



Ferdowsi University of Mashhad

## Iranian Journal of Accounting, Auditing & Finance

Received: 2021-09-27

Accepted after revision: 2021-11-28

Published online: 2021-12-24

RESEARCH ARTICLE

DOI: 10.22067/ijaaf.2021.41397

# Credit Rating of Companies listed on the Tehran Stock Exchange and the Effect of Tax Avoidance Using PSO Algorithm

Hani Gharavi Ahangar, Seyed Hossein Naslemousavi, Ali Akbar Ramezani

*Department of Accounting, Qaemshahr Branch, Islamic Azad University, Qaemshahr, Iran*

## Abstract

Credit ratings reflect the relative ability of companies to meet their financial obligations, the relative default probability, and the recovery probability if the debt is not paid. Credit rating agencies build their information analysis on financial statements, which directly affect the credit rating. Tax activities, meanwhile, may contain useful information for credit rating agencies due to their essential role in influencing corporate credit. Thus, the study aims to investigate corporate tax avoidance's effect on credit rating using the Particle Swarm Optimization (PSO) algorithm. Therefore, to achieve the research goal, 101 sample companies were collected in 9 years from 2011 to 2019. The emerging-market scoring model measured credit rating and tax avoidance using two scales of tax-book difference and effective tax rate. The Statistical test related to the results indicates relationships. It is significant between tax avoidance and credit rating.

**Keywords:** Credit Ranking, Tax Avoidance, PSO Algorithm

---

Corresponding author: Seyed Hossein Naslemousavi

Email: [nseyedhossein2@yahoo.com](mailto:nseyedhossein2@yahoo.com)

Number of Figures: 6

Number of Tables: 6

Number of References: 42

Pages: 16

<https://ijaaf.um.ac.ir>

E-Issn: 2717-4131

## 1. Introduction

Apart from bank loans, a company can be financed through capital markets. What shareholders and bondholders (creditors) pay attention to is the company's performance and risks. A credit rating is a quantified assessment of a business entity's credit based on its ability to repay debt and the probability of default. A higher credit rating is always more favourable because it greatly affects the investor's perception. A great number of investment decisions depend on this rating because investors use credit rating as a risk index and help them quickly assess the risk characteristics of a large number of securities or securities-issuing companies on a single, recognized scale. Investors prefer to invest in companies with a high investment rating (high credit rating). As a result, rankings will be the main channel for disseminating information in financial markets. Credit ranking can be interpreted as a screening technology to reduce information asymmetry problems (Grunert, Norden and Weber, 2005). Credit rating has gained increasing importance with the globalization of financial markets and credit rating in regulating financial contracts (Frost, 2007). Thus, the importance of the analysis performed by credit rating agencies is also determined by the amount of debt financing for companies. Despite the vital role of credit rating in capital markets, little is known about what information affects credit rating.

Following the corporate scandals of the early 2000s, Section 702 (b) of the Sarbanes Oxley Act of 2002 called for presenting a report on the role and performance of credit rating agencies in securities market performance. Shortly afterwards, in 2003, the U.S. Securities and Exchange Commission (SEC) stated that the market needs to fully understand the reasons for rating decisions and the type of information that rating agencies use in their analyses. Numerous studies indicate that public and private information, financial information, quality of accruals, information quality, accounting conservatism, book-tax differences, profit quality and off-balance-sheet financing can be used by rating agencies in rating analysis. (Ahmed et al., 2002; 2005; Cheng and Subramanyam, 2008; Ayers, Laplante and AcGuire, 2010; Kraft, 2015). However, there is little information on how tax avoidance affects the measurements conducted by credit rating agencies. Therefore, it is crucial to study the impact of tax avoidance on credit rating for several reasons; First, companies rely heavily on debt relief as their primary source of financing. Similarly, executive managers consider credit rating one of their most important concerns when deciding on capital structure (Graham and Harvey, 2001).

