Research article

Credit rating in dynamic response to the nature of firms and the business model of rating agencies: evidence from the Chinese bond market

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HIGHLIGHTS

• Credit rating's dynamic response to the firm's nature and payment model from the enterprise life-cycle.
• The ordered logit model on the Chinese bond market listed firms from 2010 to 2021.
• The investor-pays model works to alleviate rating inflation, especially in mature and decline stages.
• Non-state-owned enterprises have heavier false ratings and are exacerbated by financing pressure, especially in the decline stage.

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ABSTRACT

This paper takes the A-share listed companies that issued credit bonds from 2010 to 2021 as the sample to test the probability and degree of credit rating change throughout the enterprise life cycle using the ordered logit and breakpoint regression models. Further, we study the heterogeneity of the above performance from payment models and firm natures. The results show that the credit rating inflation problem generally exists in all stages of the enterprise life cycle. The inflation is lower in the investor-pays model (state-owned enterprises), while the opposite results occur for the issuer-pays model (non-state-owned enterprises). Specifically, (1) the probability of a higher credit rating and the increased credit ratings show as an inverse U in the enterprise life cycle. Credit rating increases if the enterprise successfully enters the growth phase, decreases if the enterprise fell into the decline phase. (2) In the investor-pays model, enterprises have a greater probability of obtaining a higher credit rating in the mature phase and a lower credit rating during the decline period. In the issuer-pays model, although the enterprise gets a smaller credit rating due to falling into the decline phase, the credit rating still has a high probability of belonging to a high credit rating. (3) State-owned enterprises have a higher probability of obtaining a high credit rating in the mature period and are more likely to have a low credit rating in the decline period. Generally, their credit rating quality is better than that of non-state-owned enterprises. In addition, in the context of the financing pressure period, the credit rating of non-state-owned enterprises decreases as they drop into the decline phase.

1. Introduction

With the rapid development of the bond market, credit rating (CR) has become an essential reference for investors and other market participants. From the independent third rating agency, CR contains corporate credit rating (CCR) and bond credit rating (BCR), which aims to provide information on the bond default risk by analyzing and evaluating the various credit risk of the firms. Precise CR can present many advantages, e.g., increasing the success ratio of financing for bonds by reducing the cost of the funding for the entity issuing the bond and designing a better investment strategy because of reducing asymmetric information between investors and issuers.

However, due to many adverse events, almost all CR quality suffers from global challenges. Since 2010, several turning events have happened, including the Enron scandal in 2001 and the United States subprime mortgage crisis in 2007 (Coskun, 2008). For China, the first onshore public bond default event, namely Chaori-11 Bond, occurred in 2014. Further, according to the Wind database, the bond default involved

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132 bonds as of March 2021, of which 48.3% are above A-. On the other hand, the events of the bond default still occur and the credit rating of bonds remains at a high grade until the default, though the access threshold of the bond market is as high as AAA. Therefore, the credit rating is inflated in the bond market.

The previous literature has rich results for CR quality, while there are still many problems to be resolved due to policy differences between mature and emerging markets:

1. First, for the emerging bond market in China, CR research has attracted considerable attention from regulators. Some policies and reports put forward instructions and requirements to standardize the CR industry and improve corporate bond financing. China Securities Regulatory Commission issued ‘measures for the administration of corporate bond issuance and trading (CSRC, 2015)’ clearly stipulate that corporate bonds publicly issued for investors must have an AAA rating or above.

   2. Second, some efforts have been conducted that mainly focused on three aspects: (a) accuracy and effectiveness of CR (Manso, 2013; Zhou,
The competitive pressure is intensified under the issuer's payment model because the institutions are willing to underestimate the issuer's credit risk to cater to the requirement of the issuer. In contrast, institutions that have less competitive pressure, which may be one of the effective ways to improve the false high ratings. In addition, few studies have studied the quality of credit rating from the perspective of the nature of enterprises. Financing differences exist between state-owned and non-state-owned enterprises (Ge et al., 2020), which means that the performance of credit rating quality needs to be studied based on the different natures of the firms.

Third, the existing works have not paid enough attention to the quality of credit ratings from a dynamic viewpoint in the emerging market, although they have achieved remarkable results at a static level. In fact, a company will present unique characteristics at each stage of the enterprise life cycle (Faff et al., 2016). Especially, the enterprise life cycle is one of the key factors in the company's policy decisions, and the bond financing scale will be changed with the phase change of the enterprise life-cycle. Blomkvist et al. (2021) focuses on studying the opportunities for enterprises to obtain credit ratings and enter the financing market at different stages of their life cycle through the two-category logistic model. These literatures have inspired us to study the quality of credit ratings from a dynamic perspective in the Chinese emerging bond market.

This paper studies the possibility and degree of CR changes in the enterprise life-cycle from the business model of agencies and the nature of firms. The marginal contributions are as follows: (1) this paper tests the dynamic performance of false high credit ratings in the enterprise life process from the range and possibility of credit ratings change. Our empirical results provide a new interpretation perspective for the phenomenon of CR inflated from the extent of CR growth and its possibility. (2) Providing empirical support for applying the multimodal rating based on the financing strategies of enterprises at different phases. Meanwhile, our empirical studies also point out the necessity of actively improving the bond financing measures for non-state-owned enterprises based on firm nature.

