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Abstract: In this paper, we discuss elements of systemic risk and the Chinese shadow banking sector, and analyze systemic risk in the Chinese shadow banking systems using a Markov model. Dispersion of risk across the "under-developed" shadow banking system in China has led to some cases of localized, concentrated risk, but not to large levels of systemic risk. However, based on our Markov analysis, we find that some systemic risk is presented by trust companies and that banks absorb most of this risk in the financial system. We conclude with policy recommendations.

Introduction

We analyze systemic risk in the Chinese shadow banking systems using a Markov model. Dispersion of risk across the "under-developed" shadow banking system in China has led to some cases of localized, concentrated risk, but not to large levels of systemic risk. However, based on our Markov analysis, we find that some systemic risk is presented by trust companies and that banks absorb most of this risk in the financial system.

Systemic risk has been defined by a Group of Ten (2001) report as “the risk that an event will trigger a loss of economic value or confidence in, and attendant increases in uncertainty about, a substantial portion of the financial system that is serious enough to quite probably have significant adverse effects on the real economy.” Systemic risk may arise in the form of liquidity risk, in which many institutions face difficulties in rolling over their short-term debt or in which institutions cannot trade assets at normal bid/ask spreads (Barnhill Jr. and Schumacher 2011); or solvency risk, in which institutions incur unexpected losses regardless of the source, type, or size of the losses. Systemic risk may arise due to the structure of bank balance sheets, the interconnectedness of financial institutions, and/or the intertemporal nature of financial contracts (de Bandt and Hartmann 2000). During the current crisis, the US and Europe faced both liquidity and solvency risk and contagion due to all three reasons listed above: the nature of bank balance sheets, the interconnectedness of financial institutions, and maturity mismatches in financial contracts, while China did not.

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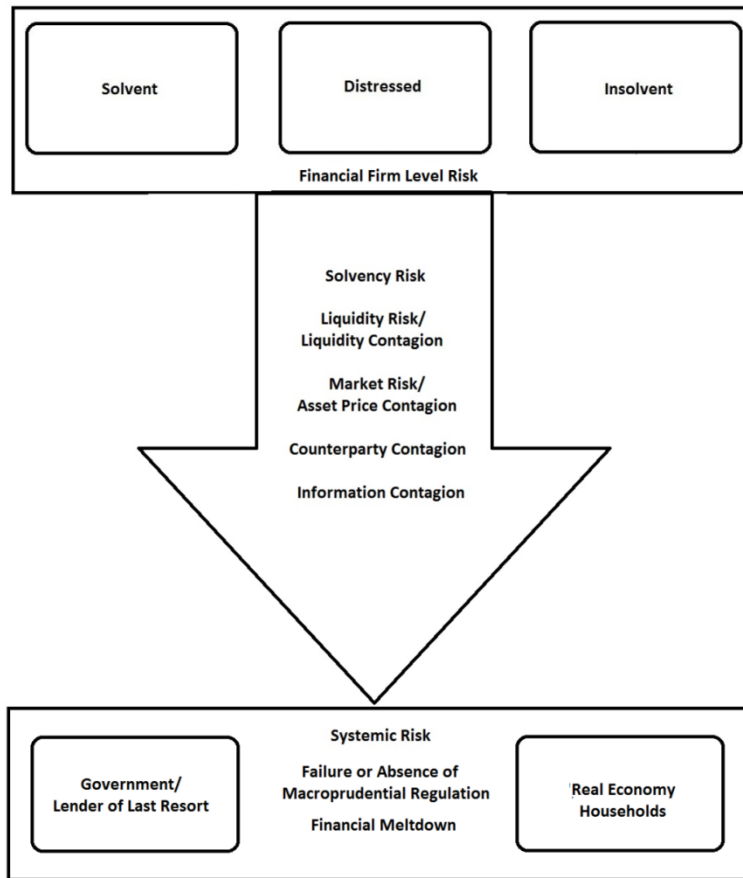
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China's financial system was less stressed during the current crisis than its real sector. Therefore, since it has not faced a system-wide financial meltdown, exposing its riskiest areas, it is not immediately obvious where the weaknesses within China's shadow banking sector may lie. However, because China's banking system has been slow to transition to a modern banking industry, other financial channels (most of which are considered to be part of the shadow banking sector) have existed for some time, while new ones have arisen as well. The largest part of the shadow banking sector in China, the informal financial sector, has existed for several decades (after reform began in 1979) and is comprised of individuals or small and medium enterprises as borrowers and individuals and small and medium enterprises as lenders. Risk is greatly dispersed within this system. The newer parts of China's shadow banking sector are somewhat more integrated with the rest of the financial sector, but their risk continues to be geographically dispersed, regulated, or segmented.

In the sections that follow, we first discuss systemic risk, then the Chinese shadow banking sector. We examine and discuss these within a more technical framework using a Markov model, then make policy recommendations.

