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The Impact of Blockchain on the Administrative Efficiency of Provincial Governments Based on the Data Envelopment Analysis–Tobit Model

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Abstract: Since its reform and opening up in 1978, China has maintained strong economic growth for more than four decades. For a long time, China's economic growth has been characterized by a crude growth mode, which is mainly manifested in growth driven by large amounts of capital, energy and raw materials, and labor inputs, with little contribution from innovation and technology, which will make it difficult to promote sustainable development in the era of the knowledge economy. On the other hand, improving administrative efficiency is one of the key paths to realizing China's sustainable development strategy. The Chinese government emphasizes high-quality development, and long-term development and stable management can be achieved only if administrative efficiency is improved on the basis of achieving sustainable development. For the purpose of transforming and developing the Chinese government to a higher standard, this study examined how blockchain affects administrative effectiveness across different provinces. The three-stage Data Envelopment Analysis (DEA) model was chosen to evaluate China's regional administrative efficiency. It used the typical markers found in both the international and domestic literature. The input–output indicators were determined using the Delphi method, and the findings showed that while most provinces had reasonably high administrative efficiency, there were notable regional variations. This article empirically employed the Tobit model to examine the effect of blockchain on administrative efficiency based on administrative efficiency calculations. The findings showed that administrative efficiency was significantly impacted by blockchain research investment, blockchain research output, the number of blockchain policies, and the size of the population. In contrast, there was not a significant impact on administrative efficiency due to the quantity of procurements for blockchain government initiatives.

Keywords: sustainable development; blockchain; administrative efficiency; the DEA-Tobit method

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1. Introduction

In today's fast-changing social environment, sustainable development and innovation in administration have become crucial. With the rapid development of science and technology and people's higher demands for the government, inefficient administration brought about by traditional means of governance has directly affected people's satisfaction with the government, and in turn, this has affected the foundation of the government's governance. In 2020, the Fifth Plenum of the 19th CPC Central Committee pointed out that it was necessary to 'improve the state administrative system, to better play the role of the government, and significantly improve administrative efficiency and credibility' and 'further improve the effectiveness of national governance'. Therefore, administration must continue to innovate in order to adapt to sustainable development.

In China, the current management style overemphasizes aspects such as forms, procedures, and regulations, which can easily lead to administrative inefficiency. On the other hand, blockchain construction is being implemented in an orderly manner in various countries around the world and is being applied in many scenarios, such as identity authentication, financial allocation, land registration, healthcare services, and public sector reform. Based on this, the authors propose that the introduction of blockchain technology in government work can help the government to better collect, manage, and utilize data, improve work efficiency and decision-making ability, and thus achieve sustainable development of administration.

Generally speaking, blockchain is a form of distributed ledger technology in which blocks of data are assembled chronologically into a chained data structure that is sequentially linked and cryptographically guaranteed to be tamper-proof and unforgeable.

It is important to note that Distributed Ledger Technology (DLT) is a decentralized system that contains a series of transactions (ledger). The ledger is maintained by a peer-to-peer network of nodes, which use consistency algorithms to synchronize data between nodes in a reliable and attack-resistant manner. The underlying structure of a DLT can be a blockchain, a DAG (Directed Acyclic Graph), a hashmap, or another structure, and the consistency algorithms can be proof-of-work, proof-of-stake, pragmatic Byzantine fault-tolerance, asynchronous Byzantine protocol, and so on. As you can see, DLT technology includes a large class of distributed systems of which blockchain is only a part.

Blockchain was initially designed as the underlying technology for the cryptocurrency Bitcoin. Still, in recent years, blockchain technology and industry have been developing rapidly around the world, and applications have been extended to a variety of fields [1]. Industries such as finance, supply chain, healthcare, and more are exploring its potential to improve efficiency, reduce fraud, and enhance transparency in various processes. The processing of blockchain is shown in Figure 1 [2].

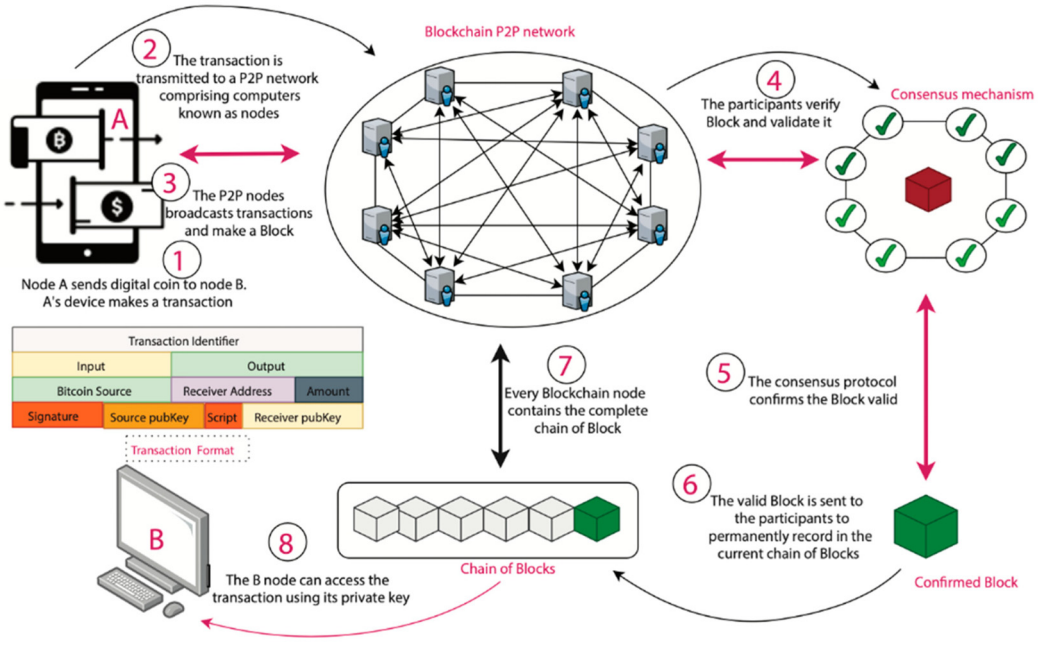


Figure 1. The processing of blockchain. In the figure, both A and B are nodes representing different users, only displayed on their mobile phones and computers respectively.

There is no central administrator or central authority to control all the data-related aspects of blockchain technology [3].

On the one hand, scholars have analyzed the value of blockchain technology, and most scholars believe that blockchain technology has an important value, which is conducive to facilitating information exchange, increasing information transparency, enhancing trace-

ability, and guaranteeing the authenticity of the information. Su proposes that blockchain technology is the fifth most disruptive computing paradigm, following mainframe computers, personal computers, the Internet, and mobile social networking, and that, in the era of Industry 4.0, blockchain technology can be transformed into a sustainable manufacturing paradigm [4].

On the other hand, scholars and enterprises have launched in-depth research on the specific applications of blockchain technology, especially in governmental applications that have spawned many scenarios, which are conducive to the government's efforts to break down the barriers of 'data silos' and realize the sustainable development of administration.

