Research Article

Relationship between Green Financing and Investment Logic and Effectiveness Evaluation of Financing Decisions

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Green financing diverts more funds to green industries such as environmental protection, and clean energy, enabling the industries to realize structural adjustment. On green financing, the existing studies at home and abroad mainly focus on the definition of concepts and service scope and system construction. There are few attempts to combined green financing efficacy with corporate investment from the angles of investment level, investment efficiency, and investment risks. This paper associates green financing policy with corporate investment, analyzes the logical connection between the two, and thereby evaluates the effectiveness of green financing decisions. Specifically, a decision model was established for the government participation in green financing via green product subsidy, and a solving algorithm was developed for the model. After that, the authors analyzed the correlations of green financing with the investment level and investment efficiency of green enterprises. Next, the effectiveness of green financing decisions was discussed under dynamic operation risks. Finally, the proposed approach was demonstrated through simulation and empirical analysis.

1. Introduction

The sustainable development of all industries is severely bottlenecked by environmental pollution and resource depletion, which arise from the traditional high-pollution and high-consumption development model [1–6]. The long-term development of the green economy hinges on the optimization of industrial structure [7–9]. To achieve green industry restructuring, it is necessary to integrate green development philosophy into the financial system, which plays an important role in the allocation of social resources, and divert more funds to green industries such as environmental protection and clean energy [10–13]. Short supply, weak incentives, and period mismatch are the main problems with the green financing policy, the result of government-led policy guidelines, and system arrangements [14–16]. Green enterprises, as undertakers of green investment, often encounter inefficient investment issues, such as insufficient investment and excessive investment [17–22]. Therefore, exploring the logic relationship between green finance and green enterprise investment would provide an important reference for further optimization of green finance policy.

Wu et al. [23] highlighted how critical the commercialization of emerging green technology is to the sustainability of the industrial process, put forward two mixed-integer linear programming models to optimize the innovation financing strategies, and demonstrated the optimization effect through a case study on a biorefinery. Tan et al. [24] researched nonsymmetric competitive supply chain models with financing risks and compared the optimal quantity, optimal price, and optimal profit under two scenarios. It was found that under complete information, the financing risks of capacity investment do not affect the
selection of equilibrium price and quantity of the two supply chains. Criscuolo and Menon [25] detailed the risk capital investment of 29 countries in the green sector from 2005 to 2010 and explained the possible role of policy in the observed cross-country differences.

Green bonds are becoming a major financial source of green infrastructure, including air and water projects. Ludvigsen [26] introduced the important factors for the issuance of green bonds and the latest technical standard for water affairs of Climate Bonds Standard 2.1. Yatim et al. [27] regarded the green economy as an important path towards sustainable development goals, as well as a promoter of economic growth, and the innovation of new low-carbon production technologies and products. They also elaborated extensively on the current financing policy and measures, such as Green Technology Financing Scheme (GTFS). Dong and Li [28] summarized the recent research results on green finance, defined the basic connotations of green finance, explained the action mechanism of green finance, and provided suggestions on green credit, green insurance, green securities, and green risk investment. Koester et al. [29] pointed out that millions of new capitals from risk fund, private equity fund, and hedge fund are being diverted to clean technology, creating a huge innovation opportunity for clean technology development. In addition, they discussed the optimal organizational form, intellectual property protection, stock options, risk investment locations, offshore finance, financing options, and so on.

As green financing attracts more and more attention, many domestic and foreign scholars have defined the concept of green finance, delineated the service scope of green financing, and constructed green financing systems. However, few of them studied green financing efficiency and corporate investment from the angle of investment level, investment efficiency, and investment risk. Neither have they evaluated the effect of green financing policies from macroperspectives such as economic operation and institutional environment. There is no in-depth research into the niches. As a result, corporate managers lack a theoretical basis for implementing green financing.

To evaluate the green financial decision, this paper links the macroconcept of green financing policy with the microconcept of corporate investment and analyzes the correlation between green financing and the green corporate investment logic. The research effectively solves the information loss in the traditional discretization process. The association rules of technical indices extracted in this research greatly reduce the computing load of further research.

