Journal of Applied Finance & Banking, Vol. 10, No. 4, 2020, 157-176
ISSN: 1792-6580 (print version), 1792-6599(online)
Scientific Press International Limited

Analysis of the Pro-cyclical Behavior of Credit Spread in Chinese Bond Market

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Abstract

This paper studies the relationship between credit spread and economic cycle in China. Using secondary market transaction data in the Chinese inter-bank bond market, paper finds that credit spread behaves pro-cyclically with economy growth, which is counter to asset pricing theory and empirical findings from developed bond markets. This relationship illustrates that pricing efficiency in Chinese bond market is very low. Further, paper finds that firm type (SOE[3] or non-SOE) is a very important determinant of credit spread. SOE bond spread and non-SOE bond spread behave differently after bond default occurs in Chinese market. Behind the difference between SOE bond and non-SOE bond is whether firm can get outside government support. Though bond pricing efficiency is low, the efficiency is improving after bond default occurs, indicating that Chinese bond market becomes mature gradually.

Keywords: Credit Spread, Economic Cycle, SOE, Pricing Efficiency

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[3] SOE refers to "State Owned Enterprise". It means firm's controlling shareholder is central or local Chinese government. SOE is a very special and also important enterprise type in China.

Article Info: *Received:* March 1, 2020. *Revised:* March 15, 2020.
Published online: May 1, 2020.

1. Introduction

In the last decade, Chinese bond market has seen enormous growth (see Figure 1) and has attracted attention from all over the world. The Chinese bond market has already been the second largest one in the world. At the end of 2019, the market size is over 97 trillion (RMB) and the percentage of bond outstanding to GDP in 2019 will be over 100% with certainty. As China opens its financial market gradually, international capital invests and trades more and more in Chinese market. At the same time, academic researchers also pay close attention to Chinese bond market. Since it's a young market, many important issues need to be deeply discussed and studied.

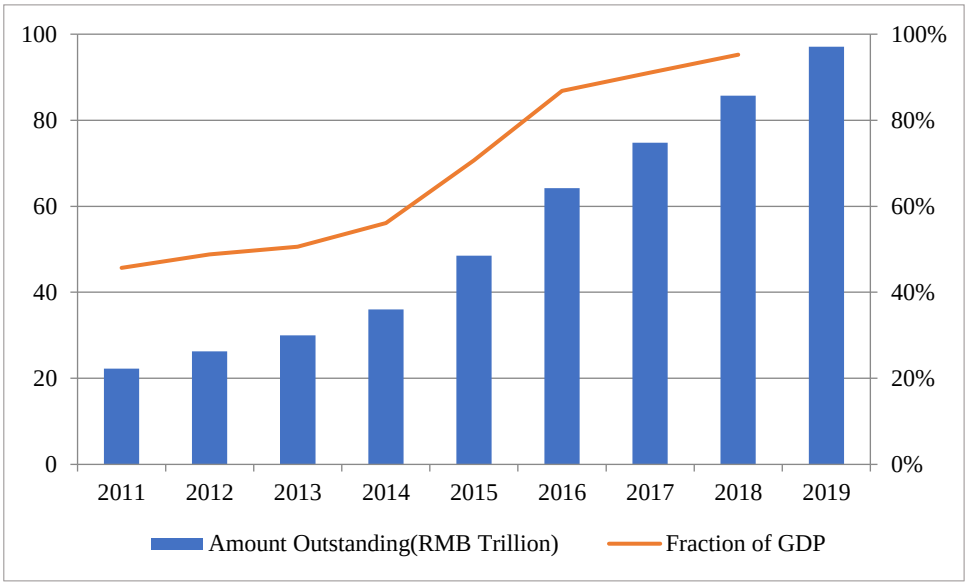

Figure 1: Chinese bond market size and its fraction of GDP

Credit spread is one of the hotly discussed issues in Chinese corporate bond market and many insightful results have been achieved. Among the studies about credit spread in Chinese corporate bond market, Zhe Geng and Jun Pan (2019) study the information content of credit spread by constructing credit measures of publicly listed firms using Merton's model of default. They find there's huge credit spread difference between SOE and non-SOE firms. Also, information efficiency of credit spread for non-SOE firms has been improved since the first bond default in 2014, but there is no information improvement for the SOE credit spread.

Following Zhe Geng and Jun Pan (2019), I study further about the information efficiency of credit spread in China. To be specific, I study the relationship between the credit spread and economic cycle in Chinese bond market, how the credit spread reacts to economy growth changes. This specific topic has not been deeply studied in Chinese corporate bond market up to now.

To see a rough picture, using industrial production (hereafter short for IP) growth

rate as the indicator for economic cycle, Figure 2 shows that there is evident positive correlation between yield curve spread[4] and IP growth rate. The correlation is roughly about 0.5.

