Data Mining Algorithm for the Impact of Digital Inclusive Finance on Urban-rural Economic Integration in the Era of the Internet of Things

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Abstract In the era of the Internet of Things (IoT), emerging technologies continue to rise. Digital technology is also in continuous development, and is gradually applied in different industries. The rise of digital inclusive finance has greatly sped up the expansion of financial markets and effectively eliminated the development barrier associated with traditional inclusive finance. However, it has not been further expanded in rural areas, and the breadth of services is more concentrated in urban areas, which restricts the growth of rural economy. Therefore, this study mainly focuses on its impact on the integration of urban and rural economies. This paper made further experimental analysis on urban-rural economic integration with data mining algorithm. According to the experimental findings, in terms of the degree of industrial integration between urban and rural areas, this algorithm performed on average 84.83% of the time compared to the traditional method's 79.13%; the average test result of this method was 80.41% in terms of the development level of urban-rural integration, and that of the traditional method was 76.17%; in terms of economic openness, the average economic openness of this algorithm was 76.37%, while the traditional method was 73.94%. In conclusion, this algorithm can effectively promote the integrated development of urban-rural economy.

Index Terms Digital Inclusive Finance, Internet of Things Technology, Urban-rural Integration Development, Integration of Urban-rural Industries

I.   Introduction

Big data technologies, digital technologies, etc., continue to evolve and be applied in multiple fields as the IoT era approaches. Under the strong impact of the IoT finance, the traditional inclusive finance has also been seriously affected, so it is urgent to integrate some modern information technology to improve this dilemma. Digital inclusive finance is to integrate digital technology into the traditional inclusive financial system, which successfully addresses numerous flaws in conventional inclusive finance. With its distinctive advantages, digital inclusive finance has gained the support of many urban dwellers, and the majority of urban users adore it. However, rural areas have not seen much of a push for digital inclusive finance. To encourage its growth in rural regions, further research is required to determine how digital inclusive finance affects urban-rural integration.

Ozili Peterson K discussed some issues related to digital finance, and pointed out that digital finance and financial inclusion would bring many positive impacts on financial service users, financial institutions, government departments, etc. [1]. Hasan Md Morshadul sought to investigate how digital financial services may help China's inclusive finance sector. Additionally, he discussed the potential role that digital financial services could play in China's development of inclusive finance and adopted the qualitative sampling system review method to achieve relevant objectives [2]. Agosto Arianna pointed out that digital finance would be seriously affected by the COVID-19, and therefore proposed a statistical model, which can be used to understand the epidemic dynamics of COVID-19, so as to predict its impact on digital finance and conduct digital monitoring [3]. Dara Nageswara Rao pointed out that digital financial services have great potential in providing a series of affordable banking services for the poor in emerging economies. Its inclusiveness promotes efficient connectivity among economic participants[4]. Geng Zhechen utilized the instrumental variable method to investigate how DFI affected long-term employment in the Belt and Road nations. The results show that it has important impacts in upper-middle-income and high-income economies and helps maintain employment [5]. He Zongyue combined the data from China's household panel study with the DFI index. According to his study, digital banking in China has encouraged urban inhabitants' consumption, particularly that which is tied to their daily needs [6].

Data mining research is very popular in various industries. There are many related research reports in the financial field. To enhance data mining's ability to be applied to online financial risk management, Feng Ran presented an ant colony optimization-based radial basis function neural network technique [7]. Kunnathuvalappil Hariharan Naveen applied data mining to portfolio management, investment risk analysis, etc. [8]. Integrating data mining methods to examine the effect of digital inclusive finance on urban-rural economic integration would appear to be required for advancing research on digital inclusive finance.

The relevant concepts, ecosystem, and business operations of digital inclusive finance are introduced, and the challenges faced in its development are also analyzed. It also concentrates on how it affected the combined growth of the rural-urban economies. The objective is to logically maximize the allocation of land, labor, and industrial resources in rural regions with the use of financial services in order to promote the expansion of the rural economy. Additionally, by more effectively bridging the wealth and poverty inequalities between urban and rural areas, it may eventually lead to the merging of the urban and rural economies.

II. IoT Technology, Digital Inclusive Finance and Integrated Development of Urban-rural Economy

II. A. Application of IoT Technology in Finance

In the IoT information system, IoT finance can change the attributes of movable property and make it real property. By integrating IoT technology, financial institutions can timely grasp the specific situation of each business link of the enterprise, which is conducive to the reasonable full life cycle management of movable property pledge by financial institutions. In this way, it can also improve the risk control ability of financial institutions. Compared with the traditional financial model, the IoT financial model has a higher degree of user information matching and more complete user information.

(1) The role of the IoT in the financing problems of small and micro enterprises

IoT has alleviated to a certain extent the high demand for financing and the difficulty of borrowing for small and micro enterprises. In 2019, power supply companies and China's capital construction financial institutions jointly launched a series of financial products. With the power IoT, financial institutions can fully grasp the power engineering data of a large number of users, and effectively understand the business status of enterprises with the power consumption data information. Connecting with financial institutions can also provide credit loan services for small and micro enterprises, thus effectively improving their financing difficulties.

