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Innovative Drivers towards Credit Evaluation Models for Cross-border Enterprise

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A B S T R A C T

With the rapid development of the digital economy, cross-border enterprises are presented with new development opportunities. However, they also face numerous challenges in credit evaluation. Traditional credit evaluation models, which often faced limitations in information collection, analytical Vigor, adaptability, and predictive accuracy, fail to meet the requirements of cross - border transactions. The study critically examined the challenges posed by cross - border enterprises in credit evaluation in the context of the digital economy. By addressing such challenges, the research proposed a five-dimensional model encompassing financial strength, enterprise quality, management factors, operational capabilities, and the external environment. Each dimension is analyzed to capture the unique attributes and risks associated with cross-border operations, giving a more multidimensional framework for credit evaluation. Also, the study explored practical, acceptable, and innovative pathways for model implementation such as strategies for integrating digital technologies focusing on transparent and predictive accuracy in credit assessments, thereby contributing to the resilience and competitiveness of global enterprises in an increasingly interconnected world.

RESUMO

Com o rápido desenvolvimento da economia digital, as empresas transfronteiriças encontram novas oportunidades de crescimento. No entanto, também enfrentam inúmeros desafios na avaliação de crédito. Os modelos tradicionais de avaliação de crédito, que frequentemente apresentam limitações na coleta de informações, rigor analítico, adaptabilidade e precisão preditiva, não atendem às exigências das transações transfronteiriças. Este estudo examinou criticamente os desafios impostos pelas empresas transfronteiriças na avaliação de crédito no contexto da economia digital. Para abordar esses desafios, a pesquisa propôs um modelo de cinco dimensões que engloba solidez financeira, qualidade da empresa, fatores de gestão, capacidades operacionais e ambiente externo. Cada dimensão é analisada para capturar os atributos e riscos únicos associados às operações transfronteiriças, proporcionando uma estrutura multidimensional para a avaliação de crédito. Além disso, o estudo explorou caminhos práticos, aceitáveis e inovadores para a implementação do modelo, como estratégias para a integração de tecnologias digitais com foco na transparência e precisão preditiva nas avaliações de crédito, contribuindo assim para a resiliência e competitividade das empresas globais em um mundo cada vez mais interconectado.

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Introduction

The scale of the global digital economy has exceeded 5 trillion US dollars (IMF, 2023), and the transaction volume of cross-border e-commerce has reached 6.7 trillion US dollars (Statista, 2023). However, cross-border trade bad debt rates remain alarmingly high at 5%-8% (WTO, 2022). Traditional credit evaluation models exhibit significant deficiencies in multi-dimensional data analysis, dynamic risk assessment, and cross-cultural adaptability, leading to escalating credit risks for international enterprises. Conventional credit systems relying on static financial data demonstrate less than 40% effectiveness in identifying dynamic cross-border risks such as geopolitical shifts and supply chain disruptions (Dun & Bradstreet, 2022).

The deepening digital economy has catalyzed multi-source data integration and intelligent analytics, creating technological foundations for credit evaluation innovation. Representative digital tools like Glent Credit Reports are revolutionizing risk assessment paradigms through five-dimensional modeling, emerging as critical breakthroughs in cross-border risk management. The five-dimensional model proposed in this study can reduce cross-border transaction disputes by more than 10% and improve the timeliness of risk warnings by over 72 hours through a dynamic weight adjustment mechanism (Gladtrust Technical Report, 2023), providing scientific support for the sustainable operation of cross-border enterprises.

Challenges in Credit Evaluation for Cross-Border Enterprises in the Digital Economy

Information Fragmentation

In the era of the digital economy, the methods of information dissemination have undergone profound transformations. Enterprise information is widely scattered across various platforms and channels. For cross-border enterprises, their information not only involves domestic systems such as business registration, taxation, and banking but also spans overseas transaction platforms, social media, industry associations, and other channels. This information exists in diverse formats and standards, distributed across different regions and systems, making unified collection and integration challenging. For instance, transaction data from different cross-border e-commerce platforms, reputation information on social media, and administrative regulatory information published by national authorities all require significant human and material resources to gather and organize, posing substantial challenges to credit evaluation. Information fragmentation may also lead to omissions and inaccuracies, undermining the comprehensiveness and accuracy of credit assessments. Models of recent studies showed there is leverage big data and advanced computational methods on dependency graphs, logistic regression with prejudice removal, fuzzy comprehensive evaluation, and hierarchical analysis in order to improve credit scoring accuracy while

addressing biases against small and medium enterprises (Tian, 2017; Zhong et.al, 2020; Xu et.al, 2023).