Firstly, China's push for blockchain may also be related to personal information protection. When governments coped with a large amount of data through large-scale computers, it was hard for traditional legislation such as PIPL (Personal Information Protection Law) to handle issues pertaining to the illegal collection and use of personal data. Peng et al. overcame the data-sharing, server-centric approach by suggesting BlockShare as a privacy-preserving, verifiable data-sharing system based on blockchain [5]. Blockchain technology uses encryption algorithms and distributed storage to ensure that data are not easily stolen or tampered with during transmission and storage. In addition, blockchain technology enables decentralized authentication, thus providing a more secure and trusted digital identity authentication mechanism. For example, in 2020, Shaw Hospital, affiliated with Zhejiang University School of Medicine, went live with a blockchain medical application that employed blockchain technology to protect electronic medical records, scientific research, and other data.

Secondly, in supply chain management, governments will want to borrow blockchain technology to guarantee a more adequate and optimal allocation of resources in order to reach the goal of sustainable development. Magnus et al. argued that globalized supply chains cross multiple regulatory boundaries and that the governance of global supply chains faces sustainability requirements for both production and consumption, which can be helped by blockchain [6]. Nir explored the impact of blockchain technology on cost, quality, speed, reliability, risk reduction, sustainability, and flexibility as key supply chain management objectives and provided evidence that the use of blockchain in supply chain activities can improve transparency and accountability and facilitate government regulation [7].

Thirdly, blockchain can help governments improve efficiency for sustainability. For example, Tianjin Port uses blockchain to cross-validate the core fields of multiple trade documents and realize a one-click declaration of enterprise trade information. At the same time, multi-level risk tips are provided for regulators and trading enterprises to help participants accurately control risks in a timely manner and enhance trade efficiency [8]. We can see that the traditional centralized system has never been able to achieve mutual trust and the mutual recognition of data among multiple participants in cross-border trade scenarios, and the credit value of core enterprises cannot be transferred and shared. On the contrary, blockchain can effectively solve the above problems. The land tax department of Jiangsu Province cooperates with the land department to transform the cadastral and property information of enterprises into the land tax information required by the land tax department through blockchain technology, so as to realize the timely monitoring of the land tax information. In addition, the risk model in the system will compare the successfully matched land information and tax source information and push the suspected risk points to the relevant departments for risk management [9]. Wu et al. proposed a government system analysis framework based on a blockchain innovation supply chain, which utilizes blockchain technology to aggregate data dispersed in various nodes into a public ledger to form a public ledger, realizing the real-time sharing and tracing of data [10].

Finally, efficiency improvement itself is also an important manifestation of sustainable development. Li et al. pointed out that the question of the sustainability of OER can be answered from the perspective of cost efficiency in the development of OER by higher education institutions [11]. Yan et al. demonstrated that the implementation of the

Shanghai–Shenzhen–Hong Kong Stock Connect trading system enhanced the total factor productivity of firms, which in turn facilitated the sustainability of firms [12].

As we can see, various countries are promoting the integration of blockchain with government governance. The following are some relevant examples:

The UK government has published 'Distributed Ledger Technology: Beyond Blockchain', which assesses the vast development potential of blockchain technology to transform public and private financial services [13].

In terms of integrating blockchain with government governance, the Estonian government has adopted a decentralized management project for blockchain—Bitnation, which builds blockchain identities for residents through the e-Residents project and provides services such as birth certificates, marriage certificates, business contracts, notarization, and more [14].

The above examples well illustrate the application of blockchain in administration. In order to promote the sustainable development of administration, scholars in various countries have begun to turn their attention to blockchain technology in order to realize the improvement of administrative efficiency.

Lemieux conducted a study on how government relief funds are used, suggesting that the use of blockchain technology can help the government to track where the funds are going and whether they are distributed appropriately, ensuring that government relief and welfare funds are secured and thus ensuring the effectiveness of social service programs [15].

Nordrum et al. compared and analyzed two blockchain government application models in Illinois, the USA, and Dubai. They concluded that blockchain government applications are suitable for public sector reforms with their tamper-proofing, traceability, and high-speed data collection and processing, which can help improve government institutions' efficiency and fairness [16].

Melanie also suggested a number of possible scenarios for applying blockchain technology, arguing that the use of blockchain technology for permanent public records can be more efficient and decentralized, which can help governments offer more personalized government services [17].

The book *Government Applications and Standards to Use Blockchain* mentions that blockchain technology has been applied in fields such as real estate, digital identity, infrastructure management, security and emergency management, and smart contracts, and through examples, blockchain technology can improve the efficiency of providing public services [18].

Another book, *Blockchain in the Global South*, discussed that blockchain could allow government agencies to fulfill their mission and responsibility effectively by managing scarce resources responsibly. What is more, it evaluated various mechanisms and features of blockchain that can help prevent fraudulent and corrupt practices by using specific cases [19].

While scholars in all countries have largely maintained a consensus that blockchain can contribute to administrative efficiency, this consensus unfortunately lacks sufficient data to prove it. Therefore, the authors have continued to look for relevant research and have attempted to use measures of efficiency to evaluate the role of blockchain.

For example, Anne Fleur van Veenstra and Tjerk Timan listed a Public Value Impact Assessment Framework for Digital Governance, which included three layers—policy, organization, and technology—and six categories related to the value of effectiveness—efficiency, social outcomes, openness, ethical behavior, professionalism, and trust. They demonstrated its use by examining three exemplary case studies of public services (OOP for Cross-Border Business, Impact of Disruptive Technology, and Impact of Artificial Intelligence) and drew up the conclusion that in the field of digital government, public value is difficult to reflect in easily measurable indicators, and the effectiveness of technology promotion needs to be seen in the long run [20].

Bitcoin and Ethereum based on Distributed Ledger Technologies such as blockchain as well as applications of machine learning, data science, the Internet of Things, artificial

intelligence, and decision and data visualization became beacons and facilitators for shaping blockchain's next phase. Blockchain improved efficiency and became a routine way for the private sector, non-governmental organizations, governments, and individuals to execute their daily operations [21].

Zhang et al. selected the Productivity Promotion Center as the research sample. They used Stochastic Frontier Analysis to evaluate the improvement of service efficiency of productivity promotion centers with different orientations and the changes in service efficiency of productivity promotion centers affected by the environment [22].

Huang et al. used DEA to analyze the efficiency and influencing factors of rural primary medical and health services in Western China from 2017 to 2019. Their study found that the efficiency of rural direct medical and health services in Western China had improved to a certain extent. Still, the regional and provincial development was unbalanced, and the low pure technical efficiency was the main reason for the low comprehensive efficiency [23].

In addition to studies that focus on blockchain technology-enabled administration, many studies focus on the factors influencing the adoption of district chain technology. For example, Queiroz et al. specifically explored the role of indicators such as performance expectations, social influence, facilitation, blockchain transparency, trust between supply chain stakeholders, behavioral willingness, and behavioral expectations, thus analyzing the adoption behavior of supply chain firms towards blockchain in the context of Indian and US organizations [24].

Wong et al., by collecting and analyzing empirical data from Malaysian SMEs, concluded that competitive pressure, complexity, cost, and related factors have a significant impact on SMEs' adoption of blockchain in operations and supply chain management [25].

Furthermore, Saberi et al. classified the barriers to blockchain technology adoption into four categories: inter-organizational, intra-organizational, technological, and external, and suggested directions to overcome these barriers [26].