Credit ratings bring about significant consequences for companies because credit ratings are often used in financial contracts. In a similar vein, they analyse factors that affect credit rating yields insight into the undeniable economic consequences for companies, investors, executives, and others. Second, it is not clear whether tax avoidance affects credit rating. On the other hand, tax avoidance is a widely debated topic today. Tax avoidance is considered legal behaviour; commercial entities attempt to reduce their tax debts by finding passways in tax law and reviewing their own economic decisions. These strategies will benefit the company. However, there may be indirect economic consequences, such as reduced credit rating, which affects the cost of stocks and capital. Although low-income tax can positively affect dividends in the short term, overdue tax debt may have negative effects in the long run. In general terms, low tax rates are very attractive to investors; however, there is a connection between tax avoidance and credit rating.

Tax avoidance is a type of official abuse of tax laws performed by finding leeways to pay tax or attempting to find legal ways to reduce the amount of payable tax. Tax avoidance strategies are recognized as techniques to prevent the transmission of cash flows from shareholders to the government, a procedure that raises the company's value (Alizadeh, 2015). Companies use tax avoidance strategies (McClure, Lanis and Govendir, 2016) to reduce tax liability, increase earnings per share, reduce effective tax rates, increase cash flow, lower prices for final products, and have a

better position in the competitive market. Tax avoidance strategies can lead to additional costs for the company (Rao and Yu, 2013). On the other hand, real results can be indirect in the long run, such as weakening market position, increasing stock costs, reducing stock prices, changing capital structure, future earnings changes (Jackson, 2015) and credit rating changes (Ayers, Laplante and AcGuire, 2010). In general, tax avoidance has potential consequences for managers, shareholders, creditors, and the government (Hanlon and Heitzman, 2010).

Therefore, the businesses' managers should not make decisions that might jeopardize future financing or growth opportunities. Failure to pay attention to this subject in financing decisions will create a risky situation for the business; because if the business cannot provide the necessary resources from the financial market in the time of need, it will be forced to ignore the appropriate investment opportunities (Mahmoudabadi and Ghayouri Moghadam, 2011). Thus, businesses are generally concerned about their credit situation in two ways: first, lest they be unable to pay their principal and interest on their debts and face a financial crisis; second, the business current credit decisions should not jeopardize its future financial flexibility. The debate on credit rating is essential for businesses and other stakeholders, including current creditors and investors. Further, potential creditors and investors will not be unaware of the credit status of businesses. Given this, it is vital to have appropriate and concise information that describes the creditworthiness of businesses. Such information can be extracted through credit rating.

Given the importance of companies' risk awareness, it is necessary to identify the factors that increase the company's risk and thus reduce the credit rating. According to the above view, in the present study, an attempt has been made to investigate the above factors using a non-linear method that rely on meta-heuristic population-based algorithms because non-linear methods have shown better performance than linear methods in previous studies. Moreover, due to the complexity of real-world problems, the need for precise methods which are both time and cost-effective has increased over time. Therefore, the present study is the first enquiry that seeks to use meta-heuristic population-based algorithms to measure the significant relationships between credit rating and tax avoidance.

## 2. Theoretical Principles of the Study

Previous research literature shows that tax avoidance carries significant risks (Hasan et al., 2014). These risks are difficult to interpret due to transactions and tax disclosures (Donahoe and Knechel, 2014). Differences in users' access to financial statement information and the complexity of analytical methods can greatly affect how credit rating agencies evaluate tax strategies. Credit rating agencies base their credit rating approach on the quality of corporate financial reporting. Poor quality of profits and less transparency of financial statements can be a sign of declining corporate credit rating. Credit rating agencies receive important information (from potential bond issuers): key transactions, multi-year forecasts including sales and capital budgets, and specific information about product lines or new product markets. Rating agency analysts are strongly encouraged to ask for additional information about complex or ambiguous transactions during credit rating. Tax transactions are significant examples because of their important role in influencing corporate credit (Ganguin and Bilardello, 2005). However, even if rating agencies obtain more accurate information about corporate tax avoidance activities, there is still disagreement about the risk of tax strategies. This is because tax avoidance often involves a wide range of outcomes that are likely to require considerable judgment. Therefore, unclear tax strategies can disrupt the ranking process to some extent. But because credit rating agencies deal with complex information, understanding tax strategies should not be difficult (Bonsall, Koharki and Watson, 2017). Credit rating agencies play a key role in debt markets. In a

survey conducted by Graham and Harvey (2001), CFOs state that credit rating is the second most important determinant of corporate debt policy. Credit rating is important for borrowers because the borrowers' credit rating often determines debt agreements and, most importantly, interest rates.

