Journal of Risk Analysis and Crisis Response, 2024, 14(2), 216-227
https://jracr.com/
ISSN Print: 2210-8491
ISSN Online: 2210-8505

Review

A Review of the Impact of Data Assets on the Operation and Development of Enterprises

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Received: May 31, 2024; Received in revised form: June 17, 2024; Accepted: June 28, 2024; Available online: June 30, 2024

Abstract: To promote the theoretical and empirical research on the impact of data assets on the operation and development of enterprises, this paper reviews the relevant research on the impact of data assets on the operation and development of enterprises. At present, scholars' research on the impact of data assets on the operation and development of enterprises mainly focuses on the impact of data assets on the micro-operation efficiency of enterprises (including: impact mechanism, impact law, impact core), the impact of data assets on the high-quality development of enterprises (including: theoretical logic, impact mechanism), and the impact of data asset information disclosure on the enterprise value (including: impact mechanism, analyst attention). In general, scholars' research on the impact of data assets on the operational risk of enterprises is relatively weak; in addition, scholars have rarely studied the impact mechanism of data assets on the credit risk and debt financing of enterprises. In the context of the digital economy, scholars' theoretical and empirical research on the impact of data assets on the operation and development of enterprises needs to be further deepened.

Keywords: Data Assets; Data Capitalization; Micro-operational Efficiency of Enterprises; High-quality Development of Enterprises; Enterprise Value; Literature Review

1. Introduction

As a new factor of production, data plays a great role in promoting the development of social productivity, improving public governance capacity and improving people's material and cultural life. But not all data factors can become data resources, and not all data resources can become data assets. Data resources are valuable data legally owned or controlled by organizations. In 2009, *The DAMA Guide to The Data Management Body of Knowledge* published by The Data Management Association (DAMA) pointed out: "In the information age, data is regarded as an important enterprise asset." In 2021, *Information Technology Service-Data Asset-Management Requirements (GB/T 40685-2021)* issued by China State Administration of Market Supervision and China National Standardization Administration Committee defined data assets as "data resources that are legally owned or controlled, can be measured, and bring economic and social value to the organization".

In 2023, *White Paper on Data Asset Management Practice (Version 6.0)* issued by Big Data Technology Standards Promotion Committee of China Communications Standards Association

(CCSA TC601) defined "data resource utilization" as: "It is a necessary prerequisite for data capitalization to make data have certain potential value by transforming original data into data resources"; and "data capitalization" is defined as: "By transforming data resources into data assets, the potential value of data resources can be fully released". The essential purpose from data to data resource utilization and then to data capitalization is to make data bring economic benefits to the organization, which is essentially the process of realizing the value of data assets.

From the enterprise level, data assets refer to data resources recorded by physical or electronic means, such as documents and electronic data, which are owned or controlled by the enterprise and can bring economic benefits to the enterprise in the future. In an enterprise, not all data constitute data assets. Data assets are data resources that can generate value for enterprises. The entry of data assets into the statement (referring to the data assets of enterprises are expressed in financial statements in the form of monetization) marks the further acceleration of enterprise data Capitalization, and the impact of data assets on enterprise operation and development will become increasingly prominent.

This paper will review the research status of the impact of data assets on the operation and development of enterprises, in order to further promote the theoretical and empirical research on the impact of data assets on the operation and development of enterprises. The structure of the rest of this paper is as follows: the second part introduces the impact of data assets on the micro-operation efficiency of enterprises; the third part introduces the impact of data assets on the high-quality development of enterprises; the fourth part introduces the impact of data asset information disclosure on the enterprise value; the fifth part is a brief comment.

2. The Impact of Data Assets on the Micro-operation Efficiency of Enterprises

2.1. Impact Mechanism

The core role of data factors in production is to use the valuable information they carry to improve the synergy between labor, capital and other factors, which is also the most typical mechanism for data factors to improve the micro-operation efficiency of enterprises. David and Wright (1999) [1] pointed out when studying the relationship between information communication technology (ICT) and productivity that ICT plays an important role in information generation, storage and transmission, which can enhance the synergy among factors in the production process, reduce the market failure caused by information asymmetry, and help improve the total factor productivity of departments using ICT. The synergy effect of digital technology is essentially that data can be produced, transmitted, processed and analyzed immediately, and effective information can be mined from it and then acted on other factors. In some emerging industries or scenarios, data factors will be more independent or important in the process of production or service provision (Jones and Tonetti, 2020) [2]. The low cost and large-scale availability of data factors make data factors widely used in production activities; the real-time characteristics of data factors are the implicit premise of improving the synergy among other factors. In the era of digital economy, the above basic characteristics and technical-economic characteristics are the basis for data factors to improve the micro-operation efficiency of enterprises by increasing the synergy of other factors (Cai and Ma, 2021; Lv and Li, 2022) [3,4]. Further research shows that exploratory R&D decision-making can promote data factors to empower traditional factors, and the effective integration of them can