Based on the above literature, it is reasonable to believe that a quantitative approach can be utilized to explore the important role of blockchain in the sustainable aspects of administration, especially in the improvement of administrative efficiency.

2. Materials and Methods

2.1. Data Envelopment Analysis (DEA)

The intersection of operations research, management science, and quantitative economics yields Data Envelopment Analysis (DEA). It is typically applied to assess the comparative effectiveness of several homogenous input–output decision-making units (DMUs). Homogeneous DMUs are similar in three ways: first, they have similar activities and objectives; second, they have similar external environments; and third, they have similar input and output indicators. Every DMU has its own economic relevance and fulfills its objectives by transforming inputs into outputs [27].

The DEA approach was introduced by the renowned American operations research scientists Charnes et al. and has undergone continual improvement over the last four decades [28].

The BCC model, which is based on variable returns to scale, and the CCR model, which is based on constant returns to scale, are the two most representative models among them. The CCR model makes the following assumptions: there are n provinces and municipalities, m input and q output indicators, and consistent returns to scale. The best answer to the following linear programming issue is the technical efficiency (TE) of the j_0th area and city as determined by the model:

$$s.t.\begin{cases} Min\theta \\ \sum_{j=1}^{n} \lambda_j X_j + S^- = \theta X_{j0} \\ \sum_{j=1}^{n} \lambda_j Y_j - S^+ = Y_{j0} \\ S^-, S^+, \quad \lambda_j \geq 0 \\ j = 1, 2 \cdots, n \end{cases} \tag{1}$$

The weight vector is represented by $\lambda = (\lambda_j, \lambda_j, \cdots, \lambda_j)^T$ and is in Formula (1). The m-dimensional input column vector of the jth province and municipality is represented by X_j, and the q-dimensional output vector of the jth area and city is represented by Y_j. The j_0th input and output slack variables for province and municipality are represented by S^+ and S^-, respectively [29].

Variable returns to scale have been a growing challenge to government organizational efficiency as the modern administrative system has evolved. To tackle the problem of continuous returns to scale [30], the BBC model adds a convexity assumption based on the CCR model. This leads to the results of pure technical efficiency (PTE) and scale efficiency (SE), and in the end, SE = TE/PTE.

The CCR and BBC models have the following discrimination rules: if $\theta^0 = 1$, then the j_0th province and municipality are considered weak DEA valid; if $\theta^0 \neq 1$, then the j_0th area and city are considered strong DEA good, and all other situations are deemed invalid.

2.2. Stochastic Frontier Analysis (SFA)

The Stochastic Frontier Analysis (SFA) approach is a relatively well-established and frequently utilized parameter for efficiency measurement in efficiency measurement research. This technique builds a specific production function and ascertains the relationships between input, output, and environmental variables to produce a random boundary model with unanticipated errors. The following is the model:

$$Y_i = f(x, \beta) + \gamma_i + \mu_i \tag{2}$$

As indicated by Formula (2), where Y_i stands for output, $f$for the productivity frontier of the x input factor estimation, β for the parameter model, and γ_i for the random disturbance term, μ_i is assumed to follow either an exponential distribution or a censored distribution, in accordance with the normal distribution [31]. This model's error can be separated into two categories: random error γ_i, which is an unpredictable component that can either boost or decrease operational efficiency, and technological inefficiency, meaning that efficiency is only reduced, not increased, by the non-negative error factor denoted by μ_i.

The administrative efficiency values of provincial governments are obtained for the article as a dependent variable using SFA and DEA.

2.3. Tobit Model

There are situations when the dependent variable's value range may be constrained, leading to truncation or deletion. We refer to this type of dependent variable as a confined dependent variable. The organizational efficiency of each provincial and municipal government is the dependent variable in this paper due to the study of the impact of blockchain on administrative efficiency. The dependent variable has a value range of 0–1, consistent with the value characteristics of the restricted dependent variable model. The ensuing bias brought on by conventional regression models can be avoided by using the Tobit model. As a dependent variable-constrained model, the Tobit regression model is more suited for the regression analysis of factors impacting administrative efficacy.

As Formula (3) demonstrates, the Tobit model is a regression model with limited dependent variable values.

$$\begin{cases} y^* = \beta x_i + \mu_i \\ y^* = y_i\ , \quad y^* > 0 \\ y^* = 0\ , \quad y^* \le 0 \end{cases} \tag{3}$$

where y^* is the prospective dependent variable, x_i is the vector of the independent variable, β is the vector of the coefficient, and μ_i is the independent error term that follows a normal distribution.

The prospective dependent variable y^* and the observed data y have the following relationship: When the likely dependent variable has a value of y_i and is more significant than zero, it can be observed. When the value is zero or less, stop at zero.

More generally, Formula (4) illustrates how it can be intercepted on either side of any finite point, as follows:

$$\begin{cases} y_i = c^-\ , \quad y^* \le c^- \\ y_i = y^*\ , \quad c^- < y_i^* < c^+ \\ y_i = c^+\ , \quad c^+ \le y^* \end{cases} \tag{4}$$

3. Empirical Analysis and Results

3.1. Dependent Variable: Administrative Efficiency

3.1.1. Indicator Selection

The foundational task of the complete efficiency evaluation in administrative efficiency evaluation research is the objective and accurate construction of a multi-indicator system, which also establishes the validity and scientific character of subsequent evaluation outcomes.

For instance, He et al. conducted a thorough evaluation of government efficiency using the international mainstream research system and methodologies. 'Government public service', 'government public provision', 'government scale', 'social security', and 'residents' welfare' are the five first-level metrics they established. In terms of government public services, they defined three second-level indicators: 'science, education, culture and health', 'public security service', and 'meteorological service' [32]. Forty-six fundamental indicators were chosen.

Two secondary hands are included in the system of government performance evaluation indicators in the first-level indicators of 'learning and growth' by Wu et al.: 'degree of network informatization' and 'degree of soundness of grassroots organizational structure.' Two second-level indicators are involved in the first-level indicator of 'internal processes': 'efficiency of handling affairs and services' and 'communication and coordination between departments'. Similarly, the second-level indicator of 'administrative operating cost' is involved in the first-level indicator of 'finance' [33].

The principles of operability, sustainable development, emphasizing key points, and combining qualitative and quantitative indicators are among the four considerations that the authors of *Natural Resource Regulation in China* observed to be important when choosing indicators while searching and organizing the literature [34].

Because the public sector's operation and efficiency are closely linked, this article assesses the public sector's efficiency in light of the government's primary functions. Lastly, the secondary indicators have been expanded based on the six significant indicators chosen in this article, which are 'transportation', 'medical and health', 'social security and employment', 'scientific education', and 'general public services'. As a result, there should not be an excessive number of indicators used; otherwise, determining administrative efficiency would be difficult.

To further enhance the indicators, this research employs the Delphi method. Based on an expert's assessment of the scenario or their knowledge of the topic, it is evident that the expert questionnaire can assist the author in narrowing down the topic. As can be seen, both Cr values are more significant than 0.7. Table 1 presents the specific findings.

Table 1. Result table of expert authority level.

Number of Times	Ca	Cs	Cr
1	0.92	0.78	0.85
2	0.88	0.8	0.84

The results of this study's input–output indicators are displayed in Table 2, along with professional judgments and previously conducted literature reviews.

