Idiosyncratic volatility has an impact on corporate bond spreads: Empirical evidence from Chinese bond markets

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Abstract: - In the paper we use panel data of weekly corporate bond yields dated from September 19th 2008 to June 1st 2012 in Shanghai and Shenzhen Stock Exchange, and the fixed effect model with variable intercept, to do empirical research. The factors which affect corporate bond spread mainly include bond market complex index, stock market complex index, CPI, bond idiosyncratic volatility and stock idiosyncratic volatility. As the research shows, the bond market complex index has strong positive effect on corporate bond spread but CPI has opposite effect on it. Additionally, stock market complex index exhibits some positive effects on corporate bond spread. And in contrast, bond idiosyncratic volatility and stock idiosyncratic volatility show some negative effects, which illustrates that idiosyncratic volatility, complex bond index, complex stock index and CPI have common effect on the corporate bond spread.

Key-Words: - Corporate bond; spreads; idiosyncratic volatility; bond complex index; stock complex index; CPI

1 Introduction

Bond markets in Europe and America have become mature and bonds are important financing tools for most of the listed firms. While Chinese bond markets are on developing phase, and state-owned enterprises and large listed corporations attain necessary capital by issuing bonds, so Chinese bond markets will be promising and potential markets.

Güntay(2010) finds the significant relationship between corporate bond spreads and forecasting dispersion by using panel data [1]. Miller (1977) proposes bond prices mainly reflect optimistic investors' view for the constraint of short-term investment behaviour, and his results indicate that the higher forecasting dispersion of analyst has greater impact on credit spreads of listed companies [2]. Dick-Nielsen(2010) presents the liquidity of corporate bonds before and after the financial crisis by using illiquidity method [3]. His empirical results show that, when financial crisis begins, bond illiquidity increases significantly, and bond spread increases continuously and slowly. When the most important guarantor is seriously affected in the financial crisis, bond liquidity becomes worse. Bonds issued by financial institutions stop flowing during financial crisis. Bewley(2004) finds stock market volatility has significant effect on bond spreads by using the implied volatility from option markets and conditional heteroskedasticity of equity market index, and the empirical results indicate that the implied volatility from option markets has no significant effect on bond spreads, but conditional heteroscedasticity of equity market index has significant and stable effect on bond spreads, and bond spreads have decreasing trend with the increase in heteroscedasticity volatility [4]. Campbell(2010) presents a regression model with

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equity idiosyncratic volatility and equity yields, and finds that equity volatility has effect on corporate bond yields by using panel data [5]. His empirical results show that equity idiosyncratic volatility has strong relation with borrowing cost of issued corporate bonds, and also equity volatility explains short-term return variations of corporate bonds and long-term increasing trends of bond returns. Kalimipalli(2012) confirms empirically bond investors are concerned about the effects of equity volatility and bond liquidity in cross-section of corporate bond spreads. His results reveal that while both volatility and liquidity effects are important, volatility, representing expectant credit shock, has the most significant effect and liquidity represented by bond characteristics and price impact measure has the secondary impact on bond spreads. Conditional analysis further shows that distressed bonds and distress regimes are both correlated with significantly higher impact of volatility and liquidity shocks. However, the impact of these effects varies conditional on bond attributes. [6] Feldhuetter(2012) presents a new estimation approach that allows him to extract from spreads the contribution of systematic and idiosyncratic default risk to total default risk. By Using an extensive dataset of 90,600 credit default swap and collateralized debt obligation tranche spreads on the North American Investment Grade CDX index. He conducts an empirical analysis of an intensity-based model. The results show that systematic default risk is an explosive process with low volatility, while idiosyncratic default risk is more unsteady but less explosive. Moreover, He finds that the model can capture both the level and the time series dynamics of CDO tranche spreads. [7]