The remainder of this paper is as follows. Section 2 contains literature reviews and research hypotheses. Section 3 presents the dataset and

![Table 1. Variable description.](image)

| Dependent Variable | Name | Explanation |
|--------------------|------|-------------|
| CCR (Corporate credit rating) | An ordinal variable from 0 to 18, i.e., 0(<CCC-), 1(CCC-), 2(CCC+), 3 (B-), 4(B), 5 (B+), 6 (BB-), 7 (BB), 8 (BB+), 9(BBB-), 10 (BBB), 11 (BBB+), 12 (A-), 13(A), 14 (A+), 15(AA-), 16 (AA), 17 (AA+), 18(>>>AAA). |

| Independent variable | Life-cycle | If CFO < 0, CFI < 0, CFF > 0, then Life cycle 1 = 1 |
|----------------------|------------|-------------------------------------------------|
|                      |            | If CFO > 0, CFI < 0, CFF > 0, then Life cycle 1 = 2 |
|                      |            | If CFO > 0, CFI < 0, CFF < 0, then Life cycle 1 = 3 |
|                      |            | If CFO < 0, CFI > 0, CFF > 0, then Life cycle 1 = 4, otherwise 0 |

| Controlled Variable  | Residual maturity | Residual maturity is the remaining time until the expiration of the bond |
|----------------------|-------------------|------------------------------------------------------------------------|
|                      | Bond issuance size | The logarithm of the number that bonds issued is taken as bond issuance size |
|                      | Coupon rate       | Coupon rate in percentage of bonds with fixed coupons                  |
|                      | Operating income growth | The ratio of (Operating Income of year (n) – Operating Income of year (n-1)) to (Operating Income of the year (n-1)) |
|                      | Cash_TA           | The ratio of cash to total assets                                       |
|                      | Nature of firms   | – 1 if Wind classifies the issuer as a state-owned enterprise by the Chinese central government, otherwise 0 |
|                      | Payment (Business model of agencies) | – 1 if the bond credit rating is paid by investors, otherwise 0 |

Notes: This table describes the variables used in this study. CFO, CFI, and CFF denote the three cash flow in operating activities, investment, and financing, respectively.
empirical models. Section 4 reports the empirical results. Section 5 concludes the paper.

2. Literature review and research hypothesis

2.1. Literature review

CR is essential for financial market regulation and is used to provide credit risk warnings. Meanwhile, its rationality needs to be timely evaluated and fully supervised (Cantor and Packer, 1995). Since the subprime mortgage crisis, the quality of credit ratings has attracted more and more literatures to conduct the related studies from multiple perspectives. In general, previous literature points out that credit rating has lost its credibility (Zhou, 2001). Credit rating agencies should be held accountable for the damaged credibility (Byoun, 2014).

In terms of the objective effort of rating agencies, they mainly focus on improving credit rating algorithms. For example, Dimitris et al. (2016) reconstructs a credit rating prediction model with significant predictability based on experience; Pertaia et al. (2021) proposed a new credit rating algorithm based on the bPoE risk function given the current situation that credit rating cannot effectively evaluate the credit risk.

Table 2. Summary statistics and correlation matrix of main variables for the full sample.

| Variable | N  | Mean | Std. Dev | Min |
|----------|----|------|----------|-----|
| CCR      | 4771 | 15.990 | 2.723   | 0   |
| LC1      | 4771 | 1.903 | 1.109    | 0   |
| LC2      | 4771 | 0.153 | 0.130    | −1.914 |
| Introduction | 4771 | 0.185 | 0.389 | 0 |
| Growth   | 4771 | 0.345 | 0.475    | 0   |
| Mature   | 4771 | 0.275 | 0.446    | 0   |
| Decline  | 4771 | 0.051 | 0.220    | 0   |
| R,M      | 4771 | 1.501 | 1.501    | 0.003 |
| B,I,S    | 4771 | 0.941 | 0.350    | −0.187 |
| C,R      | 4771 | 4.176 | 2.110    | 0.100 |
| OIGR     | 4771 | 0.198 | 0.655    | −0.805 |
| Cash_TA  | 4771 | −0.018 | 0.062  | −0.432 |
| Nature   | 4771 | 0.595 | 0.491    | 0   |
| Payment  | 4771 | 0.173 | 0.446    | 0   |

Panel A: Descriptive statistics

| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|-----|-----|-----|-----|-----|-----|-----|-----|
| LC2 | LC2 | R,M | B,I,S | C,R | OIGR | Cash_TA | Nature |

Note: This table presents summary statistics for the main variables defined in Table 1. All continuous variables are winsorized at 1% and 99% levels. The brackets’ value is p-values and ***, **, * indicates significance level at 1%, 5%, and 10%, respectively.

In terms of the subjective effort of rating agencies, credit rating agencies have a bias towards issuers. Therefore, agencies usually overestimate the rating of bonds until the bond default (Manso, 2013). Although the overestimated credit rating will reduce the reputation of rating agencies (DeHaan, 2017), it does not improve the quality of credit ratings (Bedendo et al., 2018).

Similarly, default events in the Chinese bond market increase with the development of the bond market. The credit rating of inflation in China at this stage has a limited credibility (Kou et al., 2015). Meanwhile, the researches on the credit ratings of China’s bond market follow the above methods. The objective factors of rating agencies are as follows: compared with international credit rating scales, China’s credit rating scales are generally higher (Livingston et al., 2018). The subjective factor is that the issuer’s payment mode will intensify the competition among China’s rating agencies. According to the competition theory, rating agencies are motivated to overestimate the issuer’s credit ratings. However, the existing researches on credit ratings in emerging markets have been carried out statically, not dynamically.

The corporate life-cycle theory is essential for studying information management and risk analysis in enterprise structure systems. As a concept of enterprise architecture, the enterprise life cycle helps to explain the dynamic trend of various factors of an enterprise evolve
during the stages of the development of enterprise life. The enterprise growth theory points out that the growth of enterprises is the result of the interaction between quality and quantity. More importantly, the life cycle of enterprises is reversible, i.e., enterprises in the decline phase can transition to the next life cycle through R&D, innovation, and other activities (Adizes, 2004). The life-cycle theory of enterprises with reversible characteristics provides a dynamic perspective for the related research.