Systemic Risk

In a companion piece to this paper, we analyze firm level risk in China's shadow banking system. We differentiate between firms that are solvent, distressed, and insolvent. Firms themselves must control for liquidity and solvency risk, and protect themselves against market risk, as in the diagram below. Going further, however, once firms begin to encounter distress or insolvencies, the threat of contagion to the system, or systemic risk, evolves. Contagion can occur through liquidity contagion, in which financial institutions hoard liquidity creating a shortfall of cash, counterparty contagion, in which interlinkages between institutions create system wide distress, and information contagion, in which an information shock leads to a rise in uncertainty and distress throughout the financial sector.



In this paper, we explore contagion and systemic risk. Systemic risk arises when many financial institutions fail due to a common shock.

Many aspects of systemic risk have been explored in the literature. Applicable to the recent crisis is the finding that systemic risk has been shown to be higher in clustered asset structures, in which banks hold identical asset portfolios, rather than unclustered asset structures, in which banks swap projects with neighboring banks but do not hold identical portfolios (Allen, Babus and Carletti 2011). During the crisis, clustered asset structures led to an increase in systemic risk in the US and Europe. This, in combination with other factors such as maturity mismatches in real estate finance, and underpricing of credit default swaps which limited short-selling of mortgage backed assets, created a shock to the financial system large enough to lead to a vast meltdown.

The literature on systemic risk has used a variety of measures to quantify this variable. A brief list of measures of systemic risk includes: examination of interlinkages of credit exposure (Allen and Gale 2000); the probability of default (Avesani, Pascual, and Li 2006); conditional value at risk (Adrian and Brunnermeier 2009); systemic expected shortfall (propensity to be undercapitalized) (Acharya, Pedersen, Philippon, and Richardson 2010); network-based systemic risk (Cont 2010); coupled stochastic processes (in the presence of a financial accelerator mechanism) (Battiston et al 2009); valuation of put options

written on a portfolio of aggregate bank assets (Hovakimian, Kane and Laeven 2012); and insurance against systemic financial distress (Huang, Zhou and Zhu 2010).

Ideally, we would like to utilize the Battiston et al (2009) model to determine systemic risk, but it is not easily adapted to empirical data. Rather, in this paper, we use a Markov model, which has often been applied to network models in order to measure systemic risk. The Markov model makes the simplifying assumption that future states depend only on the present state, not states that preceded the present state. We implement the Markov model to test for systemic risk. But first, we describe the vulnerabilities of the Chinese shadow banking systems in order to better understand our subject.

China's Shadow Financial System

China's shadow financial system is far smaller and less developed than those in the US and Europe. Despite variations in shadow banking definitions, we include the informal financial sector, which does not consist of money market funding of capital market lending, per Mehrling et al (2012). But it does consist of non-bank financing that has extensive ties to sectors that fund capital markets through money markets.

To that end, we describe China's shadow financial system as being comprised of three levels (Li, Hsu and Tian 2012). The first part contains commercial banking and investment banking, including banks which sell trust, wealth management, and other shadow banking products, investment banks, financing leasing companies, and insurance brokerage firms and their products. The second part includes quasi financial institutions such as micro loan companies, financing guarantee companies, and pawn shops. The third part consists of informal financial institutions.

According to PBOC data for 2011, the system wide financial aggregate is RMB ¥12.83 trillion (about €1.43 trillion Euros); banking loans comprise 58.3%, which means that general shadow financial activity, classified as activity outside bank lending, comprises 41.7% of all financial activity. Shadow banking and banking activity have some interactions, although these are not as extensive as in the US and Europe. For example, commercial banks in China may sell products of trust and investment companies, or may themselves take part in shadow financial activities such as transferring deposits into financial management products and lending the funds to investors for short-term projects. Outside of the commercial banking system, the shadow banking system encompasses property securitization, money market funds, and undiscounted instruments, for which the banks act only as intermediaries, not as institutions that back up these funds with reserves. Although there is supposed to be a firewall around commercial banks' lending activity, some investors have willfully believed that risky products purchased through a bank intermediary would be backed by government funds in the case of extensive losses. The third level of the shadow banking system, consisting of informal finance, carries out performance of financial functions and risk management outside the banking system.

Commercial banks act, in various limited capacities, in the shadow banking sector by offering several products, including trust products⁵ (and real estate investment trusts), negotiable securities, credit default swaps, and wealth management products. Outside the commercial banking system are trusts, broker-dealer pension and insurance companies, micro-loan companies, guarantee companies, pawnshops, investment or financing companies, entrepreneurs unions, private money houses and money brokers, and internet borrower-lender platforms. The ratio of commercial banking shadow activity compared to aggregate non-commercial banking shadow activity was about 18.5% at the end of Q3 2012 (Financial News 2013).

