was primarily on leverage it added and its relationships with market liquidity.

Margin trading is described as a mechanism enlarging expectation of stock returns and worsen the market liquidity condition in a market downturn or crash. Geanakoplos (2010) [16] pointed out high leverage ratio with positive expectation about the future economic (investment) performance in an expansion is the cause of the severe crisis in a contraction. Adrian and Shin (2010) [1] studied mark-to-market balance sheet of financial intermediaries and evidence showed mark-to-market leverage can forecast VIX. Besides, higher margin requirement determined by pessimistic expectations would further compress the room of speculators with funding constraints so that it left speculators with less liquid assets and weakened their ability of providing liquidity to the market, hence higher volatility will present (Brunnermeier and Pedersen, 2009 [8]).

Research studying the June 2015 market crashes and deleveraging in China’s stock market (it can be considered as part of financial deleveraging) provided more evidence on margin call caused market-wide volatility spillover. In order to verify the causes of volatility spillover effect, Hu, Liu and Zhu (2019) [17] studied data from China’s stock market at intraday level and found margin call and related liquidity demand of investors together led to illiquidity spillover. They (Hu, Liu and Zhu, 2021 [18]) further investigated margin trading investors’ trading strategies contributed to illiquidity spillovers during the stock market deleveraging in June – Sep. of 2015. This research on investors’ trading activities in June 2015 gives more concrete evidence on margin trading’s illiquidity spillover effect. And the results agree with an earlier work on relationships between common ownerships and individual stock returns, where individual stock returns can be forecasted by stock portfolios with common margin investment ownerships (Bian, Da et al., 2019 [7]).

All the works mentioned above are on margin trading’s influence on liquidity of in-
vested assets and the resulted risks. However, “300% rule” on margin account management implies margin trading can be used differently than leveraging investment in the targeting stocks, and the alternative usage can have different implication than affecting the targeting stocks’ liquidity: hiding information from the market. An exogenous financing condition changes (e.g., active deleveraging in both real economy and financial system) would lead to investment adjustment in stock market to support the economy’s financing needs. With margin trading being a temporary substitution for financing during deleveraging in 2016 and 2017, its effect over stock market volatility may offer some new views on rule-design of margin trading and firms’ alternative financing approaches. This study shows the “300% Rule” designed to alleviate margin investors’ funding constraint can also be used as an alternative financing channel for share-pledging during deleveraging to mitigate stock market volatility when financing condition is harsh for firms.

3.4 Empirical Model and Data

The interactions between the stock market and the interbank market before and after deleveraging are described using a vector error correction model (VECM) with daily realized volatility of CSI300 (CSI500), daily margin trading balance and daily interbank transaction volume from January 2014 to December 2017. Data are collected from CSMAR.

The VECM model is constructed as the following:

\[ \Delta Y_t = \alpha' \beta Y_{t-1} + \sum_{i=1}^{p} \theta_i \Delta Y_{t-i} + \varepsilon_t, \]  

(3.1)

where \( Y_t = (TRV_t, MtBalance_t, IBTVol_t)' \) and \( p \) is the number of lags in the VECM.

The coefficient matrix \( \alpha \) is a \( 3 \times r \) weighting matrix, where \( r \) is the number of cointegration relationships among the three time series. The coefficient matrix \( \beta \) is a \( r \times 3 \) matrix, containing the estimated cointegrating relationships. Daily realized volatility for CSI300 (CSI500) is estimated as truncated realized volatility \( \sigma_t^2 \) (TRV) using 1-minute log returns.
based on the following:

\[ TRV_{t,N} = \sum_{j=1}^{N-1} |\Delta_j X|^2 1\{ |\Delta_j X| \leq \alpha_n \}, \]  

(3.2)

where \( \Delta_j X = X_{t_i} - X_{t_{i-1}} \) and \( X_{t_i} \) is the log price of a stock or index at ith-minute on day \( t \). Given the trading time in the stock market is 9:30 am – 11:30 am and 1:00 pm – 3:00 pm, \( n \) is set as 240 in the estimation. The threshold \( \alpha_n \) is the criteria for truncation to separate continuous volatility part from jumps. The variable \( TRV_t \) used in Equation 3.1 is the square-root of truncated realized volatility, \( \sigma_t \).

