The study on the Financial Risk of China's Local Governments

The Study on the Financial Risk of China's Local Governments

（中国地方政府の金融リスクに関する研究）

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Abstract

Since 1980s, local government debt has occurred successively and developed rapidly. The financial system reform in 1994 and the great bailout plan in 2008 have led heavy burden on local governments and therefore generated a lot of local government debts.

In recent years, the annual growth rate of government debts is over 20%, greatly exceeding the rate of economic growth. Besides, the total amount of local government debts is over 1.5 times as annual revenue, and the proportion of local debts is much higher than other countries. The rapid growth of local debts may lead local governments unable to repay. Especially, the borrowing through non-formal channels implies high risk, so the unpayable debt could eventually lead to economic or political crisis. This phenomenon has aroused vigilance of policy makers and scholars.

The academia devotes energy on sovereign debts; however the issue of local debts has not attracted enough attention. In Chinese academia, the research on local debts has just begun; and due to the unclear market and the lack of accurate data, there is almost no quantitative analysis. In this dissertation, the objective is to extend current methods to China's local governments, which has not been well addressed so far.

A credit default swap (CDS) is a financial swap agreement. It is used to avoid potential credit risks by purchasing a contract similar to insurance. CDS quote (price) is an important signal to show the risk of the underlying asset(s).

In order to measure local government's risk, this dissertation proposes the concept of local government CDS. Similar to sovereign CDS and corporate CDS, it is a credit swap contract, representing a type of measure of risk of local government debt. Through structured model combined with Merton and Black-Cox models, Shanghai's CDS is simulated.

After that, by using intensity models, the default probabilities have also been estimated. The result shows the risk of Shanghai's bond is higher than of central government's, and their trends are not fully consistent. Province comparison is also applied to illustrate the effect of fiscal situation.

Shadow banking is another important feature of current market. It is the entirety of unregulated or weak regulated financial intermediaries. Shadow banking has already become a major bridge for the subprime borrowers and market surplus funds, including the financing platforms of local governments. It can play an active role of financial innovation and credit creation. Nevertheless, because the shadowed activities are less

regulated and supervised (so it is called "shadow"), higher interest rates are generally required and potential risk is high.

There is rare quantitative research on the issue of shadow banking and default probability, maybe because of its elusiveness. This dissertation also has only done some fundamental studies about it, but has analyzed the academic research situation exhaustively and suggested developing directions. The precise analysis should be developed in future.

Last, the topic of China's local government debt is huge and very critical. Currently, most risk is diving, but there is already unstable tendency for some provinces. It can be predicted that some small default would occur in the near future.

Key words: local government debt; financial risk; CDS; shadow banking

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1 Introduction

Financial risk of local governments is centrally reflected as the debt risk. Since Chinese economic reform, especially after 2008, most of China's local governments have borrowed a large amount of debt. Due to the long-term lack of supervision, the size and structure of debt of some local governments have exceeded their solvency levels, so as to cause various negative phenomena, which have aroused great attention of policy makers and economists.

1.1 Background

China's **local government debt** (often abbreviated as **local debt**), which local governments are responsible to repay, had initially appeared in 1979. Since 1980s, the behavior, government borrowing, has occurred successively and developed gradually.

Because the old fiscal system had some serious defects, China has carried out the fiscal system reform in 1994, and it has become a turning point. The most important point of the reform is "tax sharing system". In this system, the levy method and allocation of tax was fully changed. As a result, the central fiscal situation has been significantly improved, but the local governments have met more financial difficulties since then.

After the global financial crisis in 2008, China, in order to stimulate the economy, has taken a proactive fiscal policy and loose monetary policy. As a far-reaching policy decision, the Chinese government carried out a great bailout plan. It is a set of programs, with the core content of government investment of four trillion yuan. 70% of the investment should be paid by local governments, almost equal to their total income. Consequently, the local government debt has soared since then.

In China, there are different levels of governments: central government (中央), provinces (省, 直辖市, 自治区), cities (市), wards and counties (区县), town (乡镇) ... However, in current political system, a government in higher level is responsible for matters and events of subordinate governments. For this reason, in this dissertation, provincial governments and all the lower levels are regarded as a whole (provincial

level), and collectively called "local government", unless otherwise stated.

That a sovereign government bears some debt is common sense and not surprising at all. Putting external debt aside, the debt borrowed from the domestic market is not a worrying problem, and not particularly concerned, either. It is because the whole domestic market itself is controlled by the central government, at least by a strong government.

But how about local governments? At least, the market is not fully controlled by a local government. Local governments cannot take some methods to ease the debt burden, either (for instance, to print money). Therefore, the debt problem of local governments has become a new topic in recent years, especially in China.

Local governments have to continuously construct the urban infrastructure, to spend on social security system, and many other projects; but the revenue from traditional channels, including bank loans, is strictly limited. To compensate for the lack of local financial resources, there are two major methods: issuing government bonds and borrowing though other channels. These have also aggravated the burden on local governments. Detailed contents will be discussed in Chapter 2.

Due to the audit result of national local government debts, at the end of 2010[1], debts that need to be repaid by financial funds of local governments have reached up to 6.71 trillion yuan; and which have increased up to 10.89 trillion yuan by June, 2013[2]. The local debt has grown over 60% within 2 years and half (faster than GDP growth rate and revenue growth rate), astoundingly rapid.

As the local governments borrow debts wantonly through neither supervised nor regulated systems, it eventually caused the huge size of local debt, which is much higher than the financial capacity of local governments. This leads local governments facing huge debt risk, and there emerged undesirable phenomena such as financial difficulties, deficit expanding and debt refinancing.

[1] Data source: PRC Audit Notice No. 35 of 2011: National government debt audit results
[2] Data source: PRC Audit Notice No. 32 of 2013: National government debt audit results

The issue of government debt has begun to attract attention since the Latin American sovereign debt crisis in 1980s. Specially, the crises in 1997 and from 2008 have accelerated the research tendency.

If the rapid growth of local debt is indulged, it is very likely to lead local governments unable to repay their debt due to changes in policy or market. Once the crisis broke out, the treatment method will be another more serious problem: Shift, conversion, extension or direct repudiation: regardless of the treatment, at this step, bad influences will be certainly brought. The worst result might be political instability. Hence, not only scholars, but also policy makers, are paying great attention on the problem.

1.2 Research Approach

In this dissertation, the main purpose is to find a method of measuring local government's debt risk, and try to calculate the risk actually. Meanwhile, consider the effect of other factors as far as possible.

A common method of such research is to extend previous researches to this field. However, there are practical difficulties: One is the research on this field started very late, and not deep; another one is because of the lack of data, there is very little quantitative analysis. Therefore, the proper method is to be discovered.

To achieve the objective, the research approach is:

1. Have an overview of the current situation of China's local debt and related phenomena. In order to understand better, compare it with foreign countries.
2. Review related literatures to catch previous research mentalities and find the trace of valuable methods. In this part, a handy tool, credit default swap (CDS), is found.
3. Propose a new concept: suppose the CDS can be applied onto local government bonds. Along this line, establish a model to estimate the CDS data of a local government.
4. Apply the data to calculate the default risk, and discuss the suitability of models.
5. Considering the effect of other factors, discuss future situation and draw conclusions.

1.3 Contributions of the Dissertation

Due to the deficiency of reliable data resource, it was quite difficult to deal with local debt directly. Therefore, Chinese scholars tended to discuss the regulatory, management and risk warning theoretically, while foreign scholars were mainly targeting at sovereign debt, in country level. This dissertation has extended previous researches to provincial level, and calculated quantitatively.

In past several years, many Chinese scholars have discussed different aspect of shadow banking system, such as financial innovation, credit creation, system stability and regulatory. This dissertation has analyzed the citation network of hundreds of Chinese literatures, and has drawn a literature tree.

Besides, in this dissertation, a new concept that CDS of local government bonds is proposed, by which the quantitative analysis of risk is applied to local debt. Then, it has actually estimated and applied CDS data.

1.4 Structure and Outline

This dissertation mainly consists of the current situation, literature review and model parts. Specifically:

The first chapter is the introduction. This chapter shows a brief description of the background, problem and significance of the issue of local government debt.

The second chapter is the current situation of China's government debt. Not only China itself, but also several other countries are mentioned and compared together. It shows China's current situation is not terrible, but some characteristics should be noticed.

The third chapter is literature review. There are mainly three different aspects: general research of government debts (central, i.e. sovereign, and local); the characteristic and role of CDS; and the issue emerged in recent years, shadow banking.

The forth chapter is description about Shanghai's CDS. It is too large an issue for

analyzing all the provincial governments, so Shanghai is selected as a typical case. Data of "local CDS" is simulated in this chapter.

The fifth chapter is to use the CDS data to simulate Shanghai's risk. The effect of other factors (e.g. shadow banking system) will also be adopted here.

The rest part is future prospects and conclusions.

The structure tree of this dissertation is:

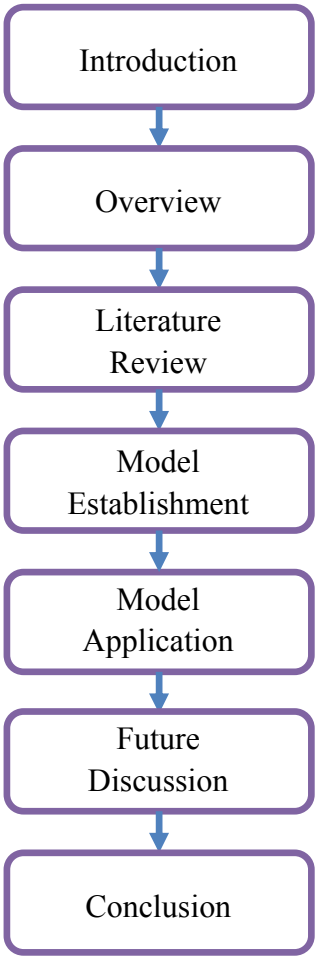

Fig. 1.1 Dissertation Structure

2 Current Situation of China's Government Debt

2.1 Bond, Financing Platform and Debt Categories

In Chapter 1, it is mentioned that in order to deal with the fiscal gap, there are two main methods: to issue local bonds and to borrow through other channels.

Due to *Budget Law of People's Republic of China* (effective as of January 1, 1995), local governments are not allowed to issue local government bonds, except as otherwise provided by law or the State Council[3]. Therefore, there were only central bonds for a long time until 2008.

From 2009, in order to meet financing needs, the Ministry of Finance (MOF) has permitted local governments to issue local bonds, of which the form and quantity are restricted and the issuance must be made by the MOF as an agent. So, in China, local bonds are examined and guaranteed to a certain extent by central government.

As an experiment, several provinces and cities with better financial status are permitted issuing their own bonds with some restrict. Concretely, Shanghai, Zhejiang, Guangdong and Shenzhen started to issue their individual bonds from 2011, and Jiangsu and Shandong started from 2013 (MOF, 2011, 2013). These six governments do not attend the general issuance. Because of their good credit, the yields are lower than that of general bonds. For more information about such governments, see Appendix A.

However, the total amount of this method, government bonds, is only about 5% of total local revenue. Therefore, in order to borrow more money smoothly and for earmark, the local governments are tending to borrow money by the other method.

This method is to establish some companies and institutions, and to operate them to borrow money from society and invest on projects. These companies and institutions are called "**financing platforms**". For example, *Hangzhou Metro Group Company Limited*

[3] Budget Law of the People's Republic of China, Article 28.

(杭州市地铁集团有限责任公司) is a financing platform established by Hangzhou city, which mainly engaged in rail transportation construction, operation and management. Due to a material released by China Banking Regulatory Commission, there are over 10,000 such platforms by 2012 (CBRC, 2012).

However, the bank loans are still banned for financing platforms because of their weak solvency. The only way is to borrow money from society. To finance by financial institutions, by trust companies, to build projects by private enterprises and redeem later (build-transfer, BT), or to borrow money from non-bank institutions, and so on.

All these methods are called "shadowed", because the transactions are generally done without being supervised. For this reason, the transactions basically do not meet the official provisos, such as credit examination or return rate.

Both governments and financing platforms borrow debt, so it is necessary to clarify the research object before discussing the situation. The definition of concept "local government debt" is provided in audit reports.

Chinese central government has paid great attention to the problem of local debt, and has investigated the debt situation from 2011; specifically, it decided to get accurate data and ordered all 30 provinces (except Tibet) to audit their debts seriously. As a result, National Audit Office has released two audit reports in 2011 and 2013, which described the whole circumstance of local debt at the end of 2010 and June 2013 (and another report describing the circumstance of 36 province/city governments at the end of 2012). Besides, all 30 provinces (except Tibet) have also released their audit reports in Jan. 2014.

In the audit reports, the borrowers are divided into provincial level, municipal level, county level and township level. The total debts are divided into three main categories:

1) **Government debt**: governments have responsibility to repay the debt by financial funds.
2) **Guarantee obligation**: Mainly made by financing platforms. This type of debts is repaid by non-financial funds. Guarantees are provided by government. The debts

will be compensated by departmental budgets or special fees if there are any risks.

3) **Responsibility of debt relief**: Mainly made by financing platforms for the public welfare projects, such as public schools, public hospitals. The government does not assume responsibility for the debt service obligations in the law. But if there are risks, the government may bear some responsibility for relief.

Category 2) and 3) are also collectively called contingent liabilities. These three types are not simply addable. In this dissertation, **the research object is only category 1**.

From the aspect of creditors, there are 11 categories in total. The top five occupying the largest share are: Bank loans, Build and Transfer (BT), Bond issuance, Trust financing, and other unit and individual borrowings.

2.2 Current Situation of Local Government debt

In this section, specific data of total local debt in 2012-2013 will be shown, with some fundamental analysis.

Due to the nationwide audit report, as of the end of June 2013, China's governments at all levels bear the responsibility to repay the debt (type 1) of 20.70 trillion yuan; the amount of local debt is one trillion larger than the central debt. By December 2012, the total amount is about 19 trillion yuan, and the local debt is almost equal to central debt.

Table 2.1 Debt Scale of China's Governments (billion yuan)[4]

Year	Gov. Level	Gov. Debt	Contingent Liabilities	
			Guarantee obligation	Responsibility of debt relief
2012.12	Central	9,437.67	283.57	2,162.12
	Local	9,628.19	2,487.12	3,770.52
	Total	19,065.86	2,770.70	5,932.63
2013.6	Central	9,812.95	260.07	2,311.08
	Local	10,885.92	2,665.58	4,339.37

[4] Data source: PRC Audit Notice No. 32 of 2013

Total	20,698.87	2,925.65	6,650.46

In order to clarify the relative size of government debt, calculate ratio of the debt amount to GDP and revenue (Table 2.2), and compare them with international standard level.

Table 2.2 GDP and Fiscal Revenue (billion yuan)[5]

		2012.12	2013.12
GDP		51,947.01	56,884.52
Revenue	**Central**	5,617.52	6,017.38
	Local	6,107.83	6,896.91
	Total	11,725.35	12,914.29

In 2012, the debt-to-GDP ratio is 36.69% (central 18.16%, local 18.53%), which is lower than the prudential limit of 60% for developed countries, or 40% for developing and emerging economies (Anis and Iyanatul, 2010). If take contingent liabilities into account, considering the government burden rate, the amended debt-to-GDP would be 39.43%, still lower than the international standard.

However, in 2012, the debt-to-revenue ratio (debt ratio) of central government was 168.0%, and of local governments was 157.6%, much higher than the internationally recognized warning line of 100%. This is because the revenue level of China is low.

Also, analyze the composition of government debts for China (Table 2.3, Fig. 2.1). It can be found that the proportion of local debt is about 53%, in a relatively high level. This will be discussed in next section.

In addition, the municipal and county debt account for the largest proportion of local debt, because they bear more responsibility for public services. As mentioned before, the local government is regarded as a whole.

[5] Data source: National Bureau of Statistics, Statistical Communiqué on National Economic and Social Development, 2012 & 2013

Table 2.3 Scale of Government Debt of All Levels, 2013.6 (billion yuan)

Level	Gov. Debt	Guarantee obligation	Responsibility of debt relief
Central	9812.95	260.07	2311.08
Province	1778.08	1562.76	1853.13
City	4843.46	742.41	1704.37
County	3957.36	348.80	735.75
Town	307.01	11.60	46.12
Total	20,698.87	2,925.65	6,650.46

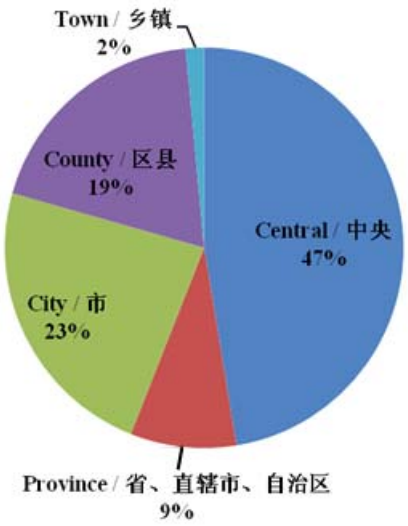

Fig. 2.1 Proportion of Government Debt of All Levels, 2013.6

2.3 Compare with Other Countries

A common approach to observe the debt level is comparing it with "industry average" (international standard level) and "other competitors" (other countries). Therefore, in this section, six countries are selected for comparison: the United States, Japan, Korea, United Kingdom, France and Germany.

Obtain their debt data from OECD database, and calculate their debt-to-GDP ratio and

the proportion of local debt (Table 2.4, Table 2.5).

Table 2.4 General Government Gross Financial Liabilities as a Percentage of GDP (%)[6]

	2006	2007	2008	2009	2010	2011	2012	2013
U.S.	60.93	62.12	71.40	85.03	94.17	98.76	102.12	104.09
Japan	172.15	167.05	174.10	194.05	199.97	210.63	218.80	227.15
Korea	28.52	28.72	30.40	33.46	34.58	36.17	35.50	35.60
U.K.	46.04	47.17	57.43	72.45	82.19	99.01	102.37	106.99
France	71.21	72.96	79.27	90.82	95.18	99.26	109.33	113.04
Germany	69.83	65.57	69.74	77.44	87.06	85.84	88.26	86.06

Table 2.5 Percentage of Local Debt of Major Developed Countries (%)[6]

	2006	2007	2008	2009	2010
U.S.	40.85	42.53	43.72	37.00	34.93
Japan	6.01	1.50	0.00	5.42	-
Korea	0.00	0.00	4.53	2.71	7.64
U.K.	6.21	9.38	0.00	0.00	0.00
France	26.79	28.57	32.63	32.58	29.17
Germany	40.95	39.68	43.29	42.92	49.00

" - " means missing data.

Significantly, the proportions of government debts of these countries have increased after the 2008 crisis, except Korea, relatively stable.

From Table 2.5, it is known that for the six countries, the proportions of local debt are almost stable and remained at origin level even after the financial crisis.