The main contents are organized as follows: (1) Section 2 models the government decision to participate in green financing in the form of green product subsidy, and provides the solving algorithm; (3) Section 3 analyzes the correlations between green financing, green corporate investment level, and investment efficiency; (4) Section 4 discusses how to analyze the effectiveness of green financing decision under dynamic operating risks; and (4) Section 5 carries out simulations and presents the empirical results.

2. Model Construction and Solution

2.1. Model Construction. Referring to the existing results on the interplay between green financing policy and green corporate investment, this paper defines the investment subject as a two-level supply chain involving a green product manufacturer and a green product service provider. Under the effect of the government’s environmental policy, green enterprises are forced to further invest in environmental protection. The resulting shortage of funds calls for financing by financial institutions. Thanks to the guidance of the government, the financing policy of financial institutions favors green enterprises. As a result, green financing helps lower the financing cost and increase the financing efficiency of green enterprises. In this paper, two green financing scenarios are considered, namely, government subsidy for green product manufacturing and green service provision. The specific mechanism of the subsidy is illustrated in Figure 1.

This paper mainly studies the government participation in green financing in the form of green product subsidy, in order to optimize the financing decisions of the relevant enterprises. Let MD be the potential market demand of the green products being invested; SE be the sensitivity coefficient of consumers to the price of green products/services; PR be the production cost per unit of green products; SQ be the amount of government subsidy per unit of green products; LR be the sales profit per unit of green products; TP be the unit price of green products; h be the green level of green products; l be the green sensitivity of consumers to green products/services; ω be the ratio of the investment cost of green products to that of the relevant green services; and FU (FU > 0) be the initial fund of the green manufacturer. Without any fund constraint, the green financing amount of a green product manufacturer needs to satisfy:

$$FU \geq (PR - SQ)(MD - SE(LR + TP) + h) + \frac{\omega}{2}h^2.$$  

Equation (1) shows that when the initial fund is fewer than the required green financing amount, the green product manufacturer needs to obtain green financing from banks, venture capital, and other financial institutions. The fund size FI required by the green product manufacturer is defined as follows:

$$FI = (PR - SQ)(MD - SE(LR + TP) + h) + \frac{\omega}{2}h^2 - FU.$$  

Considering the government participation in green financing in the form of green product subsidy, the overall objective of green financing decision was defined as the maximization of total social welfare ZF, composed of the profit of green product manufacturer and green service provider, the consumer surplus, and the environmental protection and governance cost. Let E be consumer demand; LV be the bank interest rate; GZ be consumer surplus; φSU be the profit of green product manufacturer; φSU be the profit of green service provider; and CZ = SQ. E be the government’s financial discount expenditure. Then, the functions of φSU, φSU, and ZF can be expressed as follows:
\( \phi_{SU} = (TP - PR + SQ)E - \frac{\omega_1}{2}h^2 - FI \cdot LV, \)

\( \phi_{ZH} = LR \cdot E - \frac{1}{2}h^2, \)

\( ZF = \phi_{SU} + \phi_{ZH} + GZ - CZ. \)

Substituting \( E, FI, GZ, \) and \( CZ \) separately into (3), we get

\( \phi_{SU} = (TP - PR + SQ)[MD - SE(LR + TP) + lh] - \frac{\omega_1}{2}h^2 - \left\{ (PR - SQ)[MD - SE(LR + TP) + lh] + \frac{\omega_2}{2}h^2 - FU \right\} LV, \)

\( \phi_{ZH} = LR[MD - SE(LR + TP) + lh] - \frac{1}{2}h^2, \)

\( ZF = (TP - PR)[MD - SE(LR + TP) + lh] - \frac{\omega_1}{2}h^2 - \left\{ (PR - SQ)[MD - SE(LR + TP) + lh] + \frac{\omega_2}{2}h^2 - FU \right\} LV \)

\( + LR[MD - SE(LR + TP) + lh] - \frac{1}{2}h^2 + \frac{1}{2}[MD - SE(LR + TP) + lh]^2. \)

The game between the government and the enterprises can be modeled as follows:

\[
\begin{align*}
\text{maximize } & ZF(SQ), \quad \text{s.t. } SQ \geq 0, \\
\text{maximize } & \phi_{ZH}(LR, h), \quad \text{s.t. } LR \geq 0, h \geq 0, \\
\text{maximize } & \phi_{SU}(TP), \quad \text{s.t. } TP \geq 0.
\end{align*}
\]

As shown in (7), the government leads the actions of enterprises. Therefore, the decision on green product subsidy \( SQ \) should be made first with ZF maximization as the top priority. Then, the green product manufacturer decides the greenness \( h \) of products, and the sales profit \( LR \) per unit of green products, with the aim to maximize the sales profit.
of its own products. Finally, the green service provider decides the unit price TP of green products, aiming to maximize the profit of service provision.