Enterprise life cycle theory has played an important role in credit rating. Firstly, the quality of accounting information owned by enterprises in different life stages will affect the fairness of credit ratings. Among enterprises with extreme performance, accounting information has a higher reference value (Rabier, 2018). Compared with the mature phase, the introduction and decline phases have a higher reference value. Secondly, enterprises face different risks in different life stages. If considering the enterprise life cycle, the prediction accuracy of enterprise profitability is improved significantly (Vorst and Yohn, 2018). Finally, this paper studies the CR based on the enterprise life-cycle, while the business model of agencies and the nature of firms are selected as the two factors.

2.2. Research hypothesis

The corporate life-cycle theory provides a framework to explain the power of enterprise over time. For example, asymmetric information and the reputation of an enterprise present different explanatory abilities for bond financing at the different stages of the life-cycle (Diamond, 1991). Further, the bond financing of the enterprise depends on the mode of the corporate life-cycle (Ylhainen, 2017). The different features are presented at the different stages of the corporate life-cycle: (1) low reputation at the introduction stage. Bank loans are the main financing method. Bond financing is only taken as an alternative option. Therefore, the introduction enterprise is not desperate to obtain credit ratings with high grades, resulting in the probability of false credit ratings being low. (2) High reputation at growth and mature stages. Bond financing has become the main financing method. High credit ratings as a key factor of financing activities are required, which may induce a false credit rating. (3) Descending reputation at decline stage. The enterprise suffers from

| Table 3. Comparison between different groups based on payment mode (firm nature). |
|----------------|----------------|----------------|----------------|
| Variable       | N   | Issuer-payment | N   | Investor-payment | Difference in means |
|----------------|-----|----------------|-----|------------------|--------------------|
| Panel A: Mean variable summary statistics between issuer-payment and investor-payment groups |
| CCR            | 4195| 16.350         | 576 | 12.380           | 3.070**            |
| LC1            | 4195| 1.880          | 576 | 2.081            | -0.201***          |
| LC2            | 4195| 0.152          | 576 | 0.163            | -0.011*            |
| Introduction   | 4195| 0.190          | 576 | 0.151            | 0.039**            |
| Growth         | 4195| 0.344          | 576 | 0.355            | -0.011             |
| Mature         | 4195| 0.264          | 576 | 0.358            | -0.094***          |
| Decline        | 4195| 0.053          | 576 | 0.036            | 0.017*             |
| R_M            | 4195| 1.535          | 576 | 1.246            | 0.289***           |
| B_I_S          | 4195| 0.938          | 576 | 0.965            | -0.027*            |
| C_R            | 4195| 4.172          | 576 | 4.204            | -0.032             |
| OIGR           | 4195| 0.207          | 576 | 0.135            | 0.072**            |
| Cash_TA        | 4195| -0.018         | 576 | -0.012           | -0.006             |
| Nature         | 4195| 0.591          | 576 | 0.623            | -0.032             |
| Panel B: Mean variable summary statistics between SOEs and Non-SOEs |
| CCR            | 918 | 15.490         | 1709| 16.320           | -0.830***          |
| LC1            | 918 | 1.845          | 1709| 1.943            | -0.098***          |
| LC2            | 918 | 0.165          | 1709| 0.145            | 0.020***           |
| Introduction   | 918 | 0.200          | 1709| 0.175            | 0.025**            |
| Growth         | 918 | 0.366          | 1709| 0.331            | 0.035**            |
| Mature         | 918 | 0.236          | 1709| 0.301            | -0.065***          |
| Decline        | 918 | 0.052          | 1709| 0.051            | 0.001              |
| R_M            | 918 | 1.884          | 1709| 1.240            | 0.644***           |
| B_I_S          | 918 | 0.890          | 1709| 0.976            | -0.086***          |
| C_R            | 918 | 4.364          | 1709| 4.049            | 0.315***           |
| OIGR           | 918 | 0.201          | 1709| 0.196            | 0.005              |
| Cash_TA        | 918 | -0.025         | 1709| -0.012           | -0.013***          |
| Payment        | 918 | 0.110          | 1709| 0.123            | -0.013             |

| Table 4. Comparison between different phases based on enterprise life cycle (firm nature). |
|----------------|----------------|----------------|----------------|
| Variable       | N   | Introduction | N   | Growth | Difference in means |
|----------------|-----|-------------|-----|--------|--------------------|
| Panel A: Mean values for the introduction and growth samples and their difference in means |
| CCR            | 918 | 15.790      | 1709| 16.177  | -0.387*            |
| R_M            | 918 | 1.704       | 1709| 1.386   | 0.318***           |
| B_I_S          | 918 | 0.887       | 1709| 0.944   | -0.057***          |
| C_R            | 918 | 4.540       | 1709| 4.081   | 0.459***           |
| OIGR           | 918 | 0.207       | 1709| 0.168   | 0.039              |
| Cash_TA        | 918 | 0.071       | 1709| -0.033  | -0.038***          |
| Nature         | 918 | 0.562       | 1709| 0.570   | -0.008             |
| Payment        | 918 | 0.144       | 1709| 0.167   | -0.023             |
| Panel B: Mean values for the growth and mature samples and their difference in means |
| CCR            | 1709| 16.177      | 1361| 15.848  | 0.329***           |
| R_M            | 1709| 1.486       | 1361| 1.386   | -0.100*            |
| B_I_S          | 1709| 0.944       | 1361| 0.972   | -0.028**           |
| C_R            | 1709| 4.081       | 1361| 4.011   | 0.070              |
| OIGR           | 1709| 0.168       | 1361| 0.209   | -0.041*            |
| Cash_TA        | 1709| -0.033      | 1361| 0.023   | -0.056***          |
| Nature         | 1709| 0.570       | 1361| 0.630   | -0.060***          |
| Payment        | 1709| 0.167       | 1361| 0.200   | -0.033**           |
| Panel C: Mean values for the mature and decline samples and their difference in means |
| CCR            | 1361| 15.848      | 783 | 15.610  | 0.238*             |
| R_M            | 1361| 1.486       | 783 | 1.654   | -0.168**           |
| B_I_S          | 1361| 0.972       | 783 | 0.947   | 0.025              |
| C_R            | 1361| 4.011       | 783 | 3.437   | -0.336**           |
| OIGR           | 1361| 0.209       | 783 | 0.268   | -0.059*            |
| Cash_TA        | 1361| 0.023       | 783 | 0.011   | 0.012***           |
| Nature         | 1361| 0.630       | 783 | 0.589   | 0.041*             |
| Payment        | 1361| 0.200       | 783 | 0.148   | 0.052*             |
Table 5. Enterprise life-cycle and CCR.