Compare China's debt-to-GDP ratio to these six countries, it is found that (take 2012 as an example) the ratio of China (36.69%) is much lower than of others. However, the

[6] Data source: OECD website,
http://www.oecd-ilibrary.org/economics/government-debt_gov-debt-table-en
http://www.oecd-ilibrary.org/finance-and-investment/total-central-government-debt_20758294-table1

proportion of local debt is found to be greater than other countries (Fig. 2.2):

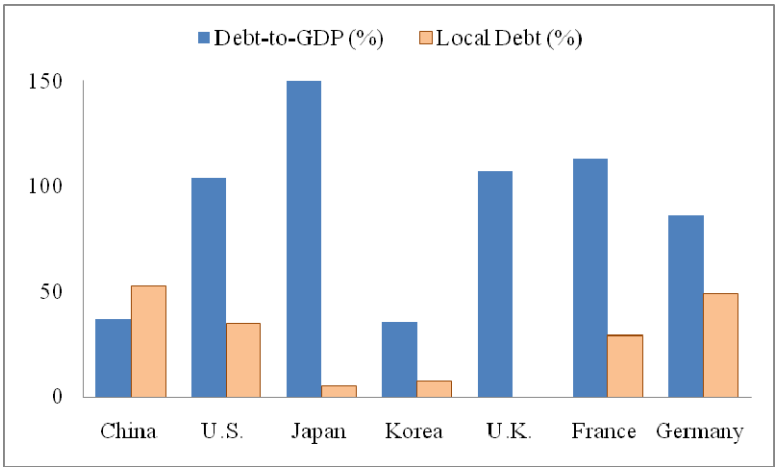

Fig. 2.2 Debt-to-GDP Ratio and Proportion of Local Debt[7]

As a conclusion of above comparative analysis, it can be said that the financial leverage of China is at a healthy degree, and is safer than most of other developed countries. However, because the revenue level is low, the financing capacity is not optimistic, and hence governments need to prepare for probable danger (Wei et al, 2012). In addition, the proportion of local debt is large. Considering the weaker status of local governments, it means the risk is also caution needed.

[7] Debt-to-GDP rate: Japan's histogram is truncated.
Proportion of local debt: use 2012 data for China, 2009 data for Japan, and 2010 data for others.

3 Literature Review

After the overview of the current situation, it is nature to consider how to analyze risk on microscopic scale, i.e. at provincial level. Generally, the method is to extend previous researches and adopt widely used analytical tools to this field. Hence to look for previous studies is quite necessary. For this purpose, in this chapter, international researches on related issues are reviewed.

3.1 Government Debt and China's Local Debt

3.1.1 Origin of Researches

The history of research about government debt can be traced even to 1910s. In 1914, Gustav Seidler has published "*Fifty Years of Government Debt 1862-1912*", creating a precedent for research in this area. In local debt field, the research also started early. Allen, H. K. and Gilbert James H. have published "*Local Government Debt Administration*" respectively in 1940.

After WWII, especially from 1970s, the research about government debt gradually increased. In the area of local debt, new directions appeared, such as state administrative supervision (Hecrist, 1972), debt administration (Bell, 1976), debt ceilings and expenditure limits (Gelfand, 1979).

In August 1982, Mexico announced that it is unable to pay its large foreign debt, triggering a debt crisis spreading throughout Latin America. From this time, related researches of sovereign debts have flourished, such as rescheduling sovereign debt (Garten, 1982) and sovereign debt restructuring (Weinberg, 1985).

3.1.2 International Research of Government Debts

From the financial crisis started in 2008, the risks of sovereign debt and government bond have attracted much more attention than before.

Sovereign (central government) risk mainly embodies in the form of bonds. For government debt itself, the researchers are concentrated to macro aspects, especially influence of policy and politics:

Firstly, if a company is not totally independent, i.e. partly owned by a government, then its credit spread will be negatively correlated with the proportion of government ownership (Borisova & Megginson, 2011).

Secondly, political struggle and short sight will bring some trouble, which seems obviously: in particular, transparency decreases debt accumulation, while increasing political polarization increases debt accumulation (Alt & Lassen, 2006). However, even if the government is short sight because of some internal or external causes, the default cost of external debt will force it seldom default, but may transfer the risk to domestic sectors (Acharya & Rajan, 2013).

Lastly, a state with a weak government or in crisis will lead some negative results. For instance, because there is little commitment of government, investment and the stock of government debt will be negatively correlated; debt relief cannot affect the long-run level of investment, either (Agular, Amador, Gopinath, 2009). A state in crisis is also fragile when there are speculators large enough. They could influence its financial market, and benefit from the arbitrage opportunities; however, the default probability of such states will increase significantly and alarmingly (Carfi & Mosolino, 2012).

Besides the influence of politics and policy, there are also other opinions. For example, the sovereign risk channel could exacerbate indeterminacy problems if monetary policy is weak (Corsetti et al, 2013); sovereign states could use stochastic programming model to issue optimal portfolios of fixed and floating securities (Consiglio & Staino, 2012); government debt could choose optimal maturity structure to cater clienteles (Guibaud et al, 2013).

There are a lot of papers discussing about government bond spreads and premia, most of which are focusing on euro area. This may be because the state of chaos after the financial crisis provided variety of independent develop route, with plenty of economic

phenomena and evidences. Here, the term "yield **spread**" or "credit **spread**" is the difference between the quoted rates of return on two different investments.

For the determinants of spreads in Euro area, there is no consensus, and possible factors are combined differently: liquidity and risk (Favero et al, 2010); those plus solvency and the expected debt-to-GDP ratio (Assmann & Boysen, 2012); mainly differences in credit quality, and partly liquidity (Beber et al, 2009); short-term interest rates, policy-relevant default risk and liquidity risk (Manganelli et al, 2009); just country-specific variables and an international common risk factor, without liquidity risk (Oliveira et al, 2012). Broadly speaking, the credit of government is a common factor, and liquidity takes advantage.

For the specific dominate and foreign factors, fiscal variables (budget balance, government debt, etc.) and global financing conditions (the US interest rate, etc) are proposed (Maltritz, 2012). Besides local variables and international factor, a third factor is also suggested as expectations of exchange rate devaluation (Furthermore & Favero, 2013).

Interestingly, there are two opposite opinions on whether the factors change by time or remain. Bernoth et al. (2012a) applied a time-varying coefficient model, and identified that the main factor altered during the pre-crisis period, from debt level and risk aversion to safe haven status to fiscal loosening. However, von Hagen et al. (2011) believe that bond yield spreads during the crisis can be considerably explained by the same variables as before.

As an application of yield spreads, compared with EMU countries, yield spreads of non-EMU ones are influenced more by systemic risk factors. It may show that government bonds of EMU countries have a better safe-haven status (Gomez-Puig, 2009).

In the field of premium, European countries also have been more studied: Risk premia of central governments are positively related to debt and deficits, but the local ones performance inconsistently (Schuknecht et al, 2009). It is suggested that interest

differentials contain risk premia, which increases with fiscal imbalances and decreases with relative bond market size of the issuer (Bernoth et al, 2012b). Besides, short-run fiscal austerity measures are not able to contain the default risk premium; however, a long-term plan for fiscal reform can ease up the rising risk premium, if the market has confidence on it (Bi, 2012). Additionally, risk premium could explain a certain degree of credit spreads (Flandeau et al, 2012).

An important conclusion is about the limit of solvency of government, which should be taken seriously: **The government faces an endogenous debt limit beyond which debt cannot be rolled over**. It is demonstrated by a stochastic model (Ghosh et al, 2013).

After these, another important discovery is that most of sovereign credit risk can be related to global factors. Furthermore, it related to the US stock market more than to local economic (Flandreau et al, 2012).

There are also lots of papers discussing the sovereign risk and default risk. Here some representative ones are commented, which are mainly divided into categories of risk management, default risk, general theory and others.

In order to shift and manage risks, asset allocation of defined benefit pension plan is a good policy, in which companies with weak financial foundation will receive a greater share of pension fund as safer securities (government debt, etc), while firms with strong basis can invest more heavily in equity. Thus the pension fund investment policy can also be better applied (Rauh, 2009). Besides, by applying fiscal austerity programs, risk, in sovereign debt crisis, are hindered from damaging elsewhere (Kalemli et al, 2014).

When sovereign debt defaults, banks and financial institutions (e.g. investors) will receive heavy shocks. On the other hand, financial institutions and government should support each other in crisis.

First, of course, government defaults will lead to declines in private credit, especially in larger countries with developed financial institutions holding government bonds. Also, in these countries, the probability of default will be lower. (Gennaioli et al, 2014)

Second, banks and governments are connected at certain degree, so bank stock returns will be negatively affected by downgrades of sovereign credit rating. The stronger support the banks received from government, the more seriously they are affected. So investors will perceive interconnected domestic banks and sovereigns (Correa et al, 2014).

Besides, in risky countries, regulators tend to let banks to hold risky assets, so governments can borrow money cheaply since risks are shared; while in safe countries, the regulation will be tighter (Uhlig, 2014).

For emerging markets, higher levels of fiscal and political decentralization will increase sovereign default risk (Eichler et al, 2013). Private sector of emerging markets, when enters international debt markets, will lead sovereign debt crises declined, especially in the non-financial sector (Arteta et al, 2008). Besides, in the case of Greece, bond yield spreads for different maturities are considered to be integrated (Karmann et al, 2012), and in Argentina, default is more likely in recessions (Arellano, 2008).

For different factors and crises, there is still relationship between them. For example, not all crises are equal. In fact, they will differ depending on whether the government faces insolvency, illiquidity or various macroeconomic risks (Janus et al, 2013). There is also sequence for different crises, that is, external debt surges are before banking crises, and banking crises often precede or accompany sovereign debt crises; besides, public borrowing surges are before external sovereign default (Reinhart & Rogoff, 2011).

In addition to these papers, there are also scholars focusing on specific countries, such as the crisis of Greece, and the potential danger of the US (Bohn, 2011; Featherstone, 2011), which are not discussed here.

3.1.3 Local Debts and China's Debts

Local government debts, also called as municipal securities, are studied for long time. By issuing municipal bonds, cities are able to raise funds for the construction or purchase of large equipment, and funds can be used to subsidize private activities, for

repayment of old debts and settle government pensions and so on. In addition, investment in local government bonds should be exempt from local tax on interest (Ronald, 2006).

Compared with the central government, local governments have the advantage of information on providing public products, so local government bond issuance will help improve local government supply pure public goods, and optimize the supply structure of public goods (Li & Ju, 2010). In addition, expenditure of local public goods is generally capital expenditures, so it is more reasonable for government to raise funds for construction rather than tax (Zhang, 2013).

For general theoretical conclusions of the relationship between central and local governments, if the amount of local bond is determined by central government, an inflation target induces excess issuance of local bonds, which is worse than in the case that local government determines the amount of local bond (Fujiki & Uchida, 2011). The central government intervention is not required to carry out an efficient local debt policy. Besides, a form of partial coordination results is more efficient rather than full coordination (Nagami & Ogawa, 2011).

Government sovereign debt risk management oversight and external shocks induced by the sovereign debt crisis is the main reason inducing sovereign debt crises (Zhang, 2010). Additionally, the external debt, with very rigid repayment obligations, of local government is likely to become a outbreak of local financial crisis (Yuan, 2004).

There are different situations of the local debts, for various reasons, in different countries.

In Indonesia, repayment of local debt has been very poor. This problem is largely a function of unwillingness to repay debts and of central government acquiescence (Lewis, 2003).

For Flemish municipalities (Belgium), there are mainly political reasons. Because of the multiparty, the governments are weak and not unified. This leads weak governments,

which affect the short-term debt levels (Ashworth et al, 2005). The level of political fragmentation of the government also affects both the need for and possibility to engage in opportunistic policy cycles (Geys, 2007).

In Norway, those local governments with good fiscal conditions behave more forward looking than other local governments. Similar to Flanders, party fragmentation is negatively associated with forward-looking behavior (Borge & Tovmo, 2009).

In the United States, revenue diversification has emerged as an important trend in US local and state government finance, while municipal debt is a critical source of revenue for local governments and is used for construction of roads, schools, and other capital costs (Beckett-Camarata, 2009). Revenue stability is a significant factor that rating agencies take into account when determining a government's capacity to pay off debt (Yan, 2011).

In Spain, local debt per capita is influenced by socioeconomic variables (population, percentage of immigrants, income, transfers and taxes), political variables (such as political strength) (Dolores, et al, 2011) and the electoral cycle (Bastida, et al, 2013). Besides, the interest rate of local debt is affected by municipal financial situation, historical interest rate, levels of expenditures, debt per capita and information openness (Bastida, et al, 2014). However, this system is not very applicable for China because almost all Chinese banks use the determined fixed rate when release loans.

In China, research in this field started very late, mainly from about 1990s. One of the earliest literatures of China's government debt was published in 1989, about government debt audit (Wang, 1989). Since 2000s, academics expanded research directions more widely.

In Chinese academia, scholars believe that the tax reform began in 1994 made the financial power centralized and general affairs decentralized, such that local financial resources and the financial burden do not match, resulting in local financial difficulties. Local governments, under financial pressure, borrow in disguised form, causing swelling debts, deficit, difficult to monitor (Shen, 2013). In the short term, local

governments issue their own bonds is an effective way to solve the problem of local government debt (Wang Zhiyang, 2013).

The great bailout plan responding to the global financial crisis was devastating, now China's government debt is larger than many other developing countries, within which the contingent liabilities is noticeable (Li and Lin, 2011). However, total public debt to GDP ratio remains under 50%, showing the risk is manageable (Fang & Lv, 2012). To deal with this problem, more attention should be paid to improving and reforming the Chinese fiscal system, especially the fiscal relationship between central and local governments.

Under the current system of Chinese intergovernmental relations, local governments are precluded from borrowing and offering guarantees for any borrowing activity (Ma, 2013). However, for political achievements (Ong, 2012) and for corruption (Zhou Xueguang, 2012), local governments, especially rural ones, have become deeply involved in debt finance.

However, as a roundabout way, governments often borrow money by enterprises (financing platforms) (Ong, 2006), and the debt occurs in the form of contingent liabilities, so risks are hidden (Ma, 2013). In the aftermath of the global financial crisis, the high level of local debt might aggravate structural imbalances in China's economy (Tsui, 2011).

Local governments in China have certain solvency. If coupled with the management experience learned abroad and from previous cases, China's local government debt can be managed (Chen, 2008). It should be considered timely to release the right of local government debt issuance, and establish a standardized local government financing system, which will help accelerate local economic development, prevent and mitigate economic risks (Wang, 2010).

However, in this process, attention should be paid to the issue of determining the appropriate local bond issue size, rationalize the relationship of power between central and local governments (Chen, 2004), and establish an effective monitoring mechanism

and restraint, to ensure a healthy financial position (Chen, 2008). Currently, the conditions for fully liberalizing local government bonds are not fully equipped (Ma, 2007).

There are also many scholars interested in foreign experiences, especially those of America and Japan. For the aspect of local finance management of central government, it is worth learning from Japanese system; for the aspect of market management, to learn from American system is recommended (Zhang, 2013). Concretely, literatures discussed about risk prevention (Huang, 2010), the regulation through legislative and administrative methods (Liu, 2010), manage system (Xu, 2010), structure of financial resources and local autonomy (Song & Niu, 2013) learned from Japanese system and American market, and so on. Additionally, some scholars also study on other countries, such as French, Brazilian and Indian experiences (Zhao & Du, 2011), etc.

Some scholars are considering to establish the local bond market outside the economically developed regions (Hu, 2006), but there is obviously higher risk because of the unstable revenue, so decision makers must be cautious (Li, Cao et al. 2010).

In the aspect of financial risk and regulation, because the data were few, the academia was focusing on the theoretical discussion and estimation. When the central government decided to audit local debts in 2013, the stock market turned negatively. This shows that the market considered the hidden financial risks as bad news (Pi, 2013). Due to the uncertainty of macro and micro factors, some local governments are willing but not able to repay principal and interest in full, resulting in credit risks (Wang Jiansheng, 2013). Though the current risk is controllable, the system risks still should be alerted (Li, 2012).

Another study is of relative solvency. By principal component analysis, in China's 30 provinces (except Tibet), governments with best solvency are Tianjin, Jiangsu, Beijing, Shandong, Shanghai, Guangdong and Zhejiang (Wu, 2012). Indeed, six of them have been allowed to issue their individual local bonds. However, it does not mean the local government can issue their debts freely (Bai, 2012).

As a summary of this section, it is noticed that most of the studies are about sovereign debt and qualitative analyses, or the regulatory and fiscal system establishment. There are almost no literatures discussing quantitatively about local government debt.

3.2 Credit Default Swap

In order to obtain a quantitative analysis tool, it is helpful to seek clues from the aspect of risk-based pricing objects. The most famous one is the credit default swap.

3.2.1 General Concepts

A **credit default swap (CDS)** is a financial swap agreement. It is similar to a insurance contract that the buyer of the CDS pays CDS fee (spread, or called coupon) to the seller periodically, and the seller will compensate the buyer when there is any credit event (such as default of loan or bond)[8]. It is similar to general insurance, but it can be traded in the market so investors need not to hold the real underlying security or suffer losses from the credit event.

The swap of business revenues of obligations, or called "synthetic" in banking terminology, took place firstly in 1981. I.B.M and the World Bank exchanged their bond earnings and obligations without actually exchanging the bonds. This deal was worth 210 million dollars over ten years and opened up a new field of finance (John, 2009).

When the profit of thus swap reduced due to competition, the new idea appeared. The J. P. Morgan team thought it would be better to swap the risk of default directly instead of swapping rates or real assets. They met the real problem in 1989, when Exxon needed a line of credit of five billion dollars. Exxon was an old client so J. P. Morgan accepted its request; however, this would tie up a lot of reserve cash and be risky.

To deal with this problem, in 1994, Blythe Sally Jess Masters, a member of the J. P. Morgan swaps team, invented an idea of selling the risk to the European Bank of Reconstruction and Development (EBRD). The EBRD beard the risk and, as "insurance

[8]Due to a file issued by ISDA (2003), "default" is officially defined as six trigger events: bankruptcy, obligation acceleration, obligation default, failure to pay, repudiation / moratorium, and restructuring. Three of them are principal in practice: bankruptcy, failure to pay and restructuring.

fee", received fee from J. P. Morgan, without other actual transfer. This deal was eventually named "credit default swap". This is considered to be the founding of the CDS.

The CDS developed mainly in inter-bank market in 1990s. In 1999, International Swaps and Derivatives Association, Inc. (ISDA) has standardized the documentation for CDS (Ranciere, 2002), and then the market extended much more rapidly. Especially from 2003, its market size doubled every year until 2007, with a notional value of CDS outstanding of $62.2 trillion (ISDA, 2010). Since the crisis in 2008, the amount has fallen every year, to $25.1 trillion in Dec. 2012 (ISDA, 2012). The abuse of CDS is considered as an important reason of the crisis started in 2008 (Shah, 2008).

Currently, most CDSs are recorded in standard forms drafted by ISDA (Weistroffer, 2009). In the standard model, which is developed by ISDA and Markit, investors can calculate CDS pricing consistently. In realistic trading, the coupon (CDS fee) is usually paid quarterly, and the coupon is decided by the notional principal of the underlying security and the quote of fixed coupon on the issuance date of the underlying security (OSE, 2014).

3.2.2 CDS and Sovereign Debt Risks

In 1997, the Asian Financial Crisis spurred a market for CDS in emerging market sovereign debt (Ranciere, 2002). Currently, the international scholars are mainly focusing on general function of CDS, Latin America, Europe, and (very rarely) China.

There are a plenty of researches about CDS pricing, risk, corporate financing, and so on. However, different from corporate CDS, the Sovereign CDSs are much fewer and more difficult to grasp because there are much more factors may affect them. In this subsection, only those articles related with government risks are paid attention.