Cross-Border Differences

Significant differences in laws and regulations, market environments, and cultural contexts across countries and regions add complexity to credit evaluations for cross-border enterprises. Legally, nations vary in requirements for corporate registration, information disclosure, debt resolution, and other aspects, making it difficult to unify credit evaluation standards. For example, some countries impose strict financial disclosure requirements on enterprises, while others are relatively lenient (World Bank Group, 2023). These disparities must be thoroughly considered during credit evaluations to ensure the rationality of results. In terms of market environments, differences in economic development levels, market competition intensity, and consumer demand characteristics across countries significantly impact enterprises' operational performance and credit behavior. Cultural differences also influence credit practices, such as varying perceptions and prioritization of commercial trust across cultures (Huang, 2022), which shape enterprises' strategic decisions and credit behaviors in different cultural contexts (Huang et.al, 2022).

Real-Time Requirements

The rapid growth of cross-border transactions has heightened the demand for real-time credit information. Under traditional credit evaluation models, the lengthy cycles of information collection and analysis often fail to reflect the latest credit status of enterprises in a timely manner. For example, when enterprises undergo major operational adjustments, financial deterioration, or legal disputes, traditional models may not promptly capture these changes, leaving trading parties exposed to credit risks unknowingly. Given the time-sensitive nature of cross-border transactions, where parties must make decisions swiftly, real-time access to credit information is critical. However, challenges such as the complexity of cross-border data transmission and varying data update frequencies across nations hinder the real-time collection and assessment of credit information.

Transformative Impact of the Digital Economy on Credit Evaluation Models

Traditional credit evaluation relies on financial statements and historical transaction data, which struggle to address the complexity of cross-border scenarios. The digital economy drives innovation in credit evaluation through the following pathways:

1) Diversified Data Acquisition: Transaction data from cross-border e-commerce platforms, user behavior data from social media, and real-time logistics tracking information provide a foundation for multi-dimensional evaluation.

2) Intelligent Analytical Tools: AI algorithms can dynamically identify corporate risk signals. For example, natural language processing (NLP) can analyze corporate sentiment to predict potential compliance risks (Kim & Sohn, 2020).
3) Real-Time Evaluation: Blockchain technology ensures the immutability of supply chain financial data, while IoT devices monitor warehouse and logistics status, improving evaluation timeliness.
4) Enhanced Scenario Adaptability: Customized evaluation weights for different regional markets (e.g., high-compliance requirements in Europe and the U.S., high-growth potential in Southeast Asia) avoid the drawbacks of a "one-size-fits-all" approach.

Methods

This study developed a Five-Dimensional Credit Evaluation Model to examine the credit worthiness of esmall and médium nterprises engaged in digital and cross-border commerce. It integrates financial analytics, behavioral data, governance indicators, operational performance, and macro-environmental risk variables to generate a comprehensive evaluation of corporate credit risk. It utilized financial ratio analysis, big-data integration, and network-based modeling techniques to evaluate the five analytical dimensions, i.e. financial strength, corporate quality, management factors, operational capability, and external environment risk. Each dimension incorporates multiple indicators derived from financial statements, digital transaction data, government compliance databases, and industry-level datasets.

Data Sample and Research Methods

This study selected 500 cross-border B2B enterprises operating between 2020 and 2023 as research samples. These enterprises span 16 industries, including but not limited to electronics, apparel, machinery, and chemicals. The selection of these 500 enterprises was based on their representativeness in cross-border B2B operations, encompassing diverse scales, development stages, and business models. This approach ensures a comprehensive reflection of the overall characteristics of cross-border B2B enterprises, enabling an accurate evaluation of the applicability and effectiveness of the Five-Dimensional Model across different types of enterprises.

Controlled Experiment Design

Credit evaluation was conducted using the Five-Dimensional Model combined with the Gladtrust System. The Five-Dimensional Model comprehensively assesses enterprises across five dimensions: financial strength, corporate quality, management factors, operational capability, and external environment. The Gladtrust System employs advanced technologies, such as multi-source heterogeneous data integration and intelligent algorithm analysis, to achieve precise credit assessments. This combination leverages the comprehensiveness of the

Five-Dimensional Model and the technical advantages of the Gladtrust System, delivering more scientific and accurate evaluation results.