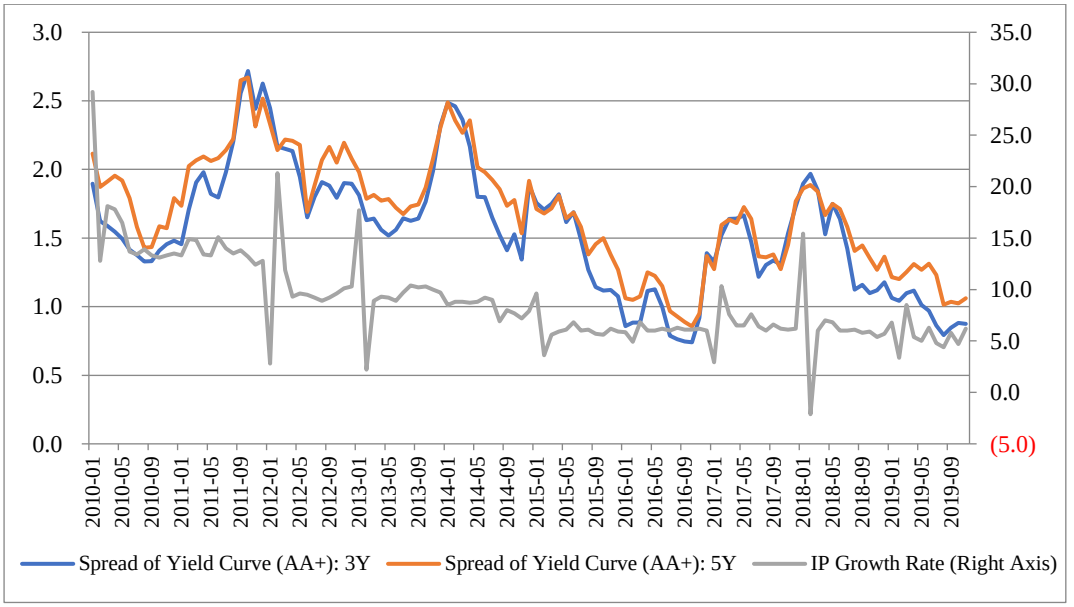

Figure 2: Time series of yield curve spread and Industrial Production (IP) growth rate

Using corporate bond transaction data in the inter-bank bond market (including bonds of both publicly listed and non-listed firms) and industrial production growth rate as the proxy and indicator for economy growth, I find that as a whole, there is pro-cyclical relationship between credit spread and economic cycle in China. Credit spread contracts when economy slows down and widens when economy is in the boom zone. This relationship contradicts to credit bond pricing theory and empirical findings in US and other highly developed markets, reflecting low information efficiency of Chinese corporate bond market. However, this finding is consistent with the viewpoint in Zhihong Ji and Yuanyuan Cao (2017), both researchers are from the People's Bank of China, China's central bank.

More in detail and consistent with the conclusions of Zhe Geng and Jun Pan (2019), firm type (SOE or non-SOE) significantly affects credit spread, with credit spread of non-SOE higher than that of SOE, reflecting a kind of market segmentation in the corporate bond market. On average from summary statistics, non-SOE bond spread is 80 bps higher than spread of SOE bond. The credit spread gap between

[4] Yield curve spread is calculated as the difference between the YTM of corporate bond yield curve and YTM of treasury bond with the same maturity. All the yield curves are from ChinaBond Pricing Center, which is the official organization to publish bonds and yield curve valuation. Bond valuation and yield curve valuation published by ChinaBond Pricing Center are used by most financial institutions to mark their portfolio to market.

SOE and non-SOE can be interpreted as the value of outside government support. Prior to the first default in 2014, credit spreads of both SOE and non-SOE behave pro-cyclically, indicating credit spread of the young market at that time delivers extremely low information. After default occurred, SOE and non-SOE spreads behave differently. Non-SOE spread became counter-cyclical with economic growth and spread winds when economy slows down. However, the relationship between SOE spread and economic growth remains unchanged, i.e. SOE spread narrows when economy slows down. It means information efficiency of non-SOE spread has improved since first bond default in 2014, but there is almost no efficiency improvement for the SOE spread. The economic interpretation is consistent with Zhe Geng and Jun Pan (2019), after default occurred, for non-SOE without outside government support, investors pay more attention to default risk and need high credit spread compensation for credit risk when economy slows down, causing non-SOE spread widen. By contrast, investors seek safety in SOE bonds because of government support and pay little attention to SOE's default risk, resulting in no information efficiency improvement for SOE bonds.

Overall, the empirical findings in the paper enrich the existing literature about the young and important Chinese corporate bond market. Also, this paper complements studies about the information efficiency of credit spread in Chinese market. More specific, this paper is the first one trying to analyze in detail the pro-cyclical relationship between credit spread and economic growth in China. This paper is closely related to Zhe Geng and Jun Pan (2019), both research focus on the information content and efficiency of credit spread in Chinese bond market, but with different aspects. Also, this paper considers all corporate bonds in the inter-bank market, while Zhe Geng and Jun Pan (2019) just uses publicly listed firms excluding Chengtou bonds[5].Moreover, data used in this paper is the secondary market transaction data, which contains much more information.

The rest of the paper is organized as follows. Section 2 briefly discusses literature related to credit bond pricing. Section 3 describes data and methodology used. Section 4 gives the main empirical results, and Section 5 concludes the paper.

2. Literature Review

2.1 Credit Bond Pricing and Empirical Determinants of Credit Spread

Credit bond model starts from Merton (1974). Merton (1974) treats credit bond as long a similar risk free bond and short a put option to equity holders with the strike price of the bond face value. The Merton model and the following improved models (Black and Cox (1976), Leland (1994), Longstaff and Schwarts (1995), Zhiguo He and Wei Xiong (2012), Hui Chen et al (2018)) are referred to as structural models since the models assume firm defaults endogenously and default is triggered when

[5] Chengtou bond: also called LGFV (Local Government Financing Vehicle) bond, a special bond category in Chinese bond market. Set up by local government, Chengtou bond is issued and used for urban construction and investment.

the firm value falls below some critical point. Reduced form model is another category of credit bond pricing model. It assumes default probability follows certain probability distribution and bond price is obtained through non-arbitrage pricing theory (Jarrow and Turnbull (1995), Duffie and Singleton (1999)).