In sovereign risk market, the high risk aversion tends to perplex the transmission mechanism between CDS prices and government bond spreads (Delis & Mylonidis, 2011). Daily CDS spreads for emerging market sovereigns are more related to global and regional risk premia than to country-specific risk factors (Fender et al, 2012), but it

may also driven by liquidity; meanwhile, the government bond spread is less driven by liquidity (Badaoui, et al, 2013).

There is an information transmission mechanism between the bond and the CDS markets, and the mutual influence could be affected by market distress (Delatte, et al, 2012). During the crisis, the rise in sovereign yield spreads and CDS spreads can be mainly explained by deterioration in fundamentals and fundamentals contagion (Beirne & Fratzscher, 2013). Deviations between CDS and bond spreads are related to counterparty risk, market illiquidity, funding costs, and other factors (Arce, et al, 2013).

The Eurozone Periphery countries show significant differences from general EU countries, especially five countries: Greece, Italy, Ireland, Portugal and Spain, which are sometimes abbreviated as PIIGS or GIIPS.

For general EU countries, fiscal space and other macroeconomic factors are important determinants of sovereign risk. However, for Eurozone Periphery countries, there is significant difference, especially in 2010. Their default risks are priced much higher and vary more severely than others (Aizenman, et al, 2013a, 2013b).

Another noticeable phenomenon is joint default; i. e. whether the default risk will spread to other countries. Related researches show that the financial linkages are active only for troubled periphery euro area economies, while for other cases the real economy linkages play a more important role (Gorea & Radev, 2014). Additionally, the debt ratio is the most important driver of default contagion (De Bruyckere et al, 2013).

For Latin American countries, the information in sovereign CDS can both lead and lag other financial sovereign debt spread determinants (Wang, Yang & Yang, 2013), and global factors including US Baa-Aaa default yield, TED spread and US Treasury rate all contribute to the changes in sovereign CDS spread, especially after the global crisis (Wang & Yao, 2014).

In the case of China, country-specific factors (the real interest rate, etc) have significant explanatory power on China's sovereign CDS spreads, especially in earlier years; while

global factors (VIX, i.e. the U.S. S&P 500 stock option volatilities, etc) have increasing impact from the global crisis (Eyssell, et al, 2013).

In Chinese academia, the research in this field is much weaker. Over half of the researches have focused on the European sovereign debt crisis, and are discussing policy topics, such as experiences and enlightening.

Removing those helpless literatures, the remains can be classified as following aspects:

On the topic of effect of Sovereign CDS on sovereign debt crisis in the Euro zone, researches showed that for general Euro-zone countries, sovereign CDS is at leading position in the price discovery process, but there is no evidence supporting the necessary relation between sovereign CDS and sovereign debt crisis (Ba, et al, 2012). However, for Greece, whose CDS price rose crazily, the deterioration of its sovereign debt crisis has been considerably influenced by the CDS (Shu, 2013).

From global perspective to consider the sovereign debt crisis, it is found that the conduction and spread become more rapidly, and secondary crises can be easily induced (Luan, 2012). Moreover, there exist infectious effects among the debt crisis of different countries (Ba et al, 2012).

Although the sovereign CDS market and the bond market are closely linked, the theoretical equivalence relation between the two markets is not precisely hold, and long-term equilibrium relationship does not always hold, either. The sovereign CDS market, in many cases, leads the government bond market, but when the bond market guides the sovereign CDS market in the process of price discovery, there is more likely to form long-run equilibrium relationship between them. And, to some extent, the debt crisis expands the price spread between the two markets (Liu, 2012).

Currently, the legal system for financial swaps mainly performs as domestic regulations supplemented by limited international cooperation. In the field of domestic regulation, the systems of the USA and UK are relatively perfect, but their supervision modes are quite different. At the international level, the Basel Committee, IOSCO and the ISDA

have played important roles, but the subprime crisis and Greek sovereign debt crisis, still reflected there is regulatory loophole (Qian, 2012).

As a summary of this section, the CDS is directly related with the credit risk of a company or a government, so it is often considered as an intuitive measure of the credit. Most literatures are discussing on topics of corporate CDS, CDS and financial crisis, and regulatory, and there are just a few mentioning sovereign CDS.

However, for the core purpose of this section, the relation between CDS and local government risk, unfortunately, there is no literature researching on this field. But there are actually methods to calculate CDS data and therefore default probability by parameters derived from real data (Damiano & Fabio, 2006; Jue Wang et al, 2012).

The methods of estimating CDS data and risk provide a new hint: is it possible to apply the concept, CDS, onto local governments with respect to their bonds and debts? If yes, the new concept can be called "local CDS" and used for characterizing local governments' risk.

Before entering this area, there is another topic that cannot be ignored: shadow banking.

3.3 Shadow Banking

As mentioned in Chapter 1, China's governments have set up a lot of financing platforms. These financing platforms borrow money from society, not only by bank loans, but also through trust, security market, build-transfer (BT) projects, and other channels.

A common feature of them is all the informal financing methods are weak supervised and almost not regulated. Hence they are called "shadowed" since they are hard to observe and capture.

Shadowed factor is not worrying in the issue of scales of China's local government debt, because all the debts are audited by strict rules. However, when analyze the financial risk and derive related results, its influence must be considered. Currently, these

shadowed factors are collectively called "**shadow banking**".

3.3.1 Definition

The term "shadow banking" is attributed to Paul McCulley of PIMCO, 2007. He firstly used this term to describe a large segment of financial intermediation in a PIMCO's publication. The origin definition is "**the whole alphabet soup of levered up non-bank investment conduits, vehicles, and structures**" (Paul, 2007).

By 2013, there is still no consensus on the definition, scope and scale of shadow banking in academic literatures. In this subsection, several viewpoints are provided:

Paul McCulley (2007) did not mention about the details of shadow banking, such as the components. However, he used the data provided by Federal Reserve and pointed out that the run of the shadow banking system has turned to decrease after July 2007, with a maximum value of about 1180 billion dollars in the United States.

In 2012, Ben S. Bernanke, the chairman of Board of Governors of the Federal Reserve System, raised the fragility of financing system and a definition of shadow banking: "**Shadow banking comprises a diverse set of institutions and markets that, collectively, carry out traditional banking functions - but do so outside, or in ways only loosely linked to, the traditional system of regulated depository institutions.**" Shadow banking includes but is not limited to securitization vehicles, asset-backed commercial paper (ABCP) conduits, money market mutual funds, markets for repurchase agreements (repos), investment banks, and mortgage companies (Ben, 2012). The data are provided by Fed, but not mentioned in his report.

Using data provided by Fed, Zoltan Pozsar et al computed the scale of American shadow banking system for a long time period. They defined the shadow banking system as a network in intermediation chain of securitization and secured funding techniques, such as asset-backed commercial paper (ABCP), asset-backed securities (ABS), collateralized debt obligations (CDOs) and repurchase agreements (repos). They measured the size of shadow bank liabilities of a peak of nearly $22 trillion in June 2007, while the total traditional banking liabilities were around $14 trillion in May 2007

(Zoltan, 2010).

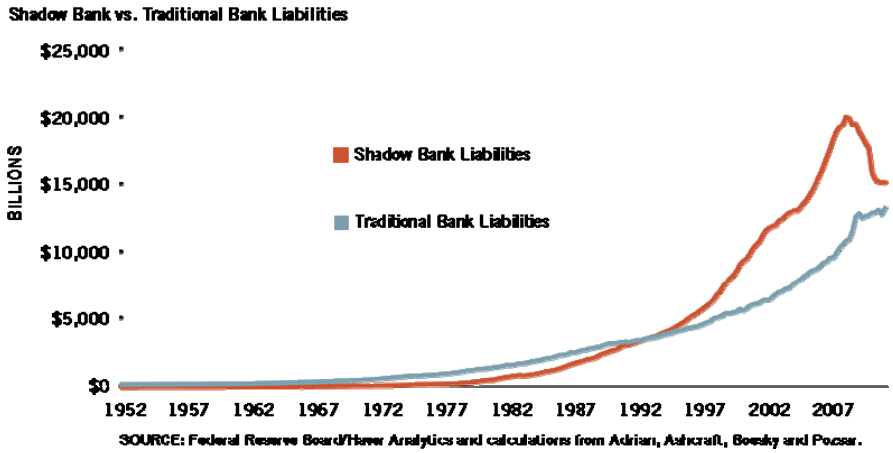

Fig. 3.1 Size of Shadow Bank vs. Traditional Bank Liabilities[9]

The Financial Stability Board (FSB) has defined shadow banking clearly and showed the data. Its definition is "**the system of credit intermediation that involves entities and activities outside the regular banking system**" (FSB, 2011a), which is of a wide range. In the monitoring report, the scale of shadow banking was:

Table 3.1 Size of Non-bank Financial Intermediaries (percentage of GDP)[10]

Jurisdiction	2011	2012	Percentage of World
China	20.0	25.8	3
USA	154.5	165.9	37
Japan	61.4	64.4	5

Standard & Pool's agrees with the definition provided by FSB, and consider the central bank and all depositary institutions (policy banks, commercial banks, credit cooperatives and licensed finance companies) as the regular banking system in China. They believe only the following credit intermediation activities should be considered as shadow banking: the credits are not properly accounted as regular ones, and have

[9] Data source: Fed website. http://www.federalreserve.gov/releases/z1/current/

Traditional Liabilities: the total liabilities of commercial banking.

Shadow Liabilities: the sum of open market paper, overnight repo, net securities lending, GSE total liabilities, GSE total pool securities, total liabilities of ABS issuers, and total shares outstanding of MMMF.

[10] Data source: FSB website, http://www.financialstabilityboard.org/shadow_bkg_data/underlying_pdf_data.pdf

increased leverage in the real economy or the financial system. From this view, they estimated China's shadow banking accounts for RMB 22.9 trillion by 2012, representing 44% of China's GDP in 2012 (S&P, 2013).

Chinese government also mentioned the range of shadow banking system in a non-public file released in Dec. 2013 (State Council, 2013). Chinese government divided the shadow banking into three main categories: completely unsupervised credit intermediaries, inadequately supervised credit intermediaries, and insufficiently supervised or unregulated businesses of institutions holding financial licenses. There are no official data of scale of China's shadow banking yet.

3.3.2 Advantages, Disadvantages and Previous Researches

As once mentioned in Chapter 1, the shadow banking system is created mainly because of the excess demand of financing and the insufficient supply capacity of conventional banking system, especially in the status of illiquidity.

The shadow banking system can build a bridge for the subprime borrowers and market surplus funds, and became the main intermediary. From this aspect, it makes capital allocation more efficiently. The dominant position of conventional banking system is therefore lowered, so the shadow banking can balance the financial system, too.

However, it widened the entry restriction of financing system, such that more investors and financiers with weaker credit entered the market. Moreover, it does not have access to the same governmental safety nets that real banks do, nor have to operate under meaningful regulatory constraints.

These defects lead regulators and financial market participants cannot clearly perceive risks and be hard to response and regulate. Therefore, the uncontrolled shadow banking system with too large scale will increase potential risks rapidly, and it may be too late to notice crises.

In international academia, scholars study on the shadow banking system mainly in the fields of influence on existing financial system and countries, government roles, and regulatory.

A compelling issue of shadow banking is whether it is stable or not, and whether it will affect the existing system. A research pointed out that, the stability of shadow banking system depends on the attitude of investors. Under rational expectations, it is stable and welfare improving; however, when investors neglect tail risks, it will be vulnerable to crises and liquidity dry-ups (Gennaioli et al, 2013). There are short-term and long-term relation expansion velocity of shadow banking and financial fragility (Zou et al, 2013), and threshold effect exists between the size of the shadow banking system and the stability of banking system: When the size of the shadow banking below the threshold, the development of shadow banking will help improve the stability of the banking system, on the contrary reduce the stability of the banking system (Wang Xiaozhen, 2013; Mao & Wan, 2012).

Related study shows, the large size of shadowed sector will be associated with higher public indebtedness, higher interest rates paid on sovereign debt, a higher level of financial instability and a higher probability of sovereign default (Elgin et al, 2013).

The shadow banking system is linked with the fragility of financial system and considered as an important factor in the subprime mortgage crisis of 2007-2008 and global recession (Bryan & Rajdeep, 2011). In the 2011 annual meeting, China Banking Regulatory Commission (CBRC) executives indicated that the shadow banks government financing platform risk, and real estate credit risk are three major risks the banking industry facing in 2012 (Wang Xiaozhen, 2013).

The aspect of regulatory is also a large and important issue. However, the current situation is not optimistic for regulators. The scale of shadow banking is increasing, and the policy conclusions are hard to apply in short time.

The rise of shadow banking was helped by regulatory and legal changes that gave advantages to the following main shadow funding sources: asset-backed commercial

paper (ABCP), money-market mutual funds (MMMFs), repurchase agreements (repos), and securitization (Adrian & Ashcraft, 2012). Two successful methods have been demonstrated for regulating privately created money: strict guidelines on collateral and government-guaranteed insurance (Gorton &d Metrick, 2010).

Since 2008, many countries started to pay attention to shadow banking system and tried to reform their regulatory. However, the result showed ineffectiveness of measures. It is because governments are engaged in competition for financial activity internationally, and are affected by financial interest groups. Thus the demand of reforms of stricter regulation will turn incremental and symbolic but ineffective (Rixen, 2013). In addition, the short-term objects, or short-term horizons, will encourage governments to create periods of intense economic activity fueled by credit booms, which will on the contrary contribute to the shadow banking system (Acharya, 2012).

3.3.3 The Framework of Researches in China

In order to have a comprehensive observation, this dissertation has searched all the articles and theses about shadow banking in CNKI website. Until March 2014, there are about 800 articles and 80 theses. In them, about 200 articles are published in Chinese core journals (hereinafter referred to as "*core articles*"), which represent relatively high academic level.

These 200 articles referred about 900 references (counted with multiplicity). The referred articles, not published in Chinese core journals, are called "*ring articles*" here. The author has drawn a simplified map of the networks between these articles.

Simplify Step 1: The following articles should be pruned:

1) Isolated core articles: with no reference, and not referred by any other core articles.
2) Single ring articles: only referred by one core article.

After the first step of simplification, there are 121 core articles and 102 ring articles (63 Chinese and 39 English) left. However this result is still too complex, so step 2 is applied:

Simplify Step 2: The following articles should be pruned:

1) Weak core articles: referred by less than two (0 or 1) other core articles.
2) Weak ring articles: referred by less than five core articles.

This step is to choose the core of the core, with high academic value. After this step, there are 25 core articles and 13 ring articles (2 Chinese and 11 English) left, over half of which are referred for over 20 times. The simplified network map is shown in next page.

In China's academia, the important international literatures, such as IMF reports, Fed reports and Paul McCulley's articles, are often referred as theoretical basis. The main series of the issue network are as follows:

Series A: Financial Innovation & System Evolution

Core: Wang Da, 2012

This series is based on two reports of FSB and one report of Federal Reserve Bank. Focusing on the development of American shadow banking system, they pointed out its role and potential risks.

Since 1970s, the inconsistency between the objectives of monetary policy and financial supervision framework has led more financial innovation than before. The financial innovation and the excess demand of institutional investors for safety assets have jointly promoted the rapid development of shadow banking in the United States (Wang, 2012). This shadow system has democratized credit. The diversified and inexpensive method of financing increased productivity, and led to increasing corporate profits and accelerating economic growth (Gross, 2007).

However, the abuse of derivatives led a lot of lower quality mortgage securities, packaged into complex structured products and traded in markets. Being held in leveraged money or capital market vehicles, many securities have substantial liquidity risk (Geithner, 2008). Hence it needs much work to regulate such a system.

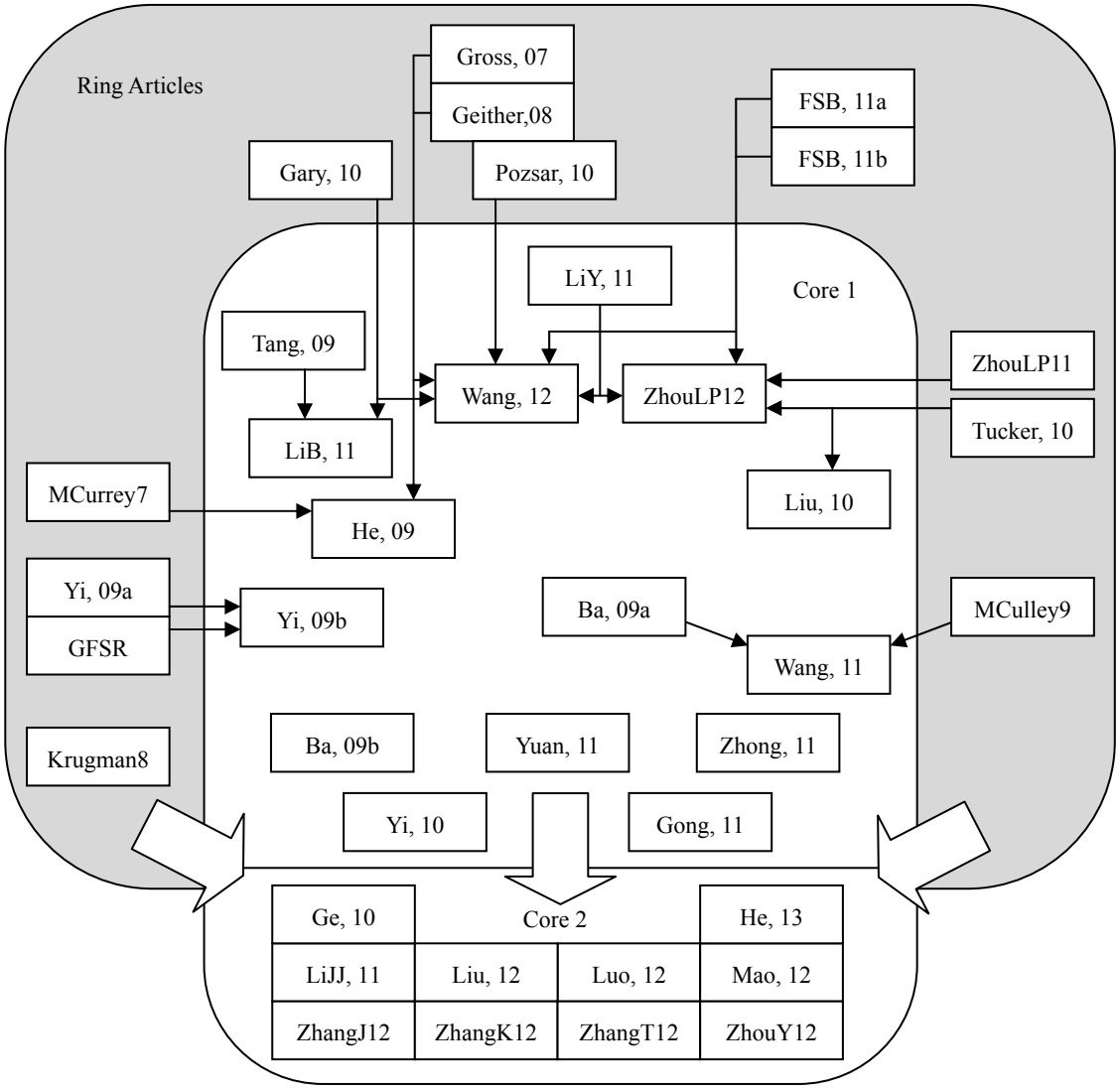

Fig. 3.2 Simplified Network Frames of Core Articles

Remark: Every black arrow indicates citation between two articles, and points to the referrer. Core 1 is the set of articles referred by others in Core 1 or Core 2; Core 2 is the set of articles referring articles from Core 1 and Ring, but not referred by articles shown in this figure. The detailed citation (over 50 arrows) of articles in Core 2 is omitted and replaced by white bold arrows.

