Research Article

Feasibility Analysis Model of Transformation from Real Economy to Virtual Economy Based on Association Rule Algorithm

Jing Gao ^{1,2}, Yu Zhao,^{1,2} Longlong Li,² and Samart Deebhijarn¹

¹School of Educational Innovation Research, King Mongkut's Institute of Technology Ladkrabang, Bangkok 10520, Thailand

²School of Trade and Circulation, Shaanxi Polytechnic Institute, Xianyang 712000, China

Correspondence should be addressed to Jing Gao; gaojing@sxpi.edu.cn

Received 3 September 2021; Revised 9 October 2021; Accepted 16 October 2021; Published 18 November 2021

Academic Editor: Sang-Bing Tsai

Copyright © 2021 Jing Gao et al. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

The transformation of the real economy to the virtual economy is one of the necessary ways for social and economic development. By analyzing the definition of real economy and virtual economy, the relationship between them, and the relationship between finance and virtual economy, a feasibility analysis model for the transition from real economy to virtual economy is designed based on association rule algorithm, and provide feasibility analysis for “from entity to virtual.” At the same time, based on the scale measurement theory of virtual economic cycle, this paper establishes the rule-constrained Apriori algorithm model. Then, the input-output structure decomposition method is used to analyze the feasibility of the transformation from the real economy to the virtual economy. Through the analysis, we know that the multiplier value in the real economy is higher than that in the virtual economy, which promotes the substantial growth of its own output. The total amount of virtual economy is growing rapidly, but economic transformation is incomplete. The expansion of the real economy has increased the total output value of virtual laser machines. Therefore, the feasibility of transforming from a real economy to a virtual economy has a good relationship.

1. Introduction

The advent of the era of big data has brought about high-quality economic development. Big data has promoted the deep integration of information technology and economic and social development. Big data provides new means to solve the new challenges and problems faced by high-quality economic transformation and development. The traditional real economy continues to move towards the Internet and gradually transforms into a virtual economy. The essence of economic transformation is the change of its operating state. Through continuous reform of the economic system, the economic structure and economic system of a country or region are changed from the root, and the economic structure is improved. Therefore, economic transformation is a process from small accumulation to qualitative change [1]. The economic management of AI and blockchain must undergo new changes to meet the basic needs of enterprise

development. Therefore, in carrying out economic management activities, financial personnel are required to provide high-level technical support to build a new financial management model. Relevant personnel need to deeply analyze the effective development direction of economic transformation under AI and blockchain. Regarding the current strategic transformation of our country's economy, relevant departments have gradually introduced relevant regulations and drafts to promote the transfer of the economy to the global high-end value chain. This process is a step-by-step process and cannot be accomplished overnight. The real economy is the cornerstone of social and economic development and the foundation of a nation [2]. The network economy is only a part of the virtual economy, and the virtual economy includes finance, covering a wide range [3]. The economy that circulates with virtual capital is virtual. The long-term development of a country or region's economy must be a stable state of economic structure. If the

virtual economy accounts for too large a proportion, it is prone to be a bubble economy [4]. Therefore, the feasibility analysis of the transition from the real economy to the virtual economy is one of the necessary means to promote the development of the regional economy.

Enterprises will generate a large amount of data in daily production and operation. Unconsciously collecting these data, in-depth data mining will find some associations between the data, which cannot be inferred from past personal experience. The purpose of association analysis is to find the association or correlation between item sets. A large number of customer purchase data can be collected through the supermarket POS processing terminal for mining and analysis. "Beer and diapers" is a classic case. In the 1990s, Walmart analyzed sales data and found that customers who bought diapers would buy some beer by the way. If diapers and beer were put together, it would obviously increase sales. In addition to some unexpected conclusions, data mining can also predict and analyze customers' interests and purchasing tendencies through historical data of customers, to achieve effective product push. If a customer purchases a book on Taobao, Taobao will push similar books again, thereby increasing the possibility of commodity transactions [5, 6]. The association rule algorithm can express the dependency and the degree of correlation between a certain event and other events. This algorithm is a type of data mining algorithm [7–9]. The core of the algorithm is to establish trust rules based on user needs through a large number of iterations. There is no need for complex theoretical logic support, the calculation accuracy is higher, and the convergence speed is faster. So, the necessity of the transition from the real economy to the virtual economy and the impact of the imbalance of the transition and the algorithm of association rules are introduced. This article combines the association rule algorithm to design a feasibility model and provides a reference for economic transformation.