2.2. Model Solution. The proposed model was solved reversely. For simplicity, the following equation can be defined first:

\[ \begin{align*}
    g_1 &= MD - SE \cdot PR (1 + LV), \\
    g_2 &= SE (SE - 2), \\
    g_3 &= \hat{l}^2 (-1 + \omega + \omega LV), \\
    g_4 &= \hat{l}^2 - 4SE, \\
    g_5 &= SE^2 (1 + LV) + SE (6LV - 2), \\
    g_6 &= \hat{l}^2 (-1 + LV + \omega + 2LV\omega + LV^2\omega). \\
\end{align*} \]

(8)

Combining (11) and (10), the derivatives relative to h and LR can be solved as follows:

\[ \begin{align*}
    \frac{\partial \phi_{ZH}}{\partial h} &= \frac{l \cdot LR}{2} - h, \\
    \frac{\partial \phi_{ZH}}{\partial h} &= \frac{1}{2} [MD + h] - (-2LR - PR \cdot LV + SQ + LV \cdot SQ)]. \\
\end{align*} \]

(12)

Next, the second-order derivative of \( \phi_{ZH} \) relative to h and LR can be solved as follows:

\[ \begin{align*}
    \frac{\partial^2 \phi_{ZH}}{\partial h^2} &= -1, \\
    \frac{\partial^2 \phi_{ZH}}{\partial LR^2} &= -SE, \\
    \frac{\partial^2 \phi_{ZH}}{\partial h \partial LR} &= \frac{\partial \phi_{ZH}}{\partial LR \partial h} \frac{l}{2}. \\
\end{align*} \]

(13)

The Hessian matrix can be defined as follows:

\[ \text{Hessian} = \begin{bmatrix} -SE & \frac{l}{2} \\ \frac{l}{2} & -1 \end{bmatrix}. \]

(14)

By (4), the first-order derivative of \( \phi_{SU} \) relative to the unit price TP of green products can be obtained as follows:

\[ \frac{\partial \phi_{SU}}{\partial TP} = MD + hl + SE \cdot LV (PR - SQ) - SE (LR + TP) \]

(9)

Then, the second-order derivative of \( \phi_{SU} \) relative to TP can be solved as follows:

\[ \frac{\partial^2 \phi_{SU}}{\partial^2 TP} = -2SE < 0. \]

(10)

Since \( \phi_{SU} \) is a concave function about TP, there is a local maximum of the profit of green product/service enterprise. Suppose the second-order derivative of \( \phi_{SU} \) relative to TP is zero. Then, TP can be described as a function of SQ, LR, and h as follows:

\[ TP = \frac{MD + SE \cdot PR + hl - SE \cdot LR + SE \cdot PR \cdot LV - SE \cdot SQ - SE \cdot LV \cdot SQ}{2SE}. \]

(11)

The Hessian matrix is negative definite when its absolute value is greater than 0, expressed as follows:

\[ |\text{Hessian}| = SE - \frac{l^2}{4}. \]

(15)

In this case, \( \phi_{ZH} \) is the combined concave function of h and LR. The simultaneous solution can be solved by

\[ LR = \frac{2 (MD + SE \cdot PR - SE \cdot PR \cdot LV + SE \cdot SQ + SE \cdot LV \cdot SQ)}{4SE - l^2}, \]

\[ h = \frac{l (-MD + SE \cdot PR + SE \cdot PR \cdot LV - SE \cdot SQ - SE \cdot LV \cdot SQ)}{4SE - l^2}. \]

(16)

Substituting h and LR into formula (11), TP can be updated as follows:

\[ TP = \frac{MD + (3SE - l^2)(1 + LV) (PR - SQ)}{4SE - l^2}. \]