For more information about these articles, see Appendix B.

Series B: Credit Creation

Core: Li Bo, 2011

This is short series, mainly discussing about credit creation of shadow banking and its influence.

Credit creation is a basic function of conventional banking system. However, being a financing system, the shadow banking also has the function of deposits and loans. Thus, its credit creation mechanism contains limited substitution effect to commercial banks, and generates external spillovers (the mystery of liquidity) in the currency market (Zhou, 2011). However, the defect of its mechanism makes the effect unstable, and then negatively influences monetary policies and financing market (Li & Wu, 2011).

Series C: Credit Expansion and System Stability

Core: Yi Xianrong, 2009b; He Dexu, 2009

The shadow banking system can create credit. However, the oversized shadow banking made excessive credit expansion, influencing the subprime crisis to some degree. So the system stability is also a victim of shadow banking. IMF releases Global Financial Stability Report (GFSR) semi-annually.

"Excessive credit expansion" refers to the expansion of credit money faster than the growth rate of real economic output. Shadow banking expands credit unlimitedly in the form of securitization to improve the leverage of financial assets, thereby seeking to maximize profits for financial institutions. In this process, the agency chain is stretched infinitely, but the consequent risk will be suffered by the entire market (Yi, 2009a, 2009b).

In booms of previous years, low real interest rates, flowed capital and lower real and inflation risk make asset prices upward and credit spreads and risk premia narrowed, which in turn increase leverage. Long-term risky and relatively illiquid assets are not covered by protection, such as deposit insurance. Once the investors withdrew or threatened to withdraw their funds from these markets, the system became vulnerable (Geithner, 2008). Hence, the excessive financial innovation and incomplete financial supervision brought new risks into financial system, which seriously threatened the

stability (He, 2009).

Series D: Response and Regulatory

Core: Wang Qian, 2011; Zhou Liping, 2012

In 2007-2008, the uncontrolled shadow banking has fueled the crisis and finally led a disaster. To learn from past mistakes, it is suggested to collect system-wide data on the flow of funds and the flow of risk in advance, thus we are able to put some hard facts alongside intelligence (Tucker, 2010). In order to prepare, FSB recommended that based on flow of funds tables, countries should analyze the internal relation between banks and non-bank intermediaries to accurately observe the size of shadow banking system (FSB, 2011b).

For securities regulators and prudential supervisors, it is a key job to ensure that leverage and maturity mismatch is transparent. Hence, to design information disclosure mechanism will be the focus of future regulation of shadow banking (Ba, 2009a). However, it should be noticed that a main reason of the rapid development of shadow banking is unbalanced demand and supply in capital market. So, in order to prevent risks arising from the shadow banking, a better way is establishing a perfect financial market (Wang, 2011). Lastly, notice not to copy the regulatory mode of other countries blindly.

By the way, not only in Series D, but almost all of the Chinese articles, in the final part, discuss the regulatory and make policy proposals.

As a summary of this section, shadow banking can affect the potential risk in financial system, so it must be noticed in related study. However, its research has just started. There is even no consensus on the definition and size.

Both in Chinese and international academia, almost all the studies are on the function, influence and regulatory of shadow banking, and to estimate the size is almost the only quantitative study. It will be alone to work along this direction for quantitative research.

4 Local CDS and Structured Model

This chapter and the next chapter are for the purpose of estimating the default probability of China's local governments. In order to capture risks, a useful tool, CDS, is adopted.

CDS, as a standardized investment product, is in transaction at every moment now. However, it is initially invented as a type of credit guarantee contract, i.e. insurance. This shows that CDS contracts also follow the general rule of investment products, such as no-arbitrage principle; its price must link with risk directly. This shows the quote (price) of CDS is a signal of risk of underlying asset. This chapter will start from this point.

In this dissertation, only single-name CDS is considered. The single-name CDS is a CDS contract that provides protection against a default event on the part of a single issuer ("name").

4.1 CDS, Risk and Local CDS

CDS is a contract on the credit of an underlying asset. So its price (quote) will directly be affected by the underlying asset. As mentioned in the previous chapter, CDS is found to be quite useful for risk analysis.

In the international market, CDS contracts of both corporate bonds and sovereign bonds are in transaction. The quote indicates their risks: CDS premium is determined so that net value of contract is zero, i.e. so that no initial fee passed between buyer and seller at inception. In the global crisis, the CDS quote of most countries rose highly, showing the investors had worried to solvencies of those countries in crisis.

The probability of default, and then credit rating, can also be estimated from the data of CDS by models. S&P Capital IQ releases the Global Sovereign Debt Credit Risk Report quarterly, in which China's cumulative probability of default is 6.0% in 2010 Q4, with

CMA implied rating of AA+ (S&P Capital IQ, 2010, 2013).

The real market has shown that sovereign CDS can reflect the risk of sovereign bonds, and corporate CDS can reflect the risk of corporate bonds. It is nature to consider that local government CDS would reflect the risk of local government bonds. Hence, in this dissertation, the new concept "**CDS of local governments**", or called "**local CDS**" for short, is proposed. It is defined as the CDS of bonds of a local government, assuming the local bonds and CDS are traded in real markets.

A little comparison of strength, flexibility and information openness of these three objects is listed as follows. Local government is like a combination of the other two, but biased to the government side.

Table 4.1 Comparison of Government and Company

	Central Gov.	**Local Gov.**	**Company**
Strength in domestic market	Strong	Weak	Weak
Flexibility	Inflexible	A little flexible	Flexible
Impact of policy change	Significant	Locally influential	Almost slight
Information	Semi-public	Semi-public	Semi-public
Fiscal Situation	Fully safe	Attentive	Due to business conditions
Other		Affected and controlled by central government	

However, currently, the local debts (mainly bonds) are only traded in domestic markets, and there is no such a local CDS market. So it is just at the conceptual level, and the data need to be estimated.

4.2 Model Establishment

In this section, pricing model of China's local CDS will be derived. Generally, there are two main types of models about internal credit risk: structural and intensity-based

models. Both of them are initially regarded for corporate risks.

Intensity model is generally applicable. Its starting point is the default probability, and thus can be applied on different objects. However, the default probability is actually what we want in this dissertation. Therefore, it is more suited to the second step, when the CDS data have been derived.

The other one is structured model. It is based on economic parameters, which can be estimated from the real market; also, it can calculate default risk by itself. However it also has a major defect: it is specialized for corporate risk.

Hence, there are two choices: to look for a third model, or to find the common characteristics and modify suitably? It is more feasible for the latter one. In fact, Wang Jue et al (2012) have already made helpful attempt by the structured model.

In setting of structured models, default is related with the value of assets of a company. When the value of a company breaches a pre-determined level, the default happens. Structured models are of a relatively popular class in recent years, and were first introduced in 1974 by Merton. In Merton's model, the default happens only at the maturity, if the asset value of a firm becomes less than a barrier level then.

Another pioneering structural model, attributed to Fisher Black and John Cox (1976), is one of the earliest extensions of Merton model. The default can occur before the predetermined maturity. Whenever the asset value of a firm becomes less than a barrier level, the default happens. The value is also called the first-passage time.

Both in Merton and Black-Cox model, the total value of a firm’s assets are assumed to follow a geometric Brownian process. From a valuation perspective, the market value of a corporation is the present value of expected future free cash flows. The biggest difference between them is the form of survival probability.

For this reason, in this chapter, both Merton model and Black-Cox model are employed. Combine these models into structural model, and derive the expression of CDS quote.

In Merton and Black-Cox model, the **asset value V_t** is assumed as a diffusion stochastic process following a geometric Brownian motion:

$$\mathrm{d}V_t = \mu V_t \mathrm{d}t + \sigma V_t \mathrm{d}B_t, \tag{4.1}$$

where B_t is the standard Brownian motion. Its solution is

$$V_t = V_0 e^{(\mu-\sigma^2/2)t+\sigma B_t}. \tag{4.2}$$

It means the log-returns of values follow a normal distribution:

$$\log\frac{V_t}{V_0} \sim N\left(\left(\mu-\frac{\sigma^2}{2}\right)t, \sigma^2 t\right). \tag{4.3}$$

Assume that the **debt level L_t** that should be paid every year also follows an exponential growth in short term: for simplicity, assume the growth is stable.

$$L_t = L_0 e^{at}. \tag{4.4}$$

If $a = 0$, the debt level will be constant.

Based on Merton and Black-Cox model, the price (quote) of CDS can be considered as the price of a call option. The key idea is attributed to Gökgöz et al (2014).

The equity (asset - debt) can be represented as the price of an option written on the asset with strike price equal to L_t of a zero coupon bond. At the maturity T (for Merton model) or whenever (for Black-Cox model) the value of underlying asset becomes lower than the strike price, the option will be exercised.

Here the price of option is not concerned, but the survival probability is the emphasis:

$$\mathbb{P}_{sur}(\tau \mid \mathcal{G}_t) = \mathbb{P}(\tau > T \mid \tau > t), \tag{4.5}$$

where $\tau = \inf\{t > 0 \mid \hat{V}_t \le L_t\}$ is the default time.

Noticing the V_t follows a log-normal distribution, the survival probability and default probability under Merton model is

$$\mathbb{P}_{sur}(T) = \mathbb{P}(V_T \geq L_T) = \Phi(d_2), \mathbb{P}_{def}(T) = 1 - \Phi(d_2), \tag{4.6}$$

where Φ is the cumulative function of standard normal distribution, and

$$d_{2,t}(T) = \frac{\log(V_t / L_t) + (r - a - \sigma^2 / 2)(T - t)}{\sigma\sqrt{T - t}} \tag{4.7}$$

is a parameter of Black-Scholes formula. For the proof, see Appendix C.

Due to T. Bielecki et al (2009), the survival probability under Black-Cox model is:

$$\mathbb{P}_{sur}(\tau > s \mid \tau > t) = \Phi(d_3) - \left(\frac{L_t}{V_t}\right)^{\frac{2(r-a)}{\sigma^2}-1} \Phi(d_4), \tag{4.8}$$

where

$$d_{3,t}(s) = \frac{\log(V_t / L_t) + (r - a - \sigma^2 / 2)(s - t)}{\sigma\sqrt{s - t}}, \tag{4.9}$$

$$d_{4,t}(s) = \frac{\log(L_t / V_t) + (r - a - \sigma^2 / 2)(s - t)}{\sigma\sqrt{s - t}}. \tag{4.10}$$

The term *a* fortunately does not affect the result.

Now, use ***c*** to denote **price (spread) of a single name CDS**, and use ***N*** to denote the **notional amount**.

Divide the time to discrete times t_i: $t_0 = 0$, t_1, …, $t_n = T$. The buyer of CDS contract pays the premium to the seller:

$$PV_{premium} = cN\sum_{i=1}^{n} D(0, t_i)\mathbb{P}_{sur}(t_i)\Delta t_i + Acc, \tag{4.11}$$

where the second term *Acc* is accrual payment, and *D* is the discount factor: $D(0,t) = e^{-\int_0^t r_t \mathrm{d}t}$.

For simplification, assume the default can also occur at the middle of two consecutive payment dates (Schoutens, 2009). Thus the term *Acc* can be estimated by

$$Acc = \frac{1}{2} cN\sum_{i=1}^{n} D(0, t_i)[\mathbb{P}_{sur}(t_{i-1}) - \mathbb{P}_{sur}(t_i)]\Delta t_i. \tag{4.12}$$

When the default occurs, the seller should pay the protection leg to the buyer (Schoutens, 2009):

$$PV_{protect} = (1-R_{ec})N\sum_{i=1}^{n} D(0,t_i)[\mathbb{P}_{sur}(t_{i-1}) - \mathbb{P}_{sur}(t_i)]. \qquad (4.13)$$

where R_{ec} is the recovery rate.

The non-arbitrage principle orders the two terms equal each other, so

$$c_{t_i} = \frac{(1-R_{ec})\sum_{j=i+1}^{n} D(t_i,t_j)[\mathbb{P}_{sur}(t_{j-1}) - \mathbb{P}_{sur}(t_j)]}{\sum_{j=i+1}^{n} D(t_i,t_j)\mathbb{P}_{sur}(t_j) - \frac{1}{2}\sum_{j=i+1}^{n} D(t_i,t_j)[\mathbb{P}_{sur}(t_{j-1}) - \mathbb{P}_{sur}(t_j)]}. \qquad (4.14)$$

4.3 Model Application and Data Collection

4.3.1 Model Application

After the establishment, consider how to apply the model onto local governments. The crucial problem is how to describe the assets of a local government?

Wang Jue, et al (2012) have considered this question and divided government's assets to two parts: financial assets and non-financial assets. Financial assets include currency and deposits and other securities, and the major of non-financial assets is fixed assets.

For Europe countries, the data access is easy: GFS database publishes financial data quarterly for all the countries, which includes data of total financial assets, measured by ESA 95. However, there is no such a source for China's data, to say nothing of local governments.

Another problem is how much of government's asset can be considered as the "total asset". For instance, it would be hard to imagine using fixed assets to ease the fiscal pressure. In United States, government shutdown has occurred for 7 times (once of federal government and 6 times of local governments) since 2005 because of funding

gap, but they never pledge fixed-assets for funding.

So the object could be limited as a part of financial assets. Within the financial assets, obviously, the revenue is the easiest to capture. Immediate thought is to use the revenue as assets.

Actually, this choice is quite rash and reckless. But there are two reasons to support this behavior:

- One is the term log V_t in the model. It shows that if the proportion of revenue to asset does not change violently, there will be only a difference of a constant.
- The other evidence is some local governments have already added repayment of local bonds into budget as public expenditure[11]. So it should be guaranteed by revenue, too.

Anyway, it is a bad approach, but currently there is no other better method.

Other key parameters used in Merton and Black-Cox models are adopted as:

- The pre-determined liability level: the amount of debt that should be repaid in the same financial period. It can be got from the audit result.
- Recovery rate: in ISDA standard model, it is set as 40%. But in this dissertation, this term is not cared. The reason will be explained in Chapter 5.
- Risk-free short-term rate: 1-year treasury yield.
- Drift and volatility: will be derived from real data.

To estimate data of all the provinces is a large work and hard to get useful information, so we are going to estimate one government at provincial level. In this chapter, Shanghai (上海) is selected as the object. It has the following characteristics:

- Good information disclosure
- Developed market economy
- Simple hierarchical structure of government
- Often selected as a representative of China's local government

[11] For example, a section of *The report on the implementation of the Shanghai's budget in 2013*: "... Plus 5 billion yuan of repayment of local government bonds ... the total public expenditure is 466.62 billion yuan."

In addition, for comparison, CDS data of 5-year bonds will be calculated.

4.3.2 Data collection

Now, look for the data. Revenue, debt, yields and derived variables are needed.

4.3.2.1 Time series

Because of the limit of valid data, in this chapter, quarter data from 2011 will be estimated. Therefore, discrete time series is set as

2010 Q4: $t_0 = 0$

2011 Q1: $t_1 = 0.25$

2011 Q2: $t_2 = 0.5$

...

2013 Q3: $t_{11} = 2.75$

2013 Q4: $t_{12} = 3$

2014 Q1: $t_{13} = 3.25$

...

4.3.2.2 Revenue

The revenue data can be obtained directly from Shanghai Finance Bureau website. The quarter data are:

Table 4.2 Shanghai's Quarter Revenue (billion yuan)

	Q1	**Q2**	**Q3**	**Q4**
2010	75.44	80.97	68.2	62.75
2011	103.45	98.66	78.87	62
2012	110.37	105.48	85.48	73.04
2013	119.76	114.82	94.19	82.18
2014	142.44			

It is easy to notice the data contain seasonality. In order to remove the seasonality, it is considered to add a seasonal factor S_t as an exogenous variable:

$$\hat{V}_t = S_t + V_t, \text{ or } \hat{V}_t = S_t \cdot V_t. \tag{4.15}$$

Here V-hat means the variable contains seasonal factor, and the period of S_t is 1 year.

No compare the two models. If the magnitude of the seasonal fluctuations does not vary with the level of the series, the additive model is better; otherwise, a multiplicative model is more appropriate (RR. Marathe et al, 2005).

A) Differences of revenues to annual revenue / 4:

Table 4.3 Test of Additive Model (billion yuan)

	Q1	Q2	Q3	Q4
2010	3.60	9.13	-3.64	-9.09
2011	17.70	12.91	-6.88	-23.75
2012	16.78	11.89	-8.11	-20.55
2013	17.02	12.08	-8.55	-20.56

B) Proportion of every quarter revenue to annual revenue:

Table 4.4 Test of Multiplicative Model (%)

	Q1	Q2	Q3	Q4
2010	26.3	28.2	23.7	21.8
2011	30.2	28.8	23.0	18.1
2012	29.5	28.2	22.8	19.5
2013	29.1	27.9	22.9	20.0

Obviously, the magnitude varies with the absolute scale, but substantially keeps general proportions. For this reason, the multiplicative model is adopted.

Take logarithm of the revenue data and establish the following linear regression model:

$$\log \hat{V}_t = a + b_1 t + b_2 D_2 + b_3 D_3 + b_4 D_4 + \varepsilon_t, \tag{4.16}$$

with dummy variables:

$$D_i = \begin{cases} 1, \text{ if the data is of } \mathrm{Q_i} \\ 0, \text{ otherwise} \end{cases}. \tag{4.17}$$

Apply generalized least squares regression, the result is:

$$\log \hat{V}_t = 4.6048 + 0.0955t - 0.0835D_2 - 0.3180D_3 - 0.5064D_4 + \varepsilon_t$$
$$(t = 190.1^{***})(10.10^{***})\ (\text{-}3.08^{**})\quad (\text{-}11.77^{***})\ (\text{-}20.15^{***}) \qquad (4.18)$$
$$R^2 = 0.986;\ \text{Sig.} = 0.000$$

: 5% level; *: 1% level

The seasonal factor of four seasons can be derived directly from this result. But the result is just a proportion, so there needs another standard to rescale data: the annual revenue before and after adjustment should be consistent.

As a result, the deseasonalized data are:

Table 4.5 Deseasonalized Quarter Revenue (billion yuan)

	Q1	Q2	Q3	Q4
Factor	1	0.92	0.73	0.60
2010	(61.87)	(72.19)	(76.87)	84.53
2011	83.98	87.07	88.00	83.52
2012	89.60	93.09	95.37	98.39
2013	97.22	101.33	105.09	110.70
2014	115.63			

(*) means the data is before time 0 and would not be used in the model

Derived parameters are:

$$V_0 = 81.15,\ \text{volatility}\ \sigma = 0.0751,\ \text{drift}\ \mu = 0.0983.$$

In addition, there is another simple method to calculate seasonal factor: take the average of every season and derive their proportion. This method will be discussed in Appendix D.

4.3.2.3 Liability

Now, estimate the parameters of liability: growth rate a and initial quarter amount L_0.

To estimate the growth rate, it is better to get information from historical data rather than future data. In Shanghai's audit result, the debt amount of June 2013 is 506.42 billion yuan, and of Dec. 2010 is 349.06 billion yuan. Annual growth rate is 16.05%.

