Proceedings of the 2023 International Conference on Management Research and Economic Development
DOI: 10.54254/2754-1169/18/20230069

The Effect of Ambiguity and Asset Pricing on Credit Spreads

Ning Qian[1,a,*]

[1]*Zhejiang University of Finance & Economics, Hangzhou ZJ 310000, China*
a. Chaning_j@foxmail.com
**corresponding author*

Abstract: The purpose of this study is to analyze the impact of ambiguity on credit spreads, help investors to clarify the quantitative impact of ambiguity on the bond market, so that investors can make better use of ambiguity to make the most economic decisions in future investment activities.We obtain relevant data of maturing corporate bonds in China's bond market, measure the degree of ambiguity through bid-ask spread, explore the internal relationship between ambiguity and credit spreads through VAR model, and explore the impact of volatility of two variables, ambiguity and credit spreads, on each other through impulse analysis. We find that there is a negative correlation between ambiguity and credit spreads, and the unit change of ambiguity will bring huge fluctuations to credit spreads.

Keywords: ambiguity, asset pricing, credit spread, VaR model

1. Introduction

Since the outbreak of the financial crisis in 2008, ambiguity has been widely proposed in financial markets as a way to prevent and predict future economic development.In the academic field, more experts began to study ambiguity, studying the impact of ambiguity on the stock market and credit market.

So far, there have been many developments in the measurement of ambiguity, including the maxmin expected utility theory proposed by Gilboa and Schemeidler [1], Izhakian proposed expected utility with uncertain probabilities (EUUP), etc [2]. However, these methods are mostly used to measure the relationship between ambiguity and the stock market, while the impact of ambiguity on the segmented bond market is rarely involved.Therefore, this study aims to explore the impact of ambiguity on the credit spread of credit assets through the asset pricing model, so as to make up for the gap in the research of ambiguity in the bond market, so as to help investors and creditors make better economic decisions and reduce the loss caused by information asymmetry. So that investors choose more substantial yield bonds, get higher returns.

2. Literature review

We explore the impact of ambiguity factors on credit spreads from the perspective of ambiguity. Reviewing the literature review on the theoretical framework for measuring ambiguity and the factors affecting credit spreads, the following is learned.

Ambiguity was first proposed by Knight, who began to divide uncertainty into two categories [3]. One is risk, and various possible outcomes of events can be described by unique probabilities. The second type of ambiguity cannot be described by a unique prior probability distribution.

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Ambiguity refers to the uncertainty of the probability of asset pricing distribution due to the lack of relevant information or incorrect interpretation. It describes the uncertainty of the economic environment. After proposing this concept, Ellsberg defined the uncertainty of unknown probability as fuzziness and put forward the SEU theory [4]. Schmeidler established choquet expected utility theory (CEU), abandoned the independence axiom, and introduced tolerance to indicate the decision maker's attitude toward ambiguity [5]. Gilboa and Schemeidler proposed the theory of maxmin expected utility [1]. On the basis of Schmeidler's theory, Dow and Werlang and Garlappi proposed the multi-prior utility theory to study the impact of ambiguity on asset pricing and investment portfolio [6,7].

Asset pricing models, currently relatively mature include: static cash discount method, static spread method, option adjustment spread method. Among them, the option adjustment spread method improves the shortcomings of SFCY method and SS method at the same time, and replaces the common interest rate with the market interest rate simulated by computer, taking into account the future cash flow of different situations, which will be more reasonable and accurate than the previous two methods. The determination of the bond issue price is basically the determination of the coupon rate, which consists of the risk-free rate and the risk premium. The latter is also referred to as the bond spread in the literature. However, no matter what method is used, ambiguity is not included in the consideration of asset pricing. By simulating the impact of multiple investors on the equilibrium market price in a market with or without ambiguity, Li et al. concluded that ambiguity does cause the equilibrium market price to fluctuate, and when the situation of all investors is not equal, ambiguity increases and the impact on the price becomes more significant [8]. Therefore, the introduction of ambiguity into the credit asset spread analysis can better explain the deviation between the theoretical value of asset pricing and the actual value. Investors may have an attitude of ambiguity aversion.

The internal and external factors affecting credit spreads have been introduced in detail in the literature, among which the external factors include: First, the macroeconomic environment affects the credit risk of bonds [9], and credit risk is a significant influencing factor of credit spreads. However, the uncertainty of economic policy will significantly expand credit spreads [10]; Second, Dhaliwal et al. and Wang et al. indicated that information disclosure system can effectively reduce bond credit spreads, mainly because information disclosure can form better corporate governance and information environment [11,12]. Third, Gao and Wang et al.’s researches showed that media reports can reduce information asymmetry, enhance corporate governance and reduce bond default risk, so they believe that media reports are negatively correlated with credit spreads[13]. In addition, Bradley et al. and Kaviani et al. argued that changes in policy uncertainty would lead to higher policy risks, thus increasing bond credit spreads [14,15].