In this paper, we set up an Apriori algorithm model constrained by chance rules. Then, the feasibility of transforming real economy to virtual economy is analyzed by using the input-output structure decomposition method. Through the analysis, it can be seen that the multiplication value of the real economy is higher than that of the virtual economy, which promotes the substantial growth of its own output.

The main structure of this paper is organized as follows. Section 2 mainly introduces the correlation analysis of the real economy and the virtual economy and the establishment of the feasibility analysis model based on the Apriori algorithm. Section 3 presents the empirical analysis. Finally, Section 4 draws the conclusion of this paper.

2. Feasibility Analysis Model of Transformation from Real Economy to Virtual Economy Based on Association Rule Algorithm

2.1. Analysis of the Relationship between the Real Economy and Virtual Economy

2.1.1. Two Economic Definitions. The economy formed during the production and circulation of material and

spiritual products is called the real economy. The real economy includes multiple sectors of the economy, with characteristics such as tangible, dominant, and carrier. The real economy is the cornerstone of social development [10, 11]. The real economy and the virtual economy each form an independent range of economic activity. The virtual economy is greatly affected by capitalization and human factors and has strong volatility. Excessive development will lead to a bubble economy phenomenon [12, 13].

In fact, virtual economy is not an independent concept. It is relative to the real economy and depends on the operation of the real economy to a certain extent. Therefore, it is of more practical significance to link the virtual economy with the real economy to measure the proportion of virtual economic activities in the macroeconomic system, that is, the degree of economic "virtualization" development. Under the guidance of the idea of systematic statistical measurement, this paper defines the basic concepts and constructs a multidimensional virtualization measurement index system, in order to provide a more comprehensive and accurate reference for the study of such macroeconomic problems.

2.1.2. Two Kinds of Economic Relations. Although the two operating mechanisms are different, there is a certain overlap in the industries covered, and the relationship between the two is inseparable. The virtual economy is a certain degree of derivative economic industry developed by the market economy, accounting for a large proportion [14]. The development of the virtual economy has promoted the development of the real economy to a certain extent. The following analyzes the relationship between the two from two angles.

(1) The Real Economy Relies on the Virtual Economy. The real economic environment is divided into external and internal environments. In the external economic environment, economic funds determine the development of the real economy.

The strong support for the rapid development of the real economy is the virtual economy. The virtual economy can provide stamina for the development of the real economy. The necessary condition for the operation of the real economy is that the amount of money is sufficient. After all, the amount of institutional loans is limited.

Most of the money needed by the real economy comes from stocks and bonds. These money-raising methods have the characteristics of convenience and speed, which increase the stamina for the development of the real economy [15, 16].

To a certain extent, the development of the virtual economy restricts the development of the real economy. The development process of the virtual economy can be divided into stages, such as the capitalization of idle currency, the transformation of interest-bearing capital to socialization, the gradual movement of securities to the market, the internationalization and integration of financial markets. The virtual economy at different stages has different impacts on the real economy.

(2) *The Virtual Economy Depends on the Real Economy.* The virtual economy is not invisible and intangible but is based on actual materials. The basis for the renewal and progress of the overall economic system is the real economy. At this level, its trend is bound to advance to a higher level. While developing upward, the virtual economy needs to continuously provide corresponding financial support for the development of the real economy [17]. When the two kinds of economic relations are broken, the virtual economy will not be able to develop by leaps and bounds.