Take this rate as average annual growth rate of liability,

$$a = \ln 1.1605 = 0.1488.$$

Also, due to the audit result, the amount of debt to repay in July to Dec. 2013 (short-term debt) is 67.363 billion yuan. i.e.

$$L_{2.75} + L_3 = L_{13Q3} + L_{13Q4} = 67.363,$$

assuming the liability growth stably,

$$L_0 = 21.952.$$

4.3.2.4 Risk-Free Short Term Rate

1-year treasury yield is a common type of risk-free short-term rate. The run of recent years is shown in the following figure:

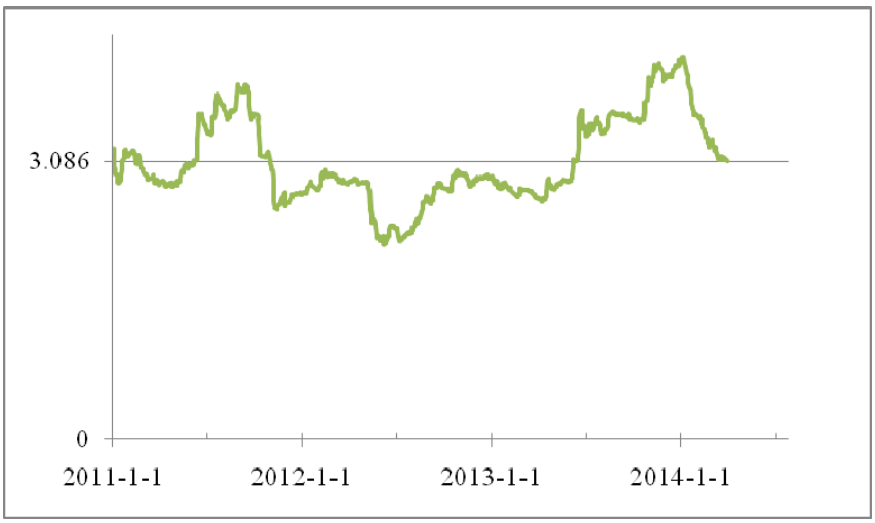

Fig. 4.1 One-year Treasury Yield[12]

For simplicity, the average rate 3.086% (annual) is adopted.

[12] Data source: http://bond.hexun.com

4.4 Estimation, Prediction and Discussion

When accompany the seasonal factor, some expression of previous models would change:

The expression of V_t :

$$\hat{V_t} = S_t V_0 e^{(\mu-\sigma^2/2)t+\sigma B_t}. \tag{4.19}$$

Survival probability in Merton model:

$$\begin{aligned} &\mathbb{P}_{sur}(T) = \Phi(d_2), \\ &d_{2,t}(T) = \frac{\log(V_t / L_t) + \log S_T + (r - a - \sigma^2/2)(T-t)}{\sigma\sqrt{T-t}}. \end{aligned} \tag{4.20}$$

Survival probability in Black-Cox model:

$$\begin{aligned} &\mathbb{P}_{sur}(\tau > s \mid \tau > t) = \Phi(d_3) - \left(\frac{L_t}{S_s V_t}\right)^{\frac{2(r-a)}{\sigma^2}-1} \Phi(d_4), \\ &d_{3,t}(s) = \frac{\log(V_t S_s / L_t) + (r - a - \sigma^2/2)(s-t)}{\sigma\sqrt{s-t}}, \\ &d_{4,t}(s) = \frac{\log(L_t / V_t S_s) + (r - a - \sigma^2/2)(s-t)}{\sigma\sqrt{s-t}}. \end{aligned} \tag{4.21}$$

Fortunately, the results are not changed by the seasonal factor.

4.4.1 Estimation and Prediction

Use Merton model and Black-Cox model to estimate Shanghai's CDS data from 2011 to 2014. Because the factor R_{ec} is not cared in this chapter, the result does not contain this factor, and thereby called "ortho-CDS". Here the prefix "ortho-" means "straight, free from resize".

The result is shown in Table 4.6; a comparison with observed China's CDS is in Fig. 4.2. Compared with China's quarter-average CDS:

- The correlation between Merton's result and China's is 0.38.
- The correlation between Black-Cox's result and China's is 0.37.
- The correlation between Merton's and Black-Cox's results (until 2014 Q1) is 0.74.

Table 4.6 Ortho-CDS

	Merton	Black-Cox		Merton	Black-Cox
2011Q1	90.3	114.1	**2013Q1**	147.4	202.2
Q2	111.3	106.0	**Q2**	171.2	183.2
Q3	145.5	122.4	**Q3**	187.3	171.4
Q4	248.1	223.3	**Q4**	176.6	141.8
2012Q1	123.1	164.4	**2014Q1**	97.1	124.4
Q2	147.1	151.5	***Q2***	*106.0*	*204.5*
Q3	173.8	155.3	***Q3***	*124.8*	*70.0*
Q4	184.8	151.0	***Q4***	*73.8*	*388.7*

Italics are predicted data.

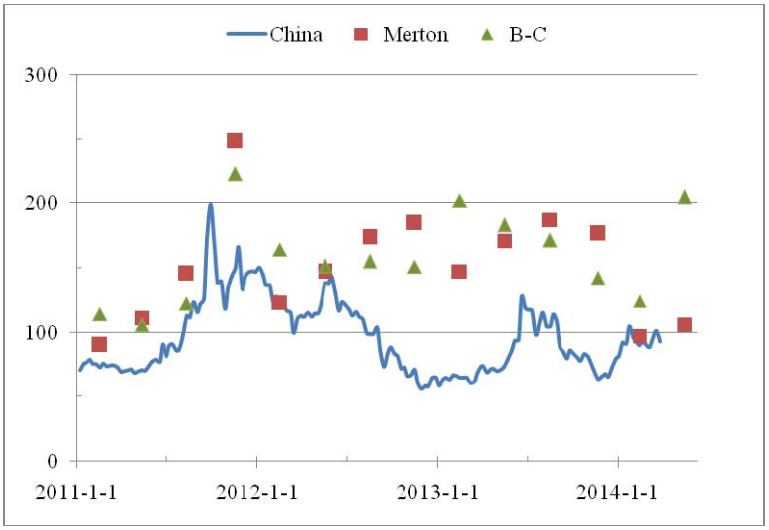

Fig. 4.2 Ortho-CDS and Comparison

Remark: The curve is the real China's CDS in international market (source: Bloomberg).
Unit is basis point (0.01%).

Because of uncertainty, data of last three periods (2014Q2 - 2014Q4) vary severely. Here is a simulation result of Monte-Carlo method for the next seven seasons (repeated for 30 times):

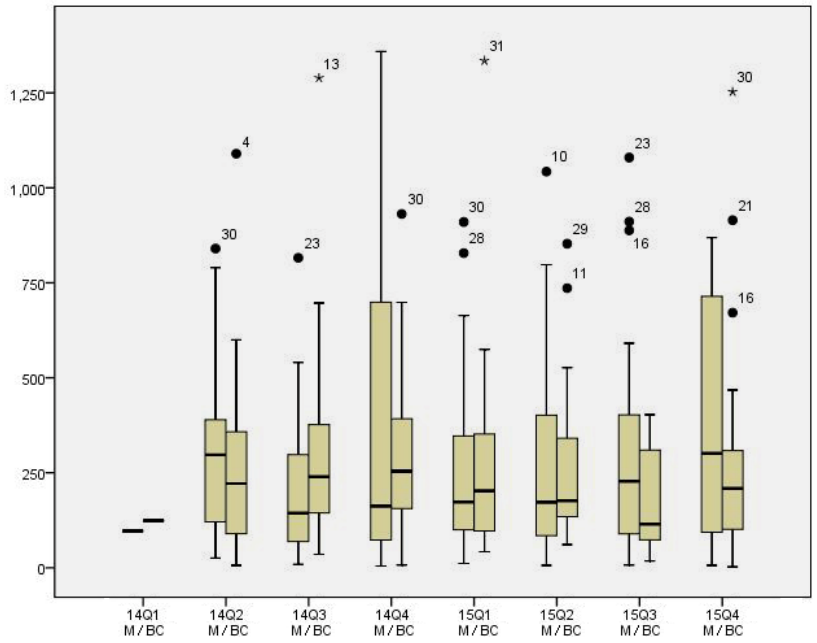

Fig. 4.3 Overlapped Box Plot (Left: Merton; Right: Black-Cox)

4.4.2 Discussion

Compare the trend of data above, the following features can be noticed:

1) There is seasonality in the simulated CDS data. It shows in the model, the seasonal factor acts a significance role, and the seasonal location of revenue also affects investor's confidence.

2) Until 2012 Q2, the trend of Shanghai's and China's CDS is highly consistent (correlation = 0.81 for Merton and 0.90 for Black-Cox). There may be great global event affecting both of them.

3) In other period, the result is not quite consistent with China's CDS, but the trend of two models is roughly consistent. It may be because the local government also has its own feature, but an important reason is the model is too simple to reflect enough market information.

4) Because of uncertainty, the results from 2014 Q3 vary severely. Merton's volatility is

higher. This might be because Merton model only observe the status on the maturity, and the unknown information, therefore randomness is higher; while Black-Cox model considers real-time status, and contains more information.

As an overall review of this model, the following points are proposed:

This model has firstly attempted to analyze risk of local government quantitatively, and has actually found a feasible method to simulate CDS data. As will be shown later, the model is identifiable for different fiscal situation.

Also, this model shows a possibility to apply firm specialized models, such as structured model, to local governments. Although still imperfect, it has good prospects.

However, it is just a simple model, and also contains defects:

The first one is it contains too little information for a local government. The uncertainty only comes from the volatility of revenue, and the latter one contains just vague information of real economy. Besides, many other factors that may affect risk are not reflected in this model, such as asset structure, debt structure, real-time growth rate, shadowed factor, and so on.

The second is to use the revenue as the asset is too rough. What should be considered as the "asset value" of a local government in this model could be a separate issue. Also, government is not a company, and therefore to use all the assets (or revenue) as the capital for the solvency is also strange and unrealistic. It seems better to take just a part of assets.

Another problem is the jump between time points is a little long (three months). This is because the valid data are insufficiency. Macroeconomic data are often released quarterly or even annually, and very few are released monthly. This problem is hard to overcome in short time, until the real market is established.

Last is the result cannot be verified by observed real data, because there is no such a

market. In physics, such estimation or calculation of unobservable variables can be verified though other derived observable variables. This could be a hint, but for local CDS, the derived variable (default probability) is also hard to observe in current situation.

The improvement and future prospects of this model are:

First, introduce more volatility factors into this model. For example, in current model, the uncertainty only comes from the asset value V_t; it would be progress if consider the integrated variable V_t / L_t, in which the volatility of liability is concerned together. Of course, if there were enough data, their individual volatilities could be captured separately.

Second, introduce the asset structure and other information into this model. It is necessary to characterize the asset more precisely. A feasible method is to create government balance sheets periodically, but it is patent for governments. Another method is to study on the estimation of government asset, which is a new field. In current model, only the seasonal factor is adopted. Other market information (such as shadowed factors) should also be considered when improve it.

Another role of this model is to derive the limit of debt and debt growth. Rapid growth of government debt will lead high risk and high CDS. Conversely, to maintain a stable development, it is possible to derive a limit of debt growth. This can be used as policy suggestion.

The last issue is to look for a method to examine the result. If the result can be verified by real data without lost of information, its practicality will be significantly improved. This method would be a signal for investors and policy makers.

These can be left as tasks for future research. Improvement of this model will be encouraging progress for both theory and practice.

4.5 Province Comparison

As the last section of this chapter, a comparison of CDS of different provinces will be introduced to illustrate the effect of different fiscal situation. For simplicity, this section adopts Merton model.

Generally speaking, Shanghai is a strong local government in China. Its GDP, financial revenue and political status are all in top of China's provinces. To compare the difference reflected by fiscal situation, in this section, another province, Shaanxi (陕西), is selected as a representative of medium provinces.

Shaanxi is an inland province, belonging to northwestern China. Its capital is Xi'an. Shaanxi's economic is at a medium level, GDP rank = 16 of 31 in 2012 (Shanghai = 11); its fiscal situation is also medium, revenue rank = 17 of 31 in 2012 (Shanghai = 4).

Generally speaking, Shaanxi's debt situation is worse than Shanghai's:

- Total amount of debt is about 53% as Shanghai's.
- The amount of short-term debt (should be repaid within 6 months) is more. (SX 88.6 : SH 67.4).
- Shaanxi's revenue growth rate is lower (SX 7% : SH 10%)
- Annual debt growth rate (2010-13) is higher (SX 23.4% : SH 16.1%)

The result of Merton model is:

Table 4.7 Comparison of Shanghai & Shaanxi

	SH	SX		SH	SX		SH	SX
2011Q1	90.3	376.9	**2012Q1**	123.1	450.6	**2013Q1**	147.4	528.6
Q2	111.3	301.0	**Q2**	147.1	373.6	**Q2**	171.2	451.2
Q3	145.5	469.5	**Q3**	173.8	545.3	**Q3**	187.3	624.0
Q4	248.1	446.7	**Q4**	184.8	476.5	**Q4**	176.6	543.2

Because the parameters are not carefully considered (e.g. the unbalance of growth rate is obviously unsustainable), it is just an approximate calculation and only valid in short and med-term.

In fact, in this estimation after 2014, the rapid growth of debt has led economic collapse and therefore the CDS soars over 10000 bps. But at least, as a qualitative result, it shows there is significant difference between them.

5 Applications of Local CDS and Shadow Banking

The main purpose of this dissertation is to derive the default probability of a local government. There are two types of method: structured and intensity model.

In Chapter 4, it is mentioned that the intensity model is suitable for the second step, when the CDS data are obtained. So in this chapter, the data will be applied to estimate the risk of Shanghai's debt by applying reduced (intensity) models. This theory is mainly attributed to Damiano Brigo (2006).

5.1 Intensity Model

In intensity models, the default time τ is considered as the first jump of a Poisson process. Without jumping (defaulting) before time t, the risk neutral probability of defaulting in the next dt instants is

$$\mathbb{Q}(\tau \in [t, t+\mathrm{d}t) \mid \tau > t, \mathcal{F}_t) = \lambda(t)\mathrm{d}t \tag{5.1}$$

where the factor λ is strictly positive and generally called intensity.

The integration of λ is cumulated intensity. Due to the property of Poisson process, the cumulated intensity of time τ is exponentially distributed:

$$\Lambda(\tau) := \int_0^t \lambda(s)\mathrm{d}s := \xi \sim \text{exponential distribution} \tag{5.2}$$

It is independent of all default-free factors.

Thus the survival probability at time t is

$$\mathbb{Q}(\tau > t) = \mathbb{E}^*[e^{-\int_0^t \lambda(s)\mathrm{d}s}], \tag{5.3}$$

where $\mathbb{E}^*$ is risk-neutral probability. This is the price of a zero coupon bond in an interest rate model with short rate replaced by λ.

When price defaultable bonds, both the short rate and the intensity are adopted:

$$\mathbb{E}^*[D(0,T)1_{\{\tau>t\}}] = \mathbb{E}^*[e^{-\int_0^T (r(s)+\lambda(s))\mathrm{d}s}], \tag{5.4}$$

denoting a bond paying 1 at final maturity T without any defaulting before T.

In the calculation of CDS in intensity models, it is proved that with market value recovery, if the interest rate and the intensity are constant, the bond spread (and hence the CDS spread) will be equal to the risk neutral expected loss rate. Thus, if λ is constant over time or in a time period (often used in real transactions), it is easy to back out the default intensity from the CDS spread (quote):

$$CDS = \lambda(1 - R_{ec}) \Leftrightarrow \lambda = \frac{CDS}{1 - R_{ec}}. \tag{5.5}$$

For detailed proof, see Appendix E.

Notice that the expression of CDS in (4.14) is actually the product of ortho-CDS and the factor 1 - R_{ec}. This is why the factor R_{ec} is ignored in Chapter 4.

A corollary is: the intensity λ is actually equal to the ortho-CDS.

Piecewise constant lambda is just a simple approximation. As an extension, it may be expanded to function even stochastic. The result must change greatly.

5.2 Model comparison

It is natural to derive piecewise (quarterly) constant intensities directly from Table 4.6. Here, only the result of Black-Cox model is repeated:

Table 5.1 Shanghai's Intensity λ of B-C Model (%)

Season	λ	Season	λ	Season	λ	Season	λ
2011Q1	1.141	**2012Q1**	1.644	**2013Q1**	2.022	**2014Q1**	1.244
Q2	1.060	**Q2**	1.515	**Q2**	1.832	**Q2**	*2.045*
Q3	1.224	**Q3**	1.553	**Q3**	1.714	**Q3**	*0.700*
Q4	2.233	**Q4**	1.510	**Q4**	1.418	**Q4**	*3.887*

Italics are predicted data.

Thus the survival probability of Shanghai can be easily fitted.

Notice the structured model can also derive survival probability during the model establishment:

$$\mathbb{P}_{sur}(T) = \Phi(d_2),$$
$$d_{2,t}(T) = \frac{\log(V_t / L_t) + \log S_T + (r - a - \sigma^2 / 2)(T - t)}{\sigma\sqrt{T - t}}, \tag{5.6}$$

and

$$\mathbb{P}_{sur}(\tau > s \mid \tau > t) = \Phi(d_3) - \left(\frac{L_t}{S_s V_t}\right)^{\frac{2(r-a)}{\sigma^2} - 1} \Phi(d_4),$$
$$d_{3,t}(s) = \frac{\log(V_t S_s / L_t) + (r - a - \sigma^2 / 2)(s - t)}{\sigma\sqrt{s - t}}, \tag{5.7}$$
$$d_{4,t}(s) = \frac{\log(L_t / V_t S_s) + (r - a - \sigma^2 / 2)(s - t)}{\sigma\sqrt{s - t}}.$$

It would be interesting to compare the result of structured model and intensity model, and to compare Merton model and Black-Cox model. The comparison is shown in Fig. 5.1.

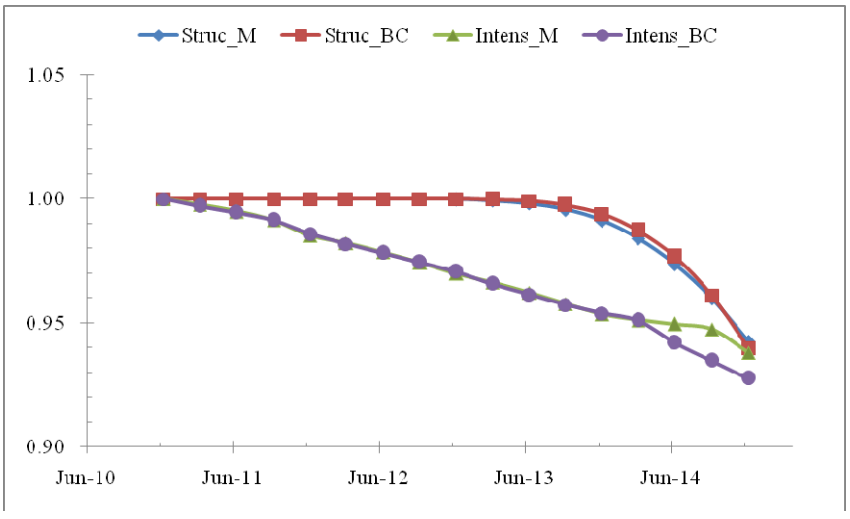

Fig. 5.1 Comparison of Survival Probability of 4 Models

In intensity model, the survival probability keeps decreasing (in exponential form); while the probability in structured model maintains for a long time and then decreases suddenly. The results of intensity model and structured model are quite different in

med-term. This is because their forms of survive probability are totally different:

- Structure model: only $\mathbb{P}_{sur}$
- Intensity model: $e^{\frac{\sum \Delta\mathbb{P}}{\sum \mathbb{P}+\sum \Delta\mathbb{P}}}$

So it is not strange there is inconsistency.

