

Analysis of Vertical Federated Technology for Effective Financing of Small and Medium-Sized Enterprises Based on Three-Party Evolutionary Game

Huijun Tang

 <https://orcid.org/0000-0002-1142-9959>

Ningbo University of Finance and Economics, China

ABSTRACT

Core enterprises can provide effective assistance for financing small and medium-sized enterprises (SMEs). Promoting data sharing between both parties is of great significance. However, a real issue is that core enterprises may not be willing to share information for SMEs or financial institutions due to concerns about privacy leakage. Vertical federated technology (VFT) considers the privacy protection issues of distributed data and has become an advanced technology for solving distributed data cooperation. But its execution is also influenced by various factors. This article conducts a dynamic evolutionary game analysis of cooperation based on the new technology. A three-party evolutionary game model was constructed. It highlights the influencing factors of the application of VFT in the cooperation for financing of SMEs. The findings indicate that VFT technology can be considered an effective strategy for solving the financing problem of SMEs under specific conditions.

KEYWORDS

Vertical Federated Technology, Data Sharing, Financing of SMEs, Dynamic Evolutionary Game

INTRODUCTION

The development of small and medium-sized enterprises (SMEs) depends upon financial support (Dou et al., 2024; Lu et al., 2020), which is crucial for the growth of enterprises. SMEs typically require a significant amount of funds for development activities. Once product development is completed, SMEs need funds to carry out marketing, establish sales channels, and expand production scale. In such processes, SMEs often encounter cash flow fluctuations (Lu et al., 2021). But the activities of SMEs are often accompanied by high risks and uncertainties; therefore, financial institutions might not be willing to provide them enough financial support. With the development of information technology, especially the advancement of big data technology (Song et al., 2021), the data of SMEs are currently known as the basis and references which can promote effective financing by implementing advanced financing methods, such as credit loans, accounts receivable financing, and so forth.

The mode of supply chain financing (SCF) is a useful way to promote financial support to SMEs based on information technology. SCF uses upstream and downstream business data and financial institutions can effectively reduce risks based on SCF (Wahdan & Emam, 2017). However, it must be pointed out that the heterogeneity of business scenarios, non-standard data formats, and widespread

DOI: 10.4018/IJKM.370317

This article published as an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0/>) which permits unrestricted use, distribution, and production in any medium, provided the author of the original work and original publication source are properly credited.

information silos make it difficult for financial institutions to effectively perceive effective information. Relying solely on the business data of SMEs does not fully gain the trust of financial institutions. Financial institutions may be concerned about the authenticity of enterprise data and about the potential risks of lending to SMEs that do not have outstanding credit. This leads to less lending or no lending. In fact, in the supply chain system, these important business data are mainly concentrated among the core enterprises that provide order to SMEs. According to existing research results, core enterprises are often more likely to gain the trust of financial institutions and obtain funding requirements that meet their own needs (Gelsomino et al., 2022). By using core enterprises as partners for SMEs, and through the effective trust role of core enterprises, SMEs' financing needs will inevitably be met considerably. Relying on the credit of core enterprises in the industrial chain can provide financing information services for upstream and downstream enterprises, but the willingness of core enterprises to share business data may not be strong. The reality is that the core enterprises are unwilling to share information for relevant stakeholders to obtain or know due to problems of operational security and privacy disclosure. Sensitive information related to corporate finance, transaction records, and customer data, once leaked, may result in economic losses and reputational damage. Each country has strict legal requirements for data protection, and companies must comply to avoid legal risks. So the cooperation of the two parties becomes a challenge in the financing process. Effective privacy protection can reduce the risk of fraud caused by data breaches and prevent data tampering or loss; data cooperation based on privacy protection may be an effective way to solve this problem.

The development of data federated learning technology (Yang et al., 2019) provides a new way to settle such cooperation problems. Federated learning is a decentralized approach where multiple parties collaborate to train a shared model while the data is kept localized. Privacy can be effectively protected, and such new method is particularly useful in scenarios where data privacy and security are of utmost importance, such as in healthcare, finance, and mobile applications (Li et al., 2022). There are three kinds of federated learning methods: horizontal federated, vertical federated, and transfer federated. Vertical federated technology (VFT) can be effectively applied to the cooperation between two datasets for one user. For example, a bank and an e-commerce company may have different user data in the same city, and their user groups may have significant overlap. However, due to the different recorded information (banks record users' income and expenditure behavior, while e-commerce companies records users' browsing and purchasing history), their feature spaces differ greatly. Vertical federated learning aggregates these different features in a privacy-preserving manner to jointly build a model. The accuracy of the joint model is definitely more advantageous for various dispersed models. The cooperation between SMEs and the core enterprises is very suitable for this data sharing mode. For example, a financing enterprise may own data such as fixed assets, employees, and accounts receivable, while the core enterprise has historical business data from the financing enterprise, including basic information such as order quantity and amount, as well as financial information such as delayed payment and on-time payment. By vertically aggregating the information of both parties, the data dimension for the financing enterprise is greatly extended, and the attributes are significantly enhanced. For financial institutions, this aggregated information may be more convincing than the information originally owned by the financing enterprise, and financial institutions have greater opportunities to carry out financing for it.

Federated learning has emerged as a promising technology in the supply chain domain, addressing critical challenges related to data privacy, security, and collaboration. In supply chains, multiple stakeholders, such as manufacturers, suppliers, distributors, and retailers, often possess fragmented and sensitive data that cannot be directly shared due to privacy concerns or regulatory restrictions. Federated learning enables these parties to collaboratively train machine learning models without exchanging raw data, thus preserving data confidentiality.

However, in the application process of VFT, it must be noted that due to problems with technical algorithms, implementation environment, data quality, or lack of proactive security measures by federation technology service providers, there may still be risks of data leakage or confusion of

22 more pages are available in the full version of this document, which may be purchased using the "Add to Cart" button on the publisher's webpage: www.igi-global.com/article/analysis-of-vertical-federated-technology-for-effective-financing-of-small-and-medium-sized-enterprises-based-on-three-party-evolutionary-game/370317

Related Content

Relating Knowledge Management Enablers, Knowledge Management Processes, and Organizational Effectiveness: The Case for the Maltese Pharmaceutical Sector

Frank Bezzina, David Baldacchino and Vincent Cassar (2020). *International Journal of Knowledge Management* (pp. 109-124).

www.irma-international.org/article/relating-knowledge-management-enablers-knowledge-management-processes-and-organizational-effectiveness/265248

Understanding Knowledge Sharing Among ICT Professionals: Multiple Models and Empirical Test

Sabah Abdullah Al-Somali and Magesh Nagarajan (2021). *International Journal of Knowledge Management* (pp. 1-27).

www.irma-international.org/article/understanding-knowledge-sharing-among-ict-professionals/288319

Actor-Network Theory and Autopoiesis: A New Perspective on Knowledge Management

Lars Steiner (2009). *Handbook of Research on Knowledge-Intensive Organizations* (pp. 67-79).

www.irma-international.org/chapter/actor-network-theory-autopoiesis/20846

Enterprise Data Warehouse Governance Best Practices

Nayem Rahman (2016). *International Journal of Knowledge-Based Organizations* (pp. 21-37).

www.irma-international.org/article/enterprise-data-warehouse-governance-best-practices/148228

Tacit Knowledge Defined

Peter Busch (2008). *Tacit Knowledge in Organizational Learning* (pp. 34-72).

www.irma-international.org/chapter/tacit-knowledge-defined/30029