Analysis of Macroeconomic Factors Affecting the Corporate Bond Yield Spread

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Abstract: **- This paper focuses on the macroeconomic factors that affect the corporate bond yield spread using time-series methods. We find that the PPI (industrial product price) and the CGPI (corporate goods price index) are significant at the 5% confidence level, and we accept the null hypothesis, which is positively correlated with the CGPI. This indicates that price changes are accepted by domestic producers for their output. The industrial cost increases with an increase in industrial product prices, which leads to a higher default risk; thus, investors ask for a higher risk premium, and the corporate bond yield spread increases. We find that the exchange rate is significant in the model. When the Chinese currency appreciates against the US dollar and the RMB is devalued, exports increase and the level of corporate risk decreases; thus, the corporate bond yield spread decreases. However, when the Chinese currency declines against the US dollar, the RMB appreciates, and corporate exports decline. Thus, corporate risk increases, and corporate bond yield spreads increase. The coefficient of VALUE is -0.003844, and it is significant at the 1% confidence level. However, its coefficient is smaller than that of the CGPI, and it has less impact on the corporate bond yield spread. We re-run the regression after adding a dummy variable for the PMI (purchasing managers' index) to the model, and we find that it is negatively correlated with the corporate bond yield spread.**

Keywords: **- spread, CGPI, PPI, exchange rate, PMI**

I. INTRODUCTION

SOMEscholars study the liquidity risk of bond yield spreads. Perraudin(2003) classified bond price data that represent liquidity, including the quote frequency, bond period and circulation, and found that the liquidity premium is an important part of the spread[1]. He found that for high credit rated bonds, the liquidity spread is higher than the risk premium. Acharya(2005) used a simple equilibrium model to examine liquidity risk[2]. He found that the expected returns of bonds depend on the expected liquidity, the covariance of the returns and market liquidity. This approach provides a unified model for understanding the effect of liquidity risk on asset prices. Ericsson(2006) used a structural bond pricing model to examine liquidity and credit risk[3]. He found that repricing during a financial crisis is affected by market illiquidity caused by the debt crisis. When the default probability increases, the illiquidity in the bond spread increases. By using 15-year bond price data, he found that the illiquidity in the bond spread is positively related to the default rate, which supports a declivitous liquidity spread term structure. Chen(2007) indicated that liquidity is contained in the bond spread[4]. He found that bonds with poor liquidity have a higher bond spread, and when liquidity increases, the bond spread decreases. Although he controlled for individual bond factors, corporate factors and macro variables, the results were robust. The results indicated that the bond spread cannot be totally explained by the default risk. Acharya(2010) studied the relationship between corporate bond yields and equity and treasury liquidity[5]. When speculative bond prices decrease, investment grade bond prices increase. This effect is time-varying, and when the economy is in a downturn, the effect is sustained. An economic downturn can be forecast by macroeconomic variables and financial market variables. His model was able to forecast bond yields during the economic downturn of 2008-2009. After controlling for systemic risk, the effects remained robust. The results indicate that corporate bond yields have a time-varying liquidity risk and that liquidity varies. Dick-Nielsen(2010) used the illiquidity method to study the liquidity of corporate bonds before and after the financial crisis[6]. He found that when the financial crisis began, bond illiquidity significantly increased, and bond spreads continuously and slowly increased. When the most important guarantor was badly affected by the financial crisis, bond liquidity worsened. Bonds issued by financial institutions even stopped flowing during the financial crisis. Bongaerts(2011) used an equilibrium asset pricing model and added corporate liquidity risk, derivative products and short positions. He confirmed that when short position holders have more assets, then illiquid assets will produce lower expected returns, and the short position holders have a lower level of risk aversion[7]. The pricing of the liquidity risk of derivative products differs from the pricing of the liquidity risk of positive net assets. The former relies on investors accepting net non-trading risks. The author used the model in the credit default swap market and found that a credit protection seller will obtain the expected liquidity premium. Lin(2011) used cross-sectional data on corporate bonds from January 1994 to March 2009 to study the pricing of liquidity risk[8]. The expected returns on bonds were positively related to β. The results indicate that liquidity risk is an important factor in expected corporate bond returns. The

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recent global financial crisis showed that inner liquidity risk is important to the corporate credit risk, but few researchers have studied the effect on bond spreads. Chen(2011) used panel data from 1993 to 2008 and found that when cash volatility, credit ratings and state variables are controlled, the corporate inner liquidity risk has an important effect on bond spreads[9]. The results indicate that liquidity risk should be included in bond spreads.

Some researchers have studied idiosyncratic volatility and downside risk. Campbell(2003) built an equity idiosyncratic volatility and equity yield regression model, and using panel data, he analyzed the effect of equity volatility on corporate bond yields. The results indicated that equity idiosyncratic volatility and the debt costs of corporate bond issuers are strongly related, and equity volatility explains not only recent corporate bond yield changes but also the increasing trends in future bond yields[10]. Based on a regression with panel data, Gemmill(2011) found that corporate bond spreads are mostly caused by default losses[11]. Although the downside risk was taken into account, the contribution of systemic factors was small. He found that corporate bond spreads and idiosyncratic risk were strongly correlated: the bond spread not only is correlated with equity idiosyncratic volatility but also is strongly correlated with bonds' idiosyncratic volatility and the value of bonds' idiosyncratic risk. Bonds' idiosyncratic volatility can explain the spread because bonds' idiosyncratic volatility could react to corporate value and stand for liquidity. When the value of bonds' idiosyncratic risk increases, the bond spread increases because the value of bonds' idiosyncratic risk contains left-skewness distribution factors for corporate value. Ang(2005) confirmed that the cross-section variation in equity returns responds to the downside risk premium. In particular, when a market decline includes high average returns, the equity strongly changes with the market. He estimated that the annual downside risk premium is 6%[12].