However, the results of Merton model and Black-Cox model are quite closed; this shows there is almost no difference between them.

5.3 Shadow Banking

Besides the above analysis, another factor that can affect the risk and thereby should be considered is the shadow banking system. As mentioned in Chapter 3, the shadow banking system can affect the potential risk, and has become a big and compelling issue for both policy makers and scholars.

However, there is quite little previous research. The only quantitative study is about its scale, but there is even no consensus. The author has tried to take the first step to this field, but has not gone far.

Because of the lack of previous research, the author proposed some points for related study with preliminary calculation. The core idea is the shadow banking system will affect the risk intensity λ. Still take Shanghai as the representative.

1) Shadow banking will increase the comprehensive return rate.

A shadowed way frequently used by local governments is BT (build-transfer). BT demands high rate of return, which is heavy burden to local governments.

At the end of June 2013, the total debt of Shanghai government was 519.43 billion yuan. Within this, there are 370 billion yuan of bank loans, 23 billion of local government bonds, and 83 billion of BT financing.

Table 5.2 Components of Shanghai's Debt

	Amount (billion)	Proportion
Loan	370.40	71.3%
Gov. Bond	23.10	4.4%
BT	82.57	15.9%
Sum	476.07	91.6%

The interest rate of general bank loan (5-year rate) is 6.4%, and the yield of bond is 3.6% on average. However, the return rate of shadow banking factor (BT here) is quite high. A study indicates that the consolidated financing cost of BT project is about 30% (Weng, 2014). Therefore, the integrated return rate of Shanghai's debt will be about 10%, over 1.5 times as the loan rate. Noticing the average growth rate of Shanghai's revenue is actually about 10%, it can be said the current return rate is quite high.

2) Shadow banking will increase contingent liability burden.

The evidence is from the audit result. Because governments should guarantee for its financing platforms, they must bear some risk, and therefore burden. For Shanghai, in 2012, its debt ratio is 76.1%; but if take the contingent liability into account, the comprehensive debt ratio is 87.6%. It means the contingent liability will increase about 15% of debt burden.

3) Shadow banking will affect the revenue resource.

This is because most of the revenue is actually tax. Shadow banking will affect the fiscal situation of firms in real economy, and thus the tax will be also influenced. The predicted effect is the volatility would increase when shadow banking works. However there is not quantitative evidence yet.

4) Shadow banking will affect the value of mortgage.

In real practice, governments often use land usage right, i.e. land premium, or projects guaranteed by land premium, as the mortgage of debt. Thus the land premium or its predicted growth potential will affect the quality of guarantee. If the land premium (price) decreases, the default risk will increase -- in fact, it is indeed the reason of the

U.S. subprime crisis. The key point of calculation is how much is such mortgage and the effect on intensity.

5) Some of government debt is shadowed.

For example, trust, BT and security financing are generally considered as shadowed method. These three parts occupy about 18% of Shanghai's total debt. In the market, these channels have their average default risks. For example, within the trust contracts mature in 2014, the default rate might soar to 40% (Leslie, 2014). These average risks can provide parameters for local governments (but the difference of a government needs to be considered).

6) Shadow banking will disturb financial system itself.

This is a macro issue and will affect the systemic risk. There are already some scholars studying on the field of stability of financial system (see Chapter 3). However, it is still quite far to apply this effect onto individual risk.

7) Some other issues

For example, debt securitization, liquidity risk, leverage and deleveraging: all these subjects can influence risk and are related with shadowed factors to a certain extent, but they are hard to capture currently and not so closed to the core purpose as the previous ones.

Currently, both China's central and local governments are trying their best to prevent a domestic financial crisis, such as to protect investors through administrative methods. This makes the market safer, but also makes it hard to observe the real risk.

Because of the lack of materials, there is no clear and definitive research in the field of default probability in shadow banking system, and it is also hard to make further progress in short term. However, this topic is attractive and there might be non mathematical approach.

The above points and approaches are left as future tasks. But because of practical

difficulties, we will still work alone recently in this field. With the cleaning up of shadow banking in China, the government may allow some default events in future. That time will be a turn point.

6 Conclusion

Historical reasons and practical demands have generated China's local government debt problem together. Weak local governments are meeting serious problems, and the default will impact the market and cause long-term effect. In order to capture the situation quantitatively, this dissertation has found a feasible way.

In this dissertation, the following topics are mainly discussed:

- General matters of local government debts.
- Significance of CDS, estimation and application.
- Shadow banking system.

6.1 Conclusion

From the aspect of China's local debts, this dissertation have clarified the fundamental knowledge and discussed the reason and problem at first. China's financial system and the heavy burden on local governments together caused the huge amount of China's local government debt.

After an overview of the current situation and comparison with foreign countries, it is concluded that the total amount of government debt is optimistic, but the low revenue is not a good signal. Additionally, the proportion of local debt is too high and therefore caution needed.

Through reviewing related literatures, the importance of this field is highlighted, and it is found that this field is a wilderness yet. So the research direction is decided.

By reviewing literatures, CDS is found as a crucial tool to deal with the risk. Imitate sovereign CDS and corporate CDS, the new concept "local government CDS" is proposed.

In this dissertation, structured model and intensity model are employed for estimation of

CDS. To characterize the features of assets, Merton and Black-Cox models are adopted. Applied onto Shanghai's real data, its CDS and default probability are simulated by different methods. The result shows Merton and Black-Cox models are closed to each other, but there is difference between structured and intensity models because of their different form. Also, provincial comparison is applied.

Shadow banking is a relatively new concept. There is no consensus about the definition, range and amount yet. However, the businesses in shadow banking system is less regulated and supervised, so it is hard to observe the potential risks. When the crisis is noticed, it might be too late. Its role of financial innovation and credit creation is already taken seriously, and its regulatory is considered by most scholars and decision makers.

In this dissertation, two main results are achieved: One is the literature tree of shadow banking research in Chinese academia. After simplification for two times, the studies are mainly divided into four series. With the academic attention on the issue, this large project is unprecedented and would be very likely unrepeatable.

The other is trying to analyze the effect of shadow banking. Because of the lack of materials, only fundamental study is applied and some future tasks are suggested.

As a summary, this dissertation has explored a feasible way to analyze the risk of local government debt quantitatively and advised some approaches for other economical factors.

6.2 Future Development and Suggestion

This dissertation has established models of local government CDS for Shanghai, and estimated the probability actually. However, the models are still simple, and need to improve in future. There are two main aspects: accuracy and practicality.

One improvement is to observe more data and introduce more factors to make the models more precise. For example, it is helpful to introduce volatility into liability term, or to find a more proper method to characterize the asset of local governments.

Another improvement is to strengthen its practicality. If the limit of debt and debt growth can be derived, or its result can be examined by real data, the practicality will be improved considerably.

Lastly, local CDS is a new concept, and it may be a little ahead of our time that even sovereign CDS is not yet completely clear and the local CDS market does not exist.

Shadow banking is more promising. Though it is hard to capture currently, there are some feasible approaches:

One approach is to analyze the effect of shadowed factors on the current debt of local governments. The composition and amount are observed, so it is much easier. To calculate their risk is helpful for the whole situation analysis.

Another approach is to analyze the influence of shadow banking system on the related market factors, such as average industry influence (affect revenue) or predicted growth potential of mortgage (affect risk). This is more difficult than the previous one, but still operable.

For China's policy makers, there are several suggestions for the chaos:

Firstly, to ease the financial strain by high return channels is drinking poison to quench thirst. However, it is not an easy decision for current governments because of unrealistic hyper growth. For this reason, it is necessary to adjust the budget constraint mechanism for local governments and state-owned enterprises based on the actual situation, and establish risk-based pricing mechanism.

Secondly, strengthen the regulatory of financial behaviors. Weak regulatory and unclear legal responsibility is a big problem of China's shadow banking, which will worsen the conduction of risk.

Thirdly, artificially preventing default is not the correct approach. It will only delay the

occurrence of the problem, make the problem worse, and even result in market distortions. Hence, default should be allowed, but transparent legal system should be established before that. In addition, occurrence of default that may lead to chain of systemic risk should be prevented, such as banks, state-owned enterprises and local governments.

Lastly, when local governments are unable to repay, central government can consider lending emergent rescue loans to avoid the spread of crisis. However, such emergent rescue loans should be accompanied with high consideration (cost) to warn local governments of reckless behaviors.

References

Acharya, Viral V. Governments as Shadow Banks: The Looming Threat to Financial Stability [J]. Texas Law Review. 2012, 90(7): 1745-1774.

Acharya, Viral V.; Rajan, Raghuram G. Sovereign Debt, Government Myopia, and the Financial Sector [J]. Review of Financial Studies. 2013, 26(6): 1526-1560.

Adrian, Tobias; Ashcraft, Adam B. Shadow Banking Regulation [G]. Annual Review of Financial Economics, 2012, 4(99+).

Aguiar, Mark; Amador, Manuel; Gopinath, Gita. Investment Cycles and Sovereign Debt Overhang [J]. Review of Economic Studies. 2009, 76(1): 1-31.

Aizenman, Joshua; Binici, Mahir; Hutchison, Michael. Credit Ratings and the Pricing of Sovereign Debt During the Euro Crisis [J]. Oxford Review of Economic Policy. 2013a, 29(3): 582-609.

Aizenman, Joshua; Hutchison, Michael; Jinjarak, Yothin. What Is the Risk of European Sovereign Debt Defaults? Fiscal Space, CDS Spreads and Market Pricing of Risk [J]. Journal of International Money and Finance. 2013b, 34(SP): 37-59.

Allen, H. K. Local government debt administration [J]. Journal of Accountancy. 1940, 69(1): 69-69.

Alt, James E.; Lassen, David Dreyer. Transparency, Political Polarization, and Political Budget Cycles in OECD Countries [J]. European Economic Review. 2006, 50(6): 1403-1439.

Anis Chowdhury and Iyanatul. Is there an optimal debt-to-GDP ratio? [EB/OL]. 2010-11-09 [2014-05-15]. http://www.voxeu.org/debates/commentaries/there-optimal-debt-gdp-ratio

Arce, Oscar; Mayordomo, Sergio; Ignacio Pena, Juan. Credit-Risk Valuation in the Sovereign CDS and Bonds Markets: Evidence from the Euro Area Crisis [J]. Journal of International Money and Finance. 2013, 35: 124-145.

Arellano, Cristina. Default Risk and Income Fluctuations in Emerging Economies [J]. American Economic Review. 2008, 98(3): 690-712.

Arteta, Carlos; Hale, Galina. Sovereign Debt Crises and Credit to the Private Sector [J]. Journal of International Economics. 2008, 74(1):53-69.

Ashworth, J; Geys, B; Heyndels, B. Government Weakness and Local Public Debt Development in Flemish Municipalities [J]. International Tax and Public Finance. 2005, 12(4): 395-422.

Assmann, Christian; Boysen-Hogrefe, Jens. Determinants of Government Bond Spreads in the Euro Area: in Good Times as in Bad [J]. Empirica. 2012, 39(3): 341-356.

Ba Shusong. Strengthen the Supervision on the Shadow Banking System [J]; China Finance. 2009a(7)

Ba, Shusong; Sun Xingliang; Gu Lei. The Impact of Sovereign CDS on the Euro Zone Sovereign Debt Crisis [J]. Studies of International Finance, 2012(7).

Badaoui, Saad; Cathcart, Lara; El-Jahel, Lina. Do Sovereign Credit Default Swaps Represent a

Clean Measure of Sovereign Default Risk? A Factor Model Approach [J]. Journal of Banking & Finance. 2013, 37(7): 2392-2407.

Bai Jingming. Unified Management System of Local Debt Cannot Be Shaken [N]. China Social Sciences. 2012-12-31.

Bastida, Francisco; Beyaert, Arielle; Benito, Bernardino. Electoral Cycles and Local Government Debt Management [J]. Local Government Studies. 2013, 39(1): 107-132.

Bastida, Francisco; Guillamon, Maria-Dolores; Benito, Bernardino. Explaining Interest Rates in Local Government Borrowing [J]. International Public Management Journal. 2014, 17(1): 45-73.

Beber, Alessandro; Brandt, Michael W.; Kavajecz, Kenneth A. Flight-to-Quality or Flight-to-Liquidity? Evidence from the Euro-Area Bond Market [J]. Review of Financial Studies. 2009, 22(3): 925-957.

Beckett-Camarata, Jane. Local Government Measurement and Use of Performance Accounting and Financial Reporting Data in Planning and Budgeting Decision Support a Multicase Study [J]. Public Performance & Management Review. 2009, 33(2):255-265.

Beirne, John; Fratzscher, Marcel. The Pricing of Sovereign Risk and Contagion during the European Sovereign Debt Crisis [J]. Journal of International Money and Finance. 2013, 34(SP): 60-82.

Bell, G. Local-government Finance – Capital Facilities Planning and Debt Administration – Steiss, AW [J]. State Government. 1976, 49(1): 58-58

Ben S. Bernanke. Some Reflections on the Crisis and the Policy Response [C]. Conference on "Rethinking Finance: Perspectives on the Crisis" Presented by the Russell Sage Foundation and the Century Foundation. New York, April 13, 2012.

Bernoth, Kerstin; Erdogan, Burcu. Sovereign Bond Yield Spreads: A Time-Varying Coefficient Approach [J]. Journal of International Money And Finance. 2012a, 31(3):639-656.

Bernoth, Kerstin; von Hagen, Juergen; Schuknecht, Ludger. Sovereign Risk Premia in the European Government Bond Market [J]. Journal of International Money and Finance. 2012b, 31(5): 975-995.

Bi Huixin. Sovereign Default Risk Premia, Fiscal Limits, and Fiscal Policy [J]. European Economic Review. 2012, 56(3):389-410.

Bohn, Henning. The Economic Consequences of Rising Us Government Debt: Privileges At Risk [J]. Finanzarchiv. 2011, 67(3): 282-302.

Borge, Lars-Erik; Tovmo, Per. Myopic or Constrained By Balanced-Budget Rules? The Intertemporal Spending Behavior of Norwegian Local Governments [J]. Finanzarchiv. 2009, 65(2): 200-219.

Borisova, Ginka; Megginson, William L.. Does Government Ownership Affect the Cost of Debt? Evidence from Privatization [J]. Review of Financial Studies. 2011, 24(8): 2693-2737

Bryan, J. Noeth and Rajdeep, Sengupta. Is Shadow Banking Really Banking? [J]. The Regional Economist. 2011(10): 8-13.

Carfi, David; Musolino, Francesco. Game Theory and Speculation on Government Bonds [J]. Economic Modeling. 2012, 29(6): 2417-2426.

Chen Si. The Study on the Issuance right of local government debt [D]. Beijing: Renmin University of China, 2008.

Chen Yi. Reflections on the Issue of Local Government Bonds Issuance [J]. Journal of Wenzhou University, 2004(1).

China Banking Regulatory Commission, 2012 4th Quarterly Report Template of government financing platforms [S].

Consiglio, Andrea; Stain,o Alessandro. A Stochastic Programming Model for the Optimal Issuance of Government Bonds [J]. Annals of Operations Research. 2012, 193(1): 159-172.

Correa, Ricardo; Lee, Kuan-Hui; Sapriza, Horacio, et al. Sovereign Credit Risk, Banks' Government Support, and Bank Stock Returns Around the World [J]. Journal of Money Credit and Banking. 2014, 46(Sup1): 93-121.

Corsetti, Giancarlo; Kuester, Keith; Meier, Andre; et al. Sovereign Risk, Fiscal Policy, and Macroeconomic Stability [J]. Economic Journal. 2013, 123(566): F99-F132.

Damiano, Brigo, Fabio, Mercurio. Interest Rate Models - Theory and Practice [M]. NY: Springer Finance. 2006: 695-755.

De Bruyckere, Valerie; Gerhardt, Maria; Schepens, Glenn; et al. Bank/Sovereign Risk Spillovers in the European Debt Crisis [J]. Journal of Banking & Finance. 2013, 37(12SP): 4793-4809.

Delatte, Anne-Laure; Gex, Mathieu; Lopez-Villavicencio, Antonia. Has the CDS Market Influenced the Borrowing Cost of European Countries During the Sovereign Crisis? [J]. Journal of International Money and Finance. 2012, 31(3): 481-497.

Delis, Manthos D.; Mylonidis, Nikolaos. The Chicken or the Egg? A Note on the Dynamic Interrelation Between Government Bond Spreads and Credit Default Swaps [J]. Finance Research Letters. 2011, 8(3): 163-170.

Dolores, Guillamon Ma.; Benito, Bernardino; Bastida, Francisco. Evaluation of Local Government Debt in Spain [J]. Revista Espanola de Financiacion Y Contabilidad-Spanish Journal of Finance and Accounting. 2011, 40(150): 251-285.

Eichler, Stefan; Hofmann, Michael. Sovereign Default Risk and Decentralization: Evidence For Emerging Markets [J]. European Journal of Political Economy. 2013(32) 113-134.

Elgin, Ceyhun; Uras, Burak R. Public Debt, Sovereign Default Risk and Shadow Economy [J]. Journal of Financial Stability. 2013, 9(4): 628-640.

Eyssell Thomas; Fung Hung-Gay; Zhang Gaiyan. Determinants and Price Discovery of China Sovereign Credit Default Swaps [J]. China Economic Review. 2013, 24: 1-15.

Fan Gang; Lv Yan. Fiscal Prudence and Growth Sustainability: An Analysis of China's Public Debts [J]. Asian Economic Policy Review. 2012, 7(2): 202-220.

Favero, Carlo A. Modeling and Forecasting Government Bond Spreads in the Euro Area: A Gvar Model [J]. Journal of Econometrics. 2013, 177(2): 343-356.

Favero, Carlo; Pagano, Marco; von Thadden, Ernst-Ludwig. How Does Liquidity Affect Government Bond Yields? [J]. Journal of Financial and Quantitative Analysis.2010, 45(1): 107-134.

Featherstone, Kevin. The Greek Sovereign Debt Crisis and EMU: A Failing State in A Skewed Regime [J]. JCMS-Journal of Common Market Studies. 2011, 49(2): 193-217.

Fender, Ingo; Hayo, Bernd; Neuenkirch, Matthias. Daily Pricing of Emerging Market Sovereign CDS before and during the Global Financial Crisis [J]. Journal of Banking & Finance. 2012, 36(10): 2786-2794.

Fisher, Black; John, C. Cox. Valuing Corporate Securities: Some Effects on Bond Indenture Provisions [J]. Journal of Finance. 1976, 31(2), 351-367.

Flandreau, Marc; Flores, Juan H. The Peaceful Conspiracy: Bond Markets and International Relations during the Pax Britannica [J]. International Organization. 2012, 66(2): 211-241.

FSB. Shadow Banking: Scoping the Issues [R/OL]. (2011a-04-12) [2014-05-19]. http://www.financialstabilityboard.org/publications/r_110412a.pdf

FSB. Shadow Banking: Strengthening Oversight and Regulation [R/OL]. (2011b-10-27) [2014-05-20]. http://www.financialstabilityboard.org/publications/r_111027a.pdf

Fujiki Hiroshi; Uchida Hirofumi. Inflation Target and Debt Management of Local Government Bonds [J]. Japan and the World Economy. 2011, 23(3): 178-189.