Issues have arisen with regard to investor understanding of commercial bank products. Commercial bank deposits, for the most part, are implicitly backed by the government, but recently it has been necessary for officials to state that the government will not back shadow banking transactions undertaken by banks. The issue is tricky, since bank ownership is held by the government in the form of shares. Looking at the structures of main shareholders of China's five commercial banks, we can better understand the relationship between banks and the government. For example, the Ministry of Finance and Central Huijin Investment Ltd play significant roles in the shareholder structures of all top five banks. While the Ministry of Finance, as well as the National Council of Social Security Funds, are obviously governmental shareholders, Central Huijin Investment Ltd, authorized by the State Council, is the main sponsor of many predominant financial institutions. Other major shareholders like China Life Insurance Company, Pingan Life Insurance Company of China and Baosteel Group Corporation are featured as large state-owned businesses. Therefore state control of banks continues to be implied.

Credit default swaps issued by banks and bond insurance companies, known as credit risk mitigation products, are far less risky than those involved in the US crisis. These are also tightly regulated-- only large, approved financial institutions are allowed to conduct trades and only when they own the underlying bonds or loans (Anderlini 2010). Ownership of these instruments is therefore quite limited.

Negotiable securities companies, which are either part of commercial bank groups or owned by independent securities traders, sell shares in funds based on pools of stocks and bonds, which are defined as collective wealth management products. These companies are supervised by the China Securities Regulatory Commission (CSRC) and their wealth management products are inevitably

⁵ For trusts, serving as a channel of issuance and distribution, banks play a third party role only as required and limited by the Law of Commercial Banks. The Rules on Trust Schemes of Collective Funds by Trust Companies states in Article 16, "When recommending a trust scheme, a trust company can sign a collection and payment agreement on entrusted funds with commercial banks, according to which a client may purchase trust units in cash through commercial banks. Where the trust company entrusts a commercial bank to deal with collection and payment business for trust schemes, it shall clearly define relevant rights and obligations for both sides, especially for commercial banks who (sic) only assume the responsibility of funds collection and payment, rather than bear investment risks in trust schemes." Any trust activity that banks themselves engage in is listed on the balance sheet, per the Notice on Further Standardizing of Bank-Trust Cooperation, which states that "By the end of 2011, all the bank-trust cooperate (sic) services should be transferred from off-balance sheet into balance sheet by commercial banks."

considerably influenced by CSRC. After restrictions on their issuance were loosened, wealth management products designed by negotiable securities companies saw a rapid development. Up to November 12, 2012, the number of the existing collective wealth management products is was 322 (Sina Finance 2012).

In transactions involving wealth management products, negotiable securities companies take the roles of initiators and custodians simultaneously, and trade with trustees, a role usually played by qualified institutions like large commercial banks. Wealth management products issued by banks also have carried implicit government backing. However, there is a lack of implicit government backing for smaller banks, which increasingly issue wealth management products (Cushnie 2012). From Q1 to Q3 of 2012, commercial banks issued over ¥20 trillion RMB of wealth management products. The stock of wealth management products was ¥6.73 trillion RMB (US \$1.07 trillion). Wealth management products comprise only 11.5% of total deposits, or ¥10.4 trillion RMB (US \$156.8 billion at the end of Q2 2012). Although potentially risky, these products do not currently pose systemic risk as their total size is so small. They should continue to be watched, however, as their underlying assets are becoming increasingly risky.

Credit guarantee companies are likely the most interlinked shadow banking institutions, often guaranteeing the credit of many non-bank companies in one area. They are not part of the commercial banking sector but are linked to the banking sector through third-party guarantees that state borrowers will not default on their loans. There have been cases⁶ in which the failure of one guarantee company has brought down a multitude of non-bank companies. Still, credit guarantee companies are not linked to other areas of the shadow banking sector, and their threat of systemic risk is low. In fact, most credit guarantee companies lend money directly to SMEs, and issue wealth management products informally.

Most of the non-bank related shadow banking is further segmented by geographical region, fund sources, and even between institutions or individuals. Although financial segmentation is a mark of financial underdevelopment, in this case, the coexistence with low-level forms of shadow banking along with high-level forms of shadow banking has served to protect the real economy from financial contagion.

Within the realm of informal or folk finance, we find that informal lenders such as money lenders, private equity funds, pawn shops, and rotating credit associations are based to a large extent on personal relationships and engage almost solely in lending and borrowing to/from small and medium enterprises and individuals, rather than in riskier or more highly leveraged forms of financial activity. Lenders know their borrowers, and borrowers are obligated by social relations to repay the loans. Money lenders and money houses rely on personal connections to obtain loan repayment. This financial

⁶ In early 2012, Zhongdan Investment Credit Guarantee Company's financial strain and inability to compensate guaranteed companies' overdue loans came about. After that, the controller and some of the senior management left the company with a financial hole involving 294 companies with an amount of 13 billion RMB unfilled.

activity is not normally linked to other types of financial activity in other firms or regions, except in the case of the rare Ponzi scheme⁷. Hence contagion from one financial institution to another is rare.