From the perspective of the risk level analysis, the real economy is relatively safer than the virtual economy, and output means a certain income. A virtual economy is a form of currency-generating currency, which will result in a situation where some people benefit and some people lose. The virtual economy can achieve high-profit income through short-term investment when the market supervision is low, so it is accompanied by greater risks [18, 19]. While the real economy is in operation, physical substances are cyclical in the formation and circulation stage, and only one cycle can be completed before a certain profit can be obtained. Therefore, the relevant departments have strong supervision over the real economy, which has high security.

Based on the above analysis, the real economy and the virtual economy are interdependent and closely linked. The currency that connects the real economy and the virtual economy constitutes the financial system. This article will analyze the relationship between finance and the virtual economy [20].

2.1.3. Finance and Virtual Economy Linkage. AI and blockchain can greatly promote the development of high-quality economic management. It can promote the informatization of financial management and help enterprises enter the intelligent management mode. It can help management accounting to analyze various business indicators more accurately and can better optimize the existing analysis system of the enterprise. AI can also solve some of the shortcomings of traditional financial management systems in the past. The unique immutability of blockchain technology [21] integrates and records all economic information in the business process to ensure that economic information is not tampered with. However, in terms of adoption and development, blockchain technology is a new and highly complex technology. As shown in Figure 1, the five structures play direct and indirect roles in the adoption of blockchain technology, especially in the financial technology market.

The operational efficiency of the financial system and institutions can improve the basic functions of financial institutions through personalized financial projects and services. Electronic information technology provides a convenient and efficient way for financial institution business clearing and currency payment, which greatly increases the speed of currency popularity [22]. The development of the virtual economy can enable the financial system to gradually move towards an internationally integrated structure and increase the sensitivity of market prices to the

FIGURE 1: External constructs affecting blockchain technology adoption.

demand for the virtual economy. The diversified currency portfolio provides a variety of development paths for the virtual economy. By adjusting and improving the operational safety of the virtual economy, it will attract a large number of investors to inject capital and form an active virtual economy trading market environment [23].

For example, Alibaba, the Chinese e-commerce giant, and its financial branch paid a total of 23.8 billion yuan (\$3.41 billion) in taxes in 2016. Also, the company outdid merchants operating on its platforms, upstream manufacturers, and logistics companies by paying at least 200 billion yuan in taxes last year and created more than 30 million jobs.

Therefore, the new economy will not curb the manufacturing sector. Instead, it can help promote its development. The key lies in whether there is a market for these products, and this market cannot be squeezed by the financial industry and capital markets.

2.2. Establishment of Feasibility Analysis Model Based on Apriori Algorithm

2.2.1. The Theory of Measuring the Scale of the Virtual Economic Cycle. Since the virtual economy and the real economy usually share the same material, it is impossible to separate the two on a large scale. In the input-output tables of the virtual economy and the real economy, the virtual economy based on actual materials is separated independently. The part of the real economy involved in the virtual economy has also been separated, forming an independent calculation model [24].

2.2.2. Apriori Algorithm Model with Rule Constraints. Association rule mining is one of the most active research methods in data mining. Its purpose is to discover the connection rules between different commodities in the

transaction database [25]. These rules characterize customer buying behavior patterns and can be used to guide businesses to arrange purchases, inventory, and shelf design scientifically. After that, many researchers have done a lot of research on the mining of association rules. Their work involves the exploration of association rule mining theory, the improvement of original algorithms and the design of new algorithms, Parallel Association Rule Mining and Quantitative Association Rule Mining, and other issues. Many scholars have made unremitting efforts to improve the efficiency, adaptability, usability, and application promotion of mining rule algorithms.