Some analysts have studied equities. Fama(1993) used a five-factor model and identified three equity market factors: the total market factor, the corporate size factor and the equity book-to-market ratio[13]. Additionally, there are two bond market factors: maturity and default risk. The equity market factors influence equity returns, and the three factors are connected to the bond market factors by affecting the variation in bond market returns. The five factors explain both equity and bond returns. Bewley(2004) examined the actual effects of equity volatility on bond spreads by using implied volatility based on option prices and different conditional variance volatilities of the equity market index, and the results indicate that the implied volatility in the options market has no significant effect on bond spreads; however, different conditional variance volatilities of the equity market index have significant and stable effects on bond spreads. As the different variance volatilities increase, bond spreads exhibit a decreasing trend[14]. King(2005) tested the importance of systemic equity market factors in explaining the cross-sectional variation in corporate bond spreads[15]. He found that once the default-related variables are controlled, the ability to explain the risk sensitivity of bonds and the equity market is limited. He found that systemic factors have limited explanatory ability, which indicates that the contingent claim method cannot be fully used. The results indicate that structural models contain determining factors in bond spreads and systemic factors in the equity market. Bao(2008) compared volatility and empirical volatility in the same model and found that large amounts of volatility cannot be explained by the model based on default[16]. He determined that variables related to liquidity are important in explaining the extra volatility in cross-sectional variations, which provides proof of corporate bond liquidity. He also found that extra volatility, which causes residual errors, is important.

Some scholars have examined equity and its impacts on corporate bond yield spreads. Merton (1974) proposed a corporate bond pricing method based on entity economic analysis, which requires inputs during observation. The method can be used to price any financial instrument[17] and is used in risk discount pricing to relieve the interest risk structure. Eom(2004) used an empirical method to test five structural corporate pricing models, including the models developed by Merton(1974), Geske(1977), Longstaff and Schwartz(1995), Leland and Toft(1996), and Collin-Dufresne and Goldstein(2001) [19-22]. He used 182 bond prices that had a simple asset structure from 1986-1997. He found that the Merton model forecasted too low of a spread. However, most of the other models forecasted too high of an average spread. Avramov(2007) explained the variation in corporate credit risk by using a structural model[23]. He found that common factors and standard corporate factors could explain 54% of the credit spread variation. Of all the credit ratings, these factors explain the FF factor. Coval(2007) regarded the main idea behind asset pricing as the bond value determined by the return distribution in the economy and regulated prices in a country[24]. In a fixed-income market, many investors only concentrate on estimates of forecast returns, such as credit ratings. Investors are attracted by bonds that can default only under extreme economic conditions. The author confirmed that many structural financial instruments have characteristics of economic catastrophe bonds, but they have lower returns. He argued that the difference between them is that the credit rating agencies are willing to rate safe products. Schaefer(2008) found that the structural model of credit risk poorly forecasts bond prices[25]. The results indicate that even the simplest structural model can produce a hedging ratio that cannot be produced in a time series test. However, he found that the Merton model does not account for corporate bond rate sensitivity. The paper also confirmed that corporate bond prices are correlated with market factors, such as SMB in FF, and a structural model cannot forecast corporate bond prices. Chen(2011) used bond data from 2001 to 2007 in the US and a structural credit model to study the effect of labor unions on corporate bond spreads[26]. He found that labor union strength has substantial and positive effects on corporate bond spreads. The results indicate that when managers have greater bargaining power, the positive effect weakens. Moreover, volatility in labor union strength has a significantly negative relation with the bond spread and the asset structure. After controlling for the impact of credit ratings, collinearity, the industry and taxes, the results remain robust.

Scholars have also examined the factors driving credit spreads. Collin-Dufresne(2001) used transaction prices and

trader quotes for corporate bonds to study variations in the credit spread. In theory, variables that explain the power of variations in the credit spread are limited[27]. Moreover, regression residuals are highly cross-sectionally correlated, and they are affected by a single common factor. Although he considered macroeconomic and financial variables as alternates, he could not explain the constitution of common system variables. His results indicate that the monthly credit spread variation was primarily caused by partial supply and demand shocks and that such shocks are dependent on credit risk and liquidity. Based on the credit risk theory model, Tsuji(2005) found that the credit worthiness of companies determines credit spreads[28].

Some scholars have studied the default risk of corporate bonds. Huang(2002) examined the proportion of credit risk incorporate bond spreads by using a structural model with a default factor and found that the credit spread accounted for a smaller part in short-duration bonds but a larger part in junk bonds[29]. Amato(2003) believed that only taxes, liquidity and systemic risk cannot be used to explain the corporate spread, and he regarded the idiosyncratic default risk and emergency risk as caused by default[30]. Based on the FF model, Gebhardt(2005) found that when duration, credit rating, maturity and other variables are controlled, the cross-sectional bond yield and default probability are strongly correlated[31]. When the default risk and period factors were controlled, only maturity was correlated with the bond yield. The important finding from the paper is that systemic risk is strongly correlated with corporate bond yields. Dionne(2010) regarded default risk as the cause of corporate bond spreads and used default data to calculate default probabilities[32]. He determined that the estimated default risk of the corporate bond spread was sensitive to the default probability term structure in advance. Tang(2010) studied the interaction between market risk and default risk in corporate bond credit spreads using a new structural model[33]. By using the credit default swap spread, he found that when GDP increases, the average credit spread decreases, but GDP growth volatility and the equity market jump risk increase. He confirmed that default risk is the main part of credit spreads, and macroeconomic variables account for a small part. Giesecke(2011) used data from 1866 to 2008 to study corporate bond defaults[34]. He found that the corporate bond market was hurt more severely by repeated reverse cluster events of default than by the Great Depression. For example, during the railway crisis of 1873-1875, defaults occurred in 36% of the corporate bond market. Using a regime-switching model, he tested whether default probability could be forecasted by financial and economic variables. He found that equity returns, equity volatility and GDP variation are strong predictors of default probability; however, the credit spread was not a strong predictor. In the long term, the credit spread was twice as strong a predictor as the default loss. He also found that the credit spread disagreed with the actual default probability.