As for the empirical studies about the determinants of credit spread, the literature is abundant. Collin-Dufresne et al (2001) and Elton et al（2001）are among the first and foundational empirical studies. Based on structural model, Collin-Dufresne et al (2001) empirically test numerous proxies for default probability and recovery rate and finds these proxies can only explain about 25 percent of credit spread changes. Even other proxies for liquidity cannot increase too much explanatory power and the paper concludes that dominant part of monthly credit spread change is driven by local supply and demand shocks. Elton et al（2001）argues that credit spread mainly comes from expected default loss, state and local taxes and a risk premium on corporate bond. Other branches of the empirical literature involve topics about the impact of trading liquidity on credit spread, the relative importance of credit risk and liquidity risk on credit spread (Covitzand Downing(2007), HaiLin et al (2011), Friewald et al (2012), Helwege et al (2014), Schwert (2017)) and so on. The control variables in the empirical setting of this paper will refer to these studies.

2.2 Relationship between Credit Spread and Economic Cycle

The relationship has two fold. First, how economic and business cycle affects credit spread. This part is rather obvious in theory and empirical findings for mature bond markets. In theoretical model, economic cycle affects firms operating situation and profitability and thus affects firm default probability and recovery rate. When economy booms, firms operate well, related debt default probability is low and recovery rate is high in case of default. So credit risk is lower and credit spread should be lower when economic situation is good and vice versa. Since the causality relationship is so straight forward, not too much research specially focuses on this relationship. Tsung-Kang Chen et al (2011), Cavallo and Valenzuela (2010), Cenesizoglu and Essid (2012) are among the studies that consider economic situation as explainatory variable to discuss credit spread.

The second part about the relationship is whether credit spread has predictive power for future economic growth. Simon Gilchrist and Egon Zakrajsek (2012) is the most cited research about this topic. Using the newly constructed “GZ credit spread”, the paper proves the excellence predictive ability of the spread. Shocks to the excess bond premium can significantly reduce consumption, investment and output. The paper further discusses the mechanism behind the observed causality relationship. An increase in the GZ credit spread reflects reduction of financial sector’s risk-

bearing capacity, which causes contraction in credit supply. Contraction in credit supply does harm to future macro economy. Jing-Zhi Huang et al (2019) use security-level data from six developed countries (Japan, the UK, Germany, France, Italy and Canada) to test the above relationship and finds similar results with Simon Gilchrist and Egon Zakrajsek (2012).

From all above studies about this relationship, several indictors are mostly used to proxy macro economy situation. Industrial production growth rate and real GDP growth rate are two mostly used indicators. Components of GDP (consumption, investment et al), inflation and employment are also used. This paper uses industrial production growth rate as the main variable indicating economy growth.

2.3 Empirical Findings about Chinese Corporate Bond Market

With the development of Chinese bond market, increasing attention has been paid to this young but important market in recent years. With the fundamental political and economic systems different from most developed countries, this market has many interesting and important issues to be discussed. Especially, as Chinese capital market opens more and more to foreign capital and integrates into international financial markets, Chinese bond market needs to be studied and known by related participants.

Zhihong Ji and Yuanyuan Cao (2017) point out that participants in Chinese bond market have strong belief with non-default of credit bond and are more prone to use leverage to increase investment return, therefore, the credit spread in Chinese market is more related to macro market liquidity premium and not credit risk premium. Chen Zhuo et al (2018) focus on the impact of asset pledgeability on asset prices using Chinese bond market data. By utilizing a policy shock on Chinese corporate bond market, they estimate that an increase in haircut from 0 to 100% will result in corporate bond yield increase about 40 to 83 bps. Jingyuan Mo and Subrahmanyam (2019) study the impact of policy interventions on Chinese corporate bond liquidity. They find that liquidity effect responds strongly to the liberalization process of Chinese bond market. Also, liquidity effect becomes more pronounced as foreign capital flows into interbank market and during more stressful market conditions. Zhe Geng and Jun Pan (2019) study the information content and information efficiency of credit spread in Chinese corporate bond market, as discussed above.

For the special Chengtou bond, there are several useful findings. Xiaolei Liu et al (2017) assess the impact of implicit government guarantee on the pricing of Chengtou bond. Further, Jennie Bai and Hao Zhou (2019) study the capability and

uncertainty[6] of local government to offer the guarantee. Zhuo Chen et al (2019) connects the 4-trillion stimulus package in 2009 with the fast growing of shadow banking since 012. Chengtou bond acts as the special bridge, and it connects the refinancing demand of the local government financial vehicle with the huge demand of asset of the fast growing shadow banking system in China.

3. Data and Methodology

3.1 Data

I use transaction by transaction corporate bond trade data in the interbank bond market to calculate credit spread. Other data relates to rating, bond characteristics, the issuer, stock market et al are all from Wind database[7].

Sample period ranges from January 2010 to November 2018, transaction by transaction trade data. The sample selection procedures are as follows:

1. Exclude bonds from financial sector.
2. Exclude CP and SCP, only include MTN, PPN and enterprise bon[8].
3. Only contain fixed rate bonds.
4. Exclude bonds with guarantee or other methods to reduce credit risk.
5. Exclude bonds with special provisions, such as callable bonds and putable bonds.
6. exclude transaction data which occurs within 30 days of the issue date or within 30 days of the maturity date.
7. Exclude transaction data with negative credit spread or spread greater than 15%. Finally, I get 693,676 transaction data.