significantly improve industrial total factor productivity (Song et al., 2022) [5]. In addition, Shi et al. (2023) [6] believe that the mechanism of improving investment efficiency by improving the utilization level of data factors in enterprise production and operation depends on the intermediary role played by activating redundant resources by using data factors and the adjustment role of enterprises' own absorption capacity.

2.2. Impact Law

Based on the utilization of information value of data factors, the micro-operation efficiency of enterprises is improved, and its improvement speed may show a changing trend of first rising and then falling. In the initial stage, the marginal return of data factors may increase in terms of efficiency improvement and value creation (OECD, 2014; Goldfarb and Trefler, 2018) [7,8]. However, in the long run, the improvement of enterprise micro-operation efficiency and the support of enterprise growth by data factors will also follow the law of diminishing marginal returns (Varian, 2018; Farboodi and Veldkamp, 2021) [9,10]. The extraction and utilization of effective information inherent in data factors can reduce the uncertainty of enterprise operation and is the source of improving the efficiency of data factors. Because the uncertainty state has its upper limit, so does the efficiency improvement caused by data accumulation. Therefore, with the increase of data accumulation scale, the speed of efficiency improvement will continue to decline (Varian, 2018; Farboodi and Veldkamp, 2021; Carriere-Swallow and Haksar, 2019) [9-11]. Although the role of data factors in efficiency improvement and value creation will eventually follow the law of diminishing marginal returns like other factors, this efficiency improvement can make other factors show "marginal return increasing" or "marginal return non-decreasing" to some extent. Under the framework of traditional neoclassical growth economics, this is equivalent to finding a new way to realize endogenous growth through the role of data factors. In addition, the research of Yu and Gao (2023) [12] also found that the data factors follow the law of diminishing marginal revenue in promoting the growth of service industry, and with the passage of time, the promotion effect of data factors on the growth of service industry in China is gradually enhanced.

2.3. Impact Core

The core of data becoming a factor of production and improving the micro-operation efficiency of enterprises lies in the effective extraction and application of valuable information it contains. Therefore, owning data resources only has the potential to transform it into production factors, while the enterprise's own data analysis ability and matching ICT infrastructure are the necessary conditions for data to play the role of production factors and improve the micro-operation efficiency and innovation performance of enterprises (Xie et al., 2020) [13]. In recent years, with the continuous progress of deep learning and artificial intelligence technology, data factors play an increasingly important role in knowledge creation, and then a new mechanism to improve the micro-operation efficiency of enterprises is derived. In many R&D activities, the combination of data factors with artificial intelligence methods such as deep learning can improve R&D efficiency (Cockburn et al., 2018; Agrawal et al., 2018) [14,15]. The improvement of research and development efficiency formed by data factors combined with AI technology means the improvement of knowledge creation efficiency. From the perspective of growth economics, knowledge creation is one of the important reasons for the improvement of production efficiency (total factor productivity). Giving full play to the role of data

factors in knowledge creation also requires enterprises (or R&D institutions) to have strong data analysis capabilities. However, due to the existence of externalities, data factors may realize the non-diminishing marginal output of knowledge creation through economies of scale or scope.

3. The Impact of Data Assets on the High-quality Development of Enterprises

3.1. Theoretical Logic

Data assets can help enterprises to provide new development ideas, build core competence, improve the efficiency of enterprise decision-making, realize demand orientation and reduce the cost of trial and error, thus promoting enterprises to achieve high-quality development (Sun and Chen, 2021) [16]. Its specific promotion role is mainly reflected in the following aspects:

1) Data assets are widely regarded as the fourth kind of production factors, (Gobble and MaryAnne, 2013) [17], which can help enterprises to further clarify and identify the information, knowledge and other factors needed in the development process (Xie et al., 2020) [13]. Therefore, data assets, as the key resources of enterprises, can provide new ideas for the comprehensive and high-quality development of enterprises, stimulate the diversified supply of services, and continuously improve the development quality of enterprises.