Additionally, many researchers have examined the effect of taxes on corporate bond spreads. Elton(2001) tested corporate bond risk premiums by using time series and cross-sectional data and confirmed that default is only a small part of bond spreads, but taxes can explain a considerable portion of corporate bond spreads, and the other factor is systemic risk[35]. Driessen(2005) studied default, liquidity and taxes to empirically determine corporate bond yields. In particular, default events were related to the risk premium[36]. He used the historical default probability and price data on 104 corporate bonds in the US to estimate a density model. Liu(2007) believed that the available default bond term structure model underestimated the corporate bond spread[37]. The potential problem is that the model ignores investors' taxes. He proposed a pricing model to explain the stochastic default probability of premium bonds and discount bonds with different taxes. The results indicate that taxes explain a large portion of corporate bond spreads. Wang(2008) used a generalized liquidity risk model to study the effects of liquidity, default and personal taxes on treasury and municipal bond yields[38]. Jacoby(2009) believed that callable bonds and tax effects should be considered in empirical studies of corporate bond spreads[39]. However, after controlling for callability, the relationship between the risk-free rate and corporate bond spreads remained weak. Landon(2009) A. Sai and N. Kong(2018), P. Maniriho and T. Ahmad(2018), M. Nursalman and A. Sasongko(2017), D. Purevsuren and G. Cui(2017), G. C. Nwachukwu and T. Okor(2018), and S. Lo(2018)studied how much corporate and personal taxes were capitalized in bond prices[40-46].

In all, there are many studies on corporate bonds; however, few scholars specifically examine the effects of macroeconomic factors on corporate bond yields. In this study, we examine these factors, determine their impacts on corporate bond yield spreads, and provide conclusions. This paper includes nine sections. The paper begins with the introduction and a description of the data. Second, we propose the main variables and hypotheses. Then, we explain the ADF and Engle and Granger tests. Next, we conduct our empirical analysis. Based on our analysis, we then describe our conclusions.

II. Data Description

Since 2007, the Shanghai Stock Exchange has had corporate bond transaction data, and the Shenzhen Stock Exchange has had corporate bond transaction data since 2008. From 2007 to 2010, the Shanghai Stock Exchange and Shenzhen Stock Exchange only had a few bonds, and the amounts varied. Thus, the sample size was small, and according to statistics from 2011, there were only 25 corporate bonds that matched the conditions. In 2012, there were 54 corporate bonds that matched the conditions. In order to examine continuous, comprehensive and representative data, in this study, we chose corporate bond transaction data from January 1, 2012, to December 31, 2012. In this study, we removed corporate bonds that were unmatched to treasury bonds and corporate bonds that had less than 1 year to maturity because corporate bonds that have less than 1 year to maturity are more sensitive to interest rates.

After screening, we finally obtained 54 corporate bonds that had sufficient data. Because corporate bond transactions were not very frequent and the amount of data was small, if we chose transaction data for every day, there would be less data, and if we chose transaction data for every month, the dataset would be too small. Thus, following other studies to obtain continuous data, we chose approximately 50 corporate

bonds with weekly transaction data from December 2011 to December 2012.

We obtained data from the Wind database, and the bonds had a simple fixed interest rate. Following Duffee, we divided the bonds into three categories: short-term bonds with 2 to 7 years to maturity, medium-term bonds with 7 to 10 years to maturity, and long-term bonds with a maturity of more than 10 years. In this study, most of the bonds were short term and medium term, whereas only some were long term. Additionally, the bonds can be divided into three ratings: AAA, AA+ and AA. The sample contained bonds from the manufacturing industry, power industry, building industry, mining and quarrying industry, transportation industry, and real estate and service industries. The sample thus covered almost all industries.

III. VARIABLE SELECTION

A. Purchasing managers' index

The purchasing managers' index(PMI) is an economic barometer. In theory, the PMI reflects market variations. By analyzing every subdivision of the PMI and contrasting them with macroeconomic and industry data, the returns are correlated and are consistent. The PMI can serve as a reference for decision makers, and it is very important for investing, business operations and shaping economic policy. The PMI is an international economic monitoring indicator. Many countries perform parallel analyses using the PMI, GDP, producer price index, employment index, new home construction index, stock index and exchange rate and consider the results to determine economic trends, to provide inferences for investment decisions, and for interim research forecasting. The PMI is commonly used by banks, enterprises, governments, financial institutions and the finance media. Currently, there are more than 20 countries that have built PMI systems, and some countries have begun to build global and euro indexes.

The value of fifty percent is critical for the PMI. If the PMI is above 50%, the industrial economy is expanding, and if the PMI is below 50%, the industrial economy is shrinking. We therefore use the PMI as a dummy variable. When it is above 50%, the dummy variable is 1. Otherwise, it is 0. We obtained a new dummy variable series and used it as an independent variable to analyze its impact on corporate bond yield spreads.

B. Producer price index

The producer price index is called the PPI for short. The data show the changes in the producer price index in China for different periods. In China, the producer price index includes more than 400 representative types of goods and more than 700 specific representative types of goods. We used it as an independent variable and analyzed its impact on corporate bond yield spreads.

C. Corporate goods price index

The corporate goods price index is called the CGPI for short. Its sample of representative goods includes 791 types of goods and 1700 specific representative types of goods. To facilitate the analysis, in this study, CGPI values are divided by 100to obtain a new series. We used it as an independent variable and analyzed its impact on corporate bond yield spreads.

D. Industrial sale value

The industrial sale value refers to the total volume of industrial products in monetary form that are produced by an enterprise and sold during the reporting period.

We chose the year-on-year growth rate of the industrial sale value as an independent variable and analyzed its impact on corporate bond yield spreads.

E. Industrial added value

This variable refers to the monetary value derived from enterprises' production and operational activities during a certain period. It reflects an industrial enterprise's developmental state. We chose the year-on-year growth rate as an independent variable and analyzed its impact on corporate bond yield spreads.

F. GDP growth rate

We obtained GDP growth rate data from the Giant database. The GDP growth rate is one of the most important indicators of macroeconomic development. We analyzed its impact on corporate bond yield spreads.

G. Consumer price index

The change rate of the consumer price index reflects the extent of inflation or deflation. In fact, the CPI indicates the price growth percentage, and 2% to 3% is considered acceptable. High rates of economic growth increase the CPI; however, if the price rate growth is higher than the average income growth rate, inflation occurs. The average wage growth rate usually cannot exceed of 3%-4%.

We chose weekly data. We used the CPI from the current week divided by the CPI from the prior week to obtain a new series. We used the CPI as the new consumer price index data. We chose it as an independent variable and analyzed its impact on corporate bond yield spreads.

H. The broad money supply

In macroeconomics, M2 refers to the broad money supply. Monetary aggregates refer to the money in circulation in a country at a certain moment. We chose the M2 year-on-year growth rate as an independent variable and analyzed its impact on corporate bond yield spreads.