Micro loan companies, one type of informal financial institution, do not absorb public deposits and are set up as limited liability companies. In order to direct informal funds to the countryside and to promote rural economic development, in May 2005, the Central Bank set up 7 experimental micro loan companies. After that, starting in 2007, the People's Bank of China and the Banking Regulatory Commission allowed additional micro loan companies to be set up in various provinces, touching off rapid growth of such companies. At the Q3 2012, the stock of micro loan companies measured in at ¥533 billion RMB, amounting to only 0.9% of the stock of bank loans. Their main source of funding comes from selling stock shares, endowments, and raising capital from less than two financial institutions. Risks posed by micro loan companies are low due to their small volume and high levels of repayment.

Pawnshops are one of the oldest types of informal finance and are locally based, using local physical goods as collateral rather than sophisticated financial instruments. Hence they are not connected to the rest of the financial system. The pawn shop is also not associated with usury, deferring to the legal interest rate and accepting supervision from the government as well as the public. A pawn shop must obtain an operation or closure permit from the government, and is supervised at both a macro and micro level. By the end of June 2011, China had 5,238 pawn shops, three times the number existing in 2005. Registered capital increased by over 20% in the past few years. The small volume and lack of financial interconnectedness of these institutions result in low levels of systemic risk.

Entrepreneur's clubs, also informal financial institutions, help member enterprises obtain loans due to their close relationships to government officials or experts. Most of the non-government financing transacted by entrepreneurs clubs is used for enterprise management. These clubs currently account for a small share of non-government finance at present. Entrepreneur's clubs are clearly not a threat to the financial system since they are very small in size.

Internet lending businesses in the realm of informal finance complete the whole process of lending and borrowing through the internet. The internet lending platform includes three modes: business-business (B2B), business-commodity (B2C) and person-person (P2P) lending. B2B belongs to the upstream flow of "goods" and consists of lending from business to business. B2C belongs to the terminal sales of the "commodity" from institutions to individuals, where money is lent through credit institutions. P2P is the most important financial internet lending platform, and combines personal lending and internet lending. All of the lending processes including information, money and contracts are made through the internet,

⁷ For example, in 2011 and 2012, there were some cases of Ponzi schemes in Hongsi in Jiangsu province, Zhengzhou in Henan province and Erdos in Inner Mongolia, but these brought about local informal financial problems that did not spread to other areas.

so that it can save costs and improve efficiency⁸. In 2011, the scale of the whole internet lending platform in China exceeded 14 billion RMB. The prospect looks bright. At present, the market risk of China network lending platform still exists, so it is essential to strengthen the regulation.

The investment company is another informal financial intermediary, obtaining funds from investors and providing loan to enterprises or individuals. The funds of investment companies generally come from idle enterprise funds and households⁹. Investment companies are common in Wenzhou, Ordos and Northern Shaanxi where the folk debit and credit had developed prosperously. Influenced by the economic situation and macro-control, lending business of Investment companies had developed fast and was not cooled until the Wenzhou private lending and owners Of MSEs escaped (Paolu) crisis. However, due to the lack of statutory restriction, out-dated risk management method, unreasonable internal control design and the lack of regulation, some problems such as raising interest rates in disguise and illegal raising fund emerged.

In 2012, China began to once again permit banks and financial corporations to undertake securitization. As a result, three banks and one financial corporation issued asset backed securities. In past 10 years, China's financial institutions issued ¥56.94 Billion RMB (\$7.76 billion) of ABS. Money market funds are one of the main types of shadow financial institutions which serve the purpose of providing alternatives to banks deposits and transforming credit to broker-dealers. The net value of money market funds in China was ¥4.255 billion RMB at the end of 2003 and reached ¥707.5 billion RMB at the end of 2012.

Bond repo transactions began in 1997, and the scale of the repo market was ¥18.42 trillion RMB in 2005, reaching ¥147 trillion in 2012. At the end of 2012, the first hedge fund, Zhongjin Aerfa FOHF, registered in Shenzhen Qianhai Modern Service Industrial District. China has an increasingly sophisticated shadow financial system.

Model of matrix power series based on Markov process

To measure systemic risk in China's shadow banking system, we first use a matrix power series model based on a Markov process. The model asserts that shadow banking risk contagion is a dynamic ongoing process that can be regarded as a series of time intervals short enough to be used in a Markov process. Potential risks of shadow banking products determine the credit strength of the organizations, and impact systemic risk as a whole. When an institution defaults on its shadow banking assets, it may also default on its liabilities to other institutions, resulting in a chain of defaults. We can therefore measure the systemic risk within the shadow banking system by how many defaults occur in the whole system as a result of this potential contagion.

⁸ It is also the future trend of financial services. Furthermore, P2P mode is a platform that takes fees (usually provide a third party risk guarantee) to be the intermediary of the individuals who need money and other individuals who supply it.