The daily margin trading balance \( M_{tbalance} \) is calculated as sum of daily margin trading balance of all stocks listed across both exchanges, Shanghai and Shenzhen. The interbank transaction volume \( IBTVol_t \) is the total volume of all transactions happened on day \( t \), including interbank offers, bond, pledged repo and outright repo. Both \( M_{tbalance} \) and \( IBTVol_t \) are in unit of 10 billion CNY. The value of \( TRV_t \) in Equation 3.1 is magnified by 1000 times to make it easier to be discernible. Instead of using the SHIBOR rate, as other works usually do, the interbank transaction volume is used to measure the overall changes in the difficulty of firms’ and investors’ to finance before and after deleveraging took place. Since interbank transaction volume can track how close funds in interbank market are related to funds flowed into stock market. For example, Figure 2 shows that the rise in daily margin trading balance during January - June 2015 is closely linked with interbank transactions indicating stock market activities is the force that pushed interbank transaction volume upward. The margin trading balance declined after June 2015, but interbank transaction volume continues to rise till July 2016 because of a redirection of funds into the bond market. However, the redirection of funds is accompanied by deleveraging, which affects real economy’ financing ability and operations, starting in Oct. 2015. Thus, interbank transaction volume after July 2016, the time when deleveraging is effective in financial sector, can be interpreted in an environment of an overall tightness of fund in
### Table 3.1: Unit Root Test Results

<table>
<thead>
<tr>
<th>Variables</th>
<th>Deterministic Variables</th>
<th>Lags</th>
<th>ADF Test Statistics</th>
<th>5% Critical Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mtbalance</td>
<td>Constant + Trend</td>
<td>1</td>
<td>-1.620</td>
<td>-3.414</td>
</tr>
<tr>
<td>IBTVol</td>
<td>Constant + Trend</td>
<td>19</td>
<td>-1.791</td>
<td>-3.414</td>
</tr>
<tr>
<td>CSI300 TRV</td>
<td>Constant</td>
<td>15</td>
<td>-2.548</td>
<td>-2.864</td>
</tr>
<tr>
<td>CSI500 TRV</td>
<td>Constant</td>
<td>16</td>
<td>-2.036</td>
<td>-2.864</td>
</tr>
<tr>
<td>CSI300 Jump</td>
<td>Constant</td>
<td>37</td>
<td>-2.600</td>
<td>-2.864</td>
</tr>
<tr>
<td>CSI500 Jump</td>
<td>Constant</td>
<td>38</td>
<td>-2.471</td>
<td>-2.864</td>
</tr>
</tbody>
</table>

China’s economy.

In order to capture financing conditions’ effect on discontinuous new information in volatility, Equation 3.1 is re-run with $Jump_t$ replacing $TRV_t$ in the definition of $Y_t$. Here $Jump_t$ is estimated as:

$$Jump_t = \sum_{i=1}^{n} \left( \Delta^i_t X \times 1_{\{\Delta^i_t X > \alpha_n}\} \right)^2,$$

where $\alpha_n$ and $\Delta^i_t X$ are same as they are defined in Equation 3.2.

Unit root tests were performed on all time series used in the estimation of Equation 3.1. Augmented Dickey-Fuller (Dickey and Fuller (1979), [12]) unit root tests were run with the lags used in the test chosen using the modified Schwarz information criteria described in Ng and Perron (2001) ([29]). ADF test statistics are all insignificant at 5% significance level, implying that the null hypothesis of the time series containing a unit root cannot be rejected for all variables.