Apriori algorithm is a frequent item set algorithm for mining association rules and the most influential algorithm for mining frequent item sets of Boolean association rules. The core idea is to mine frequent item sets through two stages: candidate set generation and plot downward closed detection. Its core is a recursive algorithm based on the two-stage frequency set idea. The association rule is classified as a single-dimensional, single-layer, Boolean association rule. Here, all item sets whose support degree is greater than the minimum support degree are called frequent item sets or frequency sets for short. The Apriori algorithm has been widely used in various fields such as business and network security. The Apriori algorithm uses an iterative method of layer-by-layer search. The algorithm is simple and clear, without complicated theoretical derivation, and easy to implement. The basic idea of the algorithm is as follows: first find out all frequency sets, and the frequency of these itemsets is at least the same as the pre-defined minimum support [26]. Then, strong association rules are generated from the frequency set, and these rules must meet the minimum support and minimum reliability. Then, use the frequency set found in step 1 to generate the desired rules and generate all the rules that only contain the items of the set, where there is only one item on the right of each rule, and the definition of the middle rule is used here. Once these rules are generated, only those rules that are greater than the minimum credibility given by the user are left. In order to generate all frequency sets, a recursive method is used. The economic model's transformation from the real economy to the virtual economy is manifested in the weakening of the correlation between the two.

Figure 2 illustrates the item set $I = \{A, B, C, D\}$. Let us assume that item set $\{A, B\}$ has a support below the specified threshold and, accordingly, is not frequent. Then, according to the anti-monotonicity property, all its supersets are also not frequent and are discarded. This entire branch, starting with $\{A, B\}$, is highlighted in orange. These heuristics can significantly reduce the search space.

The Apriori algorithm is used to calculate the frequent item sets of the two economies and then generate the association rules between the two economic models. The flowchart is shown in Figure 3. The specific steps are as follows:

Step 1: get frequent item sets. Establish a database after generalizing the attributes of the virtual economy and the real economy-related data and upgrading the

FIGURE 2: Item set $I = \{A, B, C, D\}$.

FIGURE 3: Apriori algorithm flowchart.

concept. Use single-pass scanning to obtain economic data in the database. Based on the conditional attributes and decision-making attributes of the virtual economy and the real economy, an item set collection is established.

Step 2: establish frequent item sets. Take any element in the set of conditional attribute item sets and each element in the decision attributes to form a frequent item

set. Traverse all the item sets in the database. If the support of the item sets does not meet the needs of the real economy and the virtual economy, delete the item sets.

Step 3: connection step. Calculate the K -th item set and denote the item set. When all items of the real economy and the virtual economy meet the association conditions in the universe of discourse, the connection operation is performed.

Step 4: according to the nature of the Apriori algorithm, when a subset of an item set is not included, it means that the item set is not frequent and can be deleted.

Step 5: iterate the third and fourth steps repeatedly until no new frequent item sets can be generated in the real economy and virtual economy data.

Step 6: generate association rules. Obtain the set of rules and the minimum confidence rules in the real economy and virtual economy data. After the rule reduction, the association rules of the real economy and the virtual economy are output, and the basic data for the transformation of the real economy to the virtual economy are provided.

The algorithm described above can be written as the following pseudocode (Algorithm 1).

$$\begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix} = \begin{bmatrix} O_{11} & & \\ & O_{22} & \\ & & O_{33} \end{bmatrix} \begin{bmatrix} I & F_{21} & K_{31} \\ K_{12} & I & F_{32} \\ F_{13} & K_{23} & I \end{bmatrix} \begin{bmatrix} H_{11} & & \\ & H_{22} & \\ & & H_{33} \end{bmatrix} \begin{bmatrix} Y_1 \\ Y_2 \\ Y_3 \end{bmatrix}, \quad (3)$$

where O_{ij} refers to the multiplier within the department and H_{ij} refers to the feedback effect.

The correlation effect between various sectors of the virtual economy and the real economy presents a form of interdependence, and the spillover effect exists in the feedback effect. Among them, big data fosters new kinetic energy, develops new industries, and forms new models which are the practical orientation of the high-quality development stage of economic transformation. With “macro-medium-micro” as the analytical framework, a big data mechanism has been constructed to promote high-quality economic transformation and development. Big data promotes economic transformation and development structure, as shown in Figure 4.