| Variables | Full sample | Payment | Payment Nature | Nature |
|-----------|-------------|---------|----------------|--------|
|          | (1)         | (2)     | (3)            | (4)    |
|          |             |         | (Investor-pays) | (State-owned) |
|          |             |         | (Issuer-pays)   | (Non-state-owned) |
| LC₁      | 0.151***    | 0.102***| 0.165***       | 0.134*** |
|          | (0.012)     | (0.034) | (0.013)        | (0.015) |
| B₁-Jₛ    | 1.832***    | 1.168***| 2.013***       | 2.058*** |
|          | (0.040)     | (0.101)| (0.043)        | (0.049) |
| Rₛ𝑀      | −0.019**    | −0.100***| −0.002         | 0.022** |
|          | (0.008)     | (0.021)| (0.008)        | (0.009) |
| CₛR      | −0.999***   | −0.111***| −0.102***      | −0.337*** |
|          | (0.008)     | (0.022)| (0.009)        | (0.013) |
| OIGR     | −0.051***   | −0.044**| −0.063***      | −0.072** |
|          | (0.009)     | (0.017)| (0.011)        | (0.012) |
| Cash_TA  | 1.765***    | 0.660   | 2.082***      | 2.978*** |
|          | (0.222)     | (0.563)| (0.243)       | (0.289) |
| Payment  | −2.796***   |         | −3.073***      | −2.274*** |
|          | (0.039)     |         | (0.047)        | (0.070) |
| Nature   | 0.795***    | 0.663***| 0.843***       |        |
|          | (0.027)     | (0.074)| (0.029)        |        |
| Year fixed effect | Yes | Yes | Yes | Yes |
| Individual fixed effect | Yes | Yes | Yes | Yes |
| Observations | 4771 | 576 | 4195 | 2838 |
| Empirical p-values | Investor-pays versus Issuer-pays | State-owned versus Non-state-owned |
|                   | 0.040 | 0.097 |          |        |
| Panel B. Test the impact of changes in various life stages of enterprises on CCR |
| Introduction      | 0.332*** | 0.049 | 0.442*** | 0.091 |
|                   | (0.052) | (0.140) | (0.056) | (0.065) |
| Growth            | 0.542*** | −0.131 | 0.710*** | 0.376*** |
|                   | (0.047) | (0.128) | (0.050) | (0.058) |
| Mature            | 0.710*** | 0.418***| 0.773*** | 0.654*** |
|                   | (0.046) | (0.126) | (0.050) | (0.057) |
| Decline           | 0.252*** | −0.752***| 0.396*** | −0.182** |
|                   | (0.067) | (0.227) | (0.071) | (0.084) |
| B₁-Jₛ            | 1.817*** | 1.153***| 1.997*** | 2.028*** |
|                   | (0.040) | (0.101) | (0.044) | (0.050) |
| Rₛ𝑀              | −0.020*** | −0.095***| −0.003 | 0.020** |
|                   | (0.008) | (0.020) | (0.008) | (0.009) |
| CₛR              | −0.596*** | −0.090***| −0.100*** | −0.335*** |
|                   | (0.008) | (0.021) | (0.009) | (0.013) |
| OIGR              | −0.051*** | −0.059***| −0.060*** | −0.065*** |
|                   | (0.009) | (0.017) | (0.011) | (0.012) |
| Cash_TA           | 1.852*** | 0.551***| 2.604*** | 1.981*** |
|                   | (0.270) | (0.001) | (0.294) | (0.354) |
| Payment           | −2.828*** |         | −3.122*** | −2.239*** |
|                   | (0.039) |         | (0.048) | (0.070) |
| Nature            | 0.786*** | 0.643***| 0.837*** |        |
|                   | (0.027) | (0.077) | (0.029) |        |
| Year fixed effect | Yes | Yes | Yes | Yes |
| Individual fixed effect | Yes | Yes | Yes | Yes |
| Observations | 4771 | 576 | 4195 | 2838 |
| Empirical p-values | Investor-pays versus Issuer-pays | State-owned versus Non-state-owned |
|                   | 0.020 | 0.000 | 0.000 | 0.000 |
| Notes: *, **, and *** indicate the significance at the 10%, 5%, and 1% levels, respectively. Standard errors are reported in brackets. Columns (1) shows the estimated coefficient of CCR on the full sample. Columns (2) and (3) show the estimated coefficient of CCR on different payment levels. Columns (4) and (5) shows the estimated coefficient of CCR on different firm nature levels. In panel A, the p-value of 0.040 in the LC₁ for investor-pays versus issuer-pays suggests that the LC₁ coefficient for the issuer-pays group is greater than that for the investor-pays group at the 4.0% significance level.
Figure 4. The independent variable's regression coefficients from Panel B of Table 5 (A) full sample, (B) investor-pays, (C) issuer-pays, (D) state-owned enterprises, (E) non-state-owned enterprises.