Formigoni, Antunes and paulo (2009) and Martinez and Passamani (2014) provide evidence that the unusual tax-book difference represents profit quality, as it indicates that managers are trying to increase accounting profits and reduce taxes. Thus, analysts of rating agencies can interpret tax avoidance as a sign of declining profit quality, thus creating a risk factor for the company's bankruptcy and forcing them to lower their credit rating (Ayers, Laplante and AcGuire, 2010).

Organizations use various methods in determining a credit rating. Some focus only on quantitative data, while others consider qualitative information obtained through meetings with corporate or government representatives (Standard & Poor's, 2011). The earliest studies to use quantitative data from accounting reports date back to the 1960s (Lopes Miiller and Lopo Martinez, 2016). Since then, many research articles have examined the use of accounting information by credit ranking agencies and have analyzed various accounting criteria such as interest payment capacity (interest coverage), asset financing percentage, profitability, and firm size. Ranking organizations use all of these metrics in their analysis (Ayers, Laplante and AcGuire, 2010).

According to Ahmed et al. (2002), credit rating is positively associated with accounting conservatism; for example, more conservative companies earn higher credit ratings. In addition, Francis, Khurana and Preira (2005) showed that credit rating is positively associated with the quality of accruals. In this sense, tax avoidance represents the profit quality that users of accounting information can interpret as a risk factor in estimating corporate debt solvency and making it a variable that potentially affects credit rating. According to Weber (2005), the market tends to minimize the risks of high tax avoidance. However, little is known about how tax avoidance affects credit rating. Clarifying these issues is important given the growing number of large corporations operating in a variety of foreign countries while also having access to global credit markets (Blouin, Krull and Robinson, 2014).

On the other hand, there are several reasons why tax avoidance is expected to influence a company's credit rating. First, tax avoidance increases the current period and post-tax cash flows, thereby reducing the risk of default. But the uncertainty increases future cash flows and affects the liquidity leverage of the company. Second, high tax avoidance may represent agency risk between management and the company's shareholders. Recent research argues that tax avoidance activities can facilitate managerial opportunism (Desai, Foley and Hines, 2003; Dhaliwal et al., 2011). Although credit rating agencies do not provide a comprehensive description of the data they review in assessing the quality of financial statements, they all state that poor data quality leads to decreased credit rating, and previous studies show that ranking agencies take risks in ranking processes (Akins, 2018; Bensall and Miller, 2017). Therefore, the present study seeks to answer this question:

Can the credit rating of companies listed on the Tehran Stock Exchange explain the inherent risks and uncertainties in companies' tax avoidance?

## 2.1. Literature Review

Alkhalwaldeh et al. (2021) examined the effect of corporate governance on the credit rating of companies. Experimental results showed that control variables (capital structure, firm size and competitive advantage of firms) determine the credit rating.

Ma, Stice and Wang (2020) examined whether credit rating agencies pay attention to international tax planning strategy when determining credit rating? They found that credit rating analysts consider tax avoidance information when analyzing a company's credit risk and that high tax avoidance is

associated with lower credit ratings.

Fadah et al. (2020) analyzed financial and non-financial factors affecting credit rating. The results of their study indicated that the variables of profitability and liquidity have a positive effect on credit rating, while the variables of growth and financial leverage do not affect credit rating.

Mamila et al. (2019) examined the economic factors influencing the credit rating of Indian companies. Their analyses showed that economic factors influence credit rating both linearly and nonlinearly. Economic factors such as GDP, industrial production and exchange rates have a linear relationship with credit rating, while crude oil prices and inflation exert a non-linear effect on credit rating.

Rafaty et al. (2018) analyzed the effect of credit rating on company performance and stock returns. The results showed that credit rating is predicted by important factors such as company size and growth opportunities, capital intensity, return on assets, etc. The results also showed that companies with higher credit ratings performed better.