Credit spread is measured as the difference between the yield to maturity of bonds and the treasury bond yield of the same maturity. Using trade volume as weight and transaction data every month, monthly credit spread is calculated. And 104,047 bond/month credit spread is obtained at last. To assure that all the data cleaning and calculation process are on problem, I calculate whole monthly spread and compare

[6] In the paper, the uncertainty refers to political risk, which is proxied by the recent anti-corruption campaign in China.

[7] Wind is widely used by domestic investors in China. It is very like Bloomberg for investors in other major financial markets.

[8] CP, SCP, MTN, PPN, enterprise bond are all different categories of credit bond. The issuance of enterprise bond is approved and supervised by National Development and Reform Commission (NDRC), a government agency that oversees the SOE reforms in China. Enterprise bond can be issued and traded both in the interbank market and in the exchange market. The issuance of CP, SCP, MTN and PPN are all approved and regulated by National Association of Financial Market Institutional Investors (NAFMII), which is supervised by the People's Bank of China, these four categories of credit bond are all issued and traded in the interbank market. CP refers to "Commercial Paper", and it is the credit bond with maturity no longer than 1 year. SCP refers to "Short-term Commercial Paper", and it is with maturity no longer than 270 days. MTN refers to "Medium Term Note", and it is publicly issued and with maturity longer than 1year. PPN refers to "Private Placement Note", and it is privately issued with maturity longer than 1 year. The most common maturity for MTN and PPN is 3 years and 5years.

it with spread of yield curves. Figure 3 shows that time series tread of the calculated spread is very similar to the tread of yield curve spread.

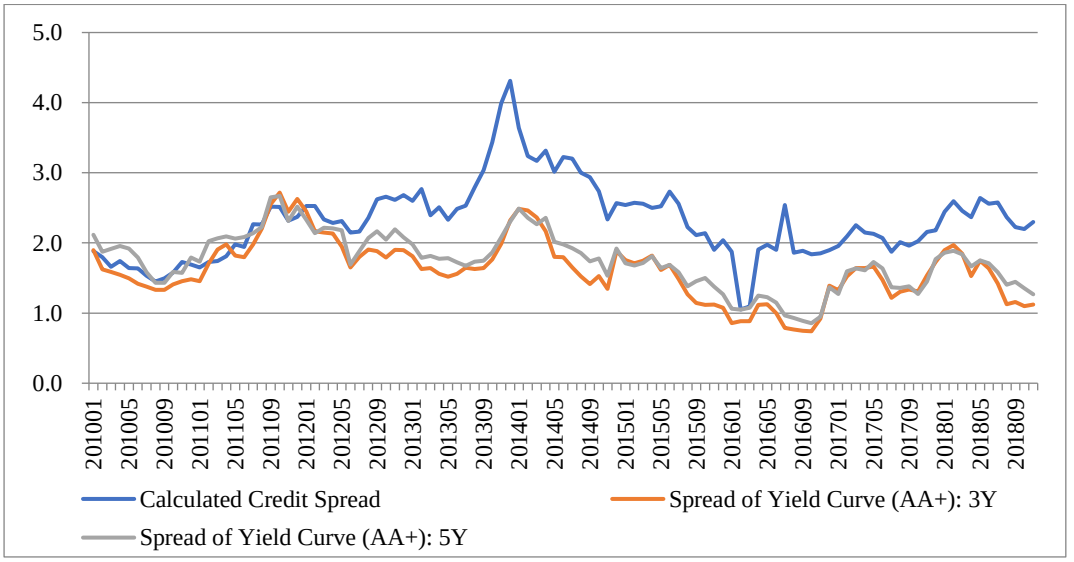

Figure 3: Time series of monthly credit spread and yield curve spread

3.2 Variables

Industrial production growth rate is used in this paper as the indicator for economy condition. IP is released monthly by National Bureau of Statistics.

For control variables, this paper considers bond rating, bond size, maturity, level and slope of risk free rate, stock return and volatility, macro liquidity, dummy variable for whether the issuer is SOE or not. See Table 1 for detailed description of variables.

Table 1: Description of variables

Variables	Description
CS	Credit spread, difference between the YTM of credit bond and the treasury bond yield of the same maturity
IP	Industrial production growth rate, released by National Bureau of Statistics monthly
non-SOE	Dummy variable, 1 for non-SOE firms, 0 for SOE firms
Rating	AAA=1, AA+=2, AA=3…
Lnsize	Natural logarithm of bond size
Maturity	Time to maturity of bonds
10y Rf	10-year treasury yield, proxy for level of risk free rate
10y Rf Square	Square of 10-year treasury yield, used to take the curvature of the yield curve into consideration
Term	Yield difference between 10-year treasury yield and 1-year treasury yield, proxy for the slope of yield curve
R007	7-day interbank market pledged repo rate, proxy for macro liquidity in the interbank market
Stock Return	Monthly return of Shanghai composite index
Stock Volatility	Standard deviation of daily return of Shanghai composite index within one month

3.3 Empirical Models

To test how economy situation affects credit spread, I first run the following panel regression:

$$CS_{i,t} = \beta_0 + \beta_1 IP_t + \beta_2 Controls + \varepsilon_{i,t} \quad (1)$$