Figure 5. This figure shows the independent variable's regression coefficients from Panel B of Table 6 (A) full sample, (B) investor-pays, (C) issuer-pays, (D) state-owned enterprises, (E) non-state-owned enterprises.
numerous negative factors, including fewer investment opportunities, weakened solvency, increased credit risk, and decreased CR. Therefore, the decline phase enterprise usually needs to maintain a high CR to successfully enter new cycle, which also means higher credit risk. According to the above analysis, we expect that CR will exhibit an ‘inverse U’ relation throughout the enterprise life-cycle. **Hypothesis 1** is as follows:

**Hypothesis 1.** The degree and probability of CCR increasing show an ‘inverse U’ over the entire enterprise life cycle. The ‘inverse U’ feature has the heterogeneity of payment models and the heterogeneity of firm natures.

On the issue of credit rating inflation, the ‘notice on promoting the healthy development of the credit rating industry in the bond market (2021)’ clearly points out the verification role of multiple rating models.

| Variables | Full sample | Payment | Nature |
|-----------|-------------|---------|--------|
|           | (1) (2) (3) (4) (5) | (Investor-pays) (Issuer-pays) (State-owned) (Non-state-owned) |

**Panel A. Robustness test for Panel A of Table 5**

| LC2 | 0.212* | 2.866*** | 0.279** | −0.147 | 2.894*** |
| (0.125) | (0.316) | (0.138) | (0.151) | (0.229) |
| BfLS | 1.834*** | 1.288*** | 1.998*** | 2.089*** | 1.323*** |
| (0.040) | (0.099) | (0.043) | (0.049) | (0.070) |
| Rm | −0.019** | −0.085*** | −0.003 | 0.018* | −0.073*** |
| (0.008) | (0.020) | (0.008) | (0.009) | (0.015) |
| CR | −0.098*** | −0.067*** | −0.109*** | −0.352*** | 0.088*** |
| (0.008) | (0.022) | (0.009) | (0.013) | (0.012) |
| OIGR | −0.051*** | −0.037*** | −0.067*** | −0.067*** | 0.094*** |
| (0.009) | (0.017) | (0.011) | (0.012) | (0.023) |
| Cash_TA | 2.283*** | 0.655 | 2.732*** | −0.172*** | −0.957*** |
| (0.218) | (0.555) | (0.240) | (0.019) | (0.353) |
| Payment | −2.779*** | (0.039) | −3.043*** | −2.319*** |
| Nature | 0.808*** | 0.715*** | 0.847*** | (0.027) | (0.073) | (0.029) |

**Panel B. Robustness test for Panel B of Table 5**

| LC2 | 0.660*** | −2.545*** | 0.278* | 0.589** | 2.909*** |
| (0.150) | (0.920) | (0.167) | (0.167) | (0.220) |
| (LC2)^2 | −1.533*** | 0.315*** | −1.957*** | −0.572** | −2.811*** |
| (0.283) | (0.044) | (0.321) | (0.303) | (0.439) |
| BfLS | 1.831*** | 1.282*** | 1.995*** | 2.218*** | 1.224*** |
| (0.040) | (0.099) | (0.043) | (0.049) | (0.068) |
| Rm | −0.029*** | −0.078*** | −0.004 | 0.032** | −0.113*** |
| (0.008) | (0.022) | (0.008) | (0.009) | (0.014) |
| CR | −0.099*** | −0.056*** | −0.111*** | −0.345*** | 0.051*** |
| (0.008) | (0.022) | (0.009) | (0.013) | (0.009) |
| OIGR | −0.053*** | −0.038*** | −0.069*** | −0.078*** | 0.095*** |
| (0.009) | (0.017) | (0.012) | (0.012) | (0.023) |
| Cash_TA | 2.319*** | 1.034 | 2.787*** | −0.174*** | −0.734*** |
| (0.219) | (0.557) | (0.240) | (0.019) | (0.354) |
| Payment | −2.781*** | (0.039) | 2.988*** | −2.318*** |
| Nature | 0.809*** | 0.707*** | 0.850*** | (0.027) | (0.073) | (0.029) |

**Notes:** The symbols are the same as in Table 5. In panel A, the p-value of 0.100 in the LC2 for investor-pays versus issuer-pays suggests that the LC2 coefficient for the issuer-pays group is greater than that for the investor-pays group at the 10.0% significance level.
including the issuer-pays model and investor-pays model. Rating agencies that adopt the issuer payment model can obtain more enterprise information and issue higher-quality credit ratings. When there is fierce competition, rating agencies are motivated to provide higher credit ratings to issuers, which indirectly contributes to the problem of false high ratings (Jiang et al., 2012; Cornaggia and Cornaggia, 2013). In contrast, the credit rating of bond financing with an investor-pays model can prevent fierce competition among rating agencies. Existing literature has found that investor payment mode can improve the quality of credit ratings and alleviate rating inflation (Baghai and Bo, 2018). Meanwhile, there is not enough research and experience to prove that the credit rating under the investor payment mode is systematically low. Generally, the investor-pays model has not been able to overcome inflation completely.

In fact, bonds with a high credit rating may suffer from default not only under the issuer-pays model, but also under the investor-pays model (as shown in Figure 1(A) and (B)). In principle, the accounting information of mature enterprises is more comprehensive, which can help rating agencies to provide better ratings. However, compared with the investor-pays model, the competitive pressure on rating agencies that adopt the issuer-pays model still exists. To obtain more rating services, they will cater to the requirements of issuers. We propose Hypothesis 2:

**Hypothesis 2.** The impact of the enterprise life-cycle on a CCR varies with the payment methods. The investor-pays model can reduce the degree and probability of rating agencies overestimating the issuer's credit rating. In addition, different natures of firms are used to test the performance of the above 'inverse U' characteristics. The 2022 Chinese government work report proposed ‘actively improve the measures to support the bond financing of non-state-owned enterprises’. The financing cost of non-state-owned enterprises, especially with low CR grades, is more sensitive to ‘breaking the rigid cashing’. To reduce the financing cost, they pursue a higher CR, which induces the problem of a false high CR. We give Hypothesis 3:

**Hypothesis 3.** The impact of the enterprise life-cycle on a CCR varies with the firm nature. State-owned enterprises have a higher probability of obtaining a high credit rating in the mature period and are more likely to have a low credit rating in the decline period.