Internal factors include: Boubakri and Ghouma believed that bondholders would charge higher credit spreads for bond issuance for companies with poor corporate governance, because they expected managers' opportunistic behavior or the potential risk of wealth appropriation that they might encounter in debt contracts [16]. In addition, some studies have found a negative relationship between the information environment and corporate credit spreads. For example, Yu found that bondholders would levy a higher premium to compensate for the increased investment risk caused by information asymmetry [17]. Bonsall and Miller showed that companies with poor readability of financial disclosure would experience higher bond credit spreads [18]. Ferrer et al. found that the reduction of information asymmetry caused by analysts can reduce information risk, thus leading to the reduction of bond credit spreads [19].

However, there is currently a lack of certain data on the impact of ambiguity on credit spreads.The impact of firm-specific characteristics on credit spreads of bond issuance.

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3. Methodology

3.1. Sample data

Our sample includes the yield to maturity of corporate bonds issued by companies listed in Shanghai Stock Exchange and Shenzhen Stock Exchange from 2018 to 2022, the yield to maturity of national bonds in the same period, and the stock buying and selling prices on the same day.The sample construction process is as follows: First, the bonds of financial companies are excluded due to differences in reporting rules and capital structure. Second, the unavailability of credit spreads precludes floating rate bonds. We also exclude callable bonds because of the uncertainty effect of embedded call options.

3.2. Model

Gilboa and Schmeidler developed the multiple-prior model with a utility function [1]:

$$U^{MP}(h) = \min_{p \in C} \int u(h)dp$$

where C is the prior set, h is the behavior, u is the von Neumann-Morgenstern (vMN) utility function [20], also known as subjective expected utility (SEU) function, and p is the prior probability.

The essence of this function is a maximin problem, min means to focus on the worst case of an event, make decisions through the worst case, and understand the possibility of the worst case.

An act is then evaluated by the weighted average of the expected utility according to the reference measure and, so we have: $p^* U^{MP}$

$$U(h) = \alpha \int u(h)dp^* + (1-\alpha) \min_{p \in C} \int u(h)dp$$

If investors are ambiguity averse, they will think more about the worst case of an event and its possibility.If investors are ambiguity-seeking, they will consider more common situations. If the type is ambiguity averse, it will occupy more proportion in $(1-\alpha) \int u(h)dp$, thus increasing the coefficient of $(1-\alpha)$and reducing the proportion of reference.

The distance between the reference measure and the ambiguity measure is:

$$R(p||p^*) = \int (\log \frac{dp}{dp^*})dp \in [0, \infty)$$

The multiple-prior model is widely used in the filed of behavioral economics. Dow and Werlang and Garlappi et al. studied the influence of ambiguity on portfolio selection by using the multiple-priors model [6,7]. Routledge and Zin and Ozsoylev and Werner explored the relationship between ambiguity and market liquidity and found that investors behave under multiple-prior utility [21,22]. Viale et al. studied the learning process in asset pricing based on the multiple-prior model and found that ambiguity measure has statistical significance in the learning process of asset pricing [23]. There is evidence that multiple-prior model performs better than the classical mean, variance methods and the Bayesian method empirically when the investors are ambiguity-averse [7]. Therefore, in the empirical study, we assume that investors are ambiguity averse and adopt the multiple-prior model in the study.

We perform the following empirical model to explore the relationship between ambiguity and credit spreads:

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$$CS_{i,t} = \beta_0 + \beta_1 * k_{i,t} + \sum_{q=2}^{m} \beta_q(ControlVariable_{i,t}) + \delta_j + \tau_t + \varepsilon_{i,t}$$

The subscripts i and t represent bonds and years, respectively. β_1 represents regression the coefficient of interest and $\varepsilon_{i,t}$ is the error term. Our dependent variable $CS_{i,t}$ measures the credit spread. $k_{i,t}$ represents degree of ambiguity. A negative (positive) β_1 suggests that ambiguity leads to a decrease (increase) in the credit spread.

3.3. Variables

Explained variable: credit spread. Following previous studies [17,24,25], we define the bond credit spread (CSi,t) as the difference between the yield to maturity (YTM) between corporate bonds and the Treasury bonds with the nearest maturity.The Treasury bond yield is obtained from the standard maturity information of the Treasury bond yield curve published by China Bond Network.