Table 2. Three-stage DEA model indicators.

Primary Indicators	Secondary Indicators	Unit	Data Sources
Input indicators	The number of administrative practitioners	ten thousand people	China National Bureau of Statistics
	General public budgeting expenditures	billion	
Output indicators	Total annual power supply	TWh	
	Three types of patent authorizations	piece	
	Pension insurance coverage rate	%	
	The number of beds per thousand people in hospitals and health institutions	piece	
	Total afforestation area	hectares	
	Actual road length at the end of the year	ten thousand kilometers	
Environment variable	The year-end resident population of each region	ten thousand people	
	The Gross Regional Product	billion	

For the sample period of 2012–2021, this article uses 31 provinces and municipalities nationwide as its research subject.

Two input variables that reflect the sorts of human and capital resources available to the government are the number of administrative practitioners and general public budgeting expenditures.

To represent the core functional divisions of government, we chose the following output indicators: total annual power supply; three types of patent authorizations; pension insurance coverage rate; the number of beds per thousand people in hospitals and health institutions; total afforestation area; and actual road length at the end of the year.

The SFA model's environmental variables are chosen based on the year-end resident population of each region and the Gross Regional Product.

3.1.2. The First Stage Measurement

An input-oriented BCC-DEA model that treated every province and municipality as a decision-making unit was chosen for the first stage. The DEAP-2.1 program was utilized to determine each DMU's administrative efficiency. Owing to space constraints, only administrative efficiency for 2021 is listed in this section; Table 3 displays the precise statistics.

As per the preceding data, Jilin Province has the lowest administrative efficiency of 0.694 and the maximum efficiency of 1. Nine provinces and municipalities make up the efficient portion of the country, which is roughly 29.03%.

Table 3. Results of the administrative efficiency calculations performed in 2021 by different Chinese provinces and municipalities, before the correction.

Province/ Municipality	TE	PTE	SE	RTS
Beijing	0.821	1	0.821	DRS
Tianjin	1	1	1	-
Hebei	0.739	0.753	0.982	DRS
Shanxi	0.875	1	0.875	DRS
Inner Mongolia	1	1	1	-
Liaoning	0.72	0.996	0.723	DRS
Jilin	0.694	1	0.694	DRS
Heilongjiang	0.721	1	0.721	DRS
Shanghai	1	1	1	-
Jiangsu	1	1	1	-
Zhejiang	0.998	0.998	1	-
Anhui	0.929	1	0.929	DRS
Fujian	0.964	0.968	0.995	DRS
Jiangxi	0.813	0.977	0.832	DRS
Shandong	1	1	1	-
Henan	0.803	0.939	0.856	DRS
Hubei	0.986	1	0.986	DRS
Hunan	0.728	1	0.728	DRS
Guangdong	1	1	1	-
Guangxi	0.704	0.734	0.958	DRS
Hainan	0.842	0.853	0.988	DRS
Chongqing	0.947	1	0.947	DRS
Sichuan	0.86	1	0.86	DRS
Guizhou	0.812	0.962	0.844	DRS
Yunnan	0.941	1	0.941	DRS
Tibet	1	1	1	-
Shanxi	0.842	1	0.842	DRS
Gansu	0.862	1	0.862	DRS
Qinghai	1	1	1	-
Ningxia	1	1	1	-
Xinjiang	0.948	1	0.948	DRS
Mean	0.889	0.974	0.914	

3.1.3. The Second Stage Measurement

In the second stage, the author used Frontier-4.1 to establish an SFA regression analysis model for input relaxation variables and environmental variables, considering that the administrative efficiency of decision-making units is influenced by three factors (random interference term, management inefficiency, and environmental variables). This was to highlight the administrative inefficiency caused by management inefficiency [35]. These include the year-end resident population of each region and the Gross Regional Product, as

well as the slack of general public budgeting expenditure and the slack of the number of administrative practitioners.

Owing to space constraints, this section only includes the analysis for 2021. The results of the generalized unilateral likelihood ratio test (LR test) show that, when assessing administrative efficiency, it is appropriate and required to remove the external environment and random confounding factors. All of the test results are greater than the critical value of 8.273, which is significant at 1%.

In addition, the relaxation of the year-end resident population on the number of administrative practitioners and the degree of freedom of general public budgeting expenditure are both significantly positive, indicating that the larger the year-end resident population of each province and municipality, the less favorable it is to reduce the redundancy of inputs of administrative practitioners and general public budgeting expenditure. The reason may be that provinces and municipalities with larger populations require more administrative practitioners for management, which tends to cause the duplication of inputs and a waste of administrative practitioners.

The relationship between the Gross Regional Product of each region and the freedom of general public budgeting expenditure and the number of administrative practitioners is significantly negative, meaning that the higher the Gross Regional Product of each region, the more favorable it is to lower the input redundancy of administrative practitioners and general public budgeting expenditure. This could be the case because it is easier to use creative and intelligent service facilities to reduce the contribution of administrative practitioners and because it is more conducive to lowering general public budgeting expenditures at greater levels of regional economic growth.

The authors removed random interference items, inefficient management, and environmental variables based on the SFA model's regression results. Table 4 illustrates the changes made to the number of administrative staff and the input value of general public budgeting expenditure in 2021. For other years, this also holds true.

Table 4. Table of comparisons between input variables for different provinces and municipalities in 2021 before and after the corrections.

Province/ Municipality	The Number of Administrative Practitioners before the Correction (Ten Thousand People)	General Public Budgeting Expenditure before the Correction (Billion)	The Number of Administrative Practitioners after the Correction (Ten Thousand People)	General Public Budgeting Expenditure after the Correction (Billion)
Beijing	43.6	7205.12	49.44	7248.98
Tianjin	20	3152.55	25.24	3196.47
Hebei	97.4	8848.21	98.61	8862.53
Shanxi	63.3	5046.62	67.07	5080.03
Inner Mongolia	56.5	5239.57	61.13	5278.72
Liaoning	64.1	5879.21	67.46	5909.26
Jilin	39.5	3696.84	43.74	3734.71
Heilongjiang	49.6	5104.81	53.27	5138.78
Shanghai	19.3	8430.86	25.01	8473.51
Jiangsu	93.2	14,585.26	97.47	14,607.34
Zhejiang	80.9	11,014.59	84.64	11,039.97
Anhui	60.2	7591.05	62.69	7613.22
Fujian	51.8	5204.72	56.33	5238.91
Jiangxi	63.1	6778.87	66.33	6807.71

Table 4. *Cont.*

Province/ Municipality	The Number of Administrative Practitioners before the Correction (Ten Thousand People)	General Public Budgeting Expenditure before the Correction (Billion)	The Number of Administrative Practitioners after the Correction (Ten Thousand People)	General Public Budgeting Expenditure after the Correction (Billion)
Shandong	134.9	11,713.16	135.93	11,719.79
Henan	123.1	9784.29	123.10	9788.12
Hubei	76.4	7933.67	79.53	7958.76
Hunan	89	8325.5	91.21	8345.39
Guangdong	154.2	18,247.01	155.20	18,247.01
Guangxi	59.3	5806.54	61.83	5831.65
Hainan	15	1971.37	20.08	2015.64
Chongqing	38	4835.06	42.28	4870.89
Sichuan	110.4	11,215.69	111.51	11,227.27
Guizhou	72.4	5590.01	75.67	5620.73
Yunnan	70.7	6634.36	73.64	6661.76
Tibet	15.4	2027.01	20.82	2074.15
Shanxi	60.7	6069.22	64.43	6101.26
Gansu	50.5	4032.56	54.48	4069.26
Qinghai	15.3	1854.52	20.59	1900.62
Ningxia	11.9	1427.89	17.14	1473.47
Xinjiang	86.1	5376.91	90.31	5414.14

3.1.4. The Third Stage Measurement

In the third stage, the corrected input indicators in the second stage were replaced by the original input indicator data in the first stage, and DEAP-2.1 was used again to analyze the administrative efficiency of China's 31 provinces and municipalities in 2021. The BCC model in the traditional DEA model was still used. Table 5 shows the corrected statistical data.