Gemmill(2011) finds that corporate bond spreads are mostly caused by default loss by using panel data regression and the contribution of systemic factors is lower when he takes downside risk into account [8]. He finds that corporate bond spreads exhibit strong correlation with idiosyncratic risk: bond spreads correlate with idiosyncratic volatility and risk value of corporate bonds. Price spread of corporate bonds increases with an increase of bond idiosyncratic risk value, because bond idiosyncratic risks have left-skewness distribution trends. Elton (2001) examines risk premium of corporate bonds by using time series and cross-sectional data, and his empirical results show that bond default is composed of lower credit rating bond spreads, but tax and systemic risk is composed of higher credit rating corporate bond spreads [9]. Huang (2002) finds that credit spreads account for a smaller part of short-run corporate bonds, and a bigger part of junk bonds due to the launch of credit risk in corporate bond spreads by using structural model with default factor [10]. Tang(2010) studies the interaction of market risk and default risk in credit spread of corporate bond by using the newest structural model [11]. He finds that, when GDP increases, average credit spread decreases, but GDP growth volatility and equity market jump risk increase by using swap spread of credit default to estimate. He proves that default risk is the main part of credit spread, and macroeconomic variables take up a small part. Based on Fama-French model, Gebhardt(2005) finds that, after controlling duration, credit ratings, maturity and other variables, bonds cross-section yields have strong correlation with default probability. When control default risk and period factors, bond maturity has correlation with bond yields [12]. Neri(2012) shows how L-FABS can be applied in a partial knowledge learning scenario or a full knowledge learning scenario to approximate financial time series [13]. Chang Kai (2012) develops a general model of the futures options valuation under the term structure of stochastic multi factors [14]. Hajek(2012) forecasts stock market trend using prototype generation classifiers [15]. Wang Susheng (2011) uses text semantic mining algorithms based on intelligent search engine framework to obtain media information data of stocks [16]. Wang Susheng(2012) investigates the differences between industrial pairs trading in different classification levels [17]. Kuentai Chen(2009) investigates the prediction of taiwan 10-Year government bond yield. The objective of this research is to provide a deep study of effects of on the performance of different neural networks in Taiwan's 10-year government bond yields forecasting. Five selected models with different structures, such as Back propagation network, Resilient Propagation, Radial Basis Function Neural Network, Adaptive Neuro-Fuzzy Inference Systems, and Support Vector Regression, are studied and the results are analyzed and compared. The results indicate that firstly, the number of nodes in the hidden layer is dull to the prediction. Secondly, the recommended number of input nodes is five. Thirdly, many training samples do enhance forecasting performance in his study. Fourthly, the performance of RBFN is the best of them, followed by ANFIS and RPROP, SVR, and then BPN. Fifthly, BPN is efficient but not the best method. In the end, his result reveals that RBFN is a very useful predicting approach in government bond yields, and it performs better than other four models. The advised structure for RBFN in application is five

input nodes, six center nodes in the hidden layer, and one output node. [18]

Foreign literatures on bond spreads are mainly on the fields of forecasting dispersion, liquidity risk, stock market volatility, default risk, taxes, credit risk, etc. These literatures propose that equity market index has an impact on corporate bond spreads, but few literatures present bond complex index has impact on bond spreads. There are different opinions about the impact of systemic risk on bond spread. Zuo Haomiao (2011) analyzes the impact of equity idiosyncratic volatility on equity yields, and finds that they have negative correlation [19].

Lv Jianglin and other scholars (2004) study bond markets volatility [20-21]. Domestic research on bond spreads mainly pay attention on treasuries and enterprise bonds, and few scholars study corporate bond spreads. Chinese corporate bond markets are emerging markets, and bond markets are immature and less effective. A fewer proportion of listed corporations have the options of issuing corporate bonds, and several larger corporations can issue corporate bonds. Accordingly it is very important to study corporate bond spread. Our empirical results give greater inspiration on estimating corporate bond spreads for many listed corporations, and bring better experiences in developing bond markets. The paper proposes the driving factors of bond spreads and returns of Chinese corporations. Main innovations are that bond complex index, bond idiosyncratic volatility and equity idiosyncratic volatility have impact on corporate bond spreads. A few Chinese scholars find that CPI has an impact on enterprise bond spreads. In the paper, we test the determination of Aggregate bond index, Composite stock price index, CPI, Stock idiosyncratic volatility and Bond idiosyncratic volatility to corporate bond spread, and find some differences from foreign bond markets. Idiosyncratic volatility risk is closely related with individual corporate bond, and when the systemic risk is stable, idiosyncratic volatility risk changes with internal situation in company, such as finance, research and development and etc. And this could be used for bond investors to avoid risk, and get higher earnings. Then the irrational investment will be less, and that's good for Chinese bond market.