(2) The change of the IoT to the new business form of financial services

The IoT integrates financial management and network management methods, and applies RFID (Radio Frequency Identification) technology to bank cards, which easily realizes the service mode that multiple transaction links can be paid with one card. The convenient services of debit cards are mainly: the financial services of the IoT for freight transport are aimed at freight vehicles, and the system of "one car one card" is implemented, so that the business activities of freight transport operation can be carried out to realize the innovation of financial services. In addition, the IoT has also opened natural gas, water meters, electricity meters and other life services, which effectively realizes service sharing.

II. B. Digital Inclusive Finance

II. B. 1)   Concept of Digital Inclusive Finance

The combination of digital technology and traditional financial inclusion to solve the problems on the financial services side is called "digital inclusive finance" [9]. Figure 1 presents their fusion. This can effectively reduce various restrictions on financial services, and also reduce expenses, thus improving the level of financial services and users' financial service experience. At the same time, it can also help traditional inclusive finance break the current unfavorable situation, and effectively meet various endogenous needs in digital financial services.

II. B. 2)   Digital Inclusive Financial Ecosystem and Business Operation

Financial technology and inclusive finance have naturally merged to create digital inclusive finance [10]. At this stage, it has gradually become an ecosystem with a certain degree of complexity. This is because the system covers many types of financial products, and the subjects involved in the system are also very diverse. The digital inclusive financial ecosystem is shown in Figure 2.
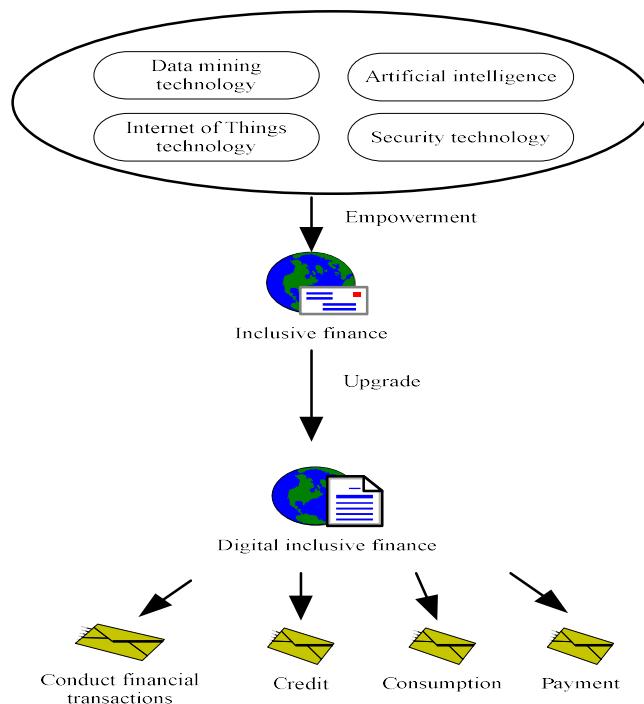
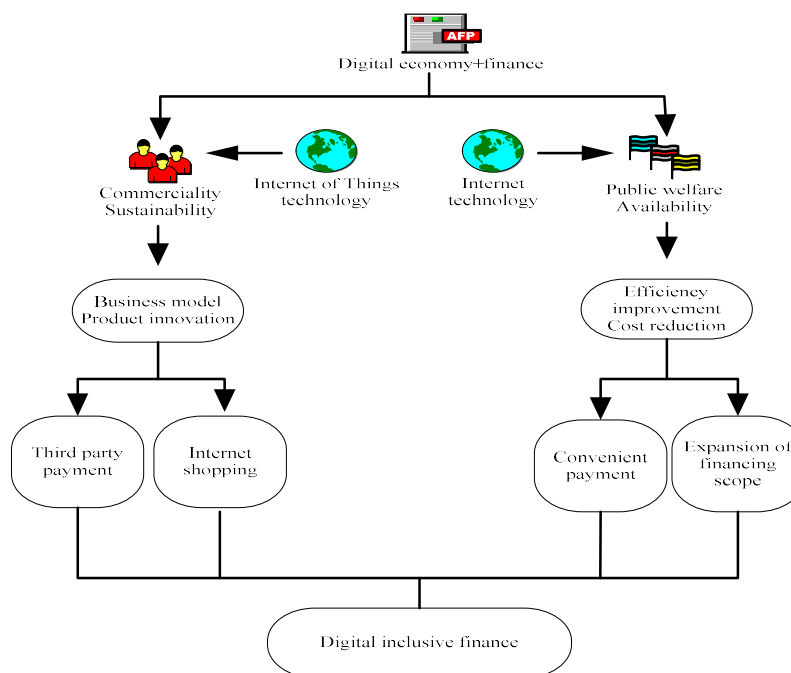Figure 1: Integrating inclusive finance and digital technology