(17)

Substituting the updated SQ, h, and LR into (6), the first-order derivative of ZF relative to SQ can be obtained, and the second-order derivative of ZF relative to SQ can be solved as follows:

\[ \frac{\partial^2 ZF}{\partial SQ^2} = \frac{SE^2 (1 + LV) (-2SE (1 - 3LV) + SE^2 (1 + LV) + \hat{l}^2 (1 - LV - \omega + 2LV\omega + LV^2\omega))}{(l^2 - 4SE)^2}. \]

(18)
If (18) is negative, ZF is a concave function of SQ and has a local maximum. Suppose the first-order derivative of ZF relative to SQ equals 0. Then

\[ SQ = \frac{g_5 - g_6 - g_4 - g_1}{SE(1 + LV)(g_5 + g_6)}. \]  

(19)

When the government participates in green financing in the form of green product subsidy, the following condition must be satisfied:

\[ l^2 SE > \frac{2}{4}. \]

\[ SE^2 (1 + LV) + SE(6LV - 2) < l^2 \left( -1 + LV + \omega + 2LV\omega + LV^2 \omega \right). \]  

(20)

The optimal TP, LR, h, and SQ can be expressed as follows:

\[ TP = g_1 \frac{(g_4 + SE)}{SE(g_6 - g_5)} + \frac{MD}{SE}, \]

\[ LR = \frac{2g_1}{g_6 - g_5}, \]

\[ h = \frac{1g_1}{g_6 - g_5}, \]

\[ SQ = \frac{g_5 - g_6 - g_4 - g_1}{SE(1 + LV)(g_5 - g_6)}. \]

3. Dynamic Risk-Based Analysis on Green Financing Decision

3.1. Correlation between Green Financing and Green Enterprise Investment. Figure 2 presents the associations between green financing and green corporate investment level. To verify the hypothesis that green enterprises invest more than nongreen enterprises under green financing, this paper takes investment level \( II_{ir} \) and the double differential cross-term \( (G_i \times T_i) \) as the explained variable and the explanatory variable, respectively, and denotes the control variable as CV, individual fixed effects as \( \xi_i \), time fixed effects as \( \beta_i \), and the random disturbance term as \( \rho_{ir} \). Then, the fixed-effects double differential model can be established as follows:

\[ II_{ir} = e_0 + e_1 G_i \times T_i + \beta CV + \xi_i + \mu_i + \rho_{ir}. \]  

(22)

The above model characterizes the associations between green financing and green corporate investment level. Our focus lies on the estimated value of \( e_0 \), which represents the degree of impact of green financing on the green corporate investment level. If the estimated value is positive, then the hypothesis holds; if the estimated value is negative, then the hypothesis fails.

3.2. Correlation Analysis between Green Financing and Green Corporate Investment Level. Figure 3 presents the association mechanism between green financing and green corporate investment level. The following parameters were defined to test the interaction between green financing, the sufficiency of green corporate investment, and investment efficiency: the actual new capital investment \( CA_i \) of the green enterprise in year \( \tau \); the Tobin’s Q \( TB_{Q_{ir-1}} \) representing the growth opportunity of the green enterprise in year \( \tau - 1 \); the working fund \( ZY_{ir-1} \) of the green enterprise in year \( \tau - 1 \); the asset-liability ratio \( DR_{ir-1} \) of the green enterprise at the end of year \( \tau - 1 \); the scale growth rate \( SC_{ir-1} \) of the green enterprise; the listing time \( MA_{ir-1} \) of the green enterprise; the actual new capital investment \( CA_{ir-1} \) of the green enterprise in year \( \tau - 1 \); and the dummy variables \( ND \) and \( HY \) of year and industry, respectively. Then, the investment efficiency of the green enterprise can be measured by

\[ CA_{ir} = r_0 + r_1 TB_{Q_{ir-1}} + r_2 ZY_{ir-1} + r_3 DR_{ir-1} + r_4 SC_{ir-1} + r_5 MA_{ir-1} + r_6 HY + \rho_{ir}. \]  

(23)