Cointegration relationships are further tested (Johansen, 1991, 1995 ([22], [23])) given their unit root test results from Table 3.1. These results are reported in Table 3.2. The vector $(TRV_t, Mtbalance_t, IBTVol_t)'$ for CSI300 and CSI500 are labeled as Model 1 and Model 2 respectively, and the vector $(Jump_t, Mtbalance_t, IBTVol_t)'$ for CSI300 and CSI500 are labelled as Model 3 and Model 4 respectively in Table 3.2. Both types of test suggest the existence of only one cointegration relationship among the three variables when using the full sample of data from 2014 to 2017. However, given the background information in
Table 3.2: Cointegration Test Results for the Four Basic Models

<table>
<thead>
<tr>
<th>Model</th>
<th>Lags</th>
<th>$H_0$</th>
<th>Test Stat.</th>
<th>Trace Test</th>
<th>Max. Eigenvalue Test</th>
</tr>
</thead>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10% cv</td>
<td>5% cv</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2014 – 2017</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model 1</td>
<td>5</td>
<td>$r = 0$</td>
<td>79.33</td>
<td>32.00</td>
<td>34.91</td>
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<tr>
<td></td>
<td></td>
<td>$r \leq 1$</td>
<td>13.96</td>
<td>17.85</td>
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<td></td>
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<td>$r \leq 2$</td>
<td>5.09</td>
<td>7.52</td>
<td>9.24</td>
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<tr>
<td>Model 2</td>
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<td>32.00</td>
<td>34.91</td>
</tr>
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<td></td>
<td></td>
<td>$r \leq 1$</td>
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<td>17.85</td>
<td>19.96</td>
</tr>
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<td>$r \leq 2$</td>
<td>4.96</td>
<td>7.52</td>
<td>9.24</td>
</tr>
<tr>
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<td>2</td>
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<td>32.00</td>
<td>34.91</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$r \leq 1$</td>
<td>26.82</td>
<td>17.85</td>
<td>19.96</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$r \leq 2$</td>
<td>3.65</td>
<td>7.52</td>
<td>9.24</td>
</tr>
<tr>
<td>Model 4</td>
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<td>32.00</td>
<td>34.91</td>
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<td>$r \leq 2$</td>
<td>3.71</td>
<td>7.52</td>
<td>9.24</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2014 – Sept. 2015</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model 1</td>
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background information in part II and motivations of brokers, listed firms’ shareholders and banks, different relationships must exist before and after the deleveraging. So coin-
integration tests for period January 2014 – September 2015 and January 2016 – December 2017 are performed as well. The sub-period cointegration test indicates all four models in the indicated different periods have two cointegration relationships. Impulse response analysis is performed for all four models before and after the deleveraging.

3.5 Results

Impulse response analysis of “three factors system” for the period before deleveraging policies, Jan. 2014 – Sep. 2015, took place (Figure 3.4 – Figure 3.7) shows a lot of difference comparing with the similar analysis (Figure 3.8 – Figure 3.11) after imposing deleveraging policies i.e. Jan. 2016 – Dec. 2017. The reason for skipping the 3-month period Oct. 2015 – Dec. 2015 is to eliminate the early period of deleveraging and make the two periods more comparable. Because deleveraging in both real economy (reducing producing capacity and reducing inventory) and financial system (cutting off networks supporting shadow banking, which providing bank funds to the exchange and other investment projects) were widely implemented and effective starting from 2016. Although the implementation of deleveraging policies in financial system was gradual and asynchronous in 2016 and 2017, deleveraging in real economy already started since Nov. 2015. So expectations on the tight access to funds from banking system set the basic environment for stock market investors and other market participants to make decisions since deleveraging started.

3.5.1 Before deleveraging, Jan. 2014 – Sep. 2015

Figure 3.1 shows daily interbank transaction volume is closely related to daily margin trading balance and the relationship is almost parallel especially obvious after July 2014. Johansen cointegration test results (Table 3.2) show two cointegration relationships exist among the three variables, $TRV_t$ and $Jump_t$ for CSI300 or CSI500 indices, $Mtbalance_t$ and $IBTVol_t$ in period Jan. 2014 – Sep. 2015. This is the period of time where shadow banking expanded and leverage was added in asset markets, real estate market and firms
with overcapacity via shadow banking. And abundant funds from banking system were injected into stock market with the credit chain of shadow banking linking interbank market and varieties of financial institutions and firms in real economy. Multilayer leverage, which was commonly recognized as one of the factors contributing to June 2015 market crash, inflated stock market investment in 2015 was thus the results of credit chain of shadow banking. Furthermore, with expectation of rise in stock market, funds was thus continuously attracted and leverage was added through margin trading as showed in Figure 3.1.