Figure 2: Digital inclusive financial ecosystem

Digital inclusive finance integrates two methods of model innovation and policy guidance in the operation of actual business [11]. Its operation mode is shown in Figure 3. At the technical level, it fully integrates a variety of emerging technologies to quickly and accurately mine the user's personal information, which can turn the financial service market to remote rural areas. As a result, the field of financial services can be expanded, and the situation of rural capital shortage and financing difficulties can be effectively improved. In addition, it can carry out financial credit activities on the network platform through emerging technologies. The integration and summary of a large amount of information can effectively overcome the information mismatch problem in the financial market. By

sorting and analyzing the customer's consumption behavior, access habits, information records and other data, financial institutions can better analyze the user's credit information and dig out useful information.
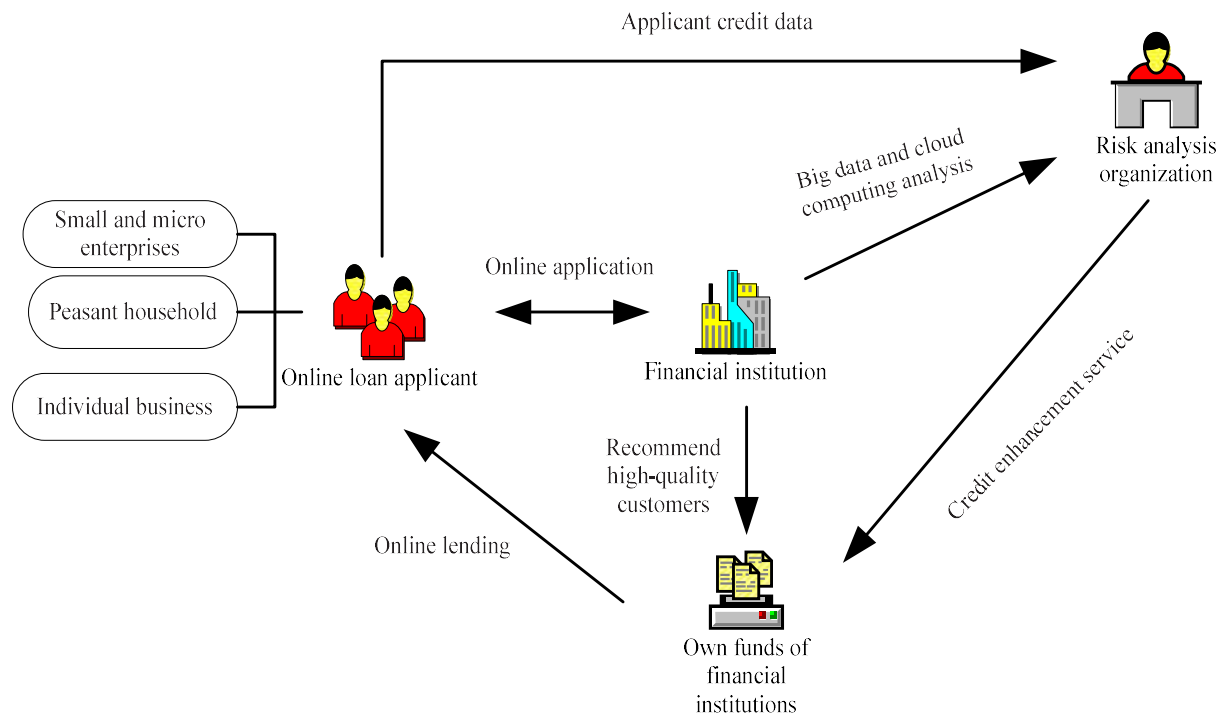

Figure 3: Operation mode of digital inclusive finance

II. B. 3)   Developing Digital Inclusive Finance Faces Challenges
(1) Lack of inclusiveness

Since the inclusive development level and coverage of digital inclusive finance in my country are relatively low, except for electronic payment, other service types are relatively few, which fails to meet people's growing demand for financial services. Furthermore, digital inclusive finance comes at a comparatively high cost. For low- and middle-income groups, although the Internet financing method lowers the service threshold, the financing cost is relatively high, which is not very friendly to individual industrial and commercial households who are still in their infancy.

(2) Information security to be improved

Users would create a data system while utilizing electronic devices as a result of the ongoing increase of the application space for digital technology. In the transmission and storage, data is vulnerable to malicious interception by network hackers, resulting in the leakage of data information. Once the information is seriously leaked, it is likely to threaten the security of users' funds, and also cause serious damage to the entire financial market.

(3) Incomplete credit reporting system

When financial institutions issue loans to users, they would verify the user's credit information. Internet financing is essentially a kind of credit financing, so the user's credit information must be verified, which is also the crucial support for lending by financial institutions. However, China's credit reporting system is not yet perfect, especially for people in remote rural areas. Their credit reporting data and information are very imperfect, which would seriously affect the stable development of inclusive finance in China.

II. B. 4)   Countermeasures for Innovative Digital Inclusive Finance Development
(1) Construction of interconnected ecosystem

The sharing and circulation of data in different fields and different application scenarios can be realized, and a sharing and intercommunication exchange platform can be built with government departments, enterprises, e-commerce platforms, etc., with the support of emerging technologies. On the basis of data factors, it can promote the virtuous circulation of funds, thus realizing the orderly implementation of inclusive financial services.