Based on the regression residual of (23), the underinvestment \( CA_{VIP_{ir}} \), overinvestment \( CA_{ZGIS_{ir}} \), and investment efficiency \( CA_{AI_{ir}} \) of the green enterprise were calculated separately. Then, \( CA_{VIP_{ir}} \), \( CA_{ZGIS_{ir}} \), and \( CA_{AI_{ir}} \) were treated as explained variables, and \((G_i \times T_i)\) as the explanatory variable to build the double differential fixed-effects models (26–28), which test the interaction between green financing, the sufficiency of green corporate investment, and investment efficiency. Let us denote the control variable as CV, individual fixed effects as \( \xi_i \), time fixed effects as \( \beta_i \), and the random disturbance term as \( \rho_{ir} \). Then, we have

\[ CA_{VIP_{ir}} = d_0 + d_1 G_i \times T_i + \beta CV + \xi_i + \mu_i + \rho_{ir}, \]

\[ CA_{ZGIS_{ir}} = d_2 + d_3 G_i \times T_i + \beta CV + \xi_i + \mu_i + \rho_{ir}, \]

\[ CA_{AI_{ir}} = d_4 + d_5 G_i \times T_i + \beta CV + \xi_i + \mu_i + \rho_{ir}. \]  

(24)

The above models focus on the estimation of parameters \( d_1, d_3, \) and \( d_5 \), which characterize how much green financing affects the sufficiency of green corporate investment and investment efficiency. If \( d_1 \) is estimated to be positive, then the green financing policy worsens the insufficiency of corporate investment; if \( d_3 \) is estimated to be negative, then the policy alleviates the insufficiency of corporate investment; if \( d_5 \) is estimated to be positive, then the green financing policy intensifies the excessiveness of corporate investment; if \( d_5 \) is estimated to be negative, then the policy alleviates the excessiveness of corporate investment; and if \( d_5 \) is estimated to be negative, then the policy drags down that efficiency.

3.3. Dynamic Operation Risks and Green Financing Decision. This paper takes the net occupation of green credit and short-term financial debt ratio as the explained variables. Let GCD and GCS be the corporate demand and supply of green credit, respectively; GFAT, GFBP, GFP, GFACR, GFNR, and GFADR be the accounts payable, notes payable, prepayment,
Dynamic risk-based analysis on green financing policy

- Dynamic risk effect
  - Highlighting green credit evaluation
  - Supervising the decrease of short-term financing debt ratio
  - Indirect incentive of legal environmental quality cognition
  - Direct incentive of green product subsidy
  - Green credit policy bias
  - Low-cost financing of green bonds
  - Capital flow of financial institutions
  - Social capital flow

- Investment incentive effect
  - Reducing investment risks
  - Enhancing investment willingness
  - Lowering financing cost
  - Diversifying fund acquisition channels

- Financing convenience
  - Increasing green enterprise expenditure

- Fund source

Figure 2: Associations between green financing and green corporate investment level.

The green enterprise makes insufficient investment
- The government participates in green financing via green product subsidy
- The green enterprise weighs operation risks
- The green enterprise meeting financing conditions relies on green financing to ease fund shortage and increase investment expenditure
- The fund shortage of the green enterprise is solved

The green enterprise makes excessive investment
- Green financial policy favors green enterprises
- Under favorable policy, investors are enthusiastic about investment
- Under sufficient funds, the green enterprise allocates fund and expands business
- Under sufficient funds, the green enterprise enters a virtuous cycle of operation
- The green enterprise relies on green financing to increase investment expenditure and expand investment
- The green enterprise grows in size and further expands investment

Figure 3: Association mechanism between green financing and green corporate investment level.
accounts receivable, notes receivable, and deposit received of green financing, respectively; and GPOI be the operation income of green products of the green enterprise. Then, the net occupation of green credit NO can be calculated by

\[
NO = GCD - GCS = \frac{GFAT + GFBP - GFP - GFACR + GFNR - GFADR}{GPOI}
\]

(25)

Let STB be the short-term borrowing of green financing; IP be the interest payment of green financing; NCL be the noncurrent liabilities expired within the year; TFL be the trading financial liabilities; CA be the current assets; and OCL be the operating current assets. Then, the short-term financial debt ratio STF can be calculated by

\[
STF = \frac{STB + IP + NCL + TFL}{CA - OCL}.
\]