The number of provinces and municipalities with administrative efficiency changed from 9 to 11, with the two additions being Shandong and Chongqing. Following the modification, 20 provinces and municipalities improved their efficiency values. Pure technological efficiency resulted in higher efficiency values for seven provinces and municipalities. By contrast, the increase in scale efficiency led to higher efficiency values in 19 provinces and municipalities. It is noteworthy that the only province with lower-scale efficiency was Hebei.

Overall, administrative efficiency is relatively good in the 31 provinces and cities. However, there are also noticeable geographical differences in administrative efficiency between different provinces and municipalities. For example, administrative efficiency is very low in the three northeastern provinces. In contrast, the administrative efficiency of coastal provinces such as Guangdong, Shanghai, Jiangsu, Zhejiang, Anhui, and Fujian is very high.

Table 5. Results of the administrative efficiency calculations performed in 2021 by different Chinese provinces and municipalities, after the correction.

Province/ Municipality	TE	PTE	SE	RTS
Beijing	0.852	1	0.852	DRS
Tianjin	1	1	1	-
Hebei	0.743	0.768	0.968	DRS
Shanxi	0.892	1	0.892	DRS
Inner Mongolia	1	1	1	-
Liaoning	0.724	0.996	0.727	DRS
Jilin	0.7	1	0.7	DRS
Heilongjiang	0.729	1	0.729	DRS
Shanghai	1	1	1	-
Jiangsu	1	1	1	-
Zhejiang	0.998	0.998	1	-
Anhui	1	1	1	-
Fujian	0.964	0.969	0.995	DRS
Jiangxi	0.827	0.985	0.84	DRS
Shandong	1	1	1	-
Henan	0.809	0.941	0.86	DRS
Hubei	0.995	1	0.995	DRS
Hunan	0.735	1	0.735	DRS
Guangdong	1	1	1	-
Guangxi	0.71	0.74	0.96	DRS
Hainan	0.891	0.899	0.992	IRS
Chongqing	1	1	1	-
Sichuan	0.876	1	0.876	DRS
Guizhou	0.818	0.963	0.85	DRS
Yunnan	0.951	1	0.951	DRS
Tibet	1	1	1	-
Shanxi	0.852	1	0.852	DRS
Gansu	0.868	1	0.868	DRS
Qinghai	1	1	1	-
Ningxia	1	1	1	-
Xinjiang	0.951	1	0.951	DRS
Mean	0.9	0.976	0.922	

3.2. Independent Variable: Blockchain-Related Variables

3.2.1. Variable Selection

As the current literature has rarely combined blockchain and administrative efficiency, to expand the sample, the authors introduced the concept of 'administration' and analyzed the variables by searching for the subject strings ('factors'), ('blockchain'), and ('administration') in the Core Collection of Web of Science.

The authors searched the content of the 104 papers obtained by the factor statistics, eliminating the invalid literature, and then carefully studied each piece of literature, seeking

all the relevant factors mentioned in the literature affecting the relationship between the blockchain and the administration, as shown in Table 6.

Table 6. Frequency statistics of influencing factors.

Factor	Frequency	Percent
Technology and technology adoption	29	31.52%
Blockchain technology structure, models, etc.	19	20.65%
Government management and policy	18	19.57%
User acceptance	11	11.96%
Information transparency	8	8.70%
Government innovation	7	7.61%

Among them, based on the TOE theory, 'technology and technology adoption' and 'blockchain technology structure, model, etc.' belong to the technology dimension; 'government management and policy' can be categorized as policy support, which belongs to the environment dimension; 'user acceptance' and 'information transparency' can be categorized as the relative advantage of the technology, which belongs to the technology dimension; and 'government innovation' can be categorized as the internal innovation capacity of the organization, which belongs to the organizational dimension.

The above influences may affect whether or not the government adopts blockchain technology. From these factors, the authors tried to extract scientifically available data and ultimately decided to use blockchain research investment, blockchain research output, the number of blockchain policies, the number of procurements for blockchain government projects, and the population size of China's 31 provinces and municipalities as the independent variables. Table 7 describes the specific variables and data sources.

Table 7. Summary of Tobit Model Variables.

Variable Type	Variable	Variable Code	Concrete Content	Data Sources
Dependent variable	Administrative efficiency	y	Comprehensive efficiency value	Based on the results obtained from the three-stage DEA
Independent variable	Blockchain research investment	x_1	Ln (R&D investment in the province and municipality)	Statistical bureaus of various provinces and municipalities
	Blockchain research output	x_2	The number of blockchain patent applications in urban areas of the province	Patent Search and Analysis System of China National Intellectual Property Administration
	The number of blockchain policies	x_3	The number of blockchain-related policies in the province's urban areas	Peking University Magic Treasure Database
	The number of procurements for blockchain government projects	x_4	The number of procurements for blockchain government projects by province and municipality	China Government Procurement Network
	Population size	x_5	Ln (The year-end resident population)	China National Bureau of Statistics

3.2.2. Hypothesis and Model Construction

Several assumptions need to be set before the model is analyzed:

H1: *There is a positive correlation between blockchain research investment and administrative efficiency*.

Generally speaking, provinces and municipalities with more investment in scientific research also have higher investments in blockchain research and a higher level of application of blockchain technology. As an emerging technology, blockchain is decentralized, tamper-proof, trustworthy, and traceable, which is conducive to the government's ability to make good use of big data, break the 'data silo,' and improve the government's administrative efficiency [36].

H2: *There is a positive correlation between blockchain research output and administrative efficiency*.

A high level of blockchain utilization, even if it mainly serves enterprises, will inevitably flow into the government application field, and it is more likely to enhance the possibility of local government data disclosure. For example, based on blockchain technology, the government can achieve the maximum degree of transparency of public welfare charity to improve the credibility of public welfare charity organizations [37]. Therefore, blockchain research output is an essential factor affecting administrative efficiency.

H3: *There is a positive correlation between the number of blockchain policies and administrative efficiency*.

The more blockchain policies there are, the more attention and importance the government pays to and attaches to blockchain development, hoping to achieve regional economic growth through blockchain technology. The more economically developed the region, the higher the demand for government service levels. In general, the more blockchain policies there are, the higher the administrative efficiency of the government.

H4: *There is a positive correlation between the number of procurements for blockchain government projects and administrative efficiency*.