The cooperation with government departments should be strengthened, and the relevant data of tax, customs, provident fund, individual social security payment, etc., need to be obtained so as to further promote the implementation of "bank-tax interaction" and "bank-commercial cooperation" activities and improve the efficient sharing of user credit information.

(2) Perfection of supply chain financial mechanism

From the perspective of commercial institutions, a complete internal inclusive financial system needs to be built [12]. A business management system that is consistent with the market expansion is also necessary so as to realize the rapid access of large-scale users. With the support of large-scale data, it is convenient to realize accurate marketing, product research and development, risk prevention and control, customer maintenance, etc. for users, and help the transformation and optimization of inclusive financial business. In addition, it needs to organically integrate the IoT, supply chain and industry to jointly create a multi-mode supply chain financial mechanism. In combination with the intensive function of Internet technology and platform, industrial resources can be fully integrated to improve the operational efficiency of industrial ecology.

(3) Strengthening the management mode of credit reporting system

First of all, commercial institutions should obtain data of different dimensions from multiple channels as much as possible, and do a good job of complementing and authenticating data information, so as to improve the ability to identify risks. Secondly, the platform should be used to complete the selection of users, real-time monitoring of loans, risk identification, etc., and improve the ability to resist risks. Finally, the traditional legal segmented management mode is adjusted to the full-process automatic risk management based on big data technology. The headquarters is uniformly responsible for user screening, credit rating, business acceptance and other services, and dynamic control of possible risks.

II. C.Impact of Digital Inclusive Finance on Urban-rural Integration Development
II. C. 1)   Direct Impact Mechanism Affecting Urban-rural Integration Development
(1) Urban and rural financial development

One important element in the growth of urban-rural integration is finance [13]. Urban and rural areas in China are clearly divided, and there are also clear inequalities in their financial development. On the one hand, it is reflected in urban-rural financial services: affected by transportation, information and wage levels, compared with urban areas, rural areas are difficult to attract the arrival of finance, and many remote areas are still in a financial vacuum. Additionally, because rural financial institutions are dispersed throughout the landscape, it is challenging for financial services to efficiently enter rural communities. It severely limits the growth of the rural economy and is particularly detrimental to the execution of the plan for reviving the rural economy. On the other hand, it is reflected in the allocation of financial resources: cities would form a "siphon effect" on rural areas, and gather resources from surrounding rural areas, which is easy to lead to a large loss of rural financial resources. and even some areas still have the "inverted pump effect".

(2) Optimization of urban-rural labor allocation

In rural areas, there are many non-agricultural small and medium-sized enterprises (SMEs), which can provide good employment opportunities for rural residents. However, their development is often constrained by funds, so the development of enterprises is relatively difficult. Digital inclusive finance can effectively solve this problem. By collecting social idle funds and investing them in SMEs, it can help enterprises solve the situation of capital shortage and financing difficulties. For unemployed residents in remote areas, it can integrate big data technology to establish an employment service platform, and provide them with zero pledge and low rate employment loan services. This can not only provide a good platform for the employment of rural residents, but also vigorously attract the return of rural labor.

II. C. 2)   Indirect Impact of Urban-rural Integration Development
Figure 4 presents the indirect impact mechanism of urban-rural integration development, which is shown in the following aspects:

(1) Indirect transmission mechanism of traditional financial development

Traditional financial institutions only serve the urban market, and the majority of their clientele are city dwellers. There are very serious financial conflicts [14]. Some financial institutions would set up service points in villages and towns in order to open up business markets and face more business groups. However, as the cost input and actual income are not ideal, the strength of its business development would also be greatly reduced.

(2) Economic development and regional restrictions

Economic development and regional constraints would also affect the integrated development of urban-rural settlements. This is because integrated growth between cities and provinces, as well as between urban and rural areas, is not limited to a single province.Cross-regional development is also one of the effective channels for rural

development. Moreover, the economic development of neighboring provinces and regions can also impact on the living and production development level of residents in the province, which mostly manifests itself in the movement of production factors. The flow of production factors can be significantly improved by offering efficient mobility between cities and the countryside. Therefore, dredging production factor circulation canals can encourage the integration of urban and rural areas.