(26)

In this paper, the dynamic operation risks of the green enterprise are evaluated under the assumption that the enterprise’s profitability changes dynamically with the operation risks. Let \(\eta_t\) be the operation risks in year \(t\); \(QP_t\) be the profit before interest, taxes, depreciation, and amortization in year \(t\); and \(ZC_{t-1}\) be the total capital in year \(t-1\). Then, we have

\[
\eta_t = \left[ \frac{1}{\psi - 1} \sum_{t=1}^{\psi} P_t - \frac{1}{\psi} \sum_{t=1}^{\psi} P_t \right]^{\frac{1}{2}},
\]

\[
P_t = \frac{QP_t}{ZC_{t-1}}.
\]

(27)

Because the green financing decision of the green enterprise is affected by many factors, several other control variables were chosen in addition to dynamic operation costs. Let B represent NO and STF; \(a_0, a_1, a_2, a_3, a_4, a_5,\) and \(a_6\) denote regression coefficients; IL denotes green product inventory level; NCF be the net cash flow of the operation activities of the green enterprise; CS be the scale of the green enterprise; CG be the growth of the green enterprise; PRO be the profitability of the green enterprise; and OR be the operating risks of the green enterprise. Then, the regression analysis model can be established as follows:

\[
B = a_0 + a_1 IL + a_2 NCF + a_3 CS + a_4 CG + a_5 PRO + a_6 OR + \rho.
\]

(28)

Model (28) mainly measures how much the operation risks of the green enterprise influence NO and STF.

4. Simulation and Empirical Analysis

The dynamic operation risks of the green enterprise are immensely impacted by market status and industry cyclicity. To ensure the reliability of experimental results, our data samples are Chinese enterprises of the same grade in the noncyclic industry of environmentally friendly electric vehicle manufacturing. After removing the enterprises lacking operation and economic data, a balanced panel data of 28 environmentally friendly electric vehicle manufacturers were established for 2010–2020, which include a total of 540 observations.

The associations between green financing and green enterprise investment change with the time series. However, the changes in the associations do not impede the time series from helping the decision-maker of green financing. The decision-maker can still acquire valuable association rules from the panel data time series. Our sample data were obtained from enterprise annual reports and bank credit disclosures and were clustered by an improved fuzzy c-means (FCE) algorithm, producing the membership matrix of the attributes of the financing time series. These attributes were then applied to association rule analysis. Figure 4 depicts the flow of our association rule analysis algorithm. A total of 30 experiments was carried out with the following parameters: the population size of the genetic algorithm (GA) was set to 25, the fuzzy weighting index to 2, the maximum number of iterations to 500, and the number of classes to 3. Table 1 compares the clustering results of different algorithms.

As shown in Table 1, our algorithm achieved the best clustering effect, although it was a bit slower than standard FCM and GA-based fuzzy clustering. This means our algorithm is very unlikely to fall into local optimum and strong in global search. Figure 5 presents the curve of the mean optimal solution to the fitness of each algorithm. It is evident that our algorithm could easily jump out of local convergence, while the other two algorithms often fell into the local optimum, during the clustering of the panel data time series. The main reason is that our algorithm adaptively optimizes crossover and mutation.

The membership matrix of the sample data could be obtained through cluster analysis. Several data were selected from the membership matrix of each kind of panel data time series, forming the financing decision form under the operation risks of green enterprises (Table 2).

Next is to demonstrate the effectiveness of our model in characterizing the influence of green financing over green enterprise investment level and investment efficiency. For this purpose, the main variables of our model were subjected to descriptive statistics. Table 3 shows the statistics on the model of the relationship between green financing and green enterprise investment level. The mean of \(IL_{t-1}\) stood at 0.045, that is, the investment level of the surveyed green enterprises averaged at 0.045; the maximum and minimum of the investment level were −0.033, and 0.235, respectively, which represent the difference between green enterprises in investment level. Meanwhile, the mean, maximum, minimum, and standard deviation of \(TB-Q_{it-1}\) were 2.627, 11.125, 0.912, and 1.865, respectively, suggesting that different green
enterprises vary in growth opportunity. Likewise, the other variables also differed across green enterprises.