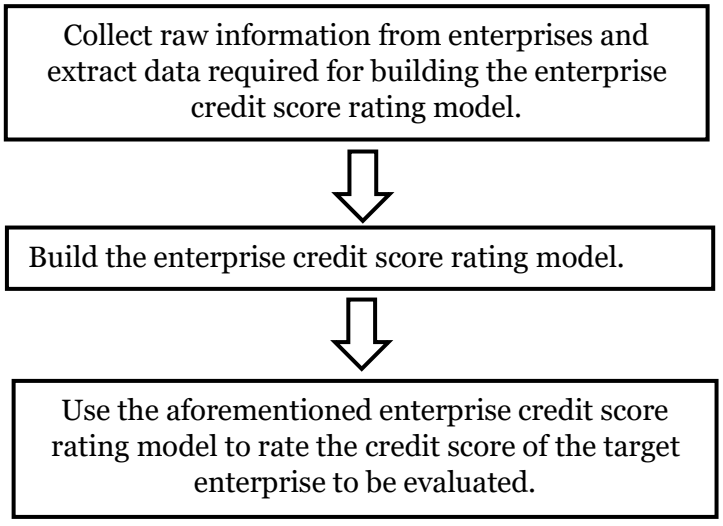
A traditional financial model combined with FICO scores was used. The traditional financial model relies on corporate financial statements and calculates financial ratios (e.g., solvency ratios, profitability ratios) to assess credit risk. FICO scores, widely applied in consumer credit scoring, are based on credit history data. However, in cross-border B2B scenarios, this traditional approach has limitations, failing to fully account for complexities such as geopolitical risks and supply chain stability.

Presentation and Results of Model Construction - Financial Case

The model belongs to the field of corporate credit rating technology, specifically involving a method for generating corporate credit scores using enterprise data. The method includes: collecting raw corporate information, extracting data required to build the credit scoring model, constructing the model, and applying it to evaluate target enterprises. The dimensions for building the model include Corporate Quality (QYPZ), Management Factors (GLYS), Operational Capability (YYNL), External Environment (WBYJ), and Financial Strength (CWSL). By analyzing corporate credit status across multiple dimensions, the model helps users avoid risks. It determines the dimensions influencing credit, assigns scores to each, calculates overall credit scores based on multi-dimensional data, and assigns credit ratings.

Figure 1

Corporate Credit Scores using Enterprise Data



Data Dimension Screening Process

According to current credit rating expertise, known variables related to outcomes should be included in the model without excessive consideration of statistical parameters. The collected data is divided into five dimensions: Financial Strength, Corporate Quality,

Management Factors, Operational Capacity, and External Environment. The fields are as follows:

Table 1.

Fields in Five Dimensions

Coding	Model	Variable
CWSL	Financial Strength	Return on Equity (ROE)
		Gross Margin gross margin
		Net Profit Margin
		Return on Assets (ROA)
		Total Asset Turnover Ratio
		Current Asset Turnover Ratio
		Accounts Receivable Turnover Days
		Debt to Asset Ratio
		Current Ratio
		Operating Revenue Growth Rate
		Operating Revenue Growth Rate
		Total Asset Growth Rate
QYPZ	Enterprise Quality	Tax Payment Grade
		Customs Rating
		Administrative Rewards
		Financing Amount
		Enterprise Ranking List
		Enterprise Status
		Administrative Punishment
		Random Inspection
GLYS	Management Factors	Shareholding Structure
		Strength of Affiliated Companies
		Age of the Principal
YYNL	Operational Capability	Years of Operation
		Number of Employees
		Revenue Scale
		Total Assets
		Trademarks and Patents
		Whether Listed
CWSL	External Environment	Industry Indicators