(3) Indirect transmission mechanism of consumption level

Project investment, consumption and import and export trade are the "three carriages" driving China's national economy. In recent years, China's economy and industrial structure are in the transition stage, and the contribution of residents' consumption to the national economy is also increasing with each passing day. The national economy shows an upward trend year by year. However, the investment rate has declined, showing a downward trend.
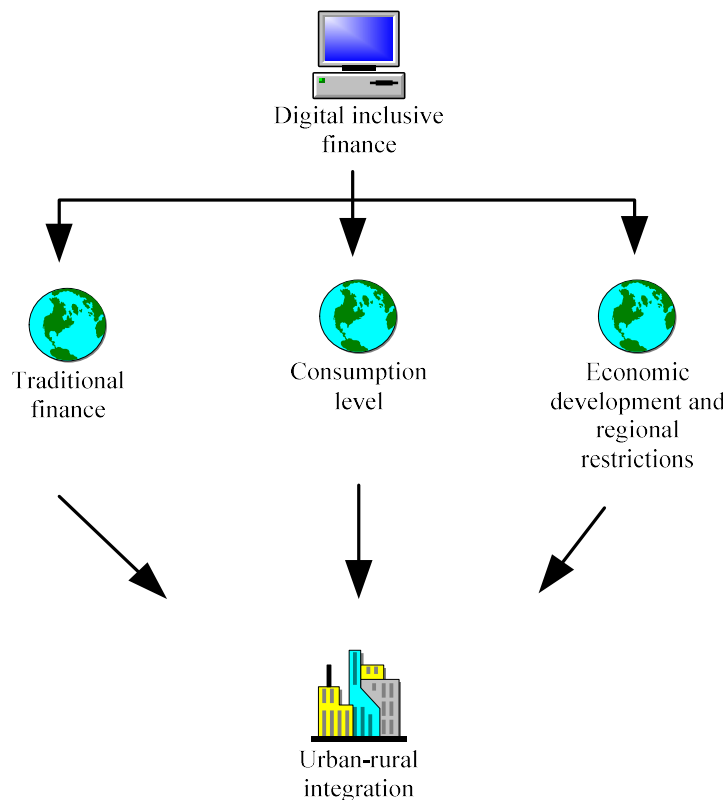

Figure 4: Indirect impact mechanism

II. C. 3)   Role of Digital Inclusive Finance in Urban-rural Integration and Development

Figure 5 shows how digital inclusive finance promotes the development and fusion of urban and rural areas with the IoT technology, which is shown in the following aspects:
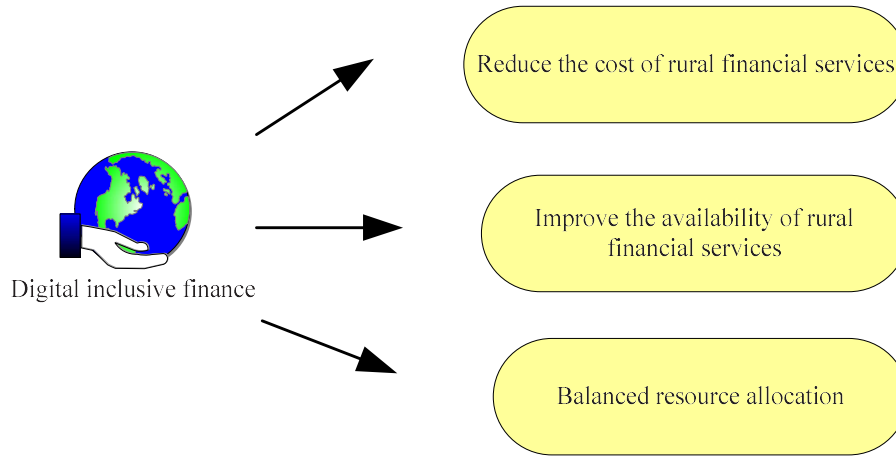
Figure 5: The contribution of inclusive digital finance to the development of urban-rural integration

(1) Reducing the cost of rural financial services

Digital inclusive finance combines the service mode of online handling with digital technology, and gradually forms the form of self-service handling, which is convenient for users. Its coverage of rural financial services led to the establishment of several financial institutions in rural areas, which may offer rural residents a variety of easy financial services while also significantly lowering the cost of entrance.

(2) Improving the availability of rural financial services

The increasingly mature digital technology also provides more safe, fast and diversified financial services for rural financial users [15]. Under the influence of digital technology, financial institutions have also continuously launched more financial service commodities suitable for the use of rural residents.

(3) Balancing the resource allocation

Digital inclusive finance must fully incorporate digital technology in order to properly implement the inclusive finance strategy and advance its development. To wisely improve resource allocation, big data and other technologies must be used jointly. Digital inclusive finance must also raise the daily income level of rural residents through investment and financing, factor allocation, and other ways in order to more effectively realize the integrated growth of the urban-rural economy.

III. Urban-rural Integration Effects of Digital Inclusive Finance under Data Mining

III. A. Data Mining

Data mining is mainly to analyze and process large-scale data information in the database system, mainly to collect, classify and process data. Potential and valuable information can be extracted from the huge, complex, incomplete and ambiguous data. In a sense, these information can provide a certain basis for human analysis, decision-making and prediction in the financial field. Data mining technology spans multiple disciplines, and has good applications in many industries such as medicine, mathematics, information management, finance, information technology, etc.

III. B. Measurement Model Setting

(1) The urban-rural integration model improved by digital inclusive finance

A benchmark regression model is constructed based on data mining algorithm. The formula is:

$$Q_{j,e} = \alpha_0 + \gamma_1 DIFI_{j,e} + \gamma R_{j,e} + \delta_{j,e} + \varepsilon_{j,e} + \epsilon_e + \vartheta_{j,e} \tag{1}$$

Among them, j is the city, and e is the year; $DIFI_{j,e}$ represents the digital inclusive financial index.