From Figure 4, the important role of big data in economic transformation is revealed in terms of improving the efficiency of production factor combination, stimulating innovation efficiency, and improving the efficiency of macrocontrol. It reveals the impact mechanism of big data on economic transformation and industrial structure upgrading from the perspective of changing industrial correlation, promoting industrial integration and big data industrial development, and analyzes the important role of big data in promoting the innovation of economic transformation model from the

2.2.3. *Feasibility Analysis of Economic Transformation Based on Input-Output Structure Decomposition.* We analyze the feasibility of economic transformation using the input-output structure decomposition method with the obtained association rules [26]. The process is as follows.

The expression formula of the input-output matrix of the transition from the real economy to the virtual economy is as follows:

$$\begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix} = \begin{bmatrix} A_{11} & A_{12} & A_{13} \\ A_{21} & A_{22} & A_{23} \\ A_{31} & A_{32} & A_{33} \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix} + \begin{bmatrix} Y_1 \\ Y_2 \\ Y_3 \end{bmatrix}, \quad (1)$$

where X refers to the output vector; j refers to the department; X_n refers to the department's total output; Y refers to the ultimate output vector; and Y_i refers to the department final demand.

$$A = [x_{ij}]_{3 \times 3} \cdot \hat{X}^{-1}, \quad (2)$$

where i refers to the direct consumption factor; A refers to the consumption coefficient matrix; and $\hat{X}^{-1}$ refers to the total input diagonal matrix.

Decomposing the first formula:

aspects of changing industrial correlation, promoting industrial integration and the development of big data industry.

The calculation formula for the total output multiplier effect of the transition from the real economy to the virtual economy is as follows:

$$\left[(z_i)^T, (z_j)^T, (z_k)^T \right] = (z_i)^T H_{ii} O_{ii} + (z_j)^T H_{ii} K_{ij}, \quad (4)$$

$[(z_i)^T, (z_j)^T, (z_k)^T]$ means increase the coefficient matrix; $(z_i)^T H_{ii} O_{ii}$ means intra-sector output multiplier; $(z_j)^T H_{ii} K_{ij}$ means sectoral spillovers.

The value of the spillover effect is related to the strength of the virtual economy to promote the real economy. Pre-set up the two kinds of economic increase coefficient matrices, calculate the value-added multiplier, and obtain the relevant effects of the transition from the real economy to the virtual economy [27, 28]. Then, obtain the feasibility analysis results of economic transformation based on each effect.

3. Empirical Analysis

Take the real economic data and virtual economic data of a province from 2000 to 2015 as the empirical analysis object.


```

(1)  $F_1 = \{\text{Frequent 1-length item sets}\};$ 
(2) for  $(k = 2, F_{k-1} < \emptyset, k++)$ 
(3) {
(4)  $C_k = \{\text{generation of candidates } k \text{ based on Apriorigen } (F_{k-1})\}$ 
(5)   for all transactions  $t \in D$ 
(6)   {
(7)  $C_t = \text{subset } (C_k, t) // \text{Removal of redundant rules}$ 
(8)   for all candidates  $c \in C_t$ 
(9)    $c.\text{count}++$ 
(10)  }
(11)  $F_k = [c \in C_k | c.\text{count} \geq \text{minsupp}] // \text{Selection of candidates}$ 
(12) }
(13) Result  $\cup F_k$ 

```

ALGORITHM 1: The pseudocode of the Apriori algorithm.

FIGURE 4: Big data promotes economic transformation and development.

Use the feasibility analysis method to calculate the output multiplier and total economic output of the real economy and the virtual economy. The results are shown in Table 1.