⁹ Investment companies' business can be divided into three types: corporate loans, individual private business loans and individual loans. The forms of loans include mortgage loans, secured loans and credit loans.

The model assumes that:

- (1) China's financial system contains a mechanism that implicitly guarantees deposits, so that there is no risk of bankruptcy due to a run on the leading institutions in the shadow banking system.
- (2) During the period of examination there is no risk of institutional bankruptcy, and that cross shareholdings which might lead to the risk of transmission can be ignored.
- (3) Shadow banking risk contagion is a dynamic ongoing process that can be regarded as a series of time intervals short enough to be used in a Markov process.

We use the following variables and components in the model:

- (1) n is the number of institutions in the shadow banking system;
- (2) MR_j represents the value of liabilities that institution j will default on if a particular value of j 's assets are defaulted on;
- (3) EMR_j represents the expected value of MR_j ;
- (4) L_j represents institution j 's shadow banking liabilities;
- (5) E_j represents institution j 's equities;
- (6) D_j represents institution j 's defaulted assets;
- (7) λ_{ij} is the proportion of shadow banking liability holdings of institution i to institution j ;
- (8) A_t is the matrix that shows the expected value of defaulted assets generated in institution i in the wave(t) of contagion resulting from j 's defaulted assets and the element of A_t is a_{ijt} ;
- (9) A is the transition matrix;
- (10) A^* is the matrix that shows the expected value of defaulted assets generated in institution i in the whole process of contagion resulting from j 's defaulted assets ;
- (11) SR_j is systemic risk for institution j .

Shadow banking risk contagion is a dynamic ongoing process. If institution j defaults on one unit of assets, it becomes the starting point of contagion, generating additional defaulted assets within the shadow banking system in a Markov process. In the first wave of contagion, the original defaulted assets generated by institution j create additional defaulted assets in institution k , with which institution j does related business. Then in the second wave of contagion, defaulted assets generated in institution k continue to generate defaulted assets in institutions with which it has business relations. The problem we face is uncovering how many defaulted assets are generated in the shadow banking system through the full contagion process by the institution j 's initial unit of defaulted assets.

To approach this problem, we first calculate the expected value of defaulted assets generated in institution i by the initial one unit of defaulted assets in institution j in the first wave of contagion. Second, we calculate the transition matrix that is needed to work out how many and where additional defaulted assets are generated in each round of contagion. Finally, we sum up the defaulted assets generated in each round of contagion.

When a part of an institution's assets are defaulted upon, the institution acquires an incentive to default on its liabilities to other institutions. That means that defaulted assets tend to generate defaulted liabilities in the same institution. Take institution j for example, if the amount of defaulted assets is smaller than j 's equity, the defaulted assets will be compensated by j 's equity, generating no defaulted liabilities. In other words, when D_j is smaller than E_j , MR_j equals to 0. In contrast, when D_j is bigger than E_j , each unit of defaulted assets has to be compensated by j 's liabilities and that means in this condition, MR_j equals to 1. The expression of MR_j is:

$$MR_j = \begin{cases} 0, & D_j \leq E_j \\ 1, & D_j > E_j \end{cases} \quad (1)$$

The risk of the transmission of assets to liabilities occurs in a gradual accumulation of risk that reaches a critical value. The critical value is based on EMR_j . Hence as for systemic risk, it is EMR_j instead of MR_j that matters. MR_j is a piecewise function and the point of demarcation is E_j . According to the properties of function MR_j , EMR_j is calculated as:

$$EMR_j = L_j / (L_j + E_j) \quad (2)$$

Shadow banking liabilities of an institution serve as another institution's assets at the same time. Let λ_{ij} be the proportion of shadow banking liability holdings of institution i to institution j . When a new unit of defaulted assets appears in j , the expected value of defaulted liabilities it will generate amounts to EMR_j . Therefore in the first wave of contagion, the amount of defaulted assets generated in i is calculated as:

$$a_{ij_1} = EMR_j \cdot \lambda_{ij} \quad (3)$$

A_1 shows in the first wave of risk transfer, how many and where defaulted assets are generated in the system. The expression of A_1 is:

$$A_1 = \begin{bmatrix} a_{11_1} & \dots & a_{1j_1} & \dots & a_{1n_1} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ a_{i1_1} & \dots & a_{ij_1} & \dots & a_{in_1} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ a_{n1_1} & \dots & a_{nj_1} & \dots & a_{nn_1} \end{bmatrix} \quad (4)$$