2 Data and variables description

2.1 Data description

Shanghai Stock Exchange has launched corporate bonds trading since 2007, and Shenzhen Stock Exchange has introduced corporate bond trading since 2008. In order to gain continuous sample data, the sample data are from weekly transaction data in Shanghai Stock Exchange and Shenzhen Stock Exchange from September 19th 2008 to 1st June 2012. During the period, there are ten corporate bonds and they have fixed rates, and they are nonconvertible and simple interest bonds. We have 1890 sample observations. Table1 exhibits the detailed information of selected ten corporate bonds.

According to duration, Duffee(1998) divides bonds into three categories, bonds with 2~7 years is short-term bond, bonds with 7~10 years is medium-term bond. In this paper, we select 6 short-run bonds, 4 medium-run bonds [21]. Mainly in power industry, steel industry and metal industry, real estate industry, light industry and heavy industry. We can see from table 1, the lower credit rating bonds have the higher coupon rates, because bonds with lower credit ratings have higher default risk, and market investors expect higher risk premium in order to offset default risk.

Table1 Eligible corporate bonds in Shanghai Stock Exchange and Shenzhen Stock Exchange

short name	duration	value date	due date	circulation	coupon rate	credit rating	match treasury
07cd	10	2007-09-24	2017-09-24	400	5.3500	AAA	100710
08ft	5	2008-02-28	2013-02-28	130	6.8000	AA+	100805
08lg	10	2008-03-25	2018-03-25	200	6.5500	AA	100803
08xh	8	2008-07-02	2016-07-02	140	9.0000	AA-	100807
08jf	5	2008-07-24	2013-07-24				
08bl	5	2008-07-11	2013-07-11				
08bc	5	2008-07-18	2013-07-18				
08zl	8	2008-04-21	2016-04-21				
08wk1	5	2008-09-05	2013-09-05				
08wk2	5	2008-09-05	2013-09-05				

100	8.2000	AA-	100805
430	7.0000	AA+	100805
170	8.2000	AA	100805
110	6.5000	AA	100807
300	5.5000	AAA	100805
290	7.0000	AA+	100805

2.2 Variables description

(1) Corporate bond spread series: we choose the corporate bonds and treasuries which have the similar maturity, and bond spreads are estimated by the difference of the two bond returns. We choose the difference of returns between treasury and corporate bond with the similar value date and delivery date. Here sp denotes corporate bond spreads.

(2) Aggregate bond index: we choose Chinese securities composite index as aggregate bond index, and select weekly data, and use closing price this week to divide closing price the week before. We use id to indicate worked aggregate bond index.

(3) Composite stock price index: we choose Hushen 300 Index as composite stock price index, and then we use closing price this week to divide closing price the week before, and get the data we need, and we use hs to indicate the worked composite stock price index.

(4) CPI: we select weekly data, and use CPI this week to divide CPI the week before, and get the data we need, and we use cpi to indicate worked CPI.

(5) Stock idiosyncratic volatility: we take Hushen 300 index as independent variable, and take bond spread as dependent variable, then regress, and get root MSE, and we take it as stock idiosyncratic volatility.

(6) Bond idiosyncratic volatility: we take Chinese securities composite index as independent variable, and bond spread as dependent variable, then regress, and get root MSE, and we take it as bond idiosyncratic volatility.

3 Basic hypotheses

Hypothesis 1: Aggregate bond index has positive relation with corporate bond spreads.

Aggregate bond index reflects the whole returns risk of bond markets. We assume that bond market yield has positive relation with corporate bond spreads, when the total returns of bond markets increase, corporate bond yields increase, and treasury yields remain fixed, and then corporate bond spreads have increasing trend.

Hypothesis2：Equity composite index has negative relation with corporate bond spreads.

Equity composite index indicates economic development. When equity composite index yields increase, financial situations gradually become better. Meanwhile, bond spreads have less risk with stable corporates development, and credit default probability decreases, credit risk and default risk in corporate bond spreads decrease significantly, so credit spread decreases significantly and then corporate bond spread decreases.