It can be seen from Table 1 that from the perspective of the internal multiplier of the real economy and the virtual economy, the internal multiplier of the real economy is relatively large, while the internal multiplier of the virtual economy is relatively small. Since 2012, the value of the internal multiplier has increased significantly. As of 2015, the internal multiplier value has increased by approximately 1.25 percentage points compared with 2010. It shows that the virtual economy is expanding rapidly, and the feedback coefficient of the real economy and the virtual economy is not much different from the overall trend of the internal multiplier rising. From the perspective of the total output of the real economy and the virtual economy, the total output increase of the virtual economy is smaller than that of the real economy, and the growth rate is higher than that of the real economy. From 2010 to 2015, the total output value of the virtual economy increased by 46.264 billion yuan. In short, the feasibility of the transition from the real economy to the virtual economy is not integral. The virtual economy is expanding rapidly, and its pulling effect is relatively small compared to the real economy. As the real economy expands, the demand for financial institutions continues to increase, resulting in a continuous increase in the total

output value of the virtual economy. Therefore, between 2010 and 2015, the transition from the real economy to the virtual economy has a good feasibility relationship.

The results of statistics on the changes in the scale of the three industries in the province from 2010 to 2015 are shown in Figure 5.

Analyzing Figure 5, since 2010, the province's overall GDP has gradually increased, and the secondary industry has increased significantly. From 2013 to 2015, the overall GDP of the secondary industry remained flat, and the primary and tertiary industries showed a gentle upward trend. Among the three industries, the growth rate of the primary industry was low. The proportion of the primary industry is relatively small, and the proportion of the secondary industry is the highest, indicating that the proportion of the province's industrial structure is relatively biased. It needs to reorganize its industrial structure and place its focus on the tertiary industry. The province's real economy needs to be further developed. At this time, the province's real economy to a virtual economy is more feasible.

From the analysis of the securities industry in the province's virtual economy, statistics of the province's listed companies and total stock issuance from 2010 to 2015 are shown in Table 2.

Analyzing Table 2, from 2010 to 2015, there were 23 more listed companies in the province, and the issued share capital and the total issuance of shares rose by 0.72 and 1.01

TABLE 1: Real economy and virtual economy output multiplier and total output.

Years	Real economy output multiplier		Virtual economy output multiplier		Real economy total output/100 million yuan		Total virtual economy output/100 million yuan	
	Inner multiplier	Number of feedback	Inner multiplier	Number of feedback	Inner multiplier	Number of feedback	Inner multiplier	Number of feedback
2010	1.113	0.026	0.126	0.133	1341.325	96.422	14.830	0.421
2011	1.111	0.03	0.149	0.131	2196.221	107.245	70.822	1.931
2012	1.074	0.029	0.138	0.182	3726.224	225.147	126.443	3.090
2013	1.104	0.025	0.191	0.166	6034.701	309.421	182.651	3.122
2014	1.162	0.033	0.224	0.181	9011.412	457.631	352.730	10.999
2015	1.165	0.046	0.284	0.172	11235.466	613.543	477.494	17.816

FIGURE 5: Industry scale from 2010 to 2015.

TABLE 2: Development data of the securities industry.

Years	Listed company (home)	Issued share capital (ten thousand shares)	Total shares issued (ten thousand shares)
2010	29	3454666	862506
2011	31	3594696	884906
2012	35	4425134	1220986
2013	41	4734007	1239633
2014	49	5094506	1426209
2015	52	5928331	1732904

percentage points, respectively. In terms of the rising ratio, the value is relatively small, indicating that the development of the virtual economy in the province is relatively lagging, the capital market has not kept up with the pace of the real economy, and the investment field and scope of the virtual economy are insufficient. At this time, the province's real economy transitioning to a virtual economy lacks rational guidance. Facing this situation, the feasibility of realizing the transformation from real economy to virtual economy, it is necessary to carry out private financing and inject a large amount of idle funds into the capital market, so as to stimulate the development of virtual economy and provide strong

support for the development of real economy. At this time, the transformation from real economy to virtual economy has high feasibility. At this time, the transformation from real economy to virtual economy is highly feasible.

The complete distribution coefficient is used as an indicator of the forward correlation effect of the real economy and the virtual economy. The indicator is used to express the supporting role of the virtual economy on the development of the real economy. The result is shown in Figure 6.