Explanatory variable: degree of ambiguity. According to the multiple-prior model improved by Gilboa and Schmeidler [1], we use the bid-ask spread of stock index ETF to measure the size of ambiguity, and the size of ambiguity is expressed as:

$$K = \frac{\ln A - \ln B}{2}$$

Where: K denotes the ambiguity size, A denotes the ask price of the stock, and B denotes the bid price of the stock

At the same time, according to Run Qing Tan, Viktor manahov and Jacco Thijssen [26], the influence of market maker should be considered when using bid-ask spread to evaluate ambiguity. If the influence of market maker on ambiguity is significant, It is necessary to adjust the ambiguity to a certain extent, and take the ambiguity size after removing the market maker as the index to measure the ambiguity.

4. Result

The obtained data are summarized to understand some descriptive data of ambiguity measurement (AM) and lnVolume (Table 1). Firstly, the linear relationship between AM and lnVolume is tested. The experimental results (Table 2) show that under Goldfeld-Quandt test, the P-value (P-value=0.0188) of AM and lnVolume is less than the significance level of 0.05, indicating that the null hypothesis is rejected. There is heteroscedasticity between them.Under the Durbin-Watson test, the P-value (P-value=0.5417) of AM and lnVolume is greater than the significance level of 0.05, indicating that the null hypothesis is accepted and there is no autocorrelation between the two.Subsequently, the linear relationship between AM and lnVolume is corrected, and the P-value of AM and lnVolume is less than the significance level by revising the results (Table 3), indicating that the null hypothesis is rejected, indicating that AM is affected by market liquidity.

Table 1: Description statistics for AM and lnVolume.

	Mean	SD	Median	Min	Max	Skew	Kurtosis
AM	0	0	0	-0.01	0	-2.96	12.76
lnVolume	20.20	0.52	20.14	17.86	21.36	-1.09	5.45

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Table 2: The result of linear relation test for AM and lnVolume.

Linear relation test	DW	GQ	P-value
Goldfeld-Quandt test		2.5774	0.0188
Durbin-Watson test	1.8406		0.5417

Table 3: The result of linear relation test for AM and lnvolume under Newey-West adjustment.

	Estimate	Std.Error	t value	P-value
Intercept	0.0122	0.0072	1.6932	0.0962
lnVolume	-0.0006	0.0004	-1.7488	0.0860

After removing the impact of market liquidity from AM, the linear relationship between new_AM and credit spread is tested, and the experimental results (Table 4 and 5) show that there is a negative correlation between new_AM and credit spread.

Next, we conducted VaR model to analyze the internal relationship between new_AM and credit spread. We first tested AM and credit spread series through unit root test. The experimental results (Table 6) show that credit spread time series is not stationary. We differentiate the AM and credit spread time series separately, and the difference results, shown in Table 7, show that the original credit spread time series is a first-order single integrated time series.Next, we choose VaR model to determine the order of credit and AM after first difference. According to the order obtained in the experiment (Table 8), we conduct Granger causality test. The experimental results (Table 9) show that: d_AM[-1] cannot Granger-cause d_spread[-1], but d_spread[-1] can Granger-cause d_AM[-1] at the 5% significance level.This is consistent with our VAR regression results, suggesting that past degree of ambiguity can affect credit spread today. Finally, we conducted relevant impulse tests on the two variables, and the experimental results (fig.1 and fig.2) show that: because the interval is above the red zero line, the credit spread suddenly responds to a shock. and AM sudden responds to a shock in credit spread.

Table 4: The result of linear relation test for correction AM and lnVolume.

Linear relation test	DW	GQ	P-value
Goldfeld-Quandt test		0.6135	0.2196
Durbin-Watson test	1.1567		0.0008

Table 5: The result of linear relation test for correction AM and lnVolume under Newey-West adjustment.

	Estimate	Std.Error	t value	P-value
Intercept	5.1810	2.8500	1.8180	0.0747
AM	-316.3810	233.7180	-1.3540	0.1815

Signif. Codes: 0 '* * *' 0.001 '* *' 0.01 '*' 0.05 '. '0.1' 1 '

Table 6: The result of time series of new_AM and credit spreads.

	Dickey-Fuller	Lag order	P-value
spread	-2.3855	3	0.4191
AM	-4.1690	3	0.0100

Table 7: The result of new_AM and credit spread time series difference.

	Dickey-Fuller	Lag order	P-value

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Table7: (continued)

d_spread[-1]	-4.3555	3	0.0100
d_AM[-1]	-4.1690	3	0.0100

Table 8: The result of VaR determination order.