### 3. Data and model

#### 3.1. Data

A dataset of credit bonds was collected from Chinese A-share listed firms by the WIND and CSMAR databases between 2010 and 2021. Meanwhile, the preprocessing is conducted as follows: (1) we exclude firms' bonds with financial firms and missing data; (2) All of the variables related to the sample are winsorized at 1% and 99%. Finally, the dataset consists of 4771 observations.

#### 3.2. Variables

Corporate credit rating is selected as the dependent variable instead of BCR and has the following advantages: (1) the dataset of CCR includes
more samples. (2) The rating agencies of CCR are from all over the world, not just China. (3) The grade of CCR is usually lower compared to that of BCR throughout all stages of the enterprise life-cycle (Figure 2(A)–(E)).

To study the relationship with CCR and its robustness described in hypothesis of Section 2.2, the enterprise life-cycle measurements are based on Dickinson (2011) and DeAngelo et al. (2006). According to Blomkvist et al. (2021), we select the residual maturity, issuance size, coupon rate, operating income growth rate and ratio of cash to total assets as the controlled variables, as shown in Table 1. It is worth noting that CCR and its quantitative score are referred to Alali et al. (2014).

3.3. Model

The ordered logit model is an extension of the multinomial logistic model, which is often applied when the dependent variable is categorical and when its categories have a meaningful order. However, the ordered logit model is a generalization of the multinomial logistic regression.

Table 8. The result of global linear regression.

| Sample I. From the introduction to the growth phase | Sample II. From the growth to the mature phase | Sample III. From the mature to the decline phase |
|---------------------------------------------------|------------------------------------------------|------------------------------------------------|
| Treatment-effects                                 | Treatment-effects                                 | Treatment-effects                                 |
| p = 1                                             | p = 1                                             | p = 1                                             |
| 0.168*                                            | 0.160*                                            | 0.168*                                            |
| (0.101)                                           | (0.081)                                           | (0.111)                                           |
| AIC                                               | AIC                                               | AIC                                               |
| 11682.596                                         | 11668.956                                         | 11666.304                                         |
| 11724.750                                         | 11723.153                                         | 11738.567                                         |
| covariates                                        | covariates                                        | covariates                                        |
| Yes                                               | Yes                                               | Yes                                               |
| Yes                                               | Yes                                               | Yes                                               |
| Yes                                               | Yes                                               | Yes                                               |
| N                                                 | 2627                                              | 3070                                              |
| 1490                                              | 1490                                              | 1862                                              |
| Non-state-owned                                   | Non-state-owned                                   | Non-state-owned                                   |
| Treatment-effects                                 | Treatment-effects                                 | Treatment-effects                                 |
| p = 1                                             | p = 1                                             | p = 1                                             |
| 0.222*                                            | 0.361*                                            | 0.220**                                           |
| (0.125)                                           | (0.206)                                           | (0.097)                                           |
| AIC                                               | AIC                                               | AIC                                               |
| 4470.419                                          | 4484.167                                          | 4501.346                                          |
| 4501.346                                          | 4504.868                                          | 4515.710                                          |
| covariates                                        | covariates                                        | covariates                                        |
| Yes                                               | Yes                                               | Yes                                               |
| Yes                                               | Yes                                               | Yes                                               |
| Yes                                               | Yes                                               | Yes                                               |
| N                                                 | 1137                                              | 1208                                              |
| 1245.285                                          | 1247.628                                          | 1251.906                                          |
| Investor-pays                                     | Investor-pays                                     | Investor-pays                                     |
| Treatment-effects                                 | Treatment-effects                                 | Treatment-effects                                 |
| p = 1                                             | p = 1                                             | p = 1                                             |
| 0.185                                             | 0.042                                             | 0.220**                                           |
| (0.196)                                           | (0.318)                                           | (0.097)                                           |
| AIC                                               | AIC                                               | AIC                                               |
| 1226.096                                          | 1220.764                                          | 7481.873                                          |
| 7517.288                                          | 7519.166                                          | 7471.947                                          |
| covariates                                        | covariates                                        | covariates                                        |
| Yes                                               | Yes                                               | Yes                                               |
| Yes                                               | Yes                                               | Yes                                               |
| Yes                                               | Yes                                               | Yes                                               |
| N                                                 | 295                                               | 416                                               |
| 1502                                              | 1502                                              | 1863                                              |

Figure 7. The regression coefficients of CCR of Table 7(A) state-owned enterprises, (B) non-state-owned enterprises.
polynomial logit model assumes that there is no ordering in the response categories and that the results are impervious to changes in their order. If the response categories are ranked, e.g. from 'worst credit' to 'best credit', a better model framework is the ordered logit model.

The ordered logit model is a better choice to test the hypothesis in our paper because of the type of dependent variables, i.e., multi-classification and discrete. The expression of the ordered logit model from Borooah (2001) is shown in Eq. (1):

$$\ln \left[ \frac{F_{ij}/(1 - F_{ij})}{F_{ij}/(1 - F_{ij})} \right] = \beta_0 + \beta_1 X_{i1} + \cdots + \beta_K X_{iK} + \epsilon$$

where $M, N, K$ and $\varepsilon$ are the value of the maximum order, the total number of samples, the number of dependent variables, and cumulative probability distribution $P(Y_{ij} \leq j)$, respectively.

4. Empirical results

4.1. Summary statistics

This section observes the relationship between CCR and the enterprise life-cycle through the descriptive statistical results of primary variables (as shown in Figure 3 and Table 2). Meanwhile, payment models and firm nature are descriptive (as shown in Table 3 and Table 4).