Hypothesis3：CPI correlates with corporate bond spreads.

Inflation increases with an increase of CPI. If national monetary policy leads to inflation, then reflation quickly rises with the flourishing economic development, and consumer demands and economic development rapidly with the increase of CPI. People's Bank of China augments issuing currency, and then promotes enterprises' investment and quick development. Enterprises profits have higher increase and credit risks have greater decline, and then corporate bond spreads decrease with decline of credit spreads.

If inflation isn't caused by national monetary policy, and inflation emerges in the process of economic development, then consumption expenses in residents' disposable income increases, then savings and investment decreases and then economy development has lower speed, and future economic situation is not optimistic. Credit risk increases with the increase of default risks, and market investors expect higher spreads of corporate bond returns in order to offset default risks and the spreads of corporate bond returns increase with the raise of CPI. So CPI has correlation with corporate bond spreads.

Hypothesis4: Bonds idiosyncratic volatility correlates with corporate bond spreads.

Based on empirical results of Gordon Gemmill, bonds idiosyncratic volatility has positive relation with corporate bond spreads in America. While we don't know that bond idiosyncratic volatility has positive or negative relation with corporate bond spreads in China.

Hypothesis5: Equity idiosyncratic volatility has correlation with corporate bond spreads.

Campbell finds equity idiosyncratic volatility has positive relation with corporate bond spreads. We don't know that equity idiosyncratic volatility has

positive or negative relation with corporate bond spreads in China.

4 Empirical analysis of fixed effects model with varying intercept

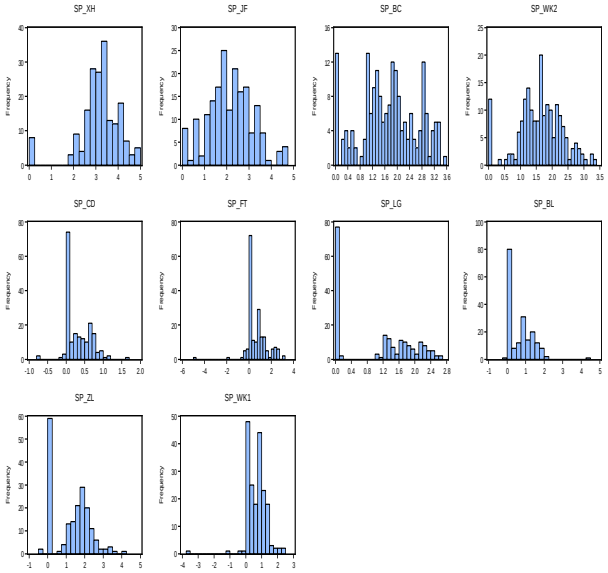
4.1 Descriptive statistics

Table2 indicates descriptive statistics of corporate bond spread, HS 300 index, bond composite index and CPI. From the table, we can see that the mean value of corporate bond spread is 1.3249, maximum value is 4.9652, minimum value is -4.9473. Mean value of HS 300 index is 1.0019, maximum value is 4.9652, minimum value is 0.8500. Mean value of bond composite index is 1.0008, maximum value is 1.0165, minimum value is 0.9931. Mean value of CPI is 0.9998, maximum value is 1.0129, minimum value is 0.9743. From the JB-value, we know that four variable series reject null hypothesis, they have higher kurtosis and fatter tail, and they don't follow normal distribution.

Graph 1 indicates bond data distribution of ten corporations. We can see that four corporations ahead have concentrating trend on bond spreads, the spread of XH bond return is from 2.0 to 5.0, and the spread of JF bond return is from 0.0 to5.0, and the spread of BC bond return is from 0 to 3.6, and the spread of WK2 bond return is from 0 to 3.5. The above four corporations have full data, and there are less than 15 missing data. The spread of CD bond yield is from 0 to1.6, the spread of FT bond yield is from -1.0~3.0, and the spread of LG bond yield is from 0 to 2.7, the spread of BL bond yield is from 0 to 2.0, the spread of ZL bond yield is from 0 to 4.0, and the spread of WK1bond yield is from -4.0 to 2.5. The missing data of six corporate bonds are 60~80, and bond spreads of FT and WKL corporation have negative trends. Negative spreads indicate that a few corporate bond yields are lower than treasury yields.