The expression of A_t can be drawn from transition matrix and A_{t-1} as follows:

$$A_t = A \cdot A_{t-1} \quad (5)$$

a_{ij_t} means that if a unit of assets was defaulted in institution j at time 0, then in wave(t) of contagion, defaulted assets generated in institution i amounted to a_{ij_t} . The source of risk for wave(t) of contagion is $a_{kj_{t-1}}$ and the negative effect from institution k to institution i is measured by a_{ik_1} . So a_{ij_t} is calculated as follows:

$$a_{ij_t} = \sum_{k=1}^n a_{ik_1} \cdot a_{kj_{t-1}} \quad (6)$$

The expression of A_t can be drawn from equation (6) as follows:

$$A_t = A_1 \cdot A_{t-1} \quad (7)$$

According to the definition of transition matrix, the expression of transition matrix can be drawn from equation (5) and equation (7) as follows:

$$A = A_1 \quad (8)$$

The expression of A_t can be drawn from the recurrent formula above:

$$A_t = A_1^t \quad (9)$$

A^* is the matrix that shows the expected value of defaulted assets added to institution i during the contagion process, resulting from a new unit of defaulted assets in institution j . In other words, A^* is the sum of defaulted assets generated in each wave of contagion. So A^* is calculated as:

$$A^* = \sum_{t=1}^{\infty} A_t \quad (10)$$

Another expression of A^* can be drawn from formula (9) and formula (10), showing that A^* is an infinite power series of matrix A_1 :

$$A^* = \sum_{t=1}^{\infty} A_1^t \quad (11)$$

a_{ij}^* , the element of A^* represents the expected value of defaulted assets generated in institution i during the contagion process if a new unit of default initially appears in j . Therefore the function for systemic risk can be calculated as:

$$SR_j = \sum_{i=1}^n a_{ij}^* \quad (12)$$

The equation containing SR_j says that if one additional unit of underlying assets in organization j is defaulted upon, the expected value of defaulted assets it generates in the entire shadow banking system is SR_j . SR_j measures externalities caused by shadow banking institution j 's risk of asset default. The equation for matrix A^* also reflects the distribution of externalities for institutional asset default risk and hence it can provide information for a specific type of inter-agency cross-risk monitoring and management.

Based on data availability, the shadow banking institutions analyzed in this paper include participants who repurchase bonds and who conduct wealth management business. China's repo market participants include banks, trust companies, securities companies, fund companies and insurance companies. These institutions constitute the main body of China's shadow banking system (outside of informal finance). The empirical analysis then includes these entities, and small loan companies, pawn shops, financial leasing companies and other non-standard shadow banking bodies are not considered here. Given the development of China's shadow banking and data availability, we examine the years from 2007 to 2012.

Between 2007 and 2012, the Chinese shadow banking system was mainly reflected in institutional bond repurchase transactions and financial product commissioning. Banks, trust companies, securities companies, fund management companies and insurance companies interacted on the inter-bank bond market and were the major players in repurchase transactions, which take place between several counterparties. Between 2007 and 2009, the Chinese shadow banking system conducted wealth management business mainly in banks and trusts. Banks bought financial products issued by trust companies with the money they collected from individuals, and most of the products issued by trust companies were invested in the loans of bank. In 2010 and 2011, the CBRC twice regulated financial products, and bank-trust cooperation business was extremely restricted. Trust companies then partnered with securities companies and fund management companies. In 2012, securities companies were allowed by the CSRC to conduct customer asset management business. This approval stimulated the cooperation between banks and securities companies through bank bills. In the same year, the CIRC allowed insurance funds to be entrusted to securities companies and fund management companies.

Resale bonds can be considered as shadow banking liabilities while repurchase bonds can be considered as assets. In the US and Europe, the trustee of wealth management products does not bear the investment risk. But from 2007 to 2012 in practice, many Chinese wealth management products played a role as a disguised form of credit, even though "caveat emptor" was not explicitly stated, the risk of default was borne by the trustee. Therefore, wealth management products offered can be considered as shadow banking liabilities, while wealth management products purchased by other institutions can be considered as shadow banking assets.

Shadow banking assets include resale bonds and wealth management products purchased while shadow banking liabilities include repurchase bonds and wealth management products issued. Sources of data include Almanac of China's Finance, Almanac of China's Trust Industry, Almanac of China's Insurance Industry, China Securities and Futures Statistical Yearbook, China Securities Depository and Clearing Corporation Limited, Chinese bond information network, Shanghai clearing house, CBRC, China Trust Industry Association, China Securities Industry Association and Wind.

At present, Chinese repo statistics are aggregated, and micro-level statistics are limited to sub-agencies' repurchase and resale data. We use a "double ratio" method¹⁰ to estimate the data of inter-agency

¹⁰ Upper, C., Worms, A., 2004, "Estimating bilateral exposures in the German interbank market: Is there a danger of contagion?", *European Economic Review*, 48, 827–849

transactions. Liability data of insurance companies from 2007 to 2009 is missing and so is equity data for banks and securities firms in 2012. These missing data were fitted based on the time series analysis.

According to formulas (1) - (12), empirical results for Chinese shadow banking systemic risk from 2007 to 2012 were calculated and shown in Table 1. Columns represent the sources of systemic risk and the rows represent the institutions that bear the risk.