I. Exchange rate

We chose the yuan-dollar exchange rate in this study. The exchange rate is the price of one currency expressed in terms of another. In the short run, a country's exchange rate is determined by the country's exchange demand and supply. Activities, such as foreigners buying goods, investing or speculating, will affect the demand for the local currency.

Additionally, activities such as residents buying foreign goods, investing abroad or engaging in exchange speculation will affect the domestic currency supply. In the long run, other factors that affect exchange rates include tariffs and quotas, comparative prices, preferences for domestic goods compared with foreign goods, and productivity.

We chose the yuan-to-dollar exchange rate as an independent variable and analyzed its impact on corporate bond yield spreads.

IV. Basic hypotheses

During the sample period, the entrepreneur confidence exponent, consumer price index and enterprise prosperity exponent were all above 100, which indicates that entrepreneurs and consumers are confident in the economy. This means that the economy is developing well. We could not find a relationship between the macroeconomic factors and corporate bond yield spreads using these factors, so we decided to analyze volatility using a trend graph. In a later regression analysis, we removed this factor. We introduce the factors in the descriptive and statistical analysis.

Hypothesis1: Corporate bond yield spreads are negatively correlated with PMI.

According to other studies, GDP is strongly correlated with PMI, and GDP changes several months after the PMI. The PMI indicates the extent of industrial economic development. In other countries, analysts have researched economic trends by using the PMI, GDP, the PPI, the employment index, the stock index and the exchange rate. Based on the design of the index, we took 50% as the critical value of the PMI. If the PMI rises above 50%, it means that the industrial economy is developing well, and if it declines below 50%, it indicates that the industrial economy is developing slowly. We took the PMI as a dummy variable: if the PMI is above 50%, the dummy variable equals 1, and if the PMI is below 50%, the dummy variable equals 0. We assumed that corporate bond yield spreads are negatively correlated with the PMI. If the industrial economy is developing well, then the macroeconomic situation is better, and fewer corporations default; thus, corporate bond yield spreads will decrease.

Hypothesis2: Corporate bond yield spreads are positively correlated with the PPI.

The PPI is an important index that measures industrial product price changes. We assumed that corporate bond yield spreads are positively correlated with the PPI. If the PPI increases, industrial product prices increase. Thus, the default risk increases, and investors ask for a higher risk premium, which results in an increase in corporate bond yield spreads.

Hypothesis3: Corporate bond yield spreads are positively correlated with the CGPI.

The CGPI reflects the changing prices of enterprise products in a concentrated transaction. It is an important index that measures the enterprises' product transaction prices. Additionally, we assumed that corporate bond yields are positively correlated with the CGPI. If the CGPI increases, then enterprises' product transaction prices increase; thus, the default risk that companies face increases, and corporate bond yield spreads increase.

Hypothesis4: Corporate bond yield spreads are negatively correlated with sales.

In this study, a sale represents industrial sale value, and it reflects the extent of macroeconomic development. If the industrial sale value is constantly increasing, the macro economy is developing well, and companies develop well. Thus, the default risk and credit risk decrease, and corporations provide lower credit risk premiums, resulting in smaller corporate bond yield spreads.

Hypothesis5: Corporate bond yield spreads are negatively correlated with value.

Value refers to the industrial added value, and it represents the development of the macro economy. It is positively correlated with macroeconomic development, and we assumed that corporate bond yield spreads are negatively correlated with sales values. If the macro economy is developing well, then credit and default risks decrease, and investors will ask for a lower credit risk premium; thus, corporate bond yield spreads will become lower.

Hypothesis6: Corporate bond yield spreads are negatively correlated with the GDP growth rate.

GDP is the most direct indicator of macroeconomic development, and many financial research institutes, governments and scholars use it for analyses. We assumed that corporate bond yield spreads are negatively correlated with GDP. If the macroeconomic situation improves, the possibility of corporate default decreases, and investors will ask for a lower risk premium; thus, corporate bond yield spreads will decrease.

Hypothesis7: Corporate bond yield spreads are positively correlated with CPI.

If the CPI increases, it means that consumer expenditures are increasing. Meanwhile, investment expenditures will decrease, and future expectations of uncertainty increase. Thus, the degree of risk aversion increases, and investors will choose low-risk financial products. For the same amount of risk, investors will ask for a higher risk premium, and they will hold fewer corporate bonds, so corporate bond yield spreads will increase. Additionally, if the CPI decreases, product prices will decrease, and interest rates for lending and borrowing will decrease. More capital will flow into corporate bond markets, bond transaction volume will increase, transaction frequency will increase, and bond liquidity will increase; thus, corporate bond yield spreads will decrease. Many scholars take this as an indicator of inflation. We chose it as an inflation factor and assumed that it is positively correlated with corporate bond yield spreads.

Lu(2006) researched the cointegration relationship between the comprehensive bond indexes, CPI and PPI and found that they have a long-term equilibrium relationship.

Hypothesis8: Corporate bond yield spreads are positively correlated with M2.

If the M2 growth rate increases, it indicates that the economy is facing a monetary easing policy. The risk-free rate will decrease in a risk neutral probability, the corporate capital drift rate will decrease, and the possibility that corporate capital value will be below the corporate debt value increases. Thus, the corporate default risk increases, and the corporate bond risk premium increases. Therefore, corporate bond yield spreads are positively correlated with M2.

Hypothesis9: Corporate bond yield spreads are negatively correlated with the exchange rate.

We chose the yuan-dollar exchange rate; if it increases, it means that the external RMB purchasing power has depreciated, which is good for increasing exports. Thus, exports increase, and corporations obtain more benefits. Thus, the credit risk and default risk will decrease, and corporate bond yield spreads will decrease. In contrast, if the yuan-dollar exchange rate decreases, it means that the external RMB purchasing power has appreciated, which is good for imports. Imports increase, corporations that depend on exports benefit less, and the credit risk increases. Thus, corporate bond yield spreads will increase.