Figure 3.4 and Figure 3.5 describes the interactions among uncertainty measured in truncated realized volatility \( (TRV_t) \) or jump risk \( (Jump_t) \), in the margin trading balance \( Mtbalance_t \), and in the daily aggregate transaction amount from interbank market \( (IBTVol_t) \) for CSI300. One unit shock in \( TRV_t \) led to 3 units positive response in \( TRV_t \) in the same day and the effect would gradually disappear in 10 days (short-term), and the effect would be slightly negative i.e. about 0.2 unit in long-term (after 22 days). So shocks in \( TRV_t \) itself didn’t increase volatility risk in long-term, instead the volatility risk decreased. One unit positive shock to \( Mtbalance_t \) would lead to -0.3 unit decrease in \( TRV_t \) on the second day and the effect quickly disappear on the third day (short-term). And in long-term, \( TRV_t \) represented volatility risk would increase by 0.3 unit. The pattern is similar in \( Jump_t \) case of CSI300 i.e. in Model 3. The short-term effect i.e. -0.3 unit decrease on \( TRV_t \) is caused by more liquidity introduced by \( Mtbalance_t \), as investors can utilize abundant funds available to them to expand their investment abilities, meanwhile transactions can be matched quickly. It is worth to mention that margin trading introduced funds crowded the market’s demand of liquidity in longer-term and led to higher prices, which would reinforce the expectation of price rising in the future. \( Mtbalance_t \)’s influence is more significant in affecting \( Jump_t \) of CSI300 in short-term and the short-term negative effect decays slower than that in affecting \( TRV_t \) of CSI300, which suggests liquidity provided by \( Mtbalance_t \) can help to reduce both volatility risk and jump risk in short-term. With promising revenues such as commission fees, interest earnings and expectation
of price rising in stock prices, exchange and other financial institutions along the credit chain of shadow banking (including investors themselves) were all benefit from encouraging leveraged investment into the stock market. Expectation of price rising in stocks would further lead to the use of margin trading. Eventually, expectation of prices would continue to be reinforced and move to the direction margin trading investors wanted. One unit shock in $IBTVol_t$ had a slight positive response (about 0.1 unit) in $TRV_t$ on the 2nd day quickly disappeared on the 3rd day. However, the response didn’t have significant influence over $TRV_t$ of CSI300 in both short and long terms. This result suggests the direct influence on volatility risk of large capital-sized stocks from interbank market was not significant. So it can be said that leveraging activities inside stock market i.e. margin trading was the main force among other leverage channel affecting and destabilizing volatility risks. And the influence was primarily in long-term. $IBTVol_t$ has a negative and significant effect on $Jump_t$ in long-term (no significant effect in short-term). The influence of $IBTVol_t$ on $Jump_t$ of CSI300 suggests some investors can utilize funds from banks to invest without through margin account and they don’t have the same opinion as margin traders since a wider range of types of shareholders than that of mid-to-small stocks makes it impossible for information to be solely controlled by margin trading.

One unit shock in $TRV_t$ of CSI500 had 3.5 units response in $TRV_t$ of CSI500 on the 1st day and decayed to zero in 10 days (short-term), which is similar to the pattern in the case of CSI300 and so is the long-term effect. The similar pattern as in CSI300 case also occurred in the response of $TRV_t$ and $Jump_t$ of CSI500 to $Mtbalance_t$’s shocks (Figure 3.6 and Figure 3.7). Except that the negative effect in $TRV_t$ of CSI500 responded to one unit shock in $Mtbalance_t$ was not significant in short-term, $Mtbalance_t$’s long-term effect on $TRV_t$ is about 0.2 unit, which suggests $Mtbalance_t$ would destabilize $TRV_t$ of CSI500 in long-term but it was not as influential as it in CSI300 case. One unit shock in $IBTVol_t$ led to short-term positive response in $TRV_t$ of CSI500 i.e. 0.5 on the 2nd day and gradually decayed to zero on the 19th day, and the long-term effect was negative but
Figure 3.4: Impulse Response Function for Model 1 ($TRV300, Mtbalance, IBTVol$)
Jan. 2014 - Sep. 2015