Garten, J. E. Rescheduling Sovereign Debt - Is There a Better Approach [J]. World Economy. 1982, 5(3): 279-289.

Geithner, Timothy F. Reducing systemic risk in a dynamic financial system [R/OL]. (2008-06-09) [2014-05-20]. http://www.newyorkfed.org/newsevents/speeches/2008/tfg080609.html.

Gelfand, M. D. Seeking Local-Government Financial Integrity through Debt Ceilings, Tax Limitations, and Expenditure Limits - New-York City Fiscal Crisis, The Taxpayers Revolt, and Beyond [J]. Minnesota Law Review. 1979, 63(4): 545-608.

Gennaioli, Nicola, Shleifer, Andrei, Vishny, Robert W. A Model of Shadow Banking [J]. Journal of Finance. 2013, 68(4): 1331-1363.

Gennaioli, Nicola; Martin, Alberto; Rossi, Stefano. Sovereign Default, Domestic Banks, and Financial Institutions [J]. Journal of Finance. 2014, 69(2): 819-866.

Geys, Benny. Government Weakness and Electoral Cycles in Local Public Debt: Evidence From Flemish Municipalities [J]. Local Government Studies. 2007, 33(2):237-251.

Ghosh, Atish R.; Kim, Jun I.; Mendoza, Enrique G., et al. Fiscal Fatigue, Fiscal Space and Debt Sustainability in Advanced Economies [J]. Economic Journal. 2013, 123(566): F4-F30.

Gilbert, James H. Local Government Debt Administration [J]. American Economic Review. 1940, 30(3): 644-645.

Gomez-Puig, Marta. Systemic and Idiosyncratic Risk in EU-15 Sovereign Yield Spreads After Seven Years of Monetary Union [J]. European Financial Management. 2009, 15(5): 971-1000.

Gorea, Denis; Radev, Deyan. The Euro Area Sovereign Debt Crisis: Can Contagion Spread From the

Periphery to the Core? [J]. International Review of Economics & Finance. 2014, 30: 78-100.

Gorton, Gary; Metrick, Andrew. Regulating the Shadow Banking System [C]. Washington, DC: Brookings Papers On Economic Activity, 19th Conference of the Brookings Panel on Economic Activity. Sep 16-17, 2010: 261-312.

Gross, Bill. Beware Our Shadow Banking System [J]. Fortune. 2007(11)

Guibaud, Stephane; Nosbusch, Yves; Vayanos, Dimitri. Bond Market Clienteles, the Yield Curve, and the Optimal Maturity Structure of Government Debt [J]. Review of Financial Studies. 2013, 26(8): 1913-1961.

Gustav, Seidler. Fifty Years of Government Debt 1962-1912 [J]. Archiv für Sozialwissenschaft und Sozialpolitik. 1914, 38(1): 254-255.

He Dexu; Zheng Liansheng. Shadow Banking System and Financial System Stability [J]. Economic Management Journal. 2009(11).

Hu Chunlan. The Study on the Establishment and Development of Western Local Bond Market [D]. Lanzhou: Lanzhou University, 2006.

Huang Guanshui. Experiences of Local Risk Prevention Mechanism Construction of Local Government Bonds Abroad [J]. Nanfanglunkan. 2010.

ISDA. 2003 ISDA Credit Derivatives Definitions [M]. NY: International Swaps and Derivatives Association, 2003.

ISDA. ISDA Market Survey [R/OL]. (2010) [2014-05-16]. http://www.isda.org/statistics/pdf/ISDA-Market-Survey-historical-data.pdf

ISDA. ISDA Year-End 2012 Market Analysis [R/OL]. (2012) [2014-05-16]. http://www2.isda.org/attachment/NTY4OA==/ISDA-Year-End-2012-Market-Analysis-FINAL.pdf

İsmail, Hakkı Gökgöz; Ömür, Uğur; Yeliz, Yolcu Okur. On the Single Name CDS Price under Structural Modeling [J]. Journal of Computational and Applied Mathematics. 2014, 259: 406-412.

Janus, Thorsten; Jinjarak, Yothin; Uruyos, Manachaya. Sovereign Default Risk, Overconfident Investors and Diverse Beliefs: Theory Aand Evidence From a New Dataset on Outstanding Credit Default Swaps [J]. Journal of Financial Stability. 2013, 9(3): 330-336.

John, Lanchester. High Finance vs. Human Nature [EB/OL] (2009-06) [2014-05-16]. http://www.newyorker.com/arts/critics/books/2009/06/01/090601crbo_books_lanchester?currentPage=all

Jue, Wang; Jiri, Svec; Maurice, Peat. A Structural Approach to Estimate Market-Assessed Sovereign Credit Risk. [s.n.] 2012(08).

Kalemli-Ozcan, Sebnem; Luttini, Emiliano; Sorensen, Bent. Debt Crises and Risk-Sharing: The Role of Markets versus Sovereigns [J]. Scandinavian Journal of Economics. 2014, 116(1): 253-276.

Karmann, Alexander; Maltritz, Dominik. Sovereign Default Risk and Recovery Rates: What Government Bond Markets Expect for Greece [J]. Review of International Economics. 2012,

20(4): 723-739

Leslie Shaffer. Get Ready for More China Shadow-banking Defaults [EB/OL]. CNBC.com. (2014-02-17) [2014-05-29]. http://www.cnbc.com/id/101421154

Lewis, B. D. Local Government Borrowing and Repayment in Indonesia: Does Fiscal Capacity Matter? [J] World Development. 2003, 31(6): 1047-1063.

Li Bo; Wu Ge. The Credit Creation Function of Shadow Banking System and Its Challenge to Monetary Policy [J]. Journal of Financial Research. 2011(12).

Li Jieming; Ju Fan. The Study on the Necessity and Risk Control from Perspective of Public Goods [J]. Journal of Yunnan University (Social Science), 2010(12)

Li Rong. Watch Local Debt Risk through Data [J]. Financial Market Research, 2012(6).

Li Shiyu; Lin Shuanglin. The Size and Structure of China's Government Debt [J]. Social Science Journal. 2011, 48(3): 527-542.

Li Zhan; Cao Ping; Cao Xin. The Current Situation and Risk Evaluation of Local Debt Issuance [J]. Securities Market Herald. 2010(12).

Liu Ying. The Price Linkage Analysis between Sovereign CDS Market and Bond Market --- take PIIGS for Example [D]. Hangzhou: Zhejiang University of Finance, 2012.

Luan Yan. The Research on the European Sovereign Debt Crisis from Global Perspective [D]. Shenyang: Liaoning University, 2012.

Ma Hongman. The Study of Conditions Precedent for China starting to issue local government bonds [J]. Special Zone Economy, 2007(2).

Ma Jun. Hidden Fiscal Risks in Local China [J]. Australian Journal of Public Administration. 2013, 72(3): 278-292.

Maltritz, Dominik. Determinants of Sovereign Yield Spreads in the Eurozone: A Bayesian Approach [J]. Journal of International Money And Finance. 2012, 31(3): 657-672.

Manganelli, Simone; Wolswijk, Guido; Ravn, Morten O. et al. What Drives Spreads in the Euro Area Government Bond Market? [J]. Economic Policy. 2009(58) 191-240.

Mao Zesheng, Wan Yalan. The Study on Threshold Effect of Chinese Shadow Banking and Banking System [J]. Studies of International Finance, 2012(11).

MOF, Pilot Measures for Autonomous Debt Issuance of Local Governments, 2011 / 2013. [2014-05-16].
http://gks.mof.gov.cn/zhengfuxinxi/gongzuodongtai/201110/t20111020_600817.html
http://gks.mof.gov.cn/zhengfuxinxi/gongzuodongtai/201307/t20130704_948951.html

Nagami Junichi; Ogawa Hikaru. Partial Coordination in Local Debt Policies [J]. Applied Economics Letters. 2011, 18(18): 1785-1787.

Oliveira, Luis; Curto, Jose Dias; Nunes, Joao Pedro. The Determinants of Sovereign Credit Spread Changes in the Euro-Zone [J]. Journal of International Financial Markets Institutions & Money. 2012, 22(2): 278-304.

Ong, Lynette H. Fiscal Federalism and Soft Budget Constraints: The Case of China [J]. International

Political Science Review. 2012, 33(4): 455-474.

Ong, Lynette. The Political Economy of Township Government Debt, Township Enterprises and Rural Financial Institutions in China [J]. China Quarterly, 2006(186): 377-400.

Osaka Exchange. A Guide to Credit Risk Trading [EB/OL]. (2014) [2014-05-16]. http://www.ose.or.jp/e/market/7135

Paul McCulley. Teton Reflections [R/OL]. pimco.com, (2007-09). [2014-5-19]. http://media.pimco-global.com/pdfs/pdf_sg/GCB Focus Sept 07 SGP-HK.pdf

Pi Haizhou. The Management of Local Debt Should be Standardized [J]. Money, 2013(9).

Qian Jin. The Study on the Internationalization of financial swap legal system [D]. Shanghai: East China University of Political Science and Law, 2012.

R. C. Merton. On the Pricing of Corporate Debt: the Risk Structure of Interest Rates [J]. Journal of Finance, 1974, 29(2), 449-470.

Ranciere, Romain G.. Credit Derivatives in Emerging Markets [EB/R]. IMF Policy Discussion Paper (2002-04) [2014-04-16]. http://www.crei.cat/people/ranciere/wpapers/imf.pdf

Rauh, Joshua D. Risk Shifting Versus Risk Management: Investment Policy in Corporate Pension Plans [J]. Review of Financial Studies. 2009, 22(7): 2687-2733.

Reinhart, Carmen M.; Rogoff, Kenneth S. From Financial Crash to Debt Crisis [J]. American Economic Review. 2011, 101(5): 1676-1706.

Rixen, Thomas. Why Reregulation after the Crisis Is Feeble: Shadow Banking, Offshore Financial Centers, and Jurisdictional Competition [J]. Regulation & Governance. 2013, 7(4): 435-459.

Ronald Fisher. State and Local Public Finance [M]. Cincinnati: South-Western College Pub, 2006, Ed. 3.

RR Marathe, SM Ryan. On The Validity of the Geometric Brownian Motion Assumption [J]. The Engineering Economist, 2005(50)2: 159-192.

S&P Capital IQ. Global Sovereign Debt Credit Risk Report, 4th quarter 2010 [R/OL]. (2011-01) [2014-05-23]. https://www.capitaliq.com/media/167888-CMA_Global_Sovereign_Credit_Risk_Report_Q4_2010.pdf

S&P Capital IQ. Global Sovereign Debt Credit Risk Report, 4th quarter 2013 [R/OL]. (2014-01) [2014-05-23]. https://www.capitaliq.com/media/177026-sovereignreport_4thQTR_2013.pdf

S&P. Why Shadow Banking Is yet to Destabilize China's Financial System [R/OL]. (2013-03-27) [2014-05-29]. https://www.globalcreditportal.com/ratingsdirect/renderArticle.do?articleId=1104832&SctArtId=147845&from=CM&nsl_code=LIME

Schuknech, Ludger; von Hagen, Juergen; Wolswijk, Guido. Government Risk Premia in the Bond Market: EMU and Canada [J]. European Journal of Political Economy. 2009, 25(3):371-384.

Secrist, H. State Administrative Supervision of Local Government Debt – North-Carolina Model [J]. Duke Law Journal. 1972(2): 487-510

Shah Gilani. The Real Reason for the Global Financial Crisis…the Story No One's Talking About [EB/OL]. Capital Wave Strategist, Money Morning (2008-09-18) [2014-05-16]. http://moneymorning.com/2008/09/18/credit-default-swaps/

Shen Yanjiao. The Study on China's Local Government Bond Issuance System [D]. Chongqing: Chongqing University, 2013.

Shu Kaitong. The Analysis of Catalysis of CDS Transactions for Greek Sovereign Debt Crisis [D]. Changchun: Jilin University, 2013.

Song Jianmin and Niu Mingshi. The Structure of Japan's Financial Resources and Characteristics of Local Autonomy [J]. Fudan Political Science Review, 2013.

State Council General Office. Notice of Issues of Strengthening the Regulatory of Shadow Banking (2013, No. 107) [S].2013, 12.

T. Bielecki, M. Jeanblanck, M. Rutkowski. Credit Risk Modelling [C]. Center for the Study of Finance and Insurance Osaka University, Osaka, Japan, 2009.

Tsui Kai Yuen. China's Infrastructure Investment Boom and Local Debt Crisis [J]. Eurasian Geography and Economics. 2011, 52(5):686-711.

Tucker, P. Shadow Banking, Financing Markets and Financial Stability [C]. Bernie Gerald Cantor (BGC) Partners Seminar, London, 2010.

Uhlig, Harald. Sovereign Default Risk and Banks in a Monetary Union [J]. German Economic Review. 2014, 15(1) 23-41.

von Hagen, Juergen; Schuknecht, Ludger; Wolswijk, Guido. Government Bond Risk Premia in the EU Revisited: The Impact of the Financial Crisis [J]. European Journal of Political Economy. 2011, 27(1): 36-43.

Wang Alan T.; Yang, Sheng-Yung; Yang Nien-Tzu. Information Transmission Between Sovereign Debt CDS and Other Financial Factors - the Case of Latin America [J]. North American Journal of Economics and Finance. 2013, 26(SP): 586-601.

Wang Alan T.; Yao Chengxue. Risks of Latin America Sovereign Debts before and after the Financial Crisis [J]. Applied Economics. 2014, 46(14): 1665-1676.

Wang Chengyi. Methods and Techniques of Public Debt Audit [J]. Audit Research. 1989(4).

Wang Da. On the Development, Operation, Influence and Regulatory of American Shadow Banking System [J]. Studies of International Finance. 2012(1).

Wang Jiansheng. The Study on Credit Risk of Local Bonds [D].Chengdu: Southwest University of Finance, 2013.

Wang Jun. To Solve the Problem of Local Financing Platform, Might Allow Local Governments to Issue Municipal Bonds Directly as well [C]. Beijing: Economic Analysis and Prospects for China and the World. 2010(8).

Wang Qian. The Study on Regulatory of Shadow Banking System in the Post-crisis Era [J]. Commercial Times. 2011(12).

Wang Xiaozhen. The Study on the Effect of Shadow Banking System on the Stability of Banking

System [D]. Jinan: Jinan University, 2013.

Wang Zhiyang. Local Governments to Issue Bonds Autonomously: the Necessity and the System Improvement [J]. Review of Investment Studies, 2013(3).

Weng Shiyou. Trillions of Hidden Liabilities [J]. Caijing Magazine, 2014(8).

Wei Jianing, Ning Jing, Zhu Taihui. The Study on the Estimation Framework and Risk Assessment of Government Debts [J]. Financial Regulation Research, 2012(11), 43-59 .

Weinberg, C. B. The Language and Techniques of Multiyear Restructuring of Sovereign Debt - Lessons from The Mexican Experience [J]. Journal of Policy Modeling. 1985, 7(3): 477-490.

Weistroffer Christian. Credit Default Swaps: Heading towards a More Stable System [R/OL]. Deutsche Bank Research (2009-12-21) [2014-05-16]. http://www.dbresearch.eu/prod/dbr_internet_de-prod/prod0000000000252032.pdf

Wu Yilin. Solvency Analysis of Local Government Bonds in Our Country [D]. Chengdu: Southwestern University of Finance, 2012.

Xu Bo. Analysis of Japan's Local Debt Management System and Discussion of the Establishment of China's Local Debt Management System [J]. Journal of Inner Mongolia Finance and Economics College, 2010(1).

Yan Wenli. The Interactive Effect of Revenue Diversification and Economic Base on Us Local Government Revenue Stability [J]. Public Money & Management. 2011, 31(6):419-426.

Yi Xianrong. The Financial Analysis of Shadow Banking Credit Crisis [J]. Jianghai Academic Journal, 2009a(3).

Yi Xianrong. The Financial Analysis of Excessive Credit Expansion in the U.S. Subprime Mortgage Crisis [J]. Studies of International Finance. 2009b(12).

Yuan Bolan. The Study on Local government Sovereign Debt Risk and Prevention [D]. Chongqing: Chongqing University, 2004.

Zhang Jiajia. The Study on Local Government Bond Issuance [D]. Kaifeng: Henan University, 2013.

Zhang Xu, The Study on the Risk Management of China's Government External Debt [D]. Beijing: Institute of Fiscal Science, 2010.

Zhao Hong and Du Shuang. Experiences and Enlightenment of Local Debt Management abroad [J]. Journal of Henan Institute of Science and Technology, 2011(5).

Zhou Liping. Credit Creation of Shadow Banking System: Mechanisms, Effects and Coping Ideas [J]. Chinese Review of Financial Studies. 2011(04).

Zhou Liping. On the Progress, Shortage and Outlet of International Regulatory of the Shadow Banking System [J]. Studies of International Finance. 2012(1).

Zhou Xueguang. The Road to Collective Debt in Rural China: Bureaucracies, Social Institutions, and Public Goods Provision [J]. Modern China. 2012, 38(3): 271-307.

Zoltan, Pozsar; Tobias, Adrian; Adam, Ashcraft; Hayley Boesky. Shadow Banking [R]. Staff Reports 458, Federal Reserve Bank of New York, July 2010.

Zou Xiaopeng; Pang Yuxiao; Zhu Huilin. The Study between Shadow Banking and Financial

Fragility in China: An Empirical Analysis Based on the Co-integration Test and Error Correction Model [J]. Quality & Quantity. 2013, 47(6): 3363-3370.

Appendix A List of Governments Allowed to Issue Individual Bonds

In section 2.1, it is mentioned that China's local government bonds have started since 2009. From 2011, some provinces and cities are allowed issuing their own bonds, with restriction on the amount, maturity and other details. Here is the list and map of those governments. In the map, deep color is the governments permitted by 2013, and light color is the new entrants:

Table A.1 List of Governments Approved to Issue Individual Bonds[13]

Year	Provinces	Cities	Total
2011	Guangdong, Zhejiang, Shanghai	Shenzhen	4
2012	(None)	(None)	4
2013	Jiangsu, Shandong	(None)	6
2014	Beijing, Jiangxi, Ningxia	Qingdao	10

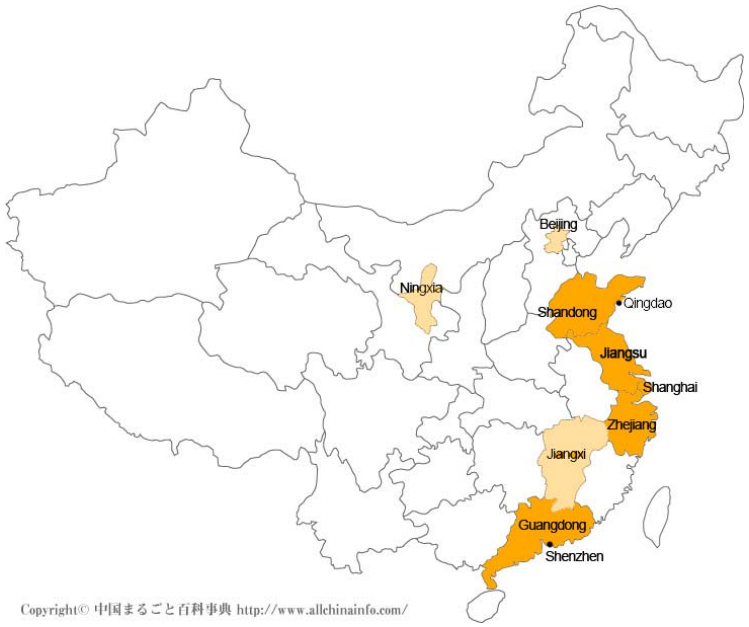

Fig. A.1 Map of Listed Provinces and Cities[14]

[13] Source: MOF website
[14] Source: http://www.allchinainvo.com

Appendix B List of Articles in Network Figure 3.2, Section 3.3.3

In chapter 3, the Chinese literature system of shadow banking was analyzed and a network map was drawn; however, because the space is too narrow, most of the literatures are abbreviated in Fig. 3.2. Here is the full list of those literatures.