V. Descriptive statistics

Table 1shows the descriptive statistics for the corporate bond spread, PPI, CGPI, SALE, VALUE, GDP, CPI, M2 and the exchange rate. From the table, we observe that the mean value of the corporate bond spread is 2.54, the maximum value is 7.28, and the minimum value is -7.04. The mean value of the PPI is 0.98, the maximum value is 1.01, and the minimum value is 0.96. The mean value of the CGPI is 0.98, the maximum value is 1.01, and the minimum value is 0.96. The mean value of SALE is 12.97, the maximum value is 29.00, and the minimum value is 2.50. The mean value of VALUE is 10.88, the maximum value is 21.30, and the minimum value is 8.9. The mean value of GDP is 7.73, the maximum value is 8.06, and the minimum value is 7.40. The mean value of the CPI is 2.61, the maximum value is 4.50, and the minimum value is 1.70. The mean value of M2 is 13.55, the maximum value is 14.80, and the minimum value is 12.40. The mean value of the EXCHANGE RATE is 6.31, the maximum value is 6.34, and the minimum value is 6.29. According to the JB value of every series, we observe that SALE, VALUE, GDP, and CPI reject the null hypothesis at a 10% confidence level, i.e., the series shows a sharp peak and heavy tail and does not obey the normal distribution. The corporate bond spread, PPI, CGPI, M2 and exchange rate accept the null hypothesis, indicating that this series obeys the normal distribution.

To test the multi collinearity of the series, we used the VIF method.

By using stepwise regression, we found that the PPI is the most significant. Thus, we used the PPI as a dependent variable, and the other variables were independent variables. Using a regression, we obtained a VIF value of 1.12, which is much smaller than 10. Thus, the PPI, CGPI, GDP, CPI, exchange rate and M2 have no multi collinearity impacts.

Table 1 Descriptive statistics of the variables

	mean	max	min	Std.	JB	P
Spread	2.54	3.49	1.75	0.48	4.01	0.13
PPI	0.98	1.01	0.96	0.01	2.90	0.23
CGPI	0.98	1.01	0.96	0.02	3.57	0.17
SALE	12.97	29.00	2.50	6.00	30.00***	0.00
VALUE	10.90	21.30	8.90	3.30	125.00***	0.00
GDP	7.73	8.06	7.40	0.26	5.17*	0.08
CPI	2.61	4.50	1.70	0.80	5.4*	0.07
M2	13.6	14.8	12.4	0.58	0.24	0.89
hl	6.31	6.34	6.29	0.01	4.46	0.11

*denotes variables that are significant at the 10% confidence level. *** denotes variables that are significant at the 1% confidence level.

Spread represents the corporate bond yield spread, and PPI represents the producer price index. CGPI represents the corporate goods price index, and SALE represents the industrial sales value. VALUE represents industrial added value, hl represents the exchange rate, and GDP, CPI, and M2 are common abbreviations that we will not explain here.

In Table 1, we present the descriptive statistics of the variables.

VI. ADF unit root test

Table 2 shows the unit root test results. The t value of the spread series is -1.34, and it is greater than the t value at the 1% confidence level at -3.57. It is also greater than the t value at the 5% confidence level at -2.92 and greater than the t value at the 10% confidence level at -2.60. Thus, the spread series accepts the null hypothesis, and it has a unit root. The t value of the PPI series is -2.07, and it is greater than the critical values at the 1%, 5% and 10% confidence levels. Thus, the PPI series accepts the null hypothesis, and it has a unit root. The t value of the CGPI series is -1.80, and it is greater than the critical values at the 1%, 5% and 10% confidence levels. Thus, the CGPI series accepts the null hypothesis, and it has a unit root. The t value of the SALE series is -3.74, and it is less than the t value at the 1% confidence level at -3.57. It is also less than the t value at the 5% confidence level at -2.92 and less than the t value at the 10% confidence level at -2.60. Thus, the series rejects the null hypothesis, and it is a stationary series that does not have a unit root. The t value of the VALUE series is -5.66, which is less than the critical values at the 1%, 5% and 10% confidence levels. Therefore, the VALUE series rejects the null hypothesis, and it is a stationary series with no unit root. The t value of the GDP series is -1.61, and it is greater than the critical values at the 1%, 5% and 10% confidence levels. Thus, the GDP series accepts the null hypothesis, and it has a unit root. The t value of the CPI series is -2.48, which is greater than the critical values at the 1%, 5% and 10% confidence levels. Therefore, the CPI series accepts the null hypothesis, and it has a unit root. The t value of the M2 series is -2.32, which is greater than the critical values at the 1%, 5% and 10% confidence levels. Thus, the M2 series accepts the null hypothesis, and it has a unit root. The t value of the hl series is -0.99, and it is greater than the critical values at the 1%, 5% and 10% confidence levels. Thus, the hl series accepts the null hypothesis, and it has a unit root.

In Table 3, we can observe that the first difference t values of the series Spread, PPI, CGPI, GDP, CPI, M2 and hl are -7.35,-7.14,-7.03,-6.86,-7.03,-6.93and -6.91, respectively, and they are all less than the critical value of -3.57 at the 1% confidence level, the critical value of -2.92 at the 5% confidence level, and the critical value of -2.60at the 10% confidence level. Thus, the seven series are stationary after the first difference.

Table 2 ADF test results of time series

	Spread	PPI	CGPI	SALE
t	-1.34	-2.07	-1.80	-3.74***
p	0.61	0.26	0.38	0.01
1%	-3.57	5%	-2.92	

Continued

	VALUE	GDP	CPI	M2	hl
t	-5.66***	-1.61	-2.48	-2.32	-0.99
p	0.00	0.47	0.13	0.17	0.75
10%	-2.60				

*** denotes variables that are significant at the 1% confidence level.

Spread represents the corporate bond yield spread, PPI represents the producer price index, CGPI represents the corporate goods price index, SALE represents the industrial sales value, VALUE represents industrial added value, hl represents the exchange rate, and GDP, CPI, and M2 are common abbreviations that we will not explain here.

Table 2 shows the ADF test results of the time series.

TABLE 3 ADF TESTS OF UNSTATIONARY TIME SERIES WITH FIRST DIFFERENCE

	D(Spread)	D(PPI)	D(CGPI)	D(GDP)
t	-7.35***	-7.14***	-7.00***	-6.86***
p	0.00	0.00	0.00	0.00
1%	-3.57	5%	-2.92	

Continued

	D(CPI)	D(M2)	D(hl)
t	-7.03***	-6.93***	-6.91***
p	0.00	0.00	0.00
10%	-2.60		

*** denotes variables that are significant at the 1% confidence level.

Spread represents the corporate bond yield spread, PPI represents the producer price index, CGPI represents the corporate goods price index, SALE represents the industrial sales value, VALUE represents industrial added value, hl represents the exchange rate, and GDP, CPI, and M2 are common abbreviations that we will not explain here.