(2) Mediation effect model

The intermediary effects of factor flow, independent innovation and industrial structure upgrading have been measured, and an intermediary effect entity model has been constructed:

$$Q_{j,e} = \alpha_0 + \gamma_1 DIFI_{j,e} + \gamma R_{j,e} + \delta_{j,e} + \varepsilon_j \tag{2}$$

$$\text{Medium}_{j,e} = \pi_0 + \pi_1 DIFI_{j,e} + \pi R_{j,e} + \varepsilon_j + \epsilon_e + \vartheta_{j,e} \tag{3}$$

$$Q_{j,e} = \rho_0 + \rho_1 DIFI_{j,e} + \rho_2 Medium_{j,e} + \rho R_{j,e} + \epsilon_e + \vartheta_{j,e} \tag{4}$$

III. C. Explanatory Variables

(1) Capital flow

Capital flow is profit-seeking. Data mining algorithm is used to calculate the capital flow using the double logarithmic gravity model. The formulas are:

$$CfT_j = ln(T_j) \times ln(Rate_a - Rate_j) \times ln(Padp_a - Padp_j) \times Y_{ja}^{-2} \tag{5}$$

$$CfT_j = \sum_{a=1}^{m} CfT_{ja} \tag{6}$$

(2) Industrial structure upgrading

The upgrading of industrial structure is embodied in the rise of labor productivity and the change of the ratio between industries. The formulas are:

$$Aiu_{j,e} = \sum_{m=1}^{3} s_{j,m,e} \times Dh_{j,m,e} \tag{7}$$

$$Dh_{j,m,e} = Q_{j,m,e}/D_{j,m,e} \tag{8}$$

III. D. Experimental Evaluation of Digital Inclusive Finance on Urban-rural Economic Development

For validating the effectiveness of fused data mining algorithms for urban-rural economic development, this paper collected relevant data information from the Internet and tested and analyzed these data information using data mining algorithms. For the sake of reflecting the comparative nature of the experiments, this paper also conducted comparative experiments using traditional algorithms.

III. D. 1)   Urban-rural Industrial Integration Test

Two algorithms are utilized to test and analyze the degree of urban-rural industrial integration, and Figure 6 shows the test results.
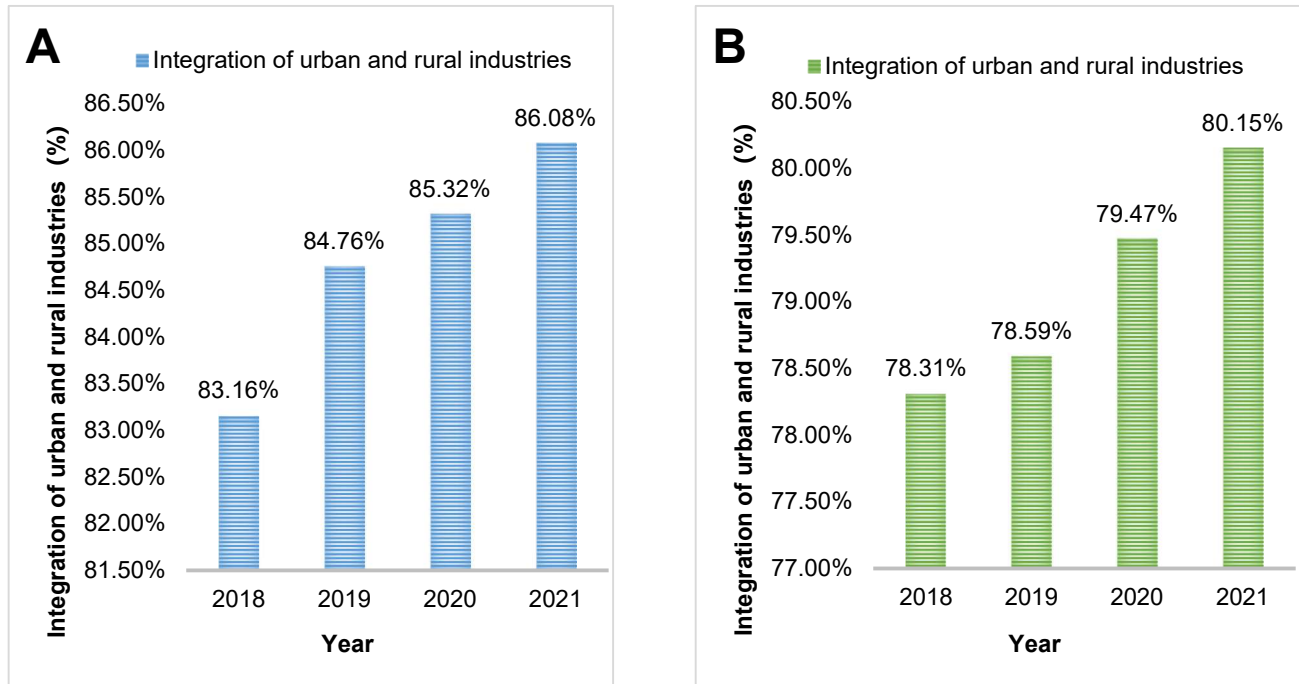
(A) presents the degree of urban-rural industrial integration under this algorithm