Table 2

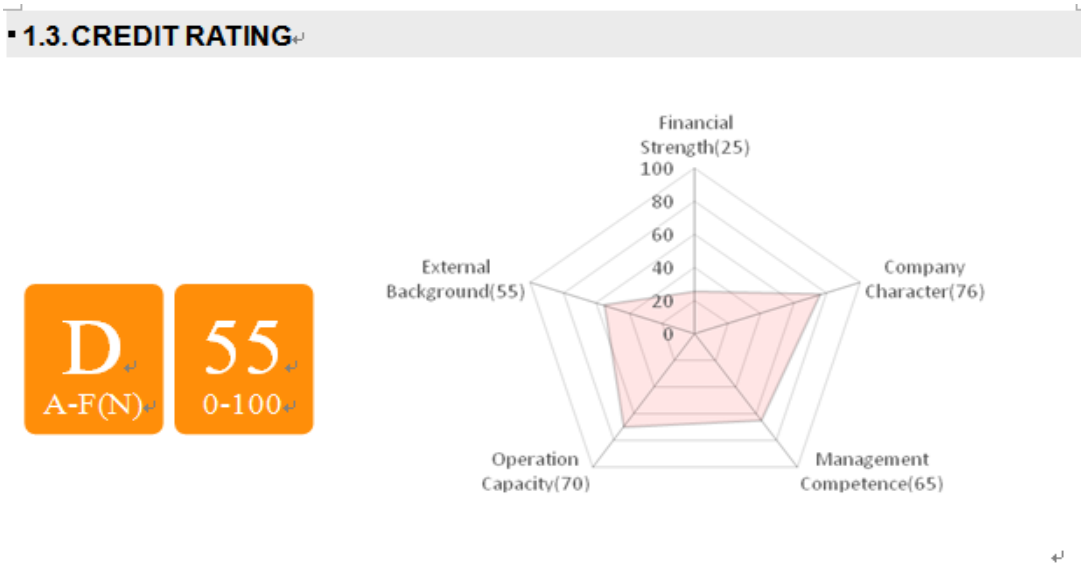
The Final Model Weight Proportions

Dimension	Dimension Analysis
Financial Strength	The financial strength of the target enterprise includes its debt repayment ability, profitability, operational capability, and development capacity, as well as comparisons with corresponding financial indicators in its industry. This aspect accounts for 8%-30% of the analysis.
Enterprise Quality	The quality of the target enterprise is influenced by factors such as transaction records, judicial information, administrative regulatory information, tax payment records, and business status. This aspect accounts for 20%-25% of the analysis.
Management Factors	Management factors encompass the background and strength of the target enterprise's shareholders, the background and strength of affiliated companies, and the experience of the management team. This aspect accounts for 15%-25% of the analysis.
Operational Capability	The analysis of the target enterprise's current operational status includes information on its products, years of operation, employee size, intellectual property, and business scale. This aspect accounts for 15%-20% of the analysis.
External Environment	External factors affecting the target enterprise are analyzed, including the industry it operates in, its geographical location, and the situation of its competitors. This aspect accounts for 10%-15% of the analysis.

Based on the theory of Enterprise Risk Management (ERM), combined with the uniqueness of cross-border trade, a dynamic weighted evaluation system is constructed. Illustration: The overall evaluation of this corporate case is D, with an overall score of 55. The distribution of each indicator is: Financial Strength 25%, Corporate Quality 76%, Management Factors 65%, Operational Capacity 70%, and External Environment 55%.

Figure 2.

Five-Dimensional Model Weight Distribution Diagram



The definitions of GLADTRUST credit ratings are given as follows:

Rating	Score	Risk Level	GLADTRUST Suggestion
A	90-100	Very low	Credit can be extended in rather loose terms
B	80-89	Lower than average	Credit can be extended in normal terms
C	60-79	Average	Credit should be on close monitoring basis
D	20-59	Higher than average	Credit should be avoided as much as possible
F	<20	Very high	Transaction should be on COD basis
N		Undetermined	More information is needed in order to propose a credit rating

Digital Technology-Driven Innovation Pathways

Data Collection Revolution

Cross-border corporate credit evaluation relies on diverse and multi-source heterogeneous data. The integration of such data is a critical step in constructing a precise credit evaluation system. This integration process encompasses various data types, each with unique characteristics, sources, and collection technologies. These elements complement one another, providing a rich informational foundation for comprehensively and accurately assessing cross-border corporate credit.

Table 3

Multi-Source Heterogeneous Data Integration

Data Type	Proportion	Collection Technology
Structured Financial Data	35%	API Direct Connection
Unstructured Text	28%	NLP Parsing
Real-Time Logistics Data	20%	IoT Sensors
Social Media Data	17%	Web Crawlers

Structured financial data (35%): Collected via API direct connections from corporate financiais systems, banks, and other sources to ensure accuracy and timeliness. For example, Gladtrust System has established API interfaces with tax authorities in over 30 countries to automate tax data verification.

Unstructured text data (28%): Sourced from corporate announcements, news reports, etc. Natural Language Processing (NLP) extracts key information such as strategic plans and operational risks. For instance, a BERT-based sentiment analysis module monitors real-time corporate reputation changes on platforms like Twitter and LinkedIn, identifying potential compliance risks (e.g., anti-money laundering keywords). Real-time logistics data (20%): Collected via IoT sensors to track cargo status and warehouse conditions, critical for evaluating supply chain stability and operational efficiency (partial key data requires corporate authorization).

Social media data (17%): Collected via web crawlers to reflect market reputation and consumer feedback, indirectly showcasing corporate influence and brand image. For example, Gladtrust System uses distributed web crawlers to capture user behavior data from platforms like TikTok and Instagram, analyzing consumer preferences to assess sales potential. Over 10 billion data entries have been independently evaluated.