Table 3 shows the ADF test of the unstationary time series with the first difference.

VII. ENGLE AND GRANGER COINTEGRATION TEST

To determine the cointegration relationship between the independent and dependent variables, we used the two-step Engle and Granger(1981) test, called the EG test, and all the variables are integrated in order from 1.

We show the model below:

$$y_t=\alpha+\beta x_t+\varepsilon_t$$

$\hat{\alpha}$ and $\hat{\beta}$are regression coefficients, and the residual errors in the model are

$$\hat{\varepsilon}=y_t-\hat{\alpha}-\hat{\beta}x_t$$

TABLE 4 EG COINTEGRATION TEST

	y_t& *PPI*	y_t& *CGPI*	y_t& *GDP*
$\hat{\alpha}$	-26.22***	-18.68***	-3.68**
	(-8.38)	(-7.40)	(-1.20)
$\hat{\beta}$	29.28***	21.57***	0.80***
	(9.19)	(8.41)	(3.37)
ADF(ε_t)	-1.57	-1.50	-2.32
Prob	0.79	0.82	0.42
R^2	0.63	0.59	0.19

Continued

	y_t& *CPI*	y_t& *M2*	y_t&*hl*
$\hat{\alpha}$	1.24***	10.56***	20.90
	(9.59)	(9.41)	(0.82)
$\hat{\beta}$	0.50***	-0.59***	-2.91
	(10.54)	(-7.12)	(-0.72)
ADF(ε_t)	-2.10	-2.33	-2.16
Prob	0.53	0.41	0.50
R^2	0.69	0.51	0.01

** denotes variables that are significant at the 5% confidence level. *** denotes variables that are significant at the 1% confidence level.

PPI represents the producer price index, CGPI represents the corporate goods price index, hl represents the exchange rate, and GDP, CPI, and M2 are common abbreviations that we will not explain here.

Table 4 shows the EG cointegration test results.

In Table 4, y_t represents the dependent variable series Spread. We can see from the table after the linear regression that the coefficients of PPI, CGPI, GDP, CPI, M2 and the constant term are all significant at the 5% confidence level. We can see from the unit root test of the residual errors of every regression equation that all the residual errors have a unit root, which means that the Spread series and the other series do not have a cointegration relationship.

VIII. EMPIRICAL ANALYSIS BASED ON MACROECONOMIC FACTORS

According to the previous unit root test, we found series of Spread, PPI, CGPI, GDP, CPI, M2 and hl that are not stationary, and they have a unit root. After the first difference, we performed the unit root test and found that the series are stationary. They therefore meet the conditions for time series analysis. Next, we performed a regression analysis.

Based on foreign studies, we built the model below:

$$\begin{aligned}(spread_t-spread_{t-1})=&\alpha_0+\beta_1(ppi_t-ppi_{t-1})+\\&\beta_2(cgpi_t-cgpi_{t-1})+\beta_3(gdp_t-gdp_{t-1})+\\&\beta_4(cpi_t-cpi_{t-1})+\beta_5(m2_t-m2_{t-1})+\\&\beta_6(hl_t-hl_{t-1})+\beta_7 value_t+\beta_8 sale_t+\beta_9\, pmi_t+\varepsilon_t\end{aligned}\quad(1)$$

We performed a stepwise regression and analyzed the impacts of the factors on the corporate bond yield spread.

A. Impact of the price index, GDP, M2 and exchange rate on the corporate bond yield spread

TABLE 5 MODEL REGRESSION RESULTS

Variable Name	Coefficient	STD	T value	Prob.
C	-0.03**	0.01	-2.50	0.02
D(PPI)	34.08**	14.83	-2.30	0.03
D(CGPI)	26.64**	12.44	2.14	0.04
D(GDP)	0.06	0.17	0.33	0.74
D(CPI)	-0.05	0.10	-0.48	0.64
D(M2)	-0.02	0.05	-0.38	0.71
D(HL)	-6.31	4.00	1.58	0.12
R^2	0.22	S.E.	0.09	
F	2.03*	DW	1.95	
Chi2	0.01	Prob	0.93	

** denotes variables that are significant at the 5% confidence level. * denotes variables that are significant at the 10% confidence level.

PPI represents the producer price index, CGPI represents the corporate goods price index, hl represents the exchange rate, and GDP, CPI, and M2 are common abbreviations that we will not explain here.

Table 5 shows the regression results of the model.

In Table 5, we can see that the DW value is 1.95, and it is within 1.8~2.2. Thus, the null hypothesis is accepted, and the result indicates that the model is not first-order correlated. In the last line of the table, the results are shown for the series of autocorrelation tests using the Breusch-Godfrey LM methods. The prob=0.93. Thus, the null hypothesis is accepted, and there is no autocorrelation in the model. Both methods indicate that there is no series autocorrelation in the model, and the model is valid.

The constant term is -0.03, and it is significant at the 5% confidence level. The coefficient of PPI is 34.08, which is significant at the 5% confidence level; thus, the null hypothesis is accepted. The coefficient of CGPI is 26.64, and

it is significant at the 5% confidence level; thus, the null hypothesis is accepted. The results for PPI and CGPI indicate macroeconomic development. The empirical results meet the expectations. When PPI and CGPI increase, industrial costs will increase, and the default risk of corporate bonds will increase. Additionally, the creditor risk will increase, and investors will ask for a higher risk premium due to the increased risk. Thus, the corporate bond yield spread will increase. According to Jerome's (1994) research, unexpected inflation will affect the default risk, but the CPI is not significant.

The coefficient of GDP is 0.06, and it is positively correlated with the corporate bond yield spread; however, the result is not significant. The coefficient of CPI is -0.05, and it is negatively correlated with the corporate bond yield spread, but the result is also not significant. The coefficient of M2 is -0.02, and it is negatively correlated with the corporate bond yield spread, but the result is not significant. The coefficient of HL is 6.31, and it is positively correlated with the corporate bond yield spread, but the result is not significant. The F value is 2.03. Thus, the model is significant at the 10% confidence level. R2 is 0.22, meaning that the model can explain 22% of the variance in the dependent variable.