	AIC (n)	HQ(n)	SC(n)	FPE(n)
d_spread[-1] d_AM[-1]	8	1	1	8

Table 9: The result of Granger causality tests.

		Res.Df	Df	F	P-value
d_AM	Model 1	29			
	Model 2	37	- 8	2.4810	0.0348
d_spread	Model 1	29			
	Model 2	37	- 8	0.8832	0.5422

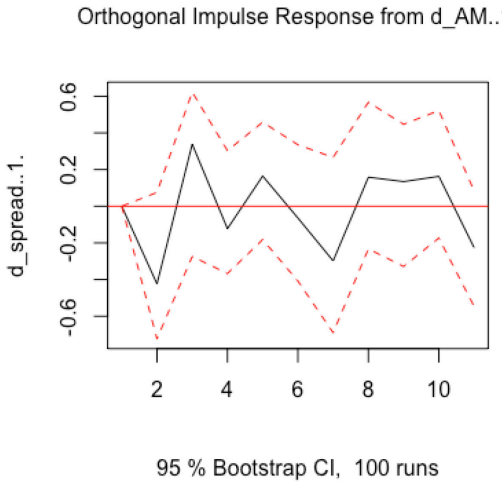

Figure 1: The response of the credit spread to the shock of new_AM.

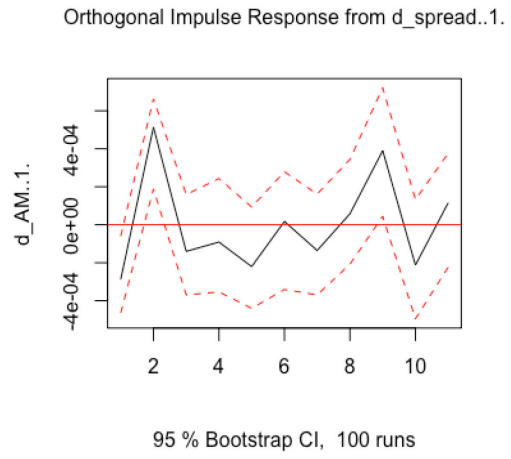

Figure 2: The response of the new_AM to the shock of credit spread.

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5. Discussion

The data show that there is a certain impact of ambiguity on credit spreads in China's bond market, and its impact is shown as a negative correlation between ambiguity and credit spreads, the smaller the degree of ambiguity, the larger the credit spreads, the larger the degree of ambiguity, the smaller the credit spreads. At the same time, momentary fluctuations in the degree of ambiguity can cause huge fluctuations and effects on credit spreads.

According to the experimental data and conclusions obtained, the following explanations are made: When an investor invests in a pool of credit assets, the degree of ambiguity refers to the extent to which the investor understands the credit spreads of various credit assets in the pool. In this case, a large number of junk bonds are mixed in the pool and investors are not aware of it. Junk bonds will increase investors' losses. Therefore, we can explain that the greater the degree of ambiguity, The smaller the credit spread, the less money investors get.

When the degree of ambiguity changes by one unit from large to small, the information asymmetry between investors and the market will be reduced by one unit, and investors can more accurately understand the changes in the profitability of various bonds in the bond market, so that more rational investors will invest funds in bonds with good profitability, so that bonds with good profitability will absorb more funds. A virtuous cycle of funds promotes positive changes in earnings, thus increasing credit spreads.

These experimental results imply that ambiguity is a factor that affects the returns in China's credit market. This provides us with an idea: in China, in order to keep the credit market in line with social expectations and reduce the impact of the economic crisis on the credit market, the credit spreads in the credit market can be regulated through the ambiguity and the degree of information disclosure, so that the credit market can develop well.

In this experiment, we refer to corporate bonds in the credit market, but there are still other types of bonds in the credit market that have not been analyzed by AM and credit spread.At the same time, we lack the use of unmatured bond analysis, which is also worth in-depth analysis in the future.

Future research can analyze the relationship between AM and credit Spread based on the outstanding bonds; Or consider the relationship between AM and credit spread for other types of bonds.

6. Conclusion

The purpose of this study is to investigate the impact of ambiguity and capital pricing model on credit spreads. Based on the multiple-prior model, we define the size of ambiguity to conduct correlation analysis with credit spreads and determine the internal relationship between them. The experimental results show that there is a negative correlation between ambiguity and credit spreads, the greater the ambiguity is, the smaller the credit spreads are. At the same time, the sudden change of ambiguity will bring huge fluctuations to credit spreads.

Although this experiment illustrates that there is a negative correlation between ambiguity and credit spreads in China's credit market, and quantitatively measures the degree of correlation between the two, the existence of this experiment also brings many new problems, such as the difference in the degree of correlation between different types of credit assets.