To verify the argument that firm type (SOE or non-SOE) affects credit spread and may affect the relationship between economic cycle and credit spread, non-SOE and its interaction with IP are added into the regression:

$$CS_{i,t}=\alpha_0 +\alpha_1 IP_t +\alpha_2 \text{non-SOE}_i+\alpha_3 IP_t *\text{non-SOE}_i+\alpha_4 Controls +\epsilon_{i,t} \quad (2)$$

In both regressions, industry fixed effect and year fixed effect are controlled. Besides the regression analysis for the whole sample period, this paper also consider two sub periods. The first sub period is from 2010 to 2013, and the second is from 2014 to 2019. In Chinese bond market, first default occurred in March 2014. Before 2014, bond investors had strong belief that principal and interest would be paid back with 100 percent certain and did not care too much about credit risk. Only after the first default, investors started to pay attention to bond credit risk. Therefore, it is meaningful to analyze the relationship between credit spread and economic cycle in the separate sub periods.

4. Empirical Results

4.1 Descriptive Statistics

Figure 4 and Figure 5 plot time series of monthly spread classified by bond rating and by firm type (SOE or non-SOE). It can be easily seen that bond rating and firm type are very important determinants of credit spread. On average, spread of AAA bond is 70 bps lower than spread of AA+ bond and spread of AA+ bond is 55 bps lower than spread of AA bond. And credit spread of non-SOE bond is consistently higher than spread of SOE bond.

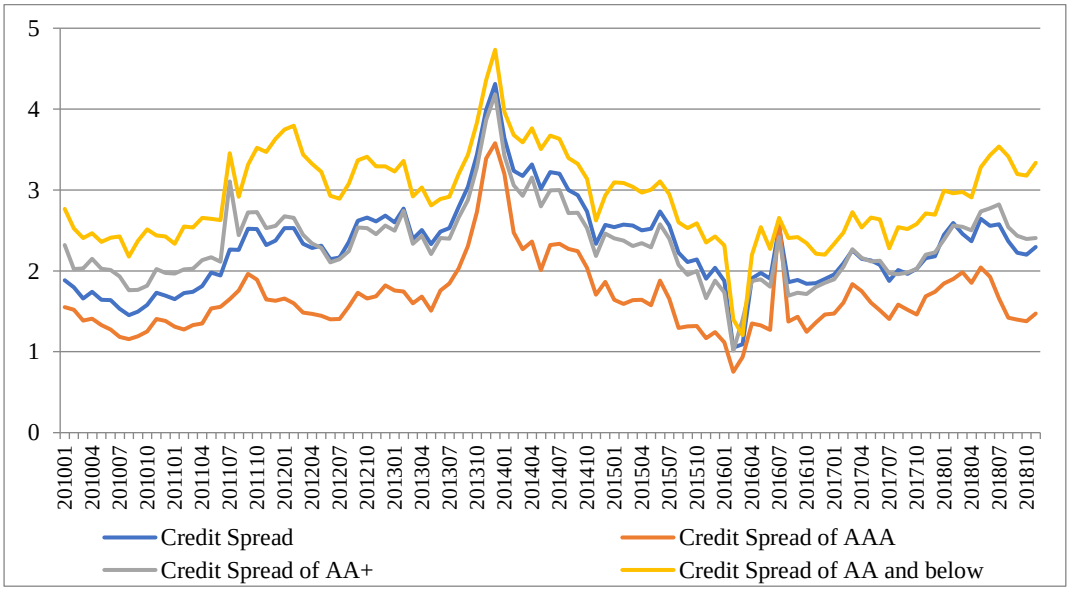

Figure 4: Time series of monthly credit spread and spread classified by rating

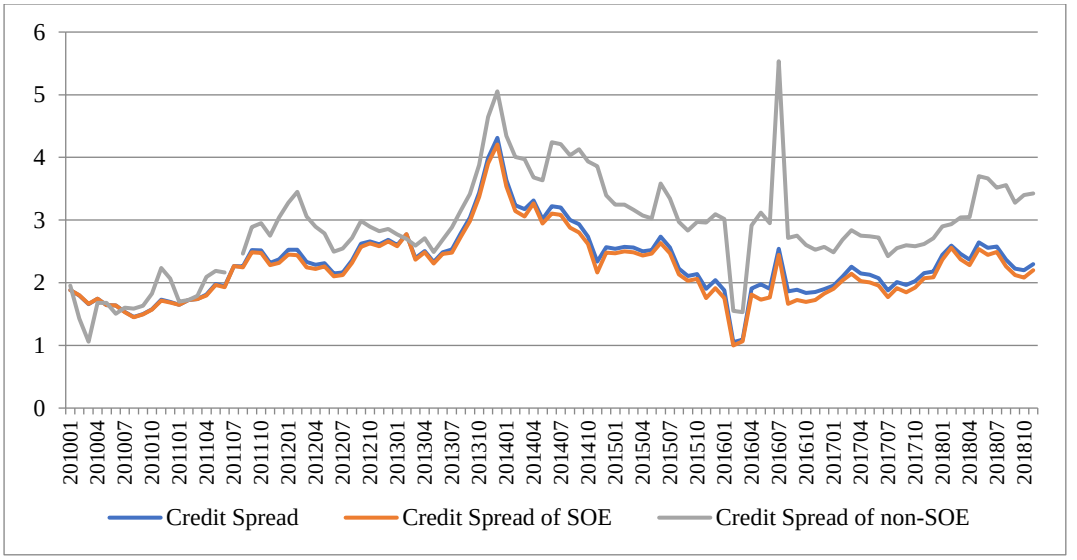

Figure 5: Time series of monthly credit spread and spread classified by firm type