Figure 3 shows the CCR distribution, which presents an inverse U curve in the enterprise life-cycle. Specially, (1) CCR is lower in the introduction and decline phases since their medians and coefficients of variation are slightly lower than those of other phases (Figure 3(A)). (2) Enterprises in the mature phase obtain a higher CCR more easily. However, the standard deviation and coefficient of variation also reach the maximum, implying that the factors related to CCR differences need more attention (Figure 3(B) and (C)). Therefore, we analyze the dynamic performance of the relationship between CCR and enterprise life-cycle from the different business models of agencies and the different nature of firms.

Table 2 reports the summary statistics for the main variables. Panel A reports the descriptive statistics of the variables for the full sample in the entire period (yearly data from 2010 to 2021). The average grade for CCR is 15.990 (between AA- and AA). The average enterprise life-cycles, including $L_{C1}$ and $L_{C2}$, are 1.903 and 0.153. The averages for each phase of the enterprise life cycle (introduction, growth, maturity, and decline) are 0.185, 0.345, 0.275, and 0.051. The mean of other variables ($R_M, B_{15}, C_R, OIGR, Cash_TA, Nature, and Payment$) are 1.501, 0.941, 4.176, 0.198, -0.018, 0.595, and 0.173, respectively. Among them, a large average with a small standard deviation of the CCR, which indicates that the range of CCR in China is generally concentrated above the AA level, was also found in the prior studies. More concerns about the phenomenon are raised by studies. Therefore, payment characteristics and firm nature that may be related to CCR are selected to study the above problem. The CCRs' change over the enterprise life-cycle is also studied.

Panel B reports the pairwise correlations matrix, and the correlation coefficients show that there is no colinear problem. The strongest correlation (0.348) is calculated based on $L_{C1}$ and $L_{C2}$. Therefore, $L_{C2}$ is selected for the robustness test. $C_R$ and $R_M$ exhibit a second strong correlation (~0.269), but it is not large enough to support significant problems with multi-collinearity.

Table 3 reports the summary statistics for the main variables between groups. Both investor-payment mode and SOEs nature perform better in relieving the problem of false high ratings. Panel A reports the means for issuer-payment and investor-payment. Issuer-payment exhibit a higher mean CCR (16.350) than that for investor-payment (13.280). Panel B reports the means for SOEs and non-SOEs. SOEs exhibit a lower mean CCR (15.490) than non-SOEs (16.320). These differences in CCR are primarily due to the enterprise life cycle, which is consistent with the growth phase having a stronger influence over other phases.

Figure 8. A positive effect on the CCR from the introduction to the growth phase (Placebo test of cut point for Sample I). (A) Full sample, (B) investor-pays, (C) issuer-pays, (D) state-owned enterprises, (E) non-state-owned enterprises.

Figure 9. A positive effect on the CCR from the mature to the decline phase (Placebo test of cut point for Sample III). (A) Full sample, (B) investor-pays, (C) issuer-pays, (D) state-owned enterprises, (E) non-state-owned enterprises.
Table 4 provides the summary statistics for the main variables between sub-samples based on the enterprise life cycle. Panel A reports mean values for the group of introduction and growth samples (the growth and mature samples, and the mature and decline samples). According to Panel A, compared with the introduction phase, growth phases have higher CCR, and are more likely to be SOEs-nature, and (not surprisingly) have more investor payment. In Panel B, growth phases have higher CCR, lesser SOEs, and investor payment firms. In Panel C, the decline phase has lower CCR, lesser SOEs-nature, and investor-payment model firms.

4.2. High CCR’s probability response to the enterprise life-cycle

We investigate the correlation between the probability of a high CCR and the enterprise life-cycle by Eq. (1), and then test the impact of different life phases on the probability of a high CCR. The method based on Dickenson (2011) is selected to measure the enterprise life-cycle and report the empirical results (as shown in Table 5). To test the robustness of the results in Table 5, the 1st and 2nd order index of the enterprise life cycle measurement are used (DeAngelo et al., 2006).

In Table 5, Panel A shows that the regression coefficients are significantly positive. Sorting in descending by each phase of Panel B regression coefficients, the corresponding phases are the mature, growth, introduction, and decline stages. Therefore, the ‘inverse U’ relationship between a high CCR’s probability and the enterprise life-cycle is verified (as shown in Figure 4(A)), while its results present robustness (as shown in Figure 5(A)). The above conclusions verify Hypothesis 1 in Section 2.2.

The performance of the above ‘inverse U’ relationship is further studied from the business model of agencies and the nature of firms. In Table 5, columns (2) to (5) are the results based on the investor-pays model, the issuer-pays model, the state-owned firm, and the non-state-owned firm.

The ‘inverse U’ relationship between the enterprise life-cycle and CCR shows heterogeneity via the rating agencies’ business model. (1) The ‘inverse U’ relationship disappears in the investor-pays model, and a falsely high CCR is alleviated (as show in Figure 4(B) and Figure 5(B)). Inflated ratings can be restrained from more competition among rating agencies. However, in the introduction and growth phases, the stability of CCR is constrained by the information acquisition of institutions because the companies’ financial information still needs to be improved. (2) The ‘inverse U’ feature is kept under the issuer-pays model. Each phase has a significant positive impact on the probability of a high CCR, and among these phases, the decline period has the least impact (as show in Figure 4(C) and Figure 5(C)). Although CCR can provide limited valuable information at all stages, CCR still is inflated. Of course, it is easier for rating agencies to obtain issuer information, which is conducive to revealing credit risks comprehensively. However, the rating agency has a more significant market reputation in the issuer-pays method, and the influence of the reputation mechanism will improve the CCR quality. Once the reputation of the rating agency is damaged, the quality of the CCR will decrease. On the other hand, rating agencies face both institutional competition pressure and issuers’ high rating expectations, so they tend to provide a higher rating, leading to CCR inflation.