Table 2 Panel data descriptive statistics

	SP	HS	ID	CPI
mean	1.3249	1.0019	1.0008	0.9998
median	1.2285	1.0000	1.0006	1.0009
maximum	4.9652	1.1600	1.0165	1.0129
minimum	-4.9473	0.8500	0.9931	0.9743
standard deviation	1.1749	0.0400	0.0026	0.0070
skewness	0.4477	0.1931	1.2191	-1.1381
kurtosis	3.1227	4.5655	9.9469	5.5933
JB	64.3284	204.7498	4268.621	937.6581
probability	0.0000	0.0000	0.0000	0.0000



Graph 1 Distribution of corporate bond spreads

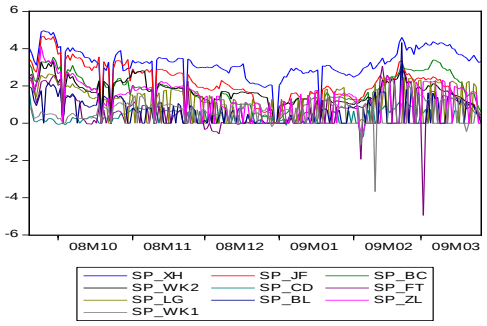
4.2 Unit root test

Table 3 shows unit root test of corporate bond spread, bond composite index, HS 300 index and CPI. From statistical results LLC、IPS、ADF and PP, we can see each statistical variable is significant on 1% confidence level, and SP、ID、HS、CPI series reject null hypothesis, they don't exhibit unit root, so they are stationary series.

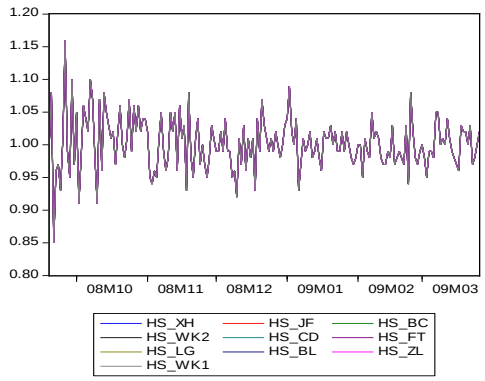
Table3 Unit root test of each series

method	sp	id	hs	cpi
LLC	-13.09***	-34.45***	-41.70***	-10.48***
IPS	-30.74***	-30.74***	-45.02***	-7.08***
ADF	687.69***	687.69***	1009.4***	91.81***
PP	738.59***	738.59***	1009.4***	186.9***

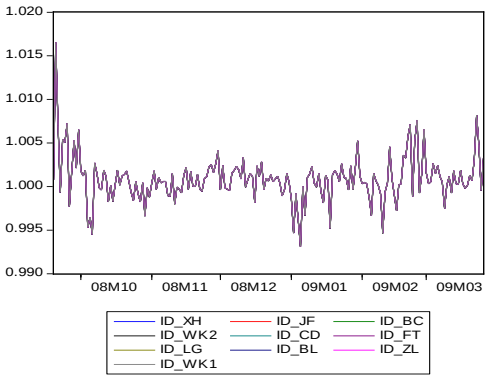
*** denotes statistical variables are significant on 1% confidence level



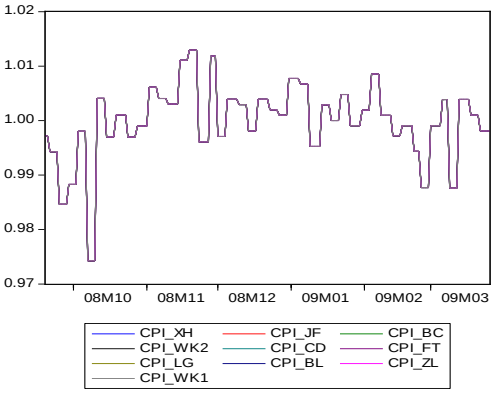
Graph 2



Graph 3



Graph 4



Graph 5

From Graph 2, we know the spread series are stationary. Also, HS300 series are stable from Graph 3. From Graph 4, we can see Aggregate bond index series are stationary. And the CPI series are quite steady too. Meanwhile, the results are the same as the unit root test results.