(B) shows the degree of urban-rural industrial integration under the traditional algorithm

Figure 6: Integration of urban-rural industries under different algorithms

The data in Figure 6 demonstrate that different algorithms had certain differences in the test of urban-rural industrial integration. In Figure 6A, the degree of industrial integration reached 83.16% in 2018 and 84.76% in 2019, and the degree of industrial integration reached 86.08% in 2021; the average integration degree of urban-rural industries in four years was 84.83%. In Figure 6B, the industrial integration degree in 2018 was 78.31%, and reached 79.47% in 2020; by 2021, the industrial integration degree was 80.15%; it can be calculated that the

average industrial integration degree in the four years was79.13%. According to the aforementioned data, it can be inferred that the digital inclusive finance method used in this paper had a higher degree of integration of urban-rural industries, which can effectively promote the development of urban-rural economic industries and consequently drive the development of township economies.

III. D. 2) Test of the Level of Urban-rural Integration Development

This research also conducted pertinent test analysis from the level of urban-rural integration development to further examine the differences between the two methods. Figure 7 displays the test outcomes.
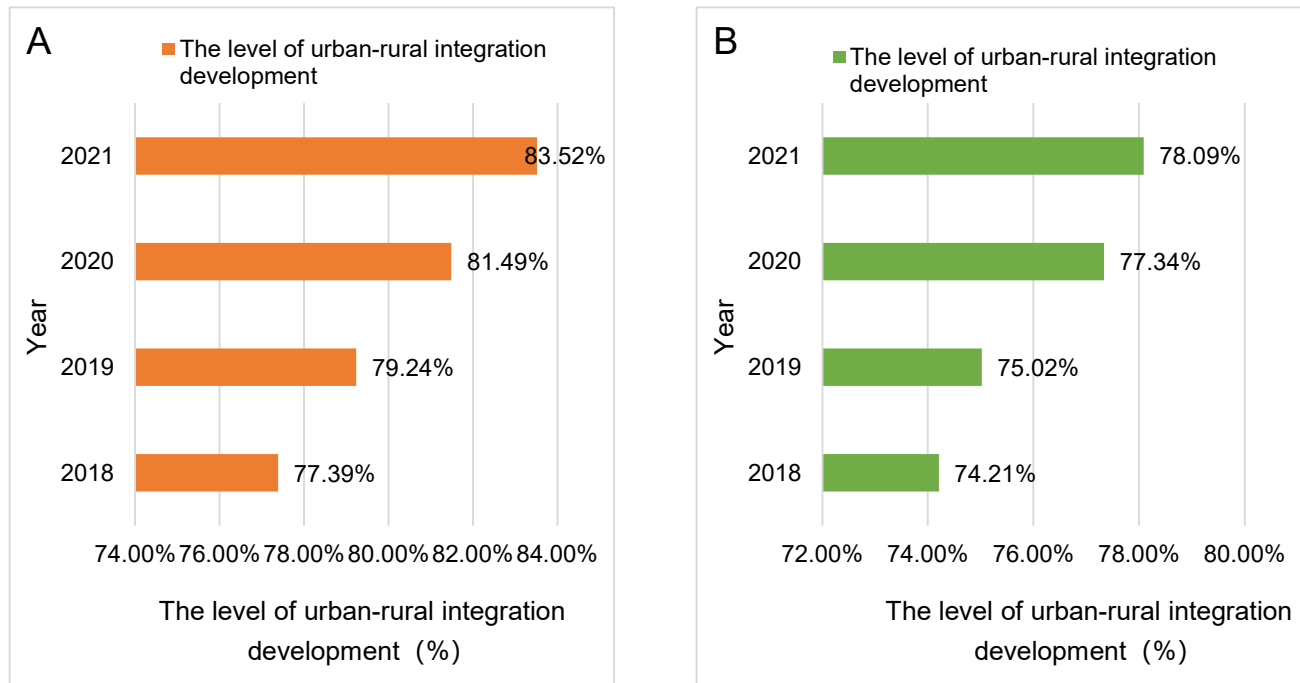
(A) shows the level of urban-rural integration development under this algorithm

(B) shows the level of urban-rural integration development under the traditional algorithm

Figure 7: The level of urban-rural integration development under different algorithms

The amount of urban-rural integration development under this strategy had greatly increased from 2018 to 2021, as illustrated in Figure 7A. The development level among them grew to 77.39% in 2018, 81.49% in 2020, and 83.52% in 2021. It can be seen that the growth rate of its level was relatively fast, from which the average development level in four years was 80.41%. According to Figure 7B, the integration of urban and rural areas was developing at a higher rate than before, but the overall degree of development was still below 80%. In 2018, the development level was 74.21%; in 2020, it was 77.34%; in 2021, it was 78.09%. As a result, the average level of improvement was 76.17% in four years. From the data above that, it can be seen that under the approach of this paper, the amount of urban-rural development integration was higher and the development rate was faster.