TABLE 6 REGRESSION RESULTS WITHOUT NONSIGNIFICANT VARIABLES

Variable Name	Coefficient	STD.	T value	Prob.
C	-0.04**	0.01	-2.66	0.01
D(PPI)	33.59**	14.05	-2.39	0.02
D(CGPI)	24.25**	10.01	2.42	0.02
D(HL)	-4.83*	2.59	1.87	0.07
R^2	0.21	S.E.	0.09	
F	4.02**	DW	1.99	
Chi2	0.01	prob	0.95	

** denotes variables that are significant at the 5% confidence level. * denotes variables that are significant at the 10% confidence level.

PPI represents the producer price index, CGPI represents the corporate goods price index, and hl represents the exchange rate.

Table 6 shows the regression results without non significant variables.

From Table 6, we observe that the DW value is 1.99, and it is between 1.8 and 2.2. Thus, the null hypothesis is accepted, which indicates that there is not a first-order correlation in the model. Using the Breusch-Godfrey LM method, the probability is 0.95. Thus, the null hypothesis is accepted, and there is no serial autocorrelation in the model. The above test results mean that the model is valid.

The constant term is -0.03, and it is significant at the 5% confidence level. The coefficient of PPI is 33.59, and it is significant at the 5% confidence level. Additionally, the coefficient of CGPI is 24.25, and it is significant at the 5% confidence level. The coefficient of HL is -4.83, and it is significant at the 10% confidence level. There are a few studies on the impact of the exchange rate on corporate bond yields. Clare et al.(2000) determined that if the exchange rate of the dollar changes, Euro bonds will have a positive risk premium. Katiuscia, Manzoni(2002) researched the exchange rates of the deutschemark and pound and compared them with the dollar and pound. He found that when the pound increases, bond prices in Germany and in America will increase, and solvency and credit will change. Thus, the corporate bond yield spread will increase. In China, Sun(2010) found that when the RMB appreciates, corporations export less, corporate risk increases, the corporate bond yield risk increases, and the corporate bond yield spread therefore increases. Our results agree with these previous studies. When the Chinese currency appreciates against the US dollar and when the RMB devalued, exports increase, corporate risk decreases, and the corporate bond yield spread decreases. In contrast, when the Chinese currency declines against the US dollar, the RMB appreciates, corporations export less, corporate risk increases, and the corporate bond yield spread increases.

In Table 7, we can observe from the White test result that the regression equation is effective, the null hypothesis is accepted, and there is no heteroscedasticity.

TABLE 7 WHITE HETEROSCEDASTICITY TEST

F	0.13	Prob	0.99
*Obs*R-squared*	1.23	Prob	0.99
Scaled explained SS	2.57	Prob	0.96

Table 7 shows the White heteroscedasticity test results.

B. Analysis after adding industrial value and industrial added value factors into the model

In Table 8, we can observe that the DW value is 2.01, and it is between 1.8 and 2.2. Thus, the null hypothesis is accepted, and there is no first-order autocorrelation in the model. Using the Breusch-Godfrey LM method, the probability is 0.89. Thus, the null hypothesis is accepted, and there is no serial autocorrelation in the model. The above test results show that the model is valid.

TABLE 8 REGRESSION RESULTS COMBINED WITH SALE AND VALUE VARIABLES

Variables	Coefficient	T value	Probability
C	-0.01	-0.26	0.80
D(PPI)	34.96**	-2.40	0.02
D(CGPI)	24.60**	2.41	0.02
D(HL)	-4.33	1.55	0.13
SALE	-0.0003	-0.08	0.94
VALUE	-0.002	-0.25	0.80
R^2	0.21	S.E.	0.09
F	2.38*	DW	2.01
Chi2	0.02	probability	0.89

** denotes variables that are significant at the 5% confidence level. * denotes variables that are significant at the 10% confidence level.

Spread represents the corporate bond yield spread, PPI represents the producer price index, CGPI represents the corporate goods price index, SALE represents the industrial sales value, VALUE represents the industrial added value, hl represents the exchange rate, and GDP, CPI, and M2 are common abbreviations that we will not explain here.

Table 8shows the regression results with the SALE and VALUE variables.

After including the industrial value and industrial added value factors in the model, we re-ran the regression, and the results are described below. The constant term is -0.01, and it is not significant. The coefficient of PPI is 34.96, and it is significant at the 5% confidence level. The coefficient of CGPI is 24.60, and it is significant at the 5% confidence level. The coefficient of HL is -4.33; however, it is not significant. The coefficient of SALE is -0.0003, and it is negatively correlated with the corporate bond yield spread. However, it is not significant. The coefficient of VALUE is -0.002, and it is negatively correlated with the corporate bond

yield spread; however, it is not significant. The F value is significant at the 10% confidence level; thus, the model explains the variables well.

In Table 9, we can observe that the DW value is 2.13, and it is between 1.8 and 2.2. Thus, the null hypothesis is accepted, and there is no first-order autocorrelation in the model. Using the Breusch-Godfrey LM method, the probability is 0.57. Thus, the null hypothesis is accepted, and there is no serial autocorrelation in the model. The above test results show that the model is valid.

We removed the non significant variables and re-ran the regression, as described below. The coefficient of PPI is 39.81, and it is significant at the 1% confidence level. The coefficient of CGPI is 23.50, and it is significant at the 5% confidence level. The coefficient of VALUE is -0.004, and it is significant at the 1% confidence level. This means that the industrial added value is negatively correlated with the corporate bond yield spread during the industrial production process. If the industrial value increases by 1 unit, the corporate bond yield spread will decrease by 0.004 units. The industrial added value represents macroeconomic development. If the industrial value increases during the production process, the macro economy develops well, and the corporate default risk will decrease. Additionally, the credit risk will decrease, and the corporate bond yield spread will decrease. However, its coefficient is smaller than that of CGPI, and it has less impact on the corporate bond yield spread.

TABLE 9 REGRESSION RESULTS WITHOUT NON SIGNIFICANT VARIABLES

Variables	Coefficient	T value	Probability
D(PPI)	39.81***	-2.83	0.01
D(CGPI)	23.50**	2.32	0.02
VALUE	-0.004***	-3.36	0.001
R^2	0.17	S.E.	0.09
AIC	-1.94	DW	2.13
Chi2	0.32	probability	0.57

***denotes variables that are significant at the 1% confidence level. ** denotes variables that are significant at the 5% confidence level.