Table 2 presents variable summary statistics. Average credit spread is 2.42% and average IP growth rate is 7.88%. And spread difference between SOE and non-SOE is 80 bps. It means that non-SOE bears higher borrowing cost and SOE enjoys a firm-type premium. It is unfair to non-SOE.[9] Average rating is 2.15 and it means that average bond rating is close to AA+ in China corporate bond market[10]. Corporate bond maturity in China is far shorter than that in US bond market, and the average bond maturity in Chinese corporate bond market is 3.24 years[11]. Average 10-year treasury bond rate is 3.56%, which is far higher than treasury rate in developed countries. Though the long trend of treasury bond rate is going down in China, the 10-year treasury bond rate is still around 3.15% by the end of year 2019. Average R007 is 3.24%, and this can be considered as average collateralized funding cost. We can also see from Table 2 that from secondary market perspective, SOE accounts for approximate 90% of the whole credit bond market.

[9] It is commonly cited that non-SOE contributes to 60% of China's GDP and provides 90% of total new jobs.

[10] The rating system in China is not comparable to the US and international rating system. Most bond in China in rated as AAA, AA+ and AA. Rating below AA is considered as with extremely high credit risk. There is much discussion about rating system in Chinese bong market in recent years.

[11] The most common bond maturity in primary market is 3 years and 5 years.

Table 2: Summary Statistics

Variables	Obs	Mean	Std. Dev.	P10	Median	P90
CS (%)	104,047	2.42	1.11	1.21	2.23	3.90
SOE	92,941	2.34	1.05	1.18	2.16	3.75
non-SOE	11,106	3.14	1.31	1.66	2.93	4.84
IP (%)		7.88	3.24	5.6	6.8	10.4
Rating		2.15	0.88	1	2	3
Size (Billion)		1.74	2.50	0.50	1	3
Maturity (y)		3.24	2.06	0.77	2.83	6.22
10Y Rf (%)		3.56	0.43	2.94	3.53	4.18
10Y Rf Square (%^2)		12.89	3.12	8.63	12.51	17.5
Term (%)		0.65	0.33	0.32	0.58	1.07
R007 (%)		3.24	0.81	2.45	3.15	4.33
Stock Return (%)		0.27	6.64	-5.64	0.06	6.85
Stock Volatility (%)		1.29	0.77	0.59	1.07	2.26
The sample period is from January 2010 to November 2018. See Table 1 for variable definitions.						

4.2 Main Results

Table 3 and Table 4 present main empirical findings. From Table 3, it can be easily seen that IP significantly affects credit spread with positive sign in all six regressions, including the whole sample period and two sub-periods. It means there is pro-cyclical relationship between credit spread and economic cycle. When industrial production growth rate slows down, credit spread narrows. This result contradicts to economic logic, since when economic slows down, firms operate in somewhat bad condition, and credit spread should widen to reflect higher default probability and loss given default. However, this finding is consistent with the viewpoint in Zhihong Ji and Yuanyuan Cao (2017), they point out that corporate bond pricing in Chinese market exists significant difference with bond pricing in market of developed countries and credit spread does not adjust significantly to economic cycle changes.

Table 3: Regressions of Credit Spread on IP and Control Variables

	Whole Sample		**Sub-Sample: 2010-2013**		**Sub-Sample: 2014-2018**	
IP	0.012*** [4.67]	0.003* [2.05]	0.005** [3.07]	0.012*** [12.46]	0.021*** [6.77]	0.005*** [3.40]
Rating	0.638*** [22.77]	0.632*** [22.41]	0.638*** [16.95]	0.632*** [18.37]	0.651*** [11.69]	0.647*** [11.74]
LnSize	-0.015 [-0.48]	-0.016 [-0.49]	0.008 [0.40]	0.014 [0.78]	-0.024 [-0.55]	-0.026 [-0.59]
Maturity	0.006 [0.30]	0.015 [0.81]	0.062** [2.05]	0.076** [2.47]	-0.022 [-1.26]	-0.017 [-1.00]
10Y Rf		-2.87*** [-4.49]		-11.57*** [-12.75]		-0.527*** [-3.22]
10Y Rf Square		0.505*** [6.07]		1.656*** [13.42]		0.141*** [9.30]
Term		0.017 [0.52]		-0.221*** [-5.09]		0.218*** [21.54]
R007		0.064*** [11.79]		-0.026** [-2.83]		0.137*** [15.42]
Stock Return		0.003*** [14.55]		0.006*** [5.54]		-0.001* [-1.95]
Stock Volatility		0.014* [1.95]		0.250*** [17.81]		-0.030** [-2.59]
N	104,047	104,047	29,141	29,141	74,906	74,906
R^2	37.53%	42.64%	44.26%	61.43%	36.43%	38.55%

This table reports results of regression $CS_{i,t} = \beta 0 + \beta 1\ IP_t + \beta 2\ Controls + \varepsilon_{i,t}$, and all variables definition are presented in Table 1. The whole sample period is from January 2010 to November 2018, and credit spread is monthly spread. Industry fixed effect and year fixed effect are controlled. T-statistics are reported in brackets. *, ** and *** stand for significance at 10%, 5% and 1% level respectively.