III. D. 3) Economic Openness Test

This paper also tests and analyzes the degree of economic openness to compare the differences between the two algorithms more comprehensively. Figure 8 presents the test results.
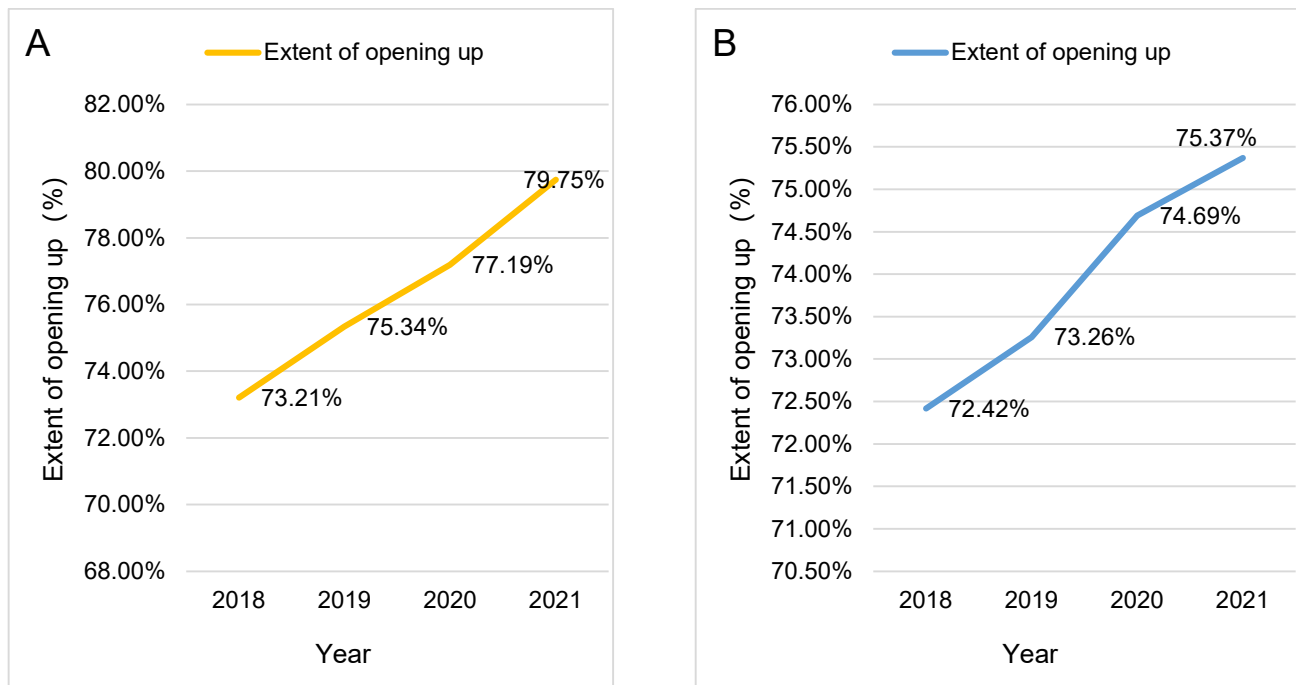
(A) shows the degree of economic openness under this algorithm

(B) shows the degree of economic openness under the traditional algorithm

Figure 8: Economic openness under different algorithms

Figure 8A demonstrates that the level of economic openness had risen year over year, reaching a level of over 70% overall, 73.21% in 2018 and 75.34% in 2019. It got as high as 79.75% by 2021. Its growth rate was quite rapid. This assessment indicated that China's economy had an average level of opening up of 76.37%. Figure 8B shows a similar upward trend for the degree of economic openness to the outside world, while the overall rise was smaller and the overall ratio was substantially lower. The percentage of the economy that was open to foreign trade in 2018 was 72.42%, and in 2019 it was 73.26%; in 2021, it has reached 75.37%, which showed that the average economic external degree in the four years was 73.94%. From the above data, it can be seen that the economic openness of this method was higher. This approach can successfully increase the openness of the rural sector.

IV. Conclusions

Digital inclusive finance has evolved as a result of the gradual integration of digital technology into inclusive finance. Traditional money lacks numerous benefits that digital inclusive finance does. Low service threshold and excellent service efficiency are the advantages of digital inclusive finance, and it has a good development prospect in the Chinese market. However, in China, digital inclusive financial services are more limited to urban areas, and many rural areas are not well covered. For the purpose of evaluating how digital inclusive finance affects urban-rural integration, pertinent tests and analyses were carried out. According to the experimental findings, this approach considerably enhanced the industrial level of urban-rural integration, and the rising trend was obvious; the economy was also more open to the outside world. These showed that this method can effectively promote the integrated development of urban-rural economy. In the future research work, the data mining algorithm needs to constantly adapt to the actual needs of digital inclusive finance for urban-rural economic development, and improve the performance of the algorithm, helping promote urban-rural economic development more effectively.

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