Spread represents the corporate bond yield spread, PPI represents the producer price index, CGPI represents the corporate goods price index, and VALUE represents the industrial added value.

Table 9 shows the regression results without non significant variables.

C. Analysis after adding a dummy variable for PMI into the model

As shown in Table 10, after adding the dummy variable for the PMI into the model, we re-ran the regression and obtained the results described below. The DW value is 2.14, and it is between 1.8 and 2.2. Thus, the null hypothesis is accepted, and there is no first-order autocorrelation in the model. Using the Breusch-Godfrey LM method, the probability is 0.54, and the null hypothesis is accepted. Thus, there is no serial autocorrelation in the model. The above test results show that the model is valid.

The coefficient of PPI is 35.64, and it is significant at the 5% confidence level. The coefficient of CGPI is 20.57, and it is significant at the 10% confidence level. The coefficient of VALUE is -0.002, and it is negatively correlated with the corporate bond yield spread. However, it is not significant. The coefficient of PMI is -0.03, and it is negatively correlated with the corporate bond yield spread, but it is not significant.

TABLE 10 REGRESSION RESULTS COMBINED WITH PMI

Variables	Coefficients	T value	Probability
D(PPI)	35.64**	-2.38	0.02
D(CGPI)	20.57*	1.92	0.06
VALUE	-0.001	-0.63	0.53
PMI	-0.03	-0.85	0.40
R^2	0.18	S.E.	0.09
AIC	-1.92	DW	2.14
Chi2	0.38	probability	0.54

** denotes variables that are significant at the 5% confidence level. * denotes variables that are significant at the 10% confidence level.

Spread represents the corporate bond yield spread, PPI represents the producer price index, CGPI represents the corporate goods price index, VALUE represents the industrial added value, and PMI represents the purchasing managers' index.

Table 10 shows the regression with the PMI series.

As shown in Table 11, the DW is 2.14, and it is between 1.8 and 2.2. Thus, the null hypothesis is accepted, and there is no first-order autocorrelation in the model. Using the Breusch-Godfrey LM method, the probability is 0.56. Thus, the null hypothesis is accepted, and there is no serial autocorrelation in the model. The above test results suggest that the model is valid.

The coefficient of PPI is 32.19, and it is significant at the 5% confidence level. The coefficient of CGPI is 18.30, and it is significant at the10% confidence level. The coefficient of PMI is -0.05, and it is significant at the 1% confidence level. PMI is negatively correlated with the corporate bond yield spread; thus, the null hypothesis is accepted. The PMI is strongly correlated with GDP. Changes in the PMI begin several months before changes in GDP, and it makes more accurate forecasts. Many analysts have examined the macro economy by using the PMI, PPI, employment rate, exchange rate and stock indexes. If the PMI increases, it means that the macro economy is developing well and that corporate default risk will decrease; thus, the corporate bond yield spread will decrease. However, if the PMI decreases, the corporate bond yield spread will increase.

TABLE 11 REGRESSION RESULTS WITHOUT NON SIGNIFICANT VARIABLES

Variables	coefficients	T value	Probability
D(PPI)	32.19**	-2.33	0.02
D(CGPI)	18.30*	1.82	0.07
PMI	-0.05***	-3.42	0.001
R^2	0.17	S.E.	0.09
AIC	-1.95	DW	2.12
Chi2	0.35	Prob	0.56

* denotes variables that are significant at the 10% confidence level. ** denotes variables that are significant at the 5% confidence level. **** denotes variables that are significant at the 1% confidence level.

Spread represents the corporate bond yield spread, PPI represents the producer price index, CGPI represents the corporate goods price index, and PMI represents the purchasing managers' index.

Table 11 shows the regression results without non significant variables.

IX. CONCLUSION

We analyzed the macroeconomic factors that affect corporate bond yield spreads using time series methods. The results are as follows.

We performed a regression using the PMI, PPI, CGPI, SALE, VALUE, GDP, CPI, M2 and the exchange rate. We found that the PPI is significant at the 5% confidence level, and the null hypothesis was accepted. The CGPI is significant at the 5% confidence level, and the null hypothesis was

accepted. It is positively correlated with the CGPI. The PPI and CGPI indicate changes in the prices received by domestic producers for their output. If industrial product prices increase, then industrial costs will increase, which will lead to a higher default risk. Investors will therefore ask for higher risk premiums, and the corporate bond yield spread will increase.

Additionally, we found that the exchange rate is significant in the model. When the Chinese currency appreciates against the US dollar and when the RMB is devalued, exports increase and corporate risk decreases; thus, corporate bond yield spreads decrease. In contrast, when the Chinese currency declines against the US dollar, the RMB appreciates, and corporations export less. Corporate risk increases, and thus, corporate bond yield spreads increase.

After including the industrial value and industrial added value factors in the model, we re-ran the regression and obtained the following results. The coefficient of VALUE was -0.004, and it was significant at the 1% confidence level, which means that increases in industrial value are negatively correlated with corporate bond yield spreads during the industrial production process. If the industrial value increases by 1 unit, corporate bond yield spreads decrease by 0.004 units. Industrial added value indicates macroeconomic development. If the industrial value increases during the production process, then the macro economy is developing well. Thus, the corporate default risk will decrease, and the credit risk will decrease. This means that corporate bond yield spreads will decrease. However, its coefficient is smaller than that of the CGPI, and it has less impact on corporate bond yield spreads.

We re-ran the regression after adding the dummy variable for the PMI to the model. It was negatively correlated with the corporate bond yield spread, and the null hypothesis was accepted. The PMI was strongly correlated with GDP. Changes in the PMI begin several months before changes in GDP, and it makes more accurate forecasts. Many analysts have examined the macro economy by using the PMI, PPI, employment rate, exchange rate and stock indexes. When the PMI increases, the macro economy is developing well. This means that the corporate default risk will decrease, and corporate bond yield spreads will decrease. However, if the PMI decreases, corporate bond yield spreads will increase.

In summary, for investors, if the PPI, CGPI, exchange rate and industrial value increase, the risk for corporate bonds will increase. Therefore, corporate bond yields will increase, which is suitable for investment for risk-biased investors. When GDP and the PMI increase, the risk for corporate bonds will decrease, and the interest rate spread of corporate bonds will also decrease. These periods are suitable for investment for stable investors.

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