The ‘inverse U’ relationship between enterprise life-cycle and CCR also shows heterogeneity according to the different natures of the firm. Columns (4) of Table 5 and Table 6 show that the ‘inverse U’ relationship is still kept in state-owned enterprises (as show in Figure 4(D) and Figure 5(D)). It is worth noting that, for non-state-owned enterprises, there is a contradiction in columns (5) of Table 5 and Table 6, in which the ‘inverse U’ relationship disappears in Table 5, but is kept in Table 6. Figure 4(E) and Figure 5(E) show the visualization results. The regression coefficients of the enterprise life-cycle in Table 5 are all significant. The corresponding stages of the coefficients sorted in descending are decline, growth, start-up, and maturity (as shown in Figure 4(E)). Among them, the regression coefficient of the decline phase is the highest; companies have a higher probability of obtaining a high credit grade during the phase, which leads to heavier inflation on CCR. To answer the contradiction, we continued to test column (5) of Table 5 after excluding the sample taken for the period of corporate financing stress in Section 4.3.

4.3. Financing pressure: enterprise life-cycle and CCR for the non-state-owned enterprises

The enterprise life-cycle in Section 4.2 is measured by the cash flow method: net cash flow from operating activities, investing activities, and financing. The internal ‘hematopoietic’ here is defined by net cash flow from operating activities and net cash flow from investing activities. Figure 6(A) shows that from 2015 until 2018, non-state-owned enterprises suffered from more cash flow pressure. Meanwhile, the ‘hematopoietic’ ability of non-state-owned enterprises showed a negative trend during the period. Conversely, the cash flow of non-state-owned enterprises faced liquidity difficulties, because it was still negative after the net cash flow of financing had been considered. Therefore, the above phenomenon led to an abnormal partitioning of the enterprise life-cycle based on cash flow.

Figure 6(B) shows that state-owned enterprises do not have the above-mentioned problems. The cash flow measurement of the enterprise life-cycle may cover the ‘inverse U’ relationship, resulting in a contradiction between Figure 4(E) and Figure 5(E). Therefore, it is necessary to exclude the samples taken for the period between 2015 and 2018, and retest column (5) of Table 5. Meanwhile, we retest column (4) of Table 5 to reveal the relationship between enterprise life-cycle and the probability of CCR for different firm natures. The results are shown in Table 7.

The results in Table 7 are consistent with the results in Table 5 and Table 6. For non-state-owned enterprises, the probability of a high CCR presents an ‘inverse U’ characteristic in its life cycle (as shown in Figure 7(A) and (B)). Meanwhile, the feature of the non-state enterprise has some differences from state-owned enterprises. Firstly, non-state-owned enterprises have a more severe problem of inflated ratings. Second, the coefficient is the largest in the growth phase but not mature phase. That is, non-state-owned enterprises are more likely to obtain a high CCR during the growth period. In the growth phase, entrepreneurs and employees are full of self-confidence, and the increased capital income enables the company to expand further and makes external financing easier. In the mature stage, their innovative spirit weakens, affecting their CCR. Here, Hypothesis 2 and Hypothesis 3 are verified.

4.4. Further research: effect on the CCR from the enterprise life-cycle process

In this section, regression discontinuity design is used to test whether there is a grade change when the phase changes. For the non-state-owned corporate or issuer-pays model, the successful transition from the introduction to the growth phase would significantly increase CCR, and the change from maturity to the decline phase would significantly decrease CCR, as shown in Table 8, Figure 8(A)–(E) and Figure 9(A)–(E). So far, Hypothesis 1 is fully verified.

5. Conclusions

Our empirical research finds that: (1) The possibility of high CCR increases as the life-cycle progresses from the introduction to the growth stage and then to the mature stage. From the mature to the decline stage, although the opportunity of a high CCR has pulled back slightly, a high CCR still appears to hold. Concerning whether the CCR's grade changes, companies receive a significant increase in their CCR if they can successfully enter the growth phase. However, the CCR suffers a significant decrease if falling into the decline phase. To sum up, both the possibility of a high CCR and the increase of CCR's grade shows the ‘inverse U’ in the enterprise life-cycle. In particular, in the decline stage, the possibility of a high CCR reaches the minimum in the enterprise life-cycle, but the
opportunity of obtaining a high CCR is still very high. Therefore, CCR generally presents the characteristics of inflation. (2) Around agencies’ business model, the ‘inverse U’ feature disappears in the investor-pays model and keeps in the issuer-pays model. If selecting the investor-pays model, the probability of a low CCR increases in the decline phase. This conclusion is in line with the fact that the credit risk is higher during the decline. Therefore, the investor-pays model can alleviate the problem of falsely high CCR. (3) From the firm’s nature level, both the probability of a high CCR and the magnitude of the CCR increasing are the ‘inverse U’ shapes in state-owned enterprises’ life-cycle, and the CCR’s inflation is lighter. However, the financing pressure exacerbates the inflated CCR of non-state-owned enterprises, which contradicts the profitability of the decline phase but caters to the financing strategy of the decline phase. The above conclusions provide empirical support not only for the use of multimodal ratings but also for improving bond financing of non-state-owned enterprises. At the same time, the following enlightenment is obtained. (1) Strengthening the supervision of CR. (2) Encouraging the synchronous development of the investor-pays and the issuer-pays to achieve the cross-verification of multiple ratings. (3) Broadening the financing channels of non-state-owned enterprises. (4) Improving the risk hedging ability of non-state-owned enterprises in response to their future cash flow uncertainty.

Declarations

Author contribution statement

Yan Huo: Conceived and designed the experiments, The acquisition of data, Performed the experiments, Analyzed and interpreted the data, Wrote the paper.
Bangming Gong: The acquisition of data, Performed the experiments, Analyzed and interpreted the data, Wrote the paper.

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Data availability statement

Data will be made available on request.

Declaration of interest’s statement

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Additional information

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