Table 1.

2007	bank	trust company	securities company	fund management company	insurance company
bank	0.119	0.470	0.028	0.001	0.070
trust company	0.007	0.003	0.002	0.000	0.004
securities company	0.004	0.002	0.001	0.000	0.003
fund management company	0.022	0.009	0.005	0.000	0.013
insurance company	0.011	0.005	0.003	0.000	0.007
systemic risk	0.163	0.489	0.039	0.001	0.096

2008	bank	trust company	securities company	fund management company	insurance company
bank	0.075	0.958	0.146	0.040	0.296
trust company	0.000	0.000	0.000	0.000	0.000
securities company	0.000	0.000	0.000	0.000	0.001
fund management company	0.002	0.002	0.004	0.001	0.009
insurance company	0.001	0.001	0.001	0.000	0.002
systemic risk	0.078	0.961	0.151	0.041	0.308

2009	bank	trust company	securities company	fund management company	insurance company
bank	0.064	0.871	0.092	0.012	0.175

trust company	0.000	0.000	0.000	0.000	0.000
securities company	0.000	0.000	0.000	0.000	0.001
fund management company	0.002	0.002	0.008	0.000	0.015
insurance company	0.000	0.000	0.000	0.000	0.001
systemic risk	0.066	0.873	0.101	0.012	0.192

2010	bank	trust company	securities company	fund management company	insurance company
bank	0.083	0.752	0.068	0.004	0.204
trust company	0.001	0.001	0.001	0.000	0.003
securities company	0.001	0.070	0.001	0.000	0.003
fund management company	0.009	0.076	0.008	0.000	0.023
insurance company	0.002	0.002	0.002	0.000	0.006
systemic risk	0.097	0.901	0.079	0.004	0.238

2011	bank	trust company	securities company	fund management company	insurance company
bank	0.101	0.559	0.116	0.026	0.194
trust company	0.001	0.001	0.001	0.000	0.002
securities company	0.001	0.176	0.001	0.000	0.002
fund management company	0.009	0.182	0.010	0.001	0.017
insurance company	0.001	0.001	0.001	0.000	0.002
systemic risk	0.113	0.919	0.130	0.028	0.217

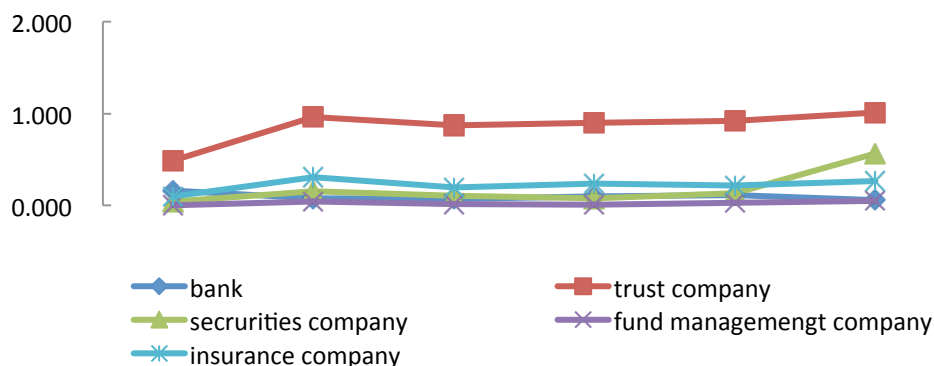
2012	bank	trust company	securities company	fund management company	insurance company
bank	0.053	0.543	0.559	0.047	0.248

trust company	0.000	0.000	0.000	0.000	0.000
securities company	0.000	0.232	0.000	0.000	0.002
fund management company	0.004	0.235	0.005	0.003	0.017
insurance company	0.000	0.000	0.000	0.000	0.001
systemic risk	0.057	1.010	0.565	0.051	0.268

Results

As is shown in Table 1, systemic risk triggered by different financial institutions varied considerably. From 2007 to 2012, the trust company was the most powerful engine for systemic risk, whose systemic risk index amounted to 1.79 times that of other institutions as a whole. The difference in the systemic risk level between insurance companies, securities companies and banks was not significant, while the systemic risk of fund management companies was relatively small compared with other financial institutions. According to the model-based analysis, two factors likely contribute to this development. One factor is that the asset-liability ratio of trust companies was low in recent years, leading to risk contagion from assets to liabilities. The other is that trust companies depend greatly on cooperation with other institutions, especially banks, concentrating the distribution of debtors. So the risk within trust companies tended to spill over.

From 2007 to 2012, insurance companies, securities companies, banks and fund management companies have associated with each other through bond repurchase transactions. In China, bond repos generated a smaller systemic risk than wealth management products because the volume of bond repos was much smaller and debtors' distribution of bond repos was less concentrated. As a result, from 2007 to 2012, insurance companies, securities companies, banks and fund management companies did not face systemic risk as serious as that of trust companies. Compared with securities companies, banks and fund management companies insurance companies had a higher level of systemic risk because the size of insurance companies' repurchase transactions in the interbank market was relatively larger.