2) Data assets can not only identify the resources needed by enterprises, but also effectively transform them into information and knowledge of enterprises. The possession of data assets also shows that enterprises attach importance to the soft power resources such as data, information and knowledge, which provide a richer information base for enterprise decision-making, accelerate and optimize the matching and supply of services (Sun et al., 2019) [18], and then help enterprises build their core competence and rapidly enhance their competitive advantage. As the endogenous driving force for the high-quality development of enterprises, data assets can enable enterprises to effectively cope with and adapt to changes in the environment, conform to the pace of the age, meet the needs of customers and society, improve the financial and non-financial performance of enterprises, create greater social value and achieve high-quality development.

3) Owning relevant data assets within the enterprise and sharing data assets can effectively enhance the interaction between various departments of the enterprise, reduce the linkage cost between departments and improve the decision-making efficiency of the enterprise, so that the enterprise can quickly seize market opportunities (Chen et al., 2020) [19], create richer economic and social values and realize the high-quality development of the enterprise.

4) Enterprises have a large number of non-financial information such as customers and suppliers, which can deepen their understanding of suppliers, customers and competitors, reduce the degree of information asymmetry, improve the efficiency of information transmission, and reduce the time and space distance between enterprises and stakeholders, so that the services provided by enterprises can meet the needs of consumers and realize demand orientation (Chen et al., 2020) [20]. At the same time, effective supply-demand matching can also help enterprises to achieve accurate pricing, and provide an optimized path for high-quality development of enterprises in the economic market, thus promoting enterprises to provide first-class services and effectively improving the development level of enterprises.

5) Data assets can help enterprises make decisions based on facts rather than intuition or experience (Osuszek et al., 2016) [21], so that enterprises can deal with the problems encountered in the

development process more objectively, reduce the uncertainty and trial-and-error cost of enterprise development, and locate the promising development fields accurately and quickly, thus effectively improving the development level and performance of enterprises.

6) As the core production factor in the era of digital economy, data factor is the new engine to drive enterprise innovation. Data assets can not only improve enterprises' willingness to innovate by easing financing constraints, but also strengthen R&D cooperation among enterprises to expand enterprise innovation resources, which is conducive to improving enterprise innovation investment (Li et al., 2023) [22]. The application of data factors promotes the quantitative and qualitative changes of enterprise innovation through the optimization effect of resource allocation and the matching effect of market preference (Ma et al., 2024) [23], thus promoting the high-quality development of enterprises.

3.2. Impact Mechanism

3.2.1. Parallel Mechanism

In the aspect of parallel mechanism, Wang (2021) [24] estimated the growth of unicorn enterprises by OLS regression by selecting 164 unicorn enterprises in China as research samples. The results show that data assets are centered on data technology and data resources, and the stronger the cooperation intensity of unicorn enterprises in algorithm, computing power and data application, the higher their growth potential; Unicorn enterprises realize the use of data assets through the comprehensive use of data technology and data application. The stronger the ability to use data assets, the stronger its growth; Unicorn enterprises have the advantage of data resources, and the marginal value generated by data application is higher than that brought by data technology. The research of Wang (2022) [25] shows that data factors, as separate production factors, can significantly promote the high-quality development of manufacturing industry by directly participating in the whole process of product production. At the same time, the integration of data factors with traditional production factors such as technology factors, capital factors and labor factors has an intermediary effect, which promotes the high-quality development of manufacturing industry and has the greatest impact on capital factors.

Wang and Dong (2022) [26] used the data of 197 listed companies in the cloud computing industry in 2020, and used the measurement methods of least squares and propensity score matching to empirically analyze the impact of data factors on enterprise development. The results show that data factors mainly promote enterprise development by helping enterprises make decisions, improving enterprise production efficiency and expanding enterprise business scope. Lu et al. (2023) [27] empirically investigated the impact of enterprise data assets on their own development and its mechanism by using the sample of A-share listed companies in Shanghai and Shenzhen from 2010 to 2020. It is found that enterprise data assets can significantly improve their own development level. Mechanism analysis shows that this promotion is achieved by reducing the degree of information asymmetry, reducing transaction costs and improving the innovation ability of enterprises. In addition, Zhang et al. [28] think that data factors can improve the development of service-oriented manufacturing in an all-round way through five aspects: data insight to optimize business decisions, software definition to achieve economies of scale, command control to improve flexibility level, real-time data flow to improve service response ability and connection aggregation to realize value multiplication.