The more procurements for blockchain government projects, the higher the level of the government's application of blockchain in the field of government affairs. For example, in 2020, Hainan completed the full-process application of blockchain financial bureau e-bills and issued more than 2.3 million e-statements in the first quarter, involving assets of RMB 3.2 billion, which significantly improved the efficiency of government invoicing [38].

H5: *There is a positive correlation between population size and administrative efficiency*.

Generally speaking, areas with a larger resident population have a greater demand for public services provided by the government and are more conducive to administrative efficiency.

According to Table 6 and the five hypotheses, the Tobit regression equation is as follows:

$$y_{it} = \beta_0 + \beta_1 x_{1,it} + \beta_2 x_{2,it} + \beta_3 x_{3,it} + \beta_4 x_{4,it} + \beta_5 x_{5,it} + \mu_{it} \quad (5)$$

Among them, β_0 is a constant term, β_1, β_2, β_3, β_4, and β_5 are the coefficients of each explanatory variable, with subscripts i and t representing region and year, respectively, and μ_{it} is a random error term.

By analyzing the data for ten years, the authors obtained the maximum and minimum values of administrative efficiency: 1 and 0.2, respectively. The specific data of other variables are detailed in Table 8. Meanwhile, the data of each province and city in terms

of blockchain are also relatively different, so it is necessary to specifically analyze the degree of influence and the effect of each province and municipality's own situation on administrative efficiency.

Table 8. Descriptive statistics of Tobit model variables.

Name of Variable	Sample Size	Mean	Standard Deviation	Minimum Value	Maximum Value
y	310	0.85	0.17	0.20	1.00
x_1	310	5.53	1.53	0.59	8.29
x_2	310	41.94	138.33	0.00	1097.00
x_3	310	0.20	0.66	0.00	6.00
x_4	310	10.07	56.39	0.00	641.00
x_5	310	8.13	0.84	5.75	9.45

3.3. Multicollinearity Test

The research period of this paper is ten years, and the data are panel data, so no linearity test is needed. However, to ensure the reliability of the results, a multicollinearity test is required. We know that the covariance of independent variables can be tested by the variance inflation factor (VIF). When VIF ≤ 10, the covariance problem can be ignored. To ensure the stability and accuracy of the Tobit regression model, the variance inflation factor (VIF) method will be used in this section to detect the covariance between the independent variables (Table 9).

Table 9. VIF test.

Variable	VIF	ONE/VIF
x_1	3.82	0.261834
x_2	3.13	0.319205
x_3	1.99	0.501756
x_4	1.42	0.705103
X_5	1.41	0.709365
Mean VIF	2.35	

The results show that the maximum value of the VIF for the independent variables is 3.82, and the minimum value is 1.41, which is much less than 10, so it can be concluded that there is no multicollinearity between the independent variables in the Tobit regression model.

3.4. Empirical Results and Analysis

When counting the statistics, the authors found that the data on blockchain in China from 2012 to 2016 are missing; in fact, it was only in October 2016 that China's Ministry of Industry and Information Technology released the first official document about the development of blockchain technology: 'White Paper on the Development of China's Blockchain Technology and Applications (2016)'. Therefore, we only took the data from 2017 to 2021 for the random-effects Tobit regression analysis. The results are shown in Table 10.

Table 10. Regression results of the Tobit model.

Variable	Value
x_1	0.0577398 *** (2.69)
x_2	0.0003761 *** (2.63)
x_3	0.0104702 ** (2.55)
x_4	0.0002871 (0.08)
x_5	0.3145285 ** (2.35)
_cons	1.830676 *** (4.99)
N	155
Waldchi2(5)	23.85
Prob > chi^2	0.0001
Log-likelihood	111.54339

Note: Values in brackets in the table are standard errors. *, **, and *** are significant at 10%, 5%, and 1%, respectively.

3.5. Robustness Test

To test the robustness of the Tobit regression model created, this test used the scale efficiency value (SE) instead of administrative efficiency (y) as a new dependent variable and established the following Tobit model for regression analysis:

$$SE_{it} = \beta_0 + \beta_1 x_{1,it} + \beta_2 x_{2,it} + \beta_3 x_{3,it} + \beta_4 x_{4,it} + \beta_5 x_{5,it} + \mu_{it} \quad (6)$$

SE is the scale efficiency of DEA in the third stage, and other variables remain unchanged. The results are shown in Table 11.

Table 11. Robustness test regression results.

Variable	Value
x_1	0.0190841 *** (2.84)
x_2	0.000353 *** (2.67)
x_3	0.0149654 ** (2.53)
x_4	0.0009253 (0.17)
x_5	0.0882341 ** (2.09)
_cons	1.56373 *** (5.82)
N	155
Waldchi2(5)	14.16
Prob > chi^2	0.0146
Log-likelihood	78.371058

Note: Values in brackets in the table are standard errors. *, **, and *** are significant at 10%, 5%, and 1%, respectively.

It can be seen that the regression results of the respective variables are in the same direction as the coefficients of the original model. Although the significance levels of some of the variables have decreased, the results show that the significance levels of most of the variables are still around 1% or 5%. This indicates that the test results are stable, and the constructed Tobit model is relatively robust and can explain the natural government administration phenomenon to a certain extent.

4. Conclusions

In fact, the government, in the process of governing each subject and its external environment and specific operational processes, constitutes a large and complex adaptive system (CAS). It is inevitable that the government will pay attention to the frequent changes and development of the external environment, such as the economy and technology, in promoting the improvement of administrative efficiency. Therefore, we believe that the evaluation of administrative efficiency cannot be limited to separate blockchain factors; economic, demographic, and other factors closely related to the evaluation of the sustainable development of administrative science and management should also be taken into account.

In this process, the authors centered on the fundamental goal of sustainable development, based on the MWS system; constructed an effective evaluation model of administrative efficiency through the Delphi method and the DEA method; and concluded that the administrative efficiency of the local government is significantly affected by external environmental factors such as the population size and the economic level, and there is still a lot of room for improvement.

In addition, in the process of targeted system analysis, the authors refined the common factors found in the literature, and the study concluded that:

Firstly, most independent variables are significant results in the time range of 2017–2021. Among them, blockchain research investment and blockchain research output are positively correlated with administrative efficiency at the significance level of 1%, which indicates that research on blockchain technology can encourage the government to improve its administrative efficiency continuously. Therefore, null hypothesis H1 and null hypothesis H2 are valid.

Secondly, the number of blockchain policies positively correlates with administrative efficiency at the significance level of 5%. It can be seen that the number of blockchains represents the government's attachment of importance to blockchain and also promotes the application of blockchain in government affairs, thereby improving the government's administrative efficiency from top to bottom. Therefore, the original hypothesis H3 is valid.

Thirdly, the number of procurements for blockchain government projects cannot pass the significance test, which proves that when there are more procurements there are for blockchain government projects, there will be a corresponding improvement in administrative efficiency. This shows that the variable has a certain degree of persuasion, but the influence is not apparent enough, and the effect is not comprehensive. Perhaps the reasons are as follows: Most of the procurement projects on the Chinese government procurement website concerning the application of blockchain are from scientific research institutes and universities and are not directly applied to government affairs, and less data may affect the construction of the model. In addition, implementing a project often takes several years, and the results presented by the data have a lag.