Empirical results of control variables in Table 3 also need discussed. Although rating industry in China is widely criticized for many aspects, bond rating is still a very important determinant for credit spread. From Table 3, it can be seen that the regression coefficients of rating are rather stable. On average, one rating difference means about 63 bps-65 bps spread difference[12]. Also different from findings from

[12] One rating difference means the difference between adjacent bond ratings, like AAA vs AA+ and AA+ vs AA. The empirical results are consistent with descriptive statistics above. In descriptive statistics, spread difference between AAA bond and AA+ bond is 70 bps, and spread difference between AA+ bond and AA bond is 55 bps.

US bond market is that bond size and maturity do not significantly affect credit spread. Consistent with asset pricing theory and empirical findings, risk free rate level negatively affect credit spread. As for other control variables, regression results differ between the two sub-periods. Term and R007 negatively affect spread in the 2010-2013 sub-period and positively affect spread in the 2014-2018 sub-period. For these two variables, regression results in the second period are consistent with pricing theory. An increase in the slope of risk free rate curve increases expected future spot rate, and thus should decrease credit spread predicted by asset pricing theory. As for R007, it can be treated as the repo transaction cost for leverage strategy in bond market, higher R007 means narrower return for leverage strategy and thus lower demand for credit bonds and further credit spread will widen. This trading logic means there should be positive relationship between credit spread and R007. Regression results also differ between the two sub-periods for stock return and stock volatility. For stock return, result in the 2014-2018 sub-period is consistent with theory and empirical finding. Result for stock volatility in the 2010-2013 sub-period is the predicted result. From the above analysis for the control variables, it can be concluded that pricing efficiency of Chinese corporate bond market is lower than the efficiency in developed countries, but it can also be seen that the pricing efficiency is increasing in Chinese bond market from the empirical analysis of the two sub-periods.

In Table 4, all the control variables give the same empirical results as in Table 3. Next this paper focuses on the influence of IP and non-SOE dummy on credit spread. First, it can be seen from Table 4 that non-SOE dummy significantly affects credit spread. On average and for the whole sample, credit spread of non-SOE bond is 114.6 bps higher than spread of SOE bond and spread difference between non-SOE bond and SOE bond is 83.1 bps for the 2014-2018 sub-period[13]. This result is consistent with findings in Zhe Geng and Jun Pan (2019), they also find huge credit spread difference between SOE and non-SOE bond.

Next, same with Table 3, IP shows pro-cyclical relationship with credit spread. When taking the influence of firm type (non-SOE or SOE) into consideration, some important information can be reached about the relationship between IP and credit spread. Regression results of interaction term IP*non-SOE are all significantly negative. It means IP affects non-SOE and SOE bond spread differently, with more negative effect on non-SOE bond spread than SOE bond spread.

[13] The regression result is consistent with the summary statistics, the spread difference between these two bond categories is 80 bps in the summary statistics.

Table 4: Regressions of Credit Spread on IP, SOE and Control Variables

	Whole Sample	**Sub-Sample: 2010-2013**	**Sub-Sample: 2014-2018**
IP	0.010*** [6.36]	0.013*** [12.64]	0.008*** [6.01]
non-SOE	1.146*** [6.09]	0.178* [2.16]	0.831*** [5.28]
IP*non-SOE	-0.082*** [-6.35]	-0.011** [-2.24]	-0.029*** [-8.47]
Rating	0.60*** [22.93]	0.626*** [14.48]	0.607*** [11.08]
LnSize	-0.017 [-0.50]	0.014 [0.72]	-0.026 [-0.58]
Maturity	0.029 [1.33]	0.077** [2.58]	0.003 [0.13]
10Y Rf	-2.853*** [-4.37]	-11.586*** [-12.76]	-0.509** [-2.88]
10Y Rf Square	0.503*** [5.94]	1.658*** [13.44]	0.139*** [8.23]
Term	0.013 [0.37]	-0.222*** [-5.24]	0.212*** [19.61]
R007	0.063*** [11.49]	-0.026** [-2.72]	0.136*** [15.92]
Stock Return	0.003*** [13.13]	0.006*** [5.62]	-0.001* [-2.07]
Stock Volatility	0.016* [1.99]	0.250*** [17.85]	-0.030** [-2.52]
N	104,047	29,141	74,906
R^2	44.84%	61.46%	41.33%

This table reports results of regression $CS_{i,t}=\alpha 0+\alpha 1\ IP_t+\alpha 2\ non\text{-}SOE_i+\alpha 3\ IP_t*non\text{-}SOE_i+\alpha 4\ Controls+\epsilon_{i,t}$, and all variables definition are presented in Table 1. The whole sample period is from January 2010 to November 2018, and credit spread is monthly spread. Industry fixed effect and year fixed effect are controlled. T-statistics are reported in brackets. *, ** and *** stand for significance at 10%, 5% and 1% level respectively.

Table 5 gives the effect of IP on credit spread when treating non-SOE and SOE separately. For the whole sample period of 2010-2018, IP positively affects SOE bond spread and negatively affects non-SOE bond spread. For the first sub-period of 2010-2013[14], the relationship between IP and SOE or non-SOE bond spread are all positive. And in the second sub-period of 2014-2018, IP positively affects SOE bond spread and negatively affects non-SOE bond spread.