3.2.2. Linkage Mechanism

In terms of linkage mechanism, the high-quality development of manufacturing industry is an advanced state in which R&D innovation, production manufacturing and market matching are integrated to achieve more efficient development (Chao et al., 2021) [29]. All aspects of manufacturing industry, such as R&D innovation, production manufacturing and market matching, can provide rich application scenarios for data factors, and the characteristics of data factors are also conducive to their comprehensive penetration into the whole process of manufacturing chain (Jiao, 2020) [30]. Therefore, data factors mainly affect the high-quality development of manufacturing industry from three aspects: R&D innovation effect (Li and Gao, 2016; Guo et al., 2020; Yu and Wang, 2020; Chao and Xue, 2022) [31-34], production synergy effect (Acemoglu and Restrepo, 2018; Xu and Wang, 2021; Wang and Fu, 2021; Wang, 2024) [35-38] and market matching effect (Wang and Zhao, 2014; Yang and Tu, 2017; He, 2020) [39-41]. The research of Chao and Wang (2022) [42] shows that data factors can significantly promote the high-quality development of China's manufacturing industry, mainly through the R&D innovation effect of key technological breakthroughs and knowledge innovation, and the production synergy effect of production process optimization and collaboration, but the market matching effect has not yet fully appeared; The role of data factors in promoting the high-quality development of China's manufacturing industry is more significant in non-state-owned enterprises, high-tech intensive industries and the eastern region. Liu (2024) [43] believes that data assets can significantly promote the high-quality development of enterprises, mainly through the R&D innovation effect of key technological breakthroughs and knowledge innovation, the production synergy effect of production process reorganization and value reconstruction, and the optimal allocation effect of market resources.

4. The Impact of Data Asset Information Disclosure on the Enterprise Value

4.1. Impact Mechanism

In the era of digital economy, data is the key factor of production, and breaking the "data island", fully exploiting the use of data resources and realizing the sharing of data resources have gradually become an important source of value for enterprises. Data assets are an effective driving force to enhance enterprise value, and the upgrading of human capital brought by data assets, that is, the improvement of employees' education level and skill level, is conducive to enhancing enterprise value (Yu et al., 2024) [44]. With data assets gradually becoming an important driver of enterprise value creation, in order to choose the best investment partner, external investors will pay more and more attention to the information of enterprise data assets, such as the data skills talents, technical support situation and data resources scale owned by enterprises and the economic benefits brought by data assets to enterprises. Information disclosure of data assets can not only enhance the transparency of enterprise information, help external investors to know the development status of enterprise data assets, and reduce the risks and information collection costs caused by information asymmetry, but also establish a positive image of enterprises attaching importance to the development of data assets to the outside world, thus attracting resources such as high-quality funds and high-end talents and enhancing enterprise value (Yuan et al., 2022) [45].

As an irreplaceable and hard-to-copy competitive resource, data assets can create economic benefits for enterprises through various ways such as precise marketing, improving management

mode and promoting innovation (Sun and Chen, 2021) [16]. Therefore, the data assets information in the annual report of an enterprise can not only provide private information of the enterprise, but also convey its business philosophy of attaching importance to the development of data assets to the outside world, establish a good corporate image in the outside world, improve market competitiveness, and gain recognition and support from all walks of life. Information disclosure of data assets can improve information transparency, and then promote enterprise value (Liu et al., 2012; Zhang et al., 2020; Tang et al., 2021; Wei et al., 2022) [46-49]. Information disclosure of data assets can attract technical human capital, and then promote enterprise value (Wang et al., 2006; Wu et al., 2021) [50,51]. Information disclosure of data assets can reduce the degree of financing constraints, and then promote the promotion of enterprise value (Botosan, 1997; Lin and Zhang, 2007) [52,53]. Yuan et al. (2022) [45] based on the data of A-share listed companies from 2007 to 2020 and used text mining method to construct data asset information disclosure indicators, and empirically tests the impact of data asset information disclosure on enterprise value and the moderating effect of institutional investors' heterogeneity by using mixed OLS model. The results show that: the more data assets information disclosed by enterprises, the greater the enterprise value; from the perspective of mechanism, information disclosure of data assets can promote enterprise value by improving information transparency, attracting technical human capital and relaxing financing constraints; in addition, pressure-resistant institutional investors play a positive regulatory effect, while pressure-sensitive institutional investors do not play a regulatory effect; the promotion of information disclosure of data assets is particularly significant in enterprises in areas with high level of digital development of financial technology, enterprises with high degree of competition in the industry, enterprises with high-tech attributes and enterprises with high R&D intensity.