This study provides a solution for future investors to invest in bonds and for the Chinese government and enterprises to regulate the bond market and avoid the economic crisis. At the same time, this study supplements the relevant content about the correlation between credit assets and the degree of ambiguity that has not appeared in the past research.

DOI: 10.54254/2754-1169/18/20230069

References

[1] Gilboa, D. Schmeidler, Maxmin expected utility with non-unique prior, J. Math, 1989.
[2] Y. Izhakian, Expected utility with uncertain probabilities theory, J. Math. Econ. 69 (2017) 91-2013.
[3] Knight, F. H. (1921). Risk, uncertainty and profit. New York: Hart, Schaffner and Marx.
[4] Ellsberg, D. (1961). Risk, ambiguity, and the Savage axioms. The Quarterly Journal of Economics, 75(4), 643-669.
[5] D. Schmeidler, Subjective probability and expected utility without additivity, Econometrica 57 (3) (1989) 571-587.
[6] Dow, J., & Werlang, S. R. da Costa (1992). Uncertainty aversion, risk aversion, and the optimal choice of portfolio. Econometrica, 60(1), 197-204.
[7] Garlappi, L., Uppal, R., & Wang, T. (2007). Portfolio selection with parameter and model uncertainty: A multi-prior approach. Review of Financial Studies, 20(1), 41-81.
[8] Li Xue, Han Liyan, ZHOU Juan, Equilibrium Numerical Experiments on asset pricing under Knight Uncertainty [J].Journal of Capital University of Economics and Business, (01) (2008).
[9] Longstaff, F.A., Schwartz, E.S., A simple approach to valuing risky fifixed and floating rate debt. J. Finance 50 (3), 789-819
[10] Guha, D., Hiris, L., 2002. The aggregate credit spread and the business cycle. Int. Rev. Financ. Anal. 11 (2), 219-227.
[11] Dhaliwal, D., Hogan, C., Trezevant, R., & Wilkins, M. (2011). Internal control disclosures, monitoring, and The cost of debt.
[12] Wang, K. T., Wu, Y., & Ho, K.-Y. (2021). Internal control reporting and cost of bond financing: Evidence from China. International Review of Economics & Finance, 76, 323-1346.
[13] Gao, H., Wang, J., Wang, Y., Wu, C., & Dong, (2020). Media coverage and the cost of debt. Journal of Financial and Quantitative Analysis, 55(2), 429-471
[14] Bradley, D., Pantzalis, C., & Yuan, X. (2016). Policy risk, corporate political strategies, and the cost of debt.
[15] Kaviani, M. S., Kryzanowski, L., Maleki, H., & Savor, Policy uncertainty and corporate credit spreads. Journal of Financial Economics, 138(3), 838-865.
[16] Boubakri, N., & Ghouma, H. (2010). Control/ownership structure, creditor rights protection, and the cost of debt financing: International evidence.
[17] Yu, F. (2005). Accounting transparency and the term structure of credit spreads. Journal of Financial Economics, 75(1), 53-84.
[18] Bonsall, S. B., & Miller, B. P. (2017). The impact of narrative disclosure readability on bond ratings and the cost of debt. Review of Accounting Studies, 22(2), 608-643.
[19] Ferrer, E., Santamaria, R., & Suarez, N. (2019). International Review of Economics & Finance, 64, 323-342.
[20] Von Neumann, J. and Morgenstern, O. (1944). Theory of Games and Economic Behavior. Princeton Univer. Press, Princeton.
[21] Routledge, B. R., & Zin, S. E. (2009). Model uncertainty and liquidity. Review of Economic dynamics, 12 (4), 543-566.
[22] Ozsoylev, H., & Werner, J. (2011). Liquidity and asset prices in rational expectations equilibrium with ambiguous information. Economic Theory, 48(2), 469-491.
[23] Viale, A. M., Garcia-Feijoo, L., & Giannetti, A. (2014). Safety First, Learning Under Ambiguity, and the Cross-Section of Stock Returns. The Review of Asset Pricing Studies, 4(1), 118-159.
[24] Byun, H.Y., Choi, S., Hwang, L.S., Kim, R.G., 2013. Business group affiliation, ownership structure, and the cost of debt.
[25] Gao, X., Wang, X., Tian, F., 2019. Do significant risk warnings in annual reports increase corporate bond credit spreads? Evidence from China. China J. Account. Res.12 (2), 191-208.
[26] Run Qing Tan, Viktor manahov, Jacco Thijssen (2017). evidence from a new empirical approach.Investment Management and Financial Innovations..