Figure 3.5: Impulse Response Function for Model 3 ($Jump300, Mtbalance, IBTVol$)
Jan. 2014 - Sep. 2015
Figure 3.6: Impulse Response Function for Model 2 ($TRV_{500}, Mtbalance, IBTVol$)' for CSI500 Jan. 2014 - Sep. 2015

insignificant. Thus interbank market transactions had direct effect on destabilizes CSI500 $TRV_t$ in short-term. The case in $Jump_t$ of CSI500 is different that $IBTVol_t$ doesn’t have significant effect on CSI500 $Jump_t$ in short-term, but the long-term effect is negative and significant at the margin of 95% level. Less symetric information of smaller capital size makes volatility risk of CSI500 (mid-to-small capital-sized stocks) more easily be created through $IBTVol_t$ than CSI500 jump risk.

So both margin trading activities and interbank market transactions had similar effect on $TRV_t$ of CSI500 as their effect on $TRV_t$ of CSI300: margin trading activities destabilized volatility in long-term and interbank market transactions had negative but no significant effect on volatility in long-term, except that interbank market transactions had positive short-term effect on volatility of CSI500.

Just as the margin trading played as the primary force pushing up volatility, $Mtbalance_t$ created expectation and influenced the activities in interbank market ($IBTVol_t$), not the reverse. For both CSI300 and CSI500 cases, one unit shock in $Mtbalance_t$ would lead to $IBTVol_t$ of CSI300 (Figure 3.4 and Figure 3.5) increase immediately and dies out on the second day in short-term while raise $IBTVol_t$ in level in long-term. $IBTVol_t$
doesn’t have significant influence over $M_{balance_t}$ as $M_{balance_t}$ does over $IBTVol_t$.
However, it must be noticed that one unit shock in $IBTVol_t$ would lead to a drop in level in $M_{balance_t}$ in long-term, though the effect is not significant. But this relationship indicates the fact that funds from $IBTVol_t$ didn’t go through margin trading channel might act as a substitution for margin trading to invest in stock market during Jan. 2014 – June 2015. And this pair of relationship has similar pattern in CSI500 case, where it’s more significant than in the CSI300 case. This suggest investment based on off-market funds were more influential to mid-to-small capital sized stocks.

A positive shock in $TRV_t$ ($Jump_t$) of CSI300 has significant (no significant) negative long-term effect on $M_{balance_t}$. This is due to margin call and forced liquidation (or close margin position when prices increase), which would reduce the amount of margin trading balance when downward (upward) market trend is expected. It’s worth to mention that one unit positive shock in $Jump_t$ of CSI300 didn’t result in significant effects in $M_{balance_t}$ in both short-term and long-term, and the shape of response indicates that jump risk in large capital sized stocks (i.e. listed firms’ operation information) was not the primary reason causing changes in margin trade balance. One unit positive shock in $TRV_t$ raised $IBTVol_t$
in level in short-term and decrease in level in long-term, and the short-term effect is significant in CSI500 case and insignificant in CSI300 case. This suggests leveraging funds not from margin trading investors was more influential for CSI500 than CSI300. Hence volatility risk from CSI500 would raise interbank transactions in short-term and higher fluctuations would discourage continuous investment into the stock market. And the rise in level of $IBTVol_t$ in short-term was due to the repayment pressure caused illiquidity, and higher liquidity demand pushed up $IBTVol_t$ level in short-term. The above results on impulse response of $IBTVol_t$ by $TRV_t$ in both CSI300 and CSI500 cases suggest the literature should study deleveraging in stock market through the perspective of margin trading investors without funds from outside resources i.e. the assumption of funding constraint. The results offered evidence for the literature with funding constraints that their assumptions on limited outside funds accessible for investors does not fully capture investors’ funding conditions, meanwhile that fallacy assumption also ignores the role banks played as investors in stock market before deleveraging. For impulse response results, one unit shock in $TRV_t$ of CSI500 leads to more significant effect on $IBTVol_t$ in both short and long terms than that of CSI300 indicating less liquidity stocks are more likely to trigger the risk of illiquidity, hence the demand from outside funding resources by investors with mid-to-small capital sized stock in their invested portfolios is higher and more prominent.