4.3 Fixed effect and random effect test

Fixed effect model is based on the effect of sample, and cares for individual. But random effect model cares for the whole, and it uses sample to forecast the whole. In table 4, from panel A, we can see statistics of F and Chi-square are significant on 1% confidence level, and reject null hypothesis. That is to say the fixed effect model we used is fit, and we take fixed effect model, because it could show the results of analysis well. From the results of panel B in table 4, we can see Chi-square isn't significant on 10% confidence level, and accept null hypothesis. That is to say cross-section fixed effect model and cross-section random effect model are the same.

Table 4 Fixed effect and Random effect test

Method	statistic	degree	p
	Panel A Fixed effect test		
F	227.462***	(9,1877)	0.0000
Chi-square	1393.83***	9	0.0000
	Panel B Random effect test		
Chi-square	0.000000	3	1.0000

Three * indicates statistics are significant on 1% confidence level

From table 5, we can see coefficient comparisons of ID、CPI and HS are not significant on 10% confidence level, and can't reject null hypothesis, that is to say, the coefficients of ID, CPI and HS in cross-section fixed effect model and cross-section random effect model are the same.

Table 5 Random effect and Fixed effect comparison

variables	fixed effect	random effect	Difference of variance	p
ID	48.6752	48.6752	0.0000	1.0000
CPI	-29.8462	-29.8462	0.0000	1.0000
HS	0.9355	0.9355	0.0000	1.0000

From table 6, we can see, by using variable intercept random effect model regression, constant and coefficients of ID、CPI and HS are significant on 5% confidence level, and reject null hypothesis, and also F statistic is significant on 1% confidence level, and reject null hypothesis. In all, either variable intercept random effect model or variable intercept fixed effect model is good, we choose variable intercept cross-section fixed effect model.

Table 6 Results of Random effect model

variables	coefficient	standardized residual	t	p
C	-18.489**	8.3129	-2.2242	0.0263
ID	48.675***	7.2342	6.7285	0.0000
CPI	-29.85***	2.6838	-11.1208	0.0000
HS	0.9355**	0.4636	2.0181	0.0437
F		188.1253***		

Two * indicates statistics are significant on 5% confidence level, and three * indicates statistics are significant on 1% confidence level

4.4 Empirical results analysis

According to Gebhardt (2005), we build the regression model below:

$$sp_{it}=c+\alpha_i^*+\beta_{1t}id_t+\beta_{2t}cpi_t+\beta_{3t}hs_t+e_{it} \quad (1)$$

Table 7 Regression results

variables	equation（1）	equation（5）	equation（8）	equation（10）
C	-18.489**	-15.360*	-17.637**	-16.501**
	（-2.22）	（-1.85）	（-2.13）	（-1.97）
ID	48.675***	48.180***	50.391***	49.4`***
	（6.73）	（6.70）	（7.00）	(6.79)
CPI	-29.85***	-32.39***	-32.30***	-32.45***
	(-11.12)	(-11.89)	(-11.88)	(-11.92)
HS	0.9355**	1.065**	1.0418**	1.0578**
	（2.02）	（2.31）	（2.26）	(2.29)
STB		-0.305***		-0.1467
		（-4.71）		(-0.94)
STH			-0.305***	-0.1723
			（-4.74）	(-1.10)
Intercepts of fixed effect				
_XH—C	1.8469	1.8321	1.8339	1.8325
_JF—C	0.8222	0.8486	0.8494	0.8503
_BC—C	0.4097	0.4267	0.4247	0.4264
_WK2—C	0.3025	0.2786	0.2778	0.2770
_CD—C	-1.0198	-1.0863	-1.0892	-1.0910
_FT—C	-0.6846	-0.6755	-0.6736	-0.6740
_LG—C	-0.2915	-0.2464	-0.2453	-0.2437
_BL—C	-0.6593	-0.6664	-0.6650	-0.6660
_ZL—C	-0.0522	-0.0140	-0.0090	-0.0094
_WK1—C	-0.6740	-0.6973	-0.7038	-0.7020
R^2	0.5460	0.5513	0.5514	0.5516
F	188.13***	177.32***	177.38***	164.76***

1. One * indicates statistics are significant on 10% confidence level, and two * indicate statistics are significant on 5% confidence level, and three * indicates statistic are significant on 1% confidence level. 2. Figures in brackets are t value, and the figures outside are constant and coefficients.