Table B.1 List of Literatures in Fig. 3.2

Code	Author	Title	Type	Source	Year
Ba, 09a	Ba Shusong	Strengthen the Supervision on the Shadow Banking System	J	China Finance	2009(7)
Ba, 09b	Ba Shusong	Trend and Outlook of Global Financial Regulation under Financial Crisis	J	Southwest Finance	2009(10)
FSB, 11a	FSB	Shadow Banking:Scoping the Issues	R/OL	FSB website	2011
FSB, 11b	FSB	Shadow Banking: Strengthening Oversight and Regulation	R/OL	FSB website	2011
Gary, 10	Gary Gorton; Andrew Metrick.	Regulating the Shadow Banking System	J	Brookings Papers on Economic Activity	2010, F(2)
Ge, 10	Ge Shuang	Mechanism and Risk Prevention of Shadow Banking in Financial Crisis	J	Journal of Finance and Economics	2010(7)
Geither, 08	Geithner, Timothy F.	Reducing systemic risk in a dynamic financial system	R/OL	FRB website	2008
GFSR	IMF	Global Financial stability Report	R/OL	IMF website	2008
Gong, 11	Gong Minghua; Zhang Xiaopu; Wen Zhu	Risks and Regulatory of Shadow Banking	J	Cnina Finance	2011(2)
Gross, 07	Gross Bill	Beware Our Shadow Banking System	J	Fortune	2007(11)
He, 09	He Dexu; Zheng Liansheng	Shadow Banking System and Financial System Stability	J	Economic Management Journal	2009(11)
He, 13	He Wuxing	Boot Chinese shadow banking play "positive energy"	J	South China Finance	2013(1)

Krugman8	Paul Krugman	Partying Like It's 1929	N	The New York Times	2008.3.21
LiB, 11	Li Bo; Wu Ge	The Credit Creation Function of Shadow Banking System and Its Challenge to Monetary Policy	J	Journal of Financial Research	2011(12)
LiJJ, 11	Li Jianjun; Tian Guangning	Analysis on Top-level Design Issues of Regulatory Reform of Shadow Banking System	J	Macroeconomics	2011(8)
Liu, 10	Liu Wenwen; Gao Ping	Implications of Collapse of the Shadow Banking System for the Development of China's Trust Industry	J	Shanghai Finance	2010(7)
Liu, 12	Liu Lanbiao; Gong Yuexin	A Review of the Shadow Banking Issues	J	Economic Perspectives	2012(2)
LiY, 11	Li Yang	Development of The Shadow Banking System and Financial Innovation	J	China Finance	2011(6)
Luo, 12	Luo Zhenxin; Feng Ke	Shadow Banking and the Monetary Policy Transmission	J	Wuhan Finance	2012(4)
Mao, 12	Mao Zesheng; Wan Yalan	The Study on the threshold effect of Chinese Shadow Banking on Stability of the Banking System	J	Studies of International Finance	2012(11)
MCulley7	Paul McCulley	Teton Reflections	R/OL	PIMCO website	2007
MCulley9	Paul McCulley	The shadow banking system and Hyman Minsky's economic journey	R/OL	PIMCO website	2009
Pozsar, 10	Pozsar Z; Adrian T; Ashcraft A; Boesky H.	Shadow Banking. Federal Reserve Bank of New York Staff Report No. 458	R	FRB website	2010
Tang, 09	Tang Zhenyu; Liu Bo; Lin Shu; Li Xiang	Looking Defects of Credit Creation in Financial Innovation Process from the U.S. Subprime Crisis	J	China Opening Herald	2009(4)
Tucker, 10	Paul Tucker	Shadow Banking, Financing Markets and Financial Stability	C	Bernie Gerald Cantor (BGC) Partners Seminar	2010
Wang, 11	Wang Qian	The Study on Regulatory of Shadow Banking System in the Post-crisis Era	J	Commercial Times	2011(12)
Wang, 12	Wang Da	On the Development, Operation, Influence and Regulatory of American Shadow Banking System	J	Studies of International Finance	2012(1)
Yi, 09a	Yi Xianrong	The Financial Analysis of Shadow Banking Credit Crisis	J	Jianghai Academic Journal	2009(3)
Yi, 09b	Yi Xianrong	The Financial Analysis of Excessive Credit Expansion in the U.S. Subprime Mortgage	J	Studies of International Finance	2009(12)

		Crisis			
Yi, 10	Yi Xianrong; Wang Guogang	Financial Analysis of Mobility Conduction Mechanism of the U.S. Subprime Crisis	J	Journal of Financial Research	2010(5)
Yuan, 11	Yuan Zengting	Nature and Regulation of Domestic and Foreign Shadow Banking System	J	China Finance	2011(1)
ZhangJ, 12	Zhang Jia; Xu Huawei	Risk and Regulatory Measures of Shadow Banking	J	Economic Review	2012(10)
ZhangK, 12	Zhang Kun	Shadow Banking: Opportunities and Challenges for Commercial Banks	J	Journal of Finance and Economics	2012(4)
ZhangT, 12	Zhang Tian	Vulnerability, Regulatory Reform of the Shadow Banking System and the Enlightenment to China	J	South China Finance	2012(1)
Zhong, 11	Zhong Wei; Xie Ting	Risk and Regulatory Reforms of Shadow Banking System	J	China Finance	2011(6)
ZhouLP, 11	Zhou Liping	Credit Creation of the Shadow Banking System: Mechanism, Effects and Coping Ideas	J	Chinese Review of Financial Studies	2011(4)
ZhouLP, 12	Zhou Liping	On the Progress, Shortage and Outlet of International Regulatory of the Shadow Banking System	J	Studies of International Finance	2012(1)
ZhouYC, 12	Zhou Weijiang	Development and Supervision of Shadow Banking	J	The Theory and Practice of Finance and Economics	2012(5)

Appendix C Survival Probability

In Chapter 4, CDS is considered as a kind of option, and therefore the survival probability contains a parameter of Black-Scholes formula. Here is the derivation of (4.6) and (4.20).

In the amended model, the asset value contains a seasonal factor, and liability bound grows stably:

$$\hat{V}_t = Se_t V_0 e^{(\mu-\sigma^2/2)t+\sigma w_t}, L_t = L_0 e^{at}. \tag{C.1}$$

Noticing

$$\log\frac{\hat{V}_t}{Se_t V_0} \sim N\left(\left(\mu-\frac{\sigma^2}{2}\right)t, \sigma^2 t\right), \tag{C.2}$$

we know the survival probability

$$\begin{aligned}
&\mathbb{P}_{sur}(T)\\
&= \mathbb{P}(\hat{V}_T \geq L_T)\\
&= \mathbb{P}(\log\frac{\hat{V}_T}{S_T V_t} \geq \log\frac{L_T}{S_T V_t})\\
&= \mathbb{P}(\frac{\log\frac{\hat{V}_T}{S_T V_t} - \left(\mu-\frac{\sigma^2}{2}\right)(T-t)}{\sigma\sqrt{T-t}} \geq \frac{\log\frac{L_T}{S_T V_t} - \left(\mu-\frac{\sigma^2}{2}\right)(T-t)}{\sigma\sqrt{T-t}})\\
&= 1-\Phi(\frac{\log\frac{L_T}{S_T V_t} - \left(\mu-\frac{\sigma^2}{2}\right)(T-t)}{\sigma\sqrt{T-t}})\\
&= \Phi(\frac{\log\frac{S_T V_t}{L_T} + \left(\mu-\frac{\sigma^2}{2}\right)(T-t)}{\sigma\sqrt{T-t}})\\
&= \Phi(\frac{\log\frac{V_t}{L_t} + \log S_T + \left(\mu-a-\frac{\sigma^2}{2}\right)(T-t)}{\sigma\sqrt{T-t}})\\
&= \Phi(d_2).
\end{aligned} \tag{C.3}$$

The proof for (4.8) of Black-Cox model is attributed to T. Bielecki et al (2009).

Appendix D Simple Method of Deseasonalization

In Chapter 4, seasonal factors were estimated by using dummy variables. However, there is another simple method to estimate them, and therefore deseasonalize rapidly, though there are some restrictions.

Assume that seasonal data satisfy the following conditions:
1) All the data follow the same structure of form. That is, the model and all the parameters remain unchanged.

In this dissertation, the form is

$$\hat{V}_t = S_t V_0 e^{rt+\sigma B_t}, \tag{D.1}$$

where r denotes the drift, and B_t is the standard Brownian motion.

2) The data are consecutive, and the numbers of data for four seasons are the same. That means the data are of consecutive n years (but not needed to start from Q1).

Denote the data as:

$$\begin{array}{cccc}
\hat{V}_1 = S_1 V_0 e^{r+\sigma B_1}, & \hat{V}_2 = S_2 V_0 e^{2r+\sigma B_2}, & \hat{V}_3 = S_3 V_0 e^{3r+\sigma B_3}, & \hat{V}_4 = S_4 V_0 e^{4r+\sigma B_4}, \\
\hat{V}_5 = S_1 V_0 e^{5r+\sigma B_5}, & \hat{V}_6 = S_2 V_0 e^{6r+\sigma B_6}, & \hat{V}_7 = S_3 V_0 e^{7r+\sigma B_7}, & \hat{V}_8 = S_4 V_0 e^{8r+\sigma B_8}, \\
\cdots & \cdots & \cdots & \cdots \\
\hat{V}_{4n-3} = S_1 V_0 e^{(4n-3)r+\sigma B_{4n-3}}, & \hat{V}_{4n-2} = S_2 V_0 e^{(4n-2)r+\sigma B_{4n-2}}, & \hat{V}_{4n-1} = S_3 V_0 e^{(4n-1)r+\sigma B_{4n-1}}, & \hat{V}_{4n} = S_4 V_0 e^{4nr+\sigma B_{4n}}.
\end{array}$$

Then, there are two propositions:

Proposition 1 The annual growth rate can be estimated directly from annual data (the sum of every 4 seasonal data), and it is unbiased.

This is simple and obvious.

Proposition 2 The proportion of (arithmetic or geometric) means of four seasons is an unbiased estimation of the proportion of four seasonal factors, adhered with a growth

rate factor.

Proof.

A) Arithmetic mean:

The arithmetic means of four seasons are:

$$\begin{aligned}
\bar{Q}_1 &= \frac{1}{n} S_1 V_0 e^{r+\sigma B_1}(1 + e^{4r+\sigma(B_5 - B_1)} + \cdots + e^{4(n-1)r+\sigma(B_{4n-3} - B_1)}),\\
\bar{Q}_2 &= \frac{1}{n} S_2 V_0 e^{2r+\sigma B_2}(1 + e^{4r+\sigma(B_6 - B_2)} + \cdots + e^{4(n-1)r+\sigma(B_{4n-2} - B_2)}),\\
\bar{Q}_3 &= \frac{1}{n} S_3 V_0 e^{3r+\sigma B_3}(1 + e^{4r+\sigma(B_7 - B_3)} + \cdots + e^{4(n-1)r+\sigma(B_{4n-1} - B_3)}),\\
\bar{Q}_4 &= \frac{1}{n} S_4 V_0 e^{4r+\sigma B_4}(1 + e^{4r+\sigma(B_8 - B_4)} + \cdots + e^{4(n-1)r+\sigma(B_{4n} - B_4)}).
\end{aligned} \tag{D.2}$$

Notice the distributions of $B_{4k-3} - B_1$, $B_{4k-2} - B_2$, $B_{4k-1} - B_3$, and $B_{4k} - B_4$ (for all nature number k) are the same N(0, $4k$ - 4), their proportion is

$$\bar{Q}_1 : \bar{Q}_2 : \bar{Q}_3 : \bar{Q}_4 = S_1 e^{\sigma B_1} : S_2 e^{r+\sigma B_2} : S_3 e^{2r+\sigma B_3} : S_4 e^{3r+\sigma B_4}. \tag{D.3}$$

Combined with the estimated growth rate, the seasonal factors can be derived.

B) Geometric mean:

The geometric means of four seasons have a similar form as the arithmetic mean. So the seasonal factors can be derived simply, too. □

This method is quite simple, but contains some obvious defects: the condition is quite strict, and there will be no information of data significance. So this is just an auxiliary method.

The result comparison of this simple method and dummy variables is in the following table.

Table D.1 Result Comparison of Deseasonalizing Methods

	Simple	Dummy
V_0	80.82	81.15
μ	0.0975	0.0983
σ	0.0946	0.0751
$S_1 : S_2 : S_3 : S_4$	1 : 0.94 : 0.74 : 0.60 (Ari) 1 : 0.93 : 0.74 : 0.60 (Geo)	1 : 0.92 : 0.73 : 0.60

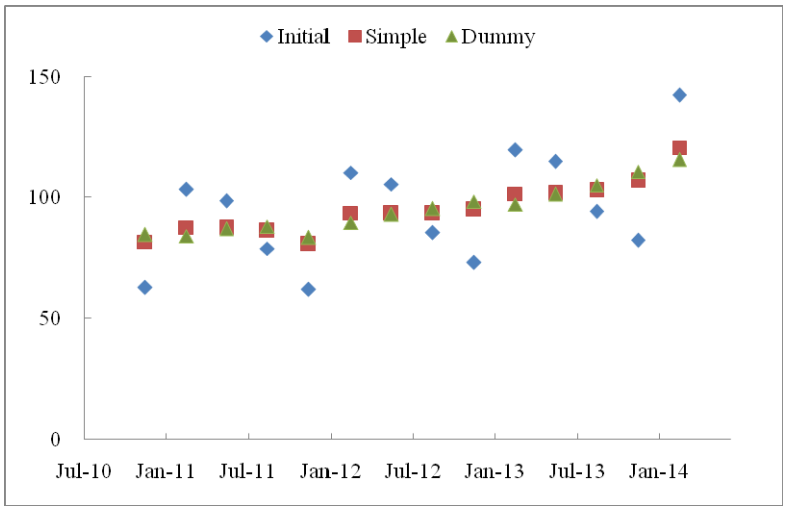

Fig. D.1 Result Comparison of Deseasonalizing Methods

Appendix E Derivation of Intensity

In this appendix, we will derive (5.5), the expression $c = \lambda(1 - R_{ec})$. The proof is attributed to Damiano Brigo (2006).

In standard intensity model, the default time τ is set as the first jump of a Poisson process. That is, having not defaulted before time t, the probability of defaulting in the next dt instants is

$$\mathbb{Q}(\tau \in [t, t+\mathrm{d}t) \mid \tau > t, \mathcal{F}_t) = \lambda(t)\mathrm{d}t, \tag{E.1}$$

where the factor λ is assumed to be strictly positive and is called intensity.

Define the cumulated intensity:

$$\Lambda(t) := \int_0^t \lambda(u)\mathrm{d}u, \tag{E.2}$$

Due to the property of Poisson processes, for the jump time τ (according to its own cumulated intensity),

$$\Lambda(\tau) =: \xi \sim \text{Exponential}(1), \tag{E.3}$$

independent of all the other variables.

However, for an exponentially distributed variable,

$$\mathbb{Q}(\tau > t) = \mathbb{Q}(\Lambda(\tau) > \Lambda(t)) = \mathbb{Q}(\xi > \Lambda(t)) = e^{-\int_0^t \lambda(u)\mathrm{d}u}, \tag{E.4}$$

and in the case of a stochastic intensity,

$$\mathbb{Q}(\tau > t) = \mathbb{E}(e^{-\int_0^t \lambda(u)\mathrm{d}u}). \tag{E.5}$$

It is the survival probability at time t. When computing the price of a zero coupon bond, it will be combined with a discount factor:

$$\mathbb{E}[D(0,T)1_{\{\tau>t\}}] = \mathbb{E}(e^{-\int_0^t r(u)+\lambda(u)\mathrm{d}u}). \tag{E.6}$$

The general intensity model of CDS can denote relatively precise expression of CDS;

however, it is used less frequently in practice because of its complexity. The market use another simplified form of the intensity model, in which the intensity λ is set as constant and, as a result, the model need not interest curve any more.

For simplicity, assume the discount factor is independent of default time τ, and the contract fee is paid continuously.

Denote the price of CDS by c and notional amount of the underlying asset by N, then the present value of the contract fee, paid by the buyer, in the next dt instants after time t is

$$cN \cdot \mathbb{E}[D(0,T)1_{\{\tau>t\}}]\mathrm{d}t. \tag{E.7}$$

So the total present value of the contract fee (until default) is

$$\begin{aligned}
&\text{Premium Leg} = \int_0^T cN\mathbb{E}[D(0,T)1_{\{\tau>t\}}]\mathrm{d}t \\
&= cN\int_0^T \mathbb{E}[D(0,T)]\mathbb{E}[1_{\{\tau>t\}}]\mathrm{d}t \\
&= cN\int_0^T P(0,T)\mathbb{Q}(\tau>t)\mathrm{d}t,
\end{aligned} \tag{E.8}$$

where $P(0, T)$ is the discounted price of a bond with the face value of 1.

On the other hand, when the default happens, the seller must pay protection to the buyer, which is equal to the lost value (total value minus recovered part):

$$\begin{aligned}
&\text{Protection Leg} = N\mathbb{E}[(1-R_{ec})D(0,T)1_{\{\tau\le T\}}] \\
&= (1-R_{ec})N\int_0^T \mathbb{E}[D(0,t)1_{\{\tau\in[t,t+\mathrm{d}t)\}}] \\
&= (1-R_{ec})N\int_0^T \mathbb{E}[D(0,t)]\mathbb{E}[1_{\{\tau\in[t,t+\mathrm{d}t)\}}] \\
&= (1-R_{ec})N\int_0^T P(0,T)\mathbb{Q}(\tau\in[t,t+\mathrm{d}t)) \\
&= -(1-R_{ec})N\int_0^T P(0,T)\mathrm{d}\mathbb{Q}(\tau>t).
\end{aligned} \tag{E.9}$$

But the default is Poisson distributed, and λ is constant here. So

$$\mathbb{Q}(\tau>t) = e^{-\lambda t}, \mathrm{d}\mathbb{Q}(\tau>t) = -\lambda e^{-\lambda t}\mathrm{d}t. \tag{E.10}$$

Thus,

$$\text{Protection Leg} = \lambda(1-R_{ec})N\int_0^T P(0,T)\mathbb{Q}(\tau > t)\mathrm{d}t. \tag{E.11}$$

The non-arbitrage principle orders these two legs be equal, so

$$\begin{aligned} & c = \lambda(1-R_{ec}), \\ & \text{or } \lambda = \frac{c}{1-R_{ec}}. \end{aligned} \tag{E.12}$$