In summary, on-market leverage in stock market (margin trading) $Mbalance_t$ was the force pulled up the level of transaction volume of interbank market before deleveraging. While interbank activities had only limited influence over margin trading, hence insignificant negative in impulse response function in both Figure 3.4 and Figure 3.5.

To conclude, margin trading is the primary force destabilized stock market before deleveraging and played a key role influencing interbank market activities. Meanwhile, transactions in interbank market had direct access influencing the stock market and destabilized mid-to-small capital sized stocks in short-term before deleveraging. The results indicate 1) margin trading raised volatility of both CSI300 and CSI500 in long-term and
reinforced the expectation of future market performance; 2) investors are interested in taking advantage of relative information asymmetry and less shareholders of mid-to-small stocks to gain profit and 3) large sized stocks with more public shareholders i.e. less information asymmetry is less likely to be affected by off-market leverage.

3.5.2 After deleveraging, Jan. 2016 – Dec. 2017

Johansen cointegration tests in Table 3.2 indicates two cointegration relationships exist among TRV$_t$ or Jump$_t$, Mtbalance$_t$ and IBTVol$_t$ after deleveraging from Jan. 2016. The limited access to funds from banking system and the existing amount of share pledging combined to created a tight financing condition for listed firms. The pressure of repaying previous loans and limited access to new loans from banks made firms illiquid. Firms had to look for new approaches to finance their operation and projects. To avoid the unwanted stock price fluctuation after deleveraging, the “300% Rule” helps firms to finance with their holding shares through a margin trading account without announcing the financing activities to the public. So, margin trading accounts’ function is not limited to adding leverage in stock investment. The regulations imposed after deleveraging raised interest rate of loans and discouraged banks from issuing new loans. The rise in interest rate in interbank market and tighter new bank loans after deleveraging didn’t change the way interbank market connected with the real economy, since the banking system is still the main financing channel and it relies more on funds from interbank market as a source of liquidity supplement. So daily interbank transaction volume IBTVol$_t$ can still be an indicator for the economy’s daily fund demand level.

The impulse response functions for the period after deleveraging can be seen in Figure 3.9 to Figure 3.11. It is clear that the relationship between IBTVol$_t$ and Mtbalance$_t$ changed after deleveraging. Though insignificant, one unit shock in IBTVol$_t$ would lead to level rise in Mtbalance$_t$ in the long-term. And a one unit shock in Mtbalance$_t$ would significantly raise IBTVol$_t$ in the short-term, and this effect lasts longer with Jump$_t$’s
influence considered for both CSI300 and CSI500 than that considering $TRV_t$. In the meantime, unlike their relationship before deleveraging, $Mtbalance_t$ doesn’t have long-term effect on $IBTVol_t$ and the effect dies out in long term. The impulse response results suggest margin trading becomes a complement for fund demanded from the banking system, which is approximated by $IBTVol_t$, in the long-term and not the reverse. And the rise in margin trading reflects the higher demand of funds in the whole economy in short-term without creating expectation about fund demanded in the future. So margin trading is indeed working as an alternative way of financing after deleveraging.