Lastly, population size is positively correlated with administrative efficiency at the 1% significance level, which shows that an increase in population size can somewhat enhance administrative efficiency. It is assumed that this is because places with large populations have higher requirements for government administrative efficiency. In addition, with the deepening of urbanization, human capital, education, science and technology, public services, and other resource elements being concentrated in cities, this generates a spatial aggregation effect, thus promoting local economic development and affecting administrative efficiency.

To verify the reliability of the results, we employed a robustness test, which demonstrated that the results were reliable.

Based on the above conclusions, the Chinese government needs to accelerate special investment in blockchain, promote the transformation of the results, and finalize the laws and regulations in order to advance the application of blockchain in government affairs and promote sustainable development.

5. Discussion

5.1. Academic Implications

This paper improves existing research from an innovation perspective and expands and enriches the existing theoretical framework.

Firstly, it improves the relevant research on government administrative efficiency. As of 1 April 2023, a search through the topic of 'blockchain and administrative efficiency' in China showed only a few pieces of research, indicating that there is still a great lack of research on this issue in Chinese academia. The exploration of administration based on the application of blockchain technology is conducive to breaking the unidirectional and one-dimensional thinking framework of traditional administration. It provides a new direction for the government to improve administrative efficiency.

Secondly, it expands the scope of research on the application of blockchain technology. While enjoying the tangible economic benefits brought about by blockchain technology, we should learn to accept the exploration and attempts of blockchain technology in different application scenarios with an open attitude and introduce blockchain as an essential technological means into the scope of government governance. This is a breakthrough direction for the transformation and optimization of government governance in the future, which will enhance the strong vitality of 'blockchain+' and is conducive to further elucidating and expanding the scope of application research on blockchain technology.

Thirdly, it promotes the integration of disciplines. This paper adopts qualitative and quantitative analyses to cross-fertilize the disciplines of economics, management, statistics, and computer science, providing a new reference for research in this field.

5.2. Managerial Implications

From the empirical results and analyses, China's current provincial administration may have the following problems:

Firstly, special measures are taken to improve administrative efficiency. Blockchain technology, as a new star in the field of information technology, has been gradually recognized and valued by the government, Internet giants, international financial institutions, and other people from all walks of life. In recent years, the Chinese government has vigorously promoted the integration and sharing of government information systems and has endeavored to define and clarify the responsibilities, rights, and benefits of data sharing.

According to reports, the governmental blockchain that has already landed or is in the process of landing covers a wide range of fields such as digital identity, electronic depository, electronic bills, property rights registration, business registration, data sharing, public supervision, administrative approval, and so on. Thus, it seems that blockchain further promotes the in-depth integration of the Internet and government affairs and offers a new solution to improve administrative efficiency further.

Secondly, blockchain, as a practical technology in the information age, has 'great potential' in government governance. Studying the advantages and disadvantages of the 'blockchain and government' service model is conducive to providing practical insights for other provinces and cities that have not yet used blockchain technology. The quantitative research in this paper clarifies the role of blockchain, which can help promote government administrative efficiency and thus enhance government governance.

5.3. Limitations

The limitations of this study are as follows:

Firstly, the research in this paper is overly reliant on quantitative data.

For example, the design and selection of the administrative efficiency evaluation indicators relied on expert opinion, which may be subject to error. In addition, administrative efficiency is a restricted variable with a value range of 0–1, and it might have been better for the significance test if it could have been further measured using the super-efficiency model. Last but not least, much of the data about blockchain is missing until 2017 due to constraints in research capacity and many influencing factors. At the time of the statistics, the data for 2022 were not yet available, meaning that the data used are not very current.

Secondly, there are various shortcomings in the blockchain itself, causing the government not to be able to apply it well, which in turn affects the accuracy of the empirical evidence.

For example, blockchain technology can be complex and challenging for some diasporic citizens who may not have a technical background [39]. In addition, Internet access may be unreliable or limited in certain parts of the world. This could impede the adoption of blockchain [40]. Moreover, blockchain technology's legal and regulatory framework varies widely across different countries and regions. This variability could create adoption barriers for diasporic citizens dispersed across multiple jurisdictions, particularly concerning GDPR compliance [41]. Finally, blockchain technology also has problems such as difficulty deleting data and traceability. These problems may cause governments to be more cautious in handling data and even affect efficiency. Protecting privacy under these problems has become a problematic issue in the development of blockchain technology. It is not a panacea for all privacy [42].

5.4. Opportunities for Further Research

Therefore, the direction of future research can be considered from the following aspects:

Firstly, when selecting administrative efficiency evaluation indexes, we should consider multidimensional data as much as possible and include 2022 data to ensure the reliability and completeness of the data. In addition, for provinces and municipalities with efficiency values of 1, we can use the super-efficiency model for further calculations to improve the significance of the results.

Secondly, the three-stage DEA model with SFA regression can effectively eliminate the bias caused by environmental variables compared with the traditional DEA model. However, the average efficiency of the third-stage DEA in this paper is not much higher than that of the first-stage DEA. We will try to change the environmental variables to test the effect in the future.

Finally, more accurately locating the different stages of government blockchain development and determining the quantitative indicators of blockchain application based on the characteristics of varying development stages will become the focus of research. Currently, there is a lack of unified quantitative indicators for blockchain application in academia, which will significantly impact the research conclusions. Therefore, accurately quantifying blockchain application indicators will be of great significance to blockchain research. In the future, we will try to replace different blockchain variables to test their impact on administrative efficiency.