Table 5: Effect of IP on Credit Spread for SOE and non-SOE bond

	Whole Sample	**Sub-Sample: 2010-2013**	**Sub-Sample: 2014-2018**
SOE	0.010	0.013	0.008
non-SOE	-0.072	0.002	-0.021
This table gives different effects of IP on SOE and non-SOE bond spread for the whole sample period and two sub-periods. The effect results are based on regression results from Table 4.			

The pro-cyclical relationship between credit spread and industrial production growth rate means that the information efficiency of credit spread in China is rather low. For non-SOE bond, credit spread becomes more informative after 2014, at which time first bond default occurred in China. While, there is no improvement in the information content of SOE bond spread in the whole period to 2018. These findings correspond with findings in Zhe Geng and Jun Pan (2019), which focuses on the price discovery and market segmentation in China's credit market. Further to explain the reasons of the different findings between the non-SOE bond spread and SOE bond spread, government support behind SOE is the central issue. SOE enjoys outside government support while non-SOE does not. Before the first bond default occurred in Chinese market, bond investors had strong belief with non-default of credit bond, paid little attention to credit risk and do not adjust bond pricing correctly to economy changes. Therefore credit spread of both SOE bonds and non-SOE bonds positively responds to economy changes, possibly due to loose of monetary policy in economic downturn. After bond default finally occurred in Chinese market on March 2014, reactions of SOE bond and non-SOE bond spread to economy changes started to diverge. Since there is no outside government support for non-SOE, non-SOE bond investors pay more attention to default risk and need high credit spread compensation for credit risk when economy slows down, causing non-SOE bond spread widen. In this way, information efficiency of non-SOE bond spread starts to improve. On the contrary, government support for SOE makes SOE bonds much more safe, investors seek safety in SOE bonds and still pay little

[14] In this sub-period, there is no bond default in Chinese bond market. The first bond default occurred on March 2014 in China.

attention to SOE's default risk, resulting in no information efficiency improvement for SOE bonds.

4.3 Robust Tests

To reduce endogeneity problem, this paper uses lagged one month industrial production growth rate (hereafter short for IP_1) to proxy for economic cycle and the regression results are presented in Table 6. All the main findings are unchanged including empirical findings for control variables.

Table 6: Regressions of Credit Spread on IP, SOE and Control Variables

	Whole Sample	Sub-Sample: 2010-2013	Sub-Sample: 2014-2018
IP_1	0.015*** [8.14]	0.006*** [4.09]	0.012*** [2.65]
non-SOE	1.083*** [5.24]	0.112 [1.39]	0.824*** [5.32]
IP_1*non-SOE	-0.075*** [-4.82]	-0.005 [-0.56]	-0.028*** [-5.09]
Rating	0.60*** [23.18]	0.625*** [14.41]	0.606*** [11.08]
LnSize	-0.018 [-0.52]	0.013 [0.67]	-0.027 [-0.59]
Maturity	0.029 [1.32]	0.077** [2.56]	0.003 [0.13]
10Y Rf	-2.839*** [-4.31]	-11.034*** [-13.07]	-0.471** [-2.80]
10Y Rf Square	0.50*** [5.86]	1.587*** [13.75]	0.133*** [7.97]
Term	0.020 [0.58]	-0.201*** [-5.25]	0.221*** [20.24]
R007	0.064*** [12.81]	-0.023** [-2.32]	0.134*** [14.12]
Stock Return	0.003*** [19.04]	0.008*** [6.89]	-0.0005 [-1.10]
Stock Volatility	0.015* [1.89]	0.214*** [19.12]	-0.030** [-2.49]
N	104,047	29,141	74,906
R^2	44.76%	61.38%	41.33%

This table reports results of regression CSi,t=α0 +α1 IPt-1 +α2 non-SOEi+α3 IPt-1 *non-SOEi+α4 $Controls$ +$\epsilon i,t$, and all variables definition are presented in Table 1. The whole sample period is from January 2010 to November 2018, and credit spread is monthly spread. Industry fixed effect and year fixed effect are controlled. T-statistics are reported in brackets. *, ** and *** stand for significance at 10%, 5% and 1% level respectively.

5. Conclusion

This paper uses credit bond transaction data in Chinese inter-bank market to study the behavior of credit spread in China. Paper finds that there is pro-cyclical relationship between credit spread and economy growth. Credit spread narrows when economy slows down and widens when economy growth is higher. This behavior is contrary to asset pricing theory and empirical finding from developed capital markets. This result illustrates that pricing and information efficiency in Chinese bond market is very low and is consistent with findings in Zhe Geng and Jun Pan (2019).

Further, paper reveals that firm type (SOE or non-SOE) is a very important determinant of credit spread. SOE bond spread and non-SOE bond spread react differently to economy changes through time. In the non-default era, credit spread of both type bonds all behaves pro-cyclically with economy growth, indicating investors do not care too much about credit risk at that time. After first bond default occurred in 2014, investors start to pay attention to credit risk of non-SOE bonds because these bonds are without outside government support, thus non-SOE bond spread starts to behave counter-cyclically with economy. On the contrary, there is no change for SOE bond spread because of government support, investors still do not care about credit risk of SOE bonds. In this way, information efficiency of non-SOE bonds improves after bond default occurs in China, while there is almost no efficiency improvement for SOE bonds in this aspect.

Empirical results of control variables in this paper also show that pricing efficiency is increasing in Chinese bond market.

Overall, credit spread in Chinese bond market behaves pro-cyclically with economy cycle, thus illustrating low pricing efficiency as a whole. However, pricing efficiency is improving in recent years indicating Chinese bond market becomes more mature gradually.

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