With margin trading being an alternative way of financing through the “300% Rule”, its effect on volatility risk and jump risk would be different from its influence before deleveraging as more listed firms or large shareholders are interested in its merits of not releasing financing activities to the public. The most obvious change from period before deleveraging is margin trading plays the role of stabilizing stock prices for both CSI300 and CSI500 indices. Both volatility risk and jump risk of CSI300 and CSI500 decline in long-term. And unlike the effect before deleveraging, $Mtbalance_t$ is more influential affecting jump risks than volatility risks though the impulse response function is significant for both types of risks. This indicates listed firms or large shareholders utilizing margin trading to finance dominates A-share’s margin trading during Jan. 2016 – Dec. 2017 after deleveraging. The dominance of using margin trading as an alternative financing method stabilized stock prices in this period. Interbank market transactions $IBTVol_t$ representing the demand for funds, does reflect the tight financing condition after deleveraging: one unit shock in $IBTVol_t$ would raise $Jump_t$ in short-term and the effect dies out in long-term. And it spends more time, about 20 trading days, for $Jump_t$ of CSI300 to decline to zero. Meanwhile, $IBTVol_t$ doesn’t have meaningful and significant short-term or long-term effect on $TRV_t$ for CSI300. $IBTVol_t$ has short-term effect on $TRV_t$ of CSI500, but it disappears the second day. So interbank market transaction volume $IBTVol_t$ indicates the tight financing conditions where the economy’s fund demand would lead to price jump of listed firms and
increase the total price volatility risk of stocks. However, as an alternative way with merits of financing through share-pledging without making public announcement, margin trading $Mtbalance_t$ does function as the listed firms and shareholders expected: reduce price volatility through both jump risk and volatility risk so that listed firms can finance without causing market reaction to unwanted information.

Although a one unit shock in $TRV_t$ of CSI300 has long-term negative effect on $IBTVol_t$, the effect is not significant (the effect is significant at the margin for CSI500 case). This change suggests the connection between stock market and interbank market through banking system was indeed cut off after deleveraging, meanwhile volatility risk in stock market would lower investors’ expectation on future economic performance hence reduced the fund demand. The magnitude of $TRV_t$’s negative long-term effect on $Mtbalance_t$ was much smaller than that before deleveraging for both CSI300 and CSI500. Furthermore, $TRV_t$ of CSI500 has larger long-term significant negative effect on $Mtbalance_t$ than that in the case of $TRV_t$ of CSI300. These phenomena suggest mid-to-small capital sized stocks are more associated with margin trading after deleveraging, whether the margin trading is for financing purposes or leverage adding purposes. A one unit positive shock in jump risk, $Jump_t$, of either CSI300 or CSI500 has an insignificant and small negative effect on $Mtbalance_t$, indicating newly arrived information is not the main reason for $Mtbalance_t$ to decline in long-term. And combining with $TRV_t$’s effect on $Mtbalance_t$, it is obvious that a decline in $Mtbalance_t$ was mainly the result of price fluctuations with little information. A one unit positive shock in $Jump_t$ of both CSI300 and CSI500 leads to a positive increase in $IBTVol_t$ in the short-term. This suggests stock price fluctuation with information would produce direct reaction in interbank market caused by change in the economy’s fund demand.

To summarize, deleveraging in both the real economy and the financial system created a tight financing environment for listed firms, and long-lasting and large fluctuation due to the reaction of the public would encourage firms to choose to finance from an unobservable
approach as a way to finance that draws less attention from the public to stabilize their stock prices. Mid-to-small capital sized listed firms prefers alternative approach than large capital sized listed firms in this process given their smaller size of public held shares. Financing from margin trading account given the rule of “300% Rule” offered listed firms an alternative to finance in deleveraging environment. Hence, $Mtbalance_t$ works as a volatility risk stabilizer, which is different from its influence over $TRV_t$ of CSI300 before deleveraging. However, $Mtbalance_t$ doesn’t have a significant effect stabilizing $TRV_t$ of CSI500, which is unlike its effect on $Jump_t$ of CSI500, though mid-to-small firms prefer to finance through margin account than large firms.
Figure 3.9: Impulse Response Function for Model 3 (\textit{Jump300, Mtbalance, IBTVol}')

Figure 3.10: Impulse Response Function for Model 2 (\textit{TRV500, Mtbalance, IBTVol}')
Figure 3.11: Impulse Response Function for Model 4 \((Jump500, Mtbalance, IBT\text{Vol})\)
### 3.6 Conclusion