4.4.1. Initial regression model

From table 7, we can see the results are significant on 5% confidence level, and coefficients of independent variables: ID、CPI and HS are significant.

$$sp_{it}=-18.4898+\alpha_i^*+48.6752\times id_t-29.8462\times cpi_t+0.9355\times hs_t+e_{it} \quad (2)$$

Table 8 Fixed effect intercepts of each bond

XH	JF	BC	WK2	CD
-16.643	-17.668	-18.080	-18.187	-19.510
FT	LG	BL	ZL	WK1
-19.174	-18.781	-19.149	-18.542	-19.164

Considering fixed effect, the intercept of bond XH is: -16.6431, and XH bond spread model is below:

$$sp_{1t}=-16.6431+48.6752\,id_t-29.8462cpi_t+0.9355hs_t+e_{1t} \quad (3)$$

Other bond spread models are similar with bond XH, and $\sum\alpha_i^*=0$.

From regression equation（2）, we know that bond composite index has positive relation with corporate bond spread, and then corporate bond spread will increase 48.6752 units when bond composite index raise 1 unit, and bond composite index has significantly positive relation with corporate bond spread, so regression accepts null hypothesis 1. When the whole bond market yields increase, corporate bond yields increase, and treasury yields are constant. Corporate bond spreads increase with an increase of bond market returns.

HS 300 equity index has positive relation with corporate bond spread. Corporate bond spread raises 0.9355 units when HS300 equity index increases 1 unit. Equity composite index has positive relation with corporate bond spread, so regression reject null hypothesis 2. When equity composite index increases, the stock markets become prosperous, and investors are keen on equity market, and they ignore bond markets, so higher corporate bond yields produce greater bond spreads with a decline of bond prices.

The empirical results accept null hypothesis 3, that is to say CPI has negative relation with corporate bond spread. When CPI rises for 1 unit, the corporate bond spread decreases -29.8462 units. CPI and corporate bond spread has negative relation. In combination with the Chinese reality, since 2008, People's Bank in China has carried out positive monetary policy in order to stimulate investment and develop economy. People's Bank in China continuously promotes issuing currency. Economy development has rapidly increased during the period. When inflation increases, consumer demand increases, corporates earn more and default risk decreases, and credit spread decreases, so corporate bond spread decreases.

4.4.2. Regression model with bond idiosyncratic volatility

According to Gemmill(2011), we add bond idiosyncratic volatility into the original regression model, and we take bond idiosyncratic volatility as the measurement of liquidity risk.

$$sp_{it}=c_{it}+\beta_t \times id_t + e_{it} \quad (4)$$

We regress on equation (4), and get Root MSE, and use stb_t to denote bond idiosyncratic volatility, and we add it into equation (1), and gain equation (5).

In table 7, we can see from the regression results in equation (5), we know that the variable coefficients of ID, CPI, HS and STB are significant on 5% confidence level.

$$sp_{it}=-15.3601+\alpha_i^* +48.1804\ id_t -32.3849\ cpi_t + 1.0649 hs_t - 0.3046 stb_t + e_{it} \quad (5)$$

Table 9 Fixed effect model of each bond with varying intercept

XH	JF	BC	WK2	CD
-13.528	-14.512	-14.933	-15.082	-16.446
FT	LG	BL	ZL	WK1
-16.036	-15.607	-16.027	-15.374	-16.057

Considering fixed effect, XH bond intercept is -13.528, and XH bond spread model equation as below:

$$sp_{1t} = -13.528 + 48.1804\ id_t - 32.3849 cpi_t + 1.0649 hs_t - 0.3046 stb_t + e_{1t} \quad (6)$$

Other bond spread models are similar with XH bond model, and $\sum \alpha_i^*=0$.

After adding bond idiosyncratic volatility, table 7 show the regression results in equation (5). From table 7, we can see that the variable coefficients of ID, CPI, HS and STB are significant on the 5% confidence level.