4.2. Analyst Attention

Analysts will choose listed companies to follow up and predict according to the information disclosure of enterprise data assets. Barron et al. (2010) [54] believe that when predicting the earnings of companies with a large number of intangible assets, analysts will pay more attention to the private (or special) information of the company itself, including data assets, as a supplement to the company's financial information. At the same time, due to the identifiability of data assets (Zhang et al., 2020) [47], according to the views of Ritter and Wells (2006) [55] , it can be inferred that data assets, as identifiable intangible assets that are valuable to enterprises, are not listed in financial statements at present, but are confirmed by enterprises themselves and voluntarily disclosed in financial reports, so the information of data assets disclosed in financial reports will help to alleviate the lack of value relevance of financial reports. Wei et al. (2022) [49] conducted an empirical study on the impact of data asset information disclosure on analysts' earnings forecast by using Word2Vec neural network model to build a text dictionary to mine the text information in the annual report. The results show that the higher the frequency of data asset information disclosure in an annual report of a stock, the more analysts' reports predicted its earnings per share (EPS) in the following year, and the lower the forecast error of EPS, which indicated that analysts were concerned about data asset information and the disclosure of data assets information can significantly improve the accuracy of analyst's predictions; information disclosure of data assets can improve the accuracy of analysts' forecasts by providing forward-looking information and improving the transparency of individual stock information; the readability of the annual report of individual stocks is high, or when the market is in a bull market, the

increase in the frequency of information disclosure of data assets can further improve the accuracy of analysts' predictions.

5. Brief Comment

At present, scholars' research on the impact of data assets on the operation and development of enterprises mainly focuses on the impact of data assets on the micro-operation efficiency of enterprises (including: impact mechanism, impact law, impact core), the impact of data assets on the high-quality development of enterprises (including: theoretical logic, impact mechanism), and the impact of data asset information disclosure on the enterprise value (including: impact mechanism, analyst attention). In terms of the impact of data assets on the micro-operation efficiency of enterprises, scholars generally believe that the core role of data factors in production is to use the valuable information they carry to improve the synergy between labor, capital and other factors; based on the utilization of information value of data factors, the micro-operation efficiency of enterprises is improved, and its improvement speed may show a changing trend of first rising and then falling; the core of data becoming a factor of production and improving the micro-operation efficiency of enterprises lies in the effective extraction and application of valuable information it contains. In terms of the impact of data assets on the high-quality development of enterprises, data assets can help enterprises to provide new development ideas, build core competence, improve the efficiency of enterprise decision-making, realize demand orientation and reduce the trial and error cost of enterprises, thus promoting enterprises to achieve high-quality development; there are parallel mechanism and linkage mechanism for the role of data assets in the high-quality development of enterprises. In terms of the impact of data asset information disclosure on enterprise value, data asset information disclosure can not only enhance the transparency of enterprise information, help external investors know the development of enterprise data assets, and reduce the risks and information collection costs caused by information asymmetry, but also establish a positive image of enterprises attaching importance to the development of data assets to the outside world, thus attracting resources such as high-quality funds and high-end talents and enhancing enterprise value; at the same time, analysts will choose listed companies to follow up and predict according to the information disclosure of enterprise data assets.

However, scholars' research on the impact of data assets on business risks is relatively weak; in addition, few scholars have studied the impact mechanism of data assets on enterprise credit risk and debt financing. Research shows that data assets are concrete and microscopic forms of property in which data factors participate in social production activities, and their use value and value are not only reflected in value creation links such as data production, data transaction and data application, but also in value utilization and financing links. Data capitalization has a multi-dimensional theoretical basis. Data assets meet the basic conditions of financing and have the characteristics of financing. The legal realization form of data asset financing is pledge. We can refer to the rules of chattel pledge to design and formulate the relevant legal system of data asset pledge (Wang and Li, 2022) [56]. However, due to the characteristics of data itself, the realization of data asset value still faces certain difficulties and challenges. To sum up, under the background of digital economy, scholars' theoretical and empirical research on the impact of data assets on enterprise operation and development needs to be further deepened.

Acknowledgments: This research obtained some technical support from Master Wen-yan Wang in the field of data asset information disclosure.

Funding: This research was funded by the Regional Project of National Natural Science Foundation of China, grant number 71861003.

Conflicts of Interest: The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

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(Executive Editor: Wang-jing Xu)