Margin trading ($M_{tbalance_i}$) plays a role stabilizing the volatility in stock prices after deleveraging unlike its role of destabilizing stock market before deleveraging. And both large and mid-to-small firms employed margin trading to finance their activities. In particular, before deleveraging, margin trading was the primary force stabilizing prices in the short-term and pushing up volatility risk and jump risk for both large (CSI300) and mid-to-small (CSI500) capital sized stocks and reinforced their expectation on prices in the future (long-term) so that more funds from banks (interbank market) are attracted into the stock market. After deleveraging, margin trading stabilizes both volatility risk and jump risk in short and long terms for large capital sized stocks, it doesn’t lower volatility risk of mid-to-small capital sized stocks in short-term but it does effectively stabilizes their jump risks. The need for alternative financing approaches made margin trading a viable choice for both large and mid-to-small capital sized listed firms, and it is adopted more often by mid-to-small sized firms since they are more sensible to fluctuation caused by related information dissemination in their stock prices. Hence, margin trading has an effect of temporarily substitute the demand of funds from banks in mid-to-small capital sized firms case.

Unlike margin trading, interbank market activities ($IBTV_{ol_i}$) don’t have a clear role in influencing stock market uncertainties before deleveraging, while it destabilizes stock prices for both CSI300 and CSI500 after deleveraging. Before deleveraging, interbank market activities raise volatility risk of CSI500 in short-term and reduce jump risk of CSI300 in long-term suggesting large capital sized stocks are not easily fully affected by margin trading activities like the way mid-to-small capital sized stocks are affected because of their less information asymmetry. While in other circumstances, interbank market activities don’t have a meaningful and significant effect on volatility risks and jump risks. After deleveraging, interbank market activities destabilize stock prices in short-term and the effect diminishes in long-term suggesting financing from resources that the public get easy
access to the information would cause short-term price fluctuations. And the reaction is more sensitive to mid-to-small capital sized stocks as both volatility risk and jump risk are affected by $IBTVol_t$ and only jump risk is affected in large capital sized stocks. Meanwhile, $IBTVol_t$ works as a supplement to margin trading before deleveraging and that relationship becomes a partially substitution after deleveraging, suggesting the change in investors’ component: mainly value and arbitrage investors before deleveraging and firms’ financing demand after deleveraging.

A one-unit positive shock in volatility of both CSI300 and CSI500 would lead to interbank market activities rise short-term and drop in long-term indicates stock market deleveraging in June 2015 was greatly affect by funds flowing from the interbank market, hence earlier literatures’ study of market-wide deleveraging in China’s stock market in June 2015 with investors’ personal fund constraint assumption doesn’t fully describe the real funding situation in the market. After deleveraging, positive shocks in volatility and jump lead to short-term increase in interbank market activities suggests unstable stock prices harms firms’ ability to circumvent traditional banking system financing approach for other less information disseminated methods. Thus, shocks in stock price uncertainties raise firms’ need of financing from banking system. Furthermore, it’s worth mention that impulse response of $Jump_t$ of CSI300 with respect to $IBTVol_t$ decays much slower than that in CSI500 case indicates firms with traditionally stable connections to banks and excessive producing capacity i.e. one of the targets in deleveraging, are now affected by financing activities too. And the effect is more influential than that in mid-to-small firms as their sizes decides their financing scale cannot be satiated through other non-major channel.

For deleveraging’s effect on uncertainty in stock market, first, firms’ need to stabilize their stock prices in a tight financing environment made them look for other approaches without making clear statement about their financing status to the public. This choice might be beneficial for firms to keep a relative smooth operation but the information asymmetry created will hurt public shareholders if default occurs. Second, capital size matters for firms
who choose other financing method. Although large capital sized firms choose to finance from other financing approach, for example margin trading account in this research, and their sizes decide margin trading accounts cannot satiate their financing needs so the major and traditional financing approach is still important for them. Meanwhile, mid-to-small firms have less of that limitation from their sizes. Third, client ends connecting funds from banks and exchange makes funds from banks participate in market-wide deleveraging in June 2015, so the assumption about widely fund constraint of individual investors doesn’t fully describe the real funding situation in market. Finally, deleveraging also change the component of investors: mainly arbitragers and value investors before deleveraging and mainly listed firms with financing need after deleveraging.
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