Empirical Analysis

This study focused on three key evaluation dimensions: short-term solvency risk, compliance risk, and supply chain disruption warnings. Comparative results between the experimental and control groups are as follows:

Table 4

Retrospective Testing based on Gladtrust Risk Control Cloud Platform

Evaluation Dimension	Five-Dimensional Model Accuracy	Traditional Model Accuracy	Improvement
Short-Term Solvency Risk	91.2%	73.5%	+24.1%
Compliance Risk	88.7%	51.3%	+72.9%
Supply Chain Disruption Warning	84.9%	62.8%	+35.2%

Short-Term Solvency Risk: The Five-Dimensional Model achieved an accuracy of 91.2%, a 24.1% improvement over the traditional model (73.5%). This enhancement stems from the integration of real-time transaction data from cross-border e-commerce platforms and the dynamic cash flow forecasting model, enabling more precise assessments of short-term solvency.

Compliance Risk: The Five-Dimensional Model demonstrated a significant advantage, achieving 88.7% accuracy compared to the traditional model's 51.3%—a 72.9% improvement. By integrating global compliance databases and NLP-based sentiment analysis, the model identifies potential compliance risks more comprehensively and promptly.

Supply Chain Disruption Warning: The Five-Dimensional Model achieved 84.9% accuracy, surpassing the traditional model's 62.8% by 35.2%. Leveraging real-time logistics data and multi-source supplier ratios, the model effectively monitors supply chain stability and preemptively detects risks, whereas traditional models lack real-time dynamic insights.

Economic Value Calculation

Analysis of real-world data shows that adopting the new credit evaluation system (Five-Dimensional Model + Gladtrust System) reduced average annual bad debt losses per enterprise by $124,000. This reduction is attributed to the system's ability to identify high-risk enterprises more accurately, enabling informed pre-transaction decisions. For example, a cross-border trading company avoided partnerships with several high-risk enterprises through comprehensive Five-Dimensional evaluations, significantly reducing bad debt losses.

Further, the new system dramatically improved operational efficiency. Traditional due diligence required an average of 45 days, while the new system reduced this cycle to 9 days. Automation and intelligent algorithms accelerated data collection, preliminary analysis, and

report generation. For instance, a cross-border e-commerce company completed supplier evaluations in 9 days, enhancing procurement efficiency and seizing market opportunities.

Conclusion

The development of the digital economy has provided opportunities and technological support for innovation in credit evaluation models for cross-border enterprises. However, it has also introduced challenges such as information fragmentation, cross-border disparities, and real-time requirements. The innovative Five-Dimensional Model (financial strength, corporate quality, management factors, operational capability, and external environment) offers a comprehensive and scientific framework for credit evaluation of cross-border enterprises. By deeply applying this model in the context of the digital economy, enterprises can be assessed across multiple dimensions, enabling more accurate judgments of their creditworthiness.

The Five-Dimensional Model integrates digital technology-driven innovation pathways, and conducting rigorous empirical analysis, it achieved a series of significant outcomes. By incorporating trade compliance, supply chain stability, market influence, and external environment into the framework, the study establishes a more comprehensive credit evaluation system tailored to the complexities of cross-border operations. This system not only enriches credit evaluation theory but also provides new perspectives and frameworks for future research in the field.

Leveraging multi-source heterogeneous data integration, intelligent algorithms, and visualization technologies, the study ensures comprehensive data collection, precise analysis, and intuitive result presentation. Innovations include the use of IoT sensing and NLP parsing for data acquisition, ensemble learning and reinforcement learning algorithms for dynamic model optimization, and visualization tools for risk display and decision support. These advancements significantly enhance the scientific rigor and practical effectiveness of credit evaluation.

The results robustly showed the superiority of the new system. Compared to traditional financial models combined with FICO scores, the Five-Dimensional Model achieves substantial improvements in accuracy across key dimensions: short-term solvency risk (+24.1%), compliance risk (+72.9%), and supply chain disruption warnings (+35.2%). Economically, the new system reduces average annual bad debt losses by $124,000 per enterprise and shortens due diligence cycles from 45 days to 9 days, effectively lowering operational risks and enhancing decision-making efficiency.

While this study gained valuable insights, there were limitations remain. Future research should expand the sample scope to include enterprises from emerging markets and niche industries, improving the generalizability of conclusions. Additionally, deeper

exploration of advanced algorithms and digital technologies is needed to continuously enhance the accuracy and timeliness of credit evaluations.

The proposed cross-border B2B enterprise credit evaluation model provides robust support for optimizing credit management and mitigating transaction risks within the industry. It also serves as a critical reference for policymakers and financial institutions in formulating regulations and strategic decisions.

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