Analyzing Figure 6, we can see that from 2010 to 2012, although the province's full distribution coefficient of the virtual economy showed an upward trend year by year, the

FIGURE 6: Virtual economy supports the real economy.

rate of increase was small. As of 2012, the complete distribution coefficient of the virtual economy rose rapidly. As of 2015, the value of the complete distribution coefficient of the supporting role of the virtual economy on the real economy has reached 4.0. It can be seen that the forward correlation effect between the real economy and the virtual economy is the highest at this time, indicating that the virtual economy has the highest support effect on the development of the real economy.

4. Conclusion

Based on the association rule algorithm, we establish a feasibility analysis model for the transition from the real economy to the virtual economy. Taking a province as an example, a feasibility analysis was carried out in terms of output multiplier, total economic output value, and the scale of three industries. From 2010 to 2015, the total output value of the virtual economy increased by 46.264 billion yuan. The feasibility of the transition from the real economy to the virtual economy is not integral. The virtual economy is expanding rapidly, its total output value is continuously increasing, and the feasibility relationship of the transformation performance is good. As of 2015, the value of the complete distribution coefficient of the virtual economy's supporting role for the real economy has reached 4.0, showing obvious feasibility.

Data Availability

The labeled dataset used to support the findings of this study is available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

References

- [1] W. Xiao, J. Hu, and X. F. Zhou, "Parallel association rules mining algorithm based on map reduce: a survey," *Application Research of Computers*, vol. 35, no. 1, pp. 13–23, 2018.
- [2] A. B. Mohamed, M. Mai, S. Florentin, and V. Chang, "Neutrosophic association rule mining algorithm for big data analysis," *Symmetry*, vol. 10, no. 4, pp. 1–20, 2018.
- [3] S. Rathee and A. Kashyap, "Adaptive-miner: an efficient distributed association rule mining algorithm on spark," *Journal of Big Data*, vol. 5, no. 1, pp. 1–17, 2018.
- [4] L. H. Son, F. Chiclana, R. Kumar et al., "ARM-AMO: an efficient association rule mining algorithm based on animal migration optimization," *Knowledge-Based Systems*, vol. 154, no. 15, pp. 68–80, 2018.
- [5] T. Su, H. Xu, and X. Zhou, "Particle swarm optimization-based association rule mining in big data environment," *IEEE Access*, vol. 7, pp. 161008–161016, 2019.
- [6] D. J. Prajapati, S. Garg, and N. C. Chauhan, "Interesting association rule mining with consistent and inconsistent rule detection from big sales data in distributed environment," *Future Computing and Informatics Journal*, vol. 2, no. 1, pp. 19–30, 2017.
- [7] T. Karthikeyan and N. Ravikumar, "A survey on association rule mining," *International Journal of Advanced Research in Computer and Communication Engineering*, vol. 3, no. 1, pp. 2278–1021, 2014.
- [8] Y. Li and Y. Li, "E-commerce order batching algorithm based on association rule mining in the era of big data," in *Proceedings of the 2018 Chinese Control And Decision Conference (CCDC)*, pp. 1934–1939, IEEE, Shenyang, China, June 2018.
- [9] C. Song, "Research of association rule algorithm based on data mining," in *Proceedings of the 2016 IEEE International Conference on Big Data Analysis (ICBDA)*, pp. 1–4, IEEE, Hangzhou, China, March 2016.
- [10] T. S. Murthy, N. P. Gopalan, and N. P. Gopalan, "A novel algorithm for association rule hiding," *International Journal of Information Engineering and Electronic Business*, vol. 10, no. 3, pp. 45–50, 2018.
- [11] Y. Liu, X. Hu, X. Luo, Y. Zhou, D. Wang, and S. Farah, "Identifying the most significant input parameters for predicting district heating load using an association rule algorithm," *Journal of Cleaner Production*, vol. 275, no. 12, Article ID 122984, 2020.
- [12] D. X. Jiang, "The regulatory logic of transferring finance "from real economy to virtual economy": taking the regulation of the listed companies' M&A activities as an example," *Modern law*, vol. 40, no. 5, pp. 79–94, 2018.
- [13] C. Sergio, P. Anthony, D. C. Luciano, Á. Riascos, and S. Oren, "A structural model to evaluate the transition from self-commitment to centralized unit commitment," *Energy Economics*, vol. 75, no. 9, pp. 560–572, 2018.
- [14] X. Zhu, S. Lin, L. Wang, W. Wu, and Q. Qin, "A study of the real economy and the virtual economy," *A Study of the Turning Point of China's Debt*, Springer, vol. 10, no. 7, pp. 165–184, Berlin, Germany, 2018.
- [15] M. I. Lugachev, N. V. Ulianova, and K. G. Skripkin, "New approaches to the interpretation of balance in the digital economy," *Statistics and Economics*, vol. 17, no. 3, pp. 25–36, 2020.
- [16] G. Shi, W. Yu, K. Wang, F. Dang, J. Gong, and Y. Lu, "Time-dependent economic risk analysis of the natural gas transmission pipeline system," *Process Safety and Environmental Protection*, vol. 146, pp. 432–440, 2021.
- [17] C. Y. Wang, "Analysis of students' achievement based on association rule apriori algorithm," *Value Engineering*, vol. 37, no. 5, pp. 171–173, 2018.
- [18] D. S. Ginting, H. Mawengkang, and S. Efendi, "Modification of a priori algorithm focused on confidence value to