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References

1. da Rosa Righi, R.; Alberti, A.M.; Singh, M. *Blockchain Technology for Industry 4.0*; Springer: Berlin/Heidelberg, Germany, 2020.
2. Tyagi, A.K.; Dananjayan, S.; Agarwal, D.; Ahmed, H.F.T. Blockchain—Internet of Things applications: Opportunities and challenges for industry 4.0 and society 5.0. *Sensors* **2023**, *23*, 947. [CrossRef] [PubMed]
3. Namasudra, S.; Akkaya, K. Introduction to Blockchain Technology. In *Blockchain and Its Applications in Industry 4.0*; Namasudra, S., Akkaya, K., Eds.; Springer Nature: Singapore, 2023.
4. Su, D.; Zhang, L.; Peng, H.; Saeidi, P.; Tirkolaee, E. Technical challenges of blockchain technology for sustainable manufacturing paradigm in Industry 4.0 era using a fuzzy decision support system. *Technol. Forecast. Soc. Change* **2023**, *188*, 122275. [CrossRef]
5. Calzada, I. Citizens' Data Privacy in China: The State of the Art of the Personal Information Protection Law (PIPL). *Smart Cities* **2022**, *5*, 1129–1150. [CrossRef]
6. Mengistle, B.T. Private environ—Mental governance in the Ethiopian pesticide supply chain: Importation, distribution and use. *NJAS—Wagening. J. Life Sci.* **2016**, *76*, 65–73. [CrossRef]
7. Kshetri, N. 1 Blockchain's roles in meeting key supply chain management objectives. *Int. J. Inf. Manag.* **2018**, *39*, 80–89. [CrossRef]
8. Chinese Academy of Engineering. *Research on China's Blockchain Development Strategy*; Chinese Academy of Engineering: Beijing, China, 2021.
9. Jia, Y.; Zhang, J. Opportunities and challenges of blockchain technology in tax governance. *Friends Account.* **2018**, *4*, 142–145.
10. Wu, Y.; Lu, C. Building a Government System Based on Blockchain Innovation Supply Chain System. *J. Artif. Intell. Pract.* **2023**, *6*, 66–73.
11. Li, F.; Rory, M. Sustainability Analysis of Open Educational Resources Development in Higher Education Institutions—Based on a Cost-Efficiency Perspective. *Mod. Educ. Technol.* **2022**, *32*, 102–108.
12. Yan, Y.; Li, L.; Liu, H. Capital Market Liberalization and High Quality Development of Enterprises—A Test Based on Economic Efficiency and Sustainable Development Perspectives. *J. Nanjing Audit Univ.* **2023**, *20*, 81–90.
13. UK Government Chief Scientific Adviser. Distributed Ledger Technology: Beyond Blockchain. 25 February 2017. Available online: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/492972/gs-16-1-distributed-ledger-technology.pdf (accessed on 19 June 2023).
14. Yang, J. Bitnation and Estonia Conduct Government Governance on Blockchain. 29 November 2015. Available online: https://www.sohu.com/a/45123432_286863 (accessed on 19 June 2023).
15. Lemieux, V.L. Trusting records: Is Blockchain technology the answer. *Rec. Manag. J.* **2016**, *26*, 110–139. [CrossRef]
16. Nordrum, A. Govern by blockchain dubai wants one platform to rule them all, while Illinois will try anything. *IEEE Spectr.* **2017**, *54*, 54–55. [CrossRef]
17. Swan, M. *Blockchain: Blueprint for a New Economy*; O'Reilly Media, Inc.: Sebastopol, CA, USA, 2015.
18. Skelaney, S.; Sahin, H.; Akkaya, K.; Ganapati, S. Government Applications and Standards to Use Blockchain. In *Blockchain and Its Applications in Industry 4.0*; Namasudra, S., Akkaya, K., Eds.; Springer Nature: Singapore, 2023.
19. Kshitri, N. *Blockchain in the Global South: Opportunities and Challenges for Businesses and Societies*; Palgrave Macmillan: Greensboro, NC, USA, 2023.
20. Veenstra, A.F.; Timan, T. A Public Value Impact Assessment Framework for Digital Governance. In *Scientific Foundations of Digital Governanceand Transformation*; Public Administration and Information Technology; Charalabidis, Y., Flak, L.S., Pereira, G.V., Eds.; Springer: Berlin/Heidelberg, Germany, 2022; Volume 38.
21. Charalabidis, Y.; Flak, L.S.; Pereira, G.V. *Scientific Foundations of Digital Governance and Transformation-Concepts, Approaches and Challenges*; Springer Nature: Berlin/Heidelberg, Germany, 2022.
22. Zhang, J.; Liu, Y.; Luo, J. Research on Technical Efficiency of High tech Industries in National High tech Zone. *Technol. Innov. Manag.* **2020**, *41*, 608–615.
23. Huang, R.; Li, W.; Hao, J. Research on the Efficiency Evaluation of Rural Grassroots Medical and Health Services in Western Regions: Analysis Based on DEA-Tobit Model. *J. Northwestern Ethn. Stud.* **2023**, *2*, 144–155.
24. Queiroz, M.M.; Fosso Wamba, S. Blockchain Adoption Challenges in Supply Chain: An Empirical Investigation of the Main Drivers in India and the USA. *Int. J. Inf. Manag.* **2019**, *46*, 70–82. [CrossRef]
25. Wong, L.W.; Leong, L.Y.; Hew, J.J. Time to Seize the Digital Evolution: Adoption of Blockchain in Operations and Supply Chain Management among Malaysian SMEs. *Int. J. Inf. Manag.* **2020**, *52*, 101997. [CrossRef]
26. Saberi, S.; Kouhizadeh, M.; Sarkis, J. Blockchain Technology and Its Relationships to Sustainable Supply Chain Management. *Int. J. Prod. Res.* **2019**, *57*, 2117–2135. [CrossRef]
27. Zeng, X. *Research on the Administrative Efficiency after Reforming the "Four in One" Institutions in Villages and Towns in Guangxi—Taking B Street in G City as an Example*; Guangxi University: Nanning, China, 2020.
28. Knack, S. Social capital and the quality of government: Evidence from the States. *Am. J. Political Sci.* **2002**, *46*, 772. [CrossRef]
29. Du, T.; Ran, L.; Li, J. Dynamic evaluation of China's medical and health service efficiency based on the DtSBM model. *J. Beijing Inst. Technol. (Soc. Sci. Ed.)* **2019**, *21*, 82–94.
30. Zhang, L.; Zhang, J.; Lv, Z. Evaluation of agricultural product logistics efficiency in Northeast China based on DEA Malmquist index model. *J. Bohai Univ.* **2021**, *1*, 71–77.

31. Banker, R.D.; Charnes, A.; Cooper, W.W. Some Models for Estimating Technical and Scale Inefficiencies in Data Envelopment Analysis. *Manag. Sci.* **1984**, *30*, 1078–1092. [CrossRef]
32. He, P.; Tang, R. Comprehensive Evaluation of Provincial Government Efficiency in China. *Stat. Decis. Mak.* **2007**, *9*, 74–76.
33. Wu, J.; Hu, C.; Zhang, P.; Wang, Y. Can Efficiency Building Improve Government Performance—Empirical research based on Panel data of 30 provinces. *J. Public Manag.* **2015**, *2*, 126–138.
34. Ding, T.; Song, M. *Natural Resource Regulation in China*; Springer Nature: Singapore, 2023.
35. Zhang, Y.; Kong, C. Tourism efficiency evaluation of China's provincial administrative regions based on analytic hierarchy process and three-stage Data envelopment analysis. *Ind. Innov.* **2022**, *6*, 38–43.
36. Zhou, M.; Pan, N. Empowerment and Reconfiguration: Blockchain Technology's Crackdown on Data Silos. *J. Commun. Rev.* **2018**, *71*, 58–67.
37. Wang, L. How public charity can be more transparent—Blockchain-based digital certificate authentication strategy. *Lanzhou J.* **2020**, *4*, 149–159.
38. Hainan Province Has Issued 19.19 Million Electronic Bills for Promoting Blockchain Finance, with a Total Amount of 31.2 Billion Yuan. 20 July 2021. Available online: https://m.thepaper.cn/baijiahao_13665141 (accessed on 19 June 2023).
39. Zook, M. Platforms, blockchains and the challenge of decentralization. *Camb. J. Reg. Econ. Soc.* **2023**, *16*, 367–372. [CrossRef]
40. Flore, M. *How Blockchain-Based Technology Is Disrupting Migrants' Remittances: A Preliminary Assessment*; Publications Office of the European Union: Luxembourg, 2018.
41. Buterin, V. *Proof of Stake: The Making of Ethereum and the Philosophy of Blockchains*; Seven Stories: New York, NY, USA, 2022.
42. Hughes, L.; Dwivedi, Y.K.; Misra, S. Blockchain research, practice, and policy: Applications, benefits, limitations, emerging research themes and research agenda. *Int. J. Int. Manag.* **2019**, *49*, 114–129. [CrossRef]

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