Picture 2 Firm-level systemic risk in China's shadow banking from 2007 to 2012

Banks suffered the most from negative externalities, absorbing about 85% systemic risk within the shadow banking system. This phenomenon reflects the special role of banks in China's shadow banking system. As is analyzed above, bond repos and wealth management products are the two most important financial instruments chosen by institutions when doing shadow banking business. When we studied the trade data for bond repurchase transactions in China from 2007 to 2012, we found that the amount of resale bonds held by banks was larger than that of repurchase bonds held by banks. And banks stood as principals in selling wealth management products with trust companies and securities companies. In other words, in China banks played the role of supplier in such financing activities. When the default risk of other institutions' assets occurred, banks were bound to be involved.

As is shown in Picture 2, the systemic risk in China's shadow banking system developed in an upward trend from 2007 to 2012 and systemic risk in 2008 and 2012 were particularly significant. This paper argues that the distinction of systemic risk between different years comes from the annual changes in the external environment and the evolution of the shadow banking itself. In 2007 and 2008, the People's Bank of China shifted monetary policy from "prudent" to "tight" in order to handle excess liquidity in the banking system and curb inflation. Credit restrictions stimulated the expansion of bond repurchase transactions. In 2008, the volume of bond repos in the interbank market increased significantly compared with 2007, strengthening the shadow banking system and thus increasing systemic risk. In 2009, China's monetary policy was somewhat eased. In such an environment, bond repurchase transactions shrunk and systemic risk declined accordingly. From 2010 to 2012, repos were conceived as an effective tool for liquidity management and the size of bond repurchase transactions continued growing. Meanwhile, as a means to circumvent interest rate controls, the wealth management business has been greatly developed. As a result, China's shadow banking systemic risk increased in this period.

Another finding is that the externality of the first wave of risk is magnified by the Markov process. As is shown in Table 1, each element in matrix A^* is bigger than that of matrix A_1 , reflecting the fact that the shadow banking risk transfer is a dynamic ongoing process which tends to magnify systemic risk.

Policy Recommendations

In China, systemic risk in the shadow banking system does not arise from the process of credit asset securitization, because the scale of securitization is very small. Risks may come from wealth management products, since these have been increasing in volume. In 2012, banks issued more than ¥20 trillion RMB products, exceeding the scale of new loans. Of these products, some floating return financial products present greater risks. However, the CBRC requires banks to back their risks, so they, and going further, the government which in turn backs the banks, take on all the risks.

The CBRC has been very sensitive to preventing financial fallout from the shadow banking sector to the banking sector. The CBRC has asked to build firewall between banks and trust companies, so that trust companies themselves will face market risks, such as enterprise default risks that occur with an

economic downturn. We suggest that these recommendations be implemented in the form of regulations and strongly enforced.

In late June 2012, an announcement titled “Interim Report of the No.1 Collective Trust Fund Plan of China Credit-ChengZhiJinKai in 2010” aroused a storm. The announcement explained that the borrower of the mineral trust, which is listed as China Credit Trust Co., Ltd with a scale of ¥3.030 billion, brought about lawsuits with the allegation that it was hiding funds in secret accounts. This presented a special case of trust risk rather than systemic risk.

There were only 65 trust companies in China through the first half of 2012, with total trust assets worth ¥7 trillion RMB at the end of 2012. Negotiable securities companies possess total assets less than ¥2 trillion while financial leasing companies possess total assets of ¥1.2 trillion RMB. We also know that the stock of banks’ wealth management products measures in at ¥6.73 trillion RMB. Therefore we can calculate the scale of the first level of the Chinese shadow banking sector in 2012 at nearly ¥18 trillion RMB.

Credit guarantee companies may encounter more risks because they lend money directly to small and medium sized enterprises. If some enterprises cannot repay their loans, they may encounter financial problems and will transfer some risks to banks. Credit guarantee companies must be more strongly regulated and monitored.

China’s shadow banking sector is in its infant stage and rapidly growing. Although the sector currently does not pose a very large systemic threat, new products and institutions must continue to be monitored and regulated. Currently, regulations control trust companies, finance guarantee companies, personal wealth management business carried out by banks, securitization, micro loan companies, bank-trust business, and illegal financial institutions. These have been created in response to the rise of new types of business, and the China Banking Regulatory Commission, State Council, and Central Bank regularly monitor financial activity. Ongoing regulation and enforcement are essential.

Conclusion

In this paper, we have discussed the topography of shadow banking systems in China as well as potential for systemic risk. We have found that trust companies present the greatest systemic risk in China. As our understanding of shadow banking grows, we will have more ammunition to prevent or curtail future financial crises. China’s regulatory authorities must closely watch developments in this area and enforce regulations.

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