- association rules,” *IOP Conference Series: Materials Science and Engineering*, vol. 420, no. 1, Article ID 012125, 2018.
- [19] A. U. Mentsiev, E. R. Guzueva, S. M. Yunaeva, M. V. Engel, and M. V. Abubakarov, “Blockchain as a technology for the transition to a new digital economy,” *Journal of Physics: Conference Series*, vol. 1399, no. 3, Article ID 033113, 2019.
 - [20] J. Fořt and R. Černý, “Transition to circular economy in the construction industry: environmental aspects of waste brick recycling scenarios,” *Waste Management*, vol. 118, pp. 510–520, 2020.
 - [21] H. Albayati, S. K. Kim, and J. J. Rho, “Accepting financial transactions using blockchain technology and cryptocurrency: a customer perspective approach,” *Technology in Society*, vol. 62, Article ID 101320, 2020.
 - [22] C. H. Wang and K. J. Min, “Transition from coal to natural gas power plants under CO₂ consideration: a real options approach,” *International Journal of Sustainable Economy*, vol. 12, no. 4, p. 344, 2020.
 - [23] N. Guogang, “Serving the real economy: the Chinese banking sector forging ahead for four decades,” *China’s Economic Transformation*, vol. 2, no. 4, pp. 63–73, 2019.
 - [24] Q. Song, J. D. Tang, and J. J. Guo, “Impacts of bank liquidity creation on real economy,” *Journal of Hebei University of Economics and Business*, vol. 40, no. 3, pp. 47–55, 2019.
 - [25] C. Borgelt and R. Kruse, “Induction of association rules: apriori implementation,” in *Proceedings of the COMPSTAT 2002*, pp. 395–400, Berlin, Germany, August 2002.
 - [26] C. Borgelt, “Efficient implementations of apriori and eclat,” in *Proceedings of the IEEE ICDM Workshop on Frequent Itemset Mining Implementations*, Melbourne, FL, USA, November 2003.
 - [27] J. Li, “How to deal with the relationship between financial system and real economy,” *World Scientific Research Journal*, vol. 5, no. 10, pp. 128–133, 2019.
 - [28] M. V. Prianyshnykova, O. D. Hudenko, and O. D. Hudenko, “Corona-test of the real economy and financial and economic imperatives to overcome the effects of the COVID-19 pandemic,” *The Problems of Economy*, vol. 3, no. 45, pp. 18–24, 2020.