The double differential model must satisfy the null hypothesis of parallel trend. This paper tests the effect of our model on green financing. Figure 6 presents the time trends of green enterprise investment level in 2010–2020. One of the curves is about the test group, and the other is about the control group. It can be observed that before 2015, the investment levels of the two groups declined similarly. This is because the investment expenditure grows slower than the total assets, due to the cluster analysis and normalization of total assets of green enterprises and relevant economic panels. After 2015, the investment level of the test group dropped at a slower pace and even slightly rebounded, while that of the control group continued to fall. After 2017, the gap between the two groups widened. The results confirm the hypothesis that green enterprises invest more than nongreen enterprises under green financing.

Table 4 gives the descriptive statistics for the model of the relationship between green financing and green enterprise investment efficiency. In 2010–2020, the annual mean of the new investment of green enterprises took up 4.5% of the total assets; the maximum, minimum, and standard deviation were 18.5%, −3.4%, and 4.2%, respectively. This means green enterprises make only a few new investments, and the enterprises differ in the investment scale. It could be similarly deduced that different enterprises varied significantly in profitability, scale growth rate, cash holding level, leverage

Table 1: Clustering results of different algorithms.

| Algorithm                        | Standard FCM | GA-based fuzzy clustering | Our algorithm |
|----------------------------------|--------------|----------------------------|---------------|
| Number of correctly clustered samples | 472          | 485                        | 503           |
| Accuracy                         | 89.6         | 91.7                       | 92.8          |
| Runtime                          | 262.7        | 335.1                      | 343.6         |

Figure 4: Flow of our association rule analysis algorithm.
ratio, working funds, and so on. That is, the new investment scale differs between enterprises, owing to the disparity between them in terms of the influencing factors on the new capital investment.

Table 5 summarizes the investment efficiency of green enterprises. The mean of \( CA_{A_{rt}} \) was 0.032, a sign of the heavy presence of inefficient investment among Chinese green enterprises, which drags down investment efficiency. The mean and quantity ratio of \( CA_{V_{rt}} \) were 0.025 and 63.26%, respectively; the mean and quantity ratio of \( CA_{ZG_{rt}} \) were 0.041 and 36.74%, respectively. Hence, underinvestment is more common among green enterprises than overinvestment. The main causes include internal factors of these enterprises, such as the long lifecycle of projects, and low environmental risk evaluation, as well as the defects of green financing and relevant financial services, namely, unreasonable financing policy, credit discrimination, and imperfect guarantee system. The underinvestment becomes a prominent problem for the following reasons: the green financing market in China started later than that in developed countries. The financing mechanism needs to be optimized; the financing channels are not diverse; and the financing instruments are outdated. Most green enterprises face different degrees of financing obstacles and constraints.
As for green credit, the approval cycle is rather long, and the qualification review is too strict. To solve the problem, more favorable policies should be rolled out to support green financing.

5. Conclusions

From the angle of dynamic risks, this paper tries to clarify the relationship between green financing and the investment logic and evaluates the effectiveness of financing decisions. Firstly, a decision model was established for the government participation in green financing via green product subsidy, and the solving algorithm was designed for the model. Next, the authors analyzed the correlations of green financing with the investment level and investment efficiency of green enterprises and then proposed a method to analyze the effectiveness of green financing decisions under dynamic operation risks. Through experiments, the associations between green financing and green enterprise investment were analyzed, followed by the cluster analysis and association rule analysis on the collected panels. In this way, the analysis results were obtained, and the operation risk-based financing decisions of green enterprises were summarized in a form. In the end, the main variables of our model were subjected to descriptive statistical analysis, which confirm that our model can effectively represent the influence of green financing on green enterprise investment level and investment efficiency.

The proposed association analysis model for green financing and green corporate investment mainly targets investment level and investment efficiency. Many other issues are yet to be analyzed from the perspective of dynamic risks. For example, one state or phenomenon under dynamic risks could be described by multiple variables. Hence, future research will deal with the prediction based on multivariate time series.

**Data Availability**

The data used to support the findings of this study are available from the corresponding author upon request.

**Conflicts of Interest**

The authors declare that they have no conflicts of interest.
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