The coefficients of idiosyncratic volatility in bond markets are -0.3046, so bond market idiosyncratic volatility has a negative relation with corporate bond spread. If idiosyncratic volatility in bond market raises 1 unit, then corporate bond spread decreases 0.3046 units. Bond idiosyncratic volatility has negative relation with corporate bond spread, so we accept null hypothesis 4. Bond market risks are composed of system risk and idiosyncratic risk. Idiosyncratic risk increases, while system risk declines. System risk decreases, and bond yields decrease.

4.4.3. Regression model with equity market idiosyncratic volatility

According to Zuo(2011), we add equity market idiosyncratic volatility into regression model.

$$sp_{it} = c_{it} + r_t \times hs_t + e_{it} \quad (7)$$

We regress on equation (7), and get Root MSE, and we use sth_t to denote bond idiosyncratic volatility, and we add it into equation (1), and we can get the regression results in table 7.

$$sp_{it}=-17.6366+\alpha_i^*+50.3912\times id_t-32.2962\times cpi_t+1.0418\times hs_t-0.3051\times sth_t+e_{it} \quad (8)$$

Table 10 Intercept of each bond model with fixed effect

XH	JF	BC	WK2	CD
-15.803	-16.787	-17.212	-17.359	-18.726
FT	LG	BL	ZL	WK1
-18.310	-17.882	-18.302	-17.646	-18.340

Considering fixed effect α_i^*, XH bond intercept is-15.8027, XH bond spread model is the following equation:

$$sp_{1t}=-15.8027+50.3912id_t-32.2962cpi_t+1.0418hs_t-0.3051sth_t+e_{1t} \quad (9)$$

Other bond spread models are as similar as XH bond, and $\sum \alpha_i^*=0$.

We can see the regression results in equation (8) from table 7, and the variable coefficients of ID, CPI, HS and STH are significant on the 5% confidence level. Equity idiosyncratic volatility coefficient is -0.3051, so equity idiosyncratic volatility has negative relation with corporate bond spread, so the empirical results accept null hypothesis 5. Equity market risk is composed of system risk and idiosyncratic risk. If idiosyncratic risk increases, system risk decreases, and if system risk decreases, bonds yields decrease.

4.4.4. Regression model with bond idiosyncratic volatility and equity idiosyncratic volatility

We add bond idiosyncratic volatility and equity idiosyncratic volatility into equation (1), and get equation (10), and we get the regression results in table 7.

From table 7, we know the variable coefficients of cpi, id, hs are significant, but the variable coefficients of bond idiosyncratic volatility and equity idiosyncratic volatility aren't significant. Bond idiosyncratic volatility correlates with equity idiosyncratic volatility.

Equity market has little effect on bond market. We get rid of equity idiosyncratic volatility, so we get the equation (5) in table 7. Considering fixed effect, each bond intercept is in table 9, and $\sum \alpha_i^*=0$.

5 Conclusion

Because Chinese corporate bond markets are emerging markets, and bond markets are immature. We pay much attention on the driving factors of bond spreads between Chinese corporate bond and treasury which have the similar term structure. The empirical results show that firstly, taken bond composite index into account, bond composite index directly reflects changing trends of bond market yields, so bond composite index has a positive relation with corporate bond spread. CPI has significant negative relation with corporate bond spread. People's Bank in China carries out positive currency policy, enterprises earn more money, and CPI increases, and default risk decreases, so corporate spread decreases. HS 300 equity index has positive relation with bond spread. When equity composite index increases, investors pay much attention on equity markets, so bond investment decreases, and bond prices goes up, so bond spread has an increasing trend. Secondly, after adding bond idiosyncratic volatility, we find idiosyncratic volatility has negative relation with bond spreads. Some scholars find they have positive relation, and we have explained reasons in the paper. Thirdly, we consider equity idiosyncratic volatility has negative relation with bond spreads, and this is different from foreign research, because they find they are positively correlated. But after taking bond idiosyncratic volatility and equity idiosyncratic volatility together into the original equation, the coefficients of the two variables aren't significant, and we infer they are correlated. In the future we will research on the effect of variables dynamic changes on corporate bond spread.

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