Bensal et al. (2017) examined tax avoidance disclosure. They found that a decrease (increase) in tax avoidance or ambiguity of tax disclosure was associated with a positive (negative) credit rating. This showed that companies could increase or decrease the disagreement among rating agencies after issuing bonds.

Tarigan and Fitriany (2017) examined the effect of corporate governance on credit rating. The results of their study showed that increased number of the board of members, institutional ownership, audit committee and the size of the independent auditor has a positive effect on the credit rating of companies, while the independent ratio of the number of managers and the size of shareholders has a negative effect. This study showed that the number of managers has an inverse relationship with the credit rating. To a certain extent, the more managers there are, the higher the credit rating will be because the more effective the monitoring and decision-making will be. However, when they reach the desired point (five individuals), additional managers reduce their credit rating due to coordination problems.

Lopez Miller and Lopo Martinez (2016) examined the Brazilian market's tax-book differences, profit management, and credit rating. Their study showed that tax avoidance does not determine the credit rating of the Brazilian market; furthermore, as profit management increases, rating decreases, while companies involved in aggressive tax planning are not penalized.

Ayers, Laplante and AcGuire (2010) examined the relationships between credit rating and the tax-book differences. The results show a significant negative relationship between positive changes in tax-book differences and changes in credit rating. This evidence is consistent with positive tax-book difference changes indicating declining profits or increased external financing. Negative changes in the tax-book difference also lead to adverse changes in the credit rating, reducing profit quality.

Ahmadvand, Rezaei and Tamliki (2017) conducted a study entitled "Identifying and Explaining the Factors Determining the Credit Rating: A Case Study on Tehran Stock Exchange." The results of their studies showed that the variables of financial leverage and profitability at the level of 99% confidence, the variables of growth and government ownership at the level of 95% and the variable of financial coverage at the level of 90% are statistically significant and can be used as factors and they can be introduced as factors determining the credit rating of companies listed on the Tehran Stock Exchange.

Jafari and Ahmadvand (2015) examined the credit rating of companies listed on the Tehran Stock Exchange using the emerging market credit scoring approach. The results showed that some of the selected companies are in the area of financial doubt or distress, and this issue can attract the attention



of investors and creditors.

## 2.2. Research Hypothesis

There is a significant relationship between tax avoidance and credit rating.

## 3. Research Methodology

In order to conduct the study at hand, the required data have been extracted from the audited financial statements of companies listed on the Tehran Stock Exchange, Codal website and the official website of the Stock Exchange. In order to determine the statistical sample of the research, the following restrictions were applied in selecting the companies: 1- their financial period ends at the end of March each year. 2- their fiscal year does not change during the studied periods. 3- the shares of the company have been traded for at least six months of the year. 4- they shall be among investment, intermediation and financial companies. 5- the information required to conduct this research should be available in the period under review. Finally, the financial information of 90 companies was analyzed as a sample in a period of 9 years from 2011 to 2019 by applying the above limitations.

### 3.1. Research Procedure

Experimental modelling and Research Methods

Theoretically, the linear regression model of the research hypothesis is described as follows:

Relation (1)

$$CR_{it} = \beta_0 + \beta_1 \sum BTD_{it} + \varepsilon_{it}$$

$$CR_{it} = \beta_0 + \beta_1 \sum ETR_{it} + \varepsilon_{it}$$

Equation (1) is an econometric regression pattern of panel data. In the panel data, despite the robustness of these patterns, it is not possible to estimate such a pattern of flexibility due to the limited degree of freedom of the pattern. With this description, patterns (1) and (2) can be presented as a non-linear pattern:

$$CR_{it} = \sum_{j=0}^J (\beta_{jit}) BTD_{it} + \varepsilon_{it} \quad (1)$$

$$CR_{it} = \sum_{j=0}^J (\beta_{jit}) ETR_{it} + \varepsilon_{it} \quad (2)$$

In this model, the coefficient  $\beta$  is calculated as the number of companies and independent variables in this model. The above pattern is linear, but since  $0\beta$ s can be freely estimated for any section (i) and even for any period (t), the above pattern is non-linear. Since the purpose of this study is not to examine the temporal effects of independent variables on dependent ones, the coefficients are estimated only for independent variables and companies. In econometric literature,  $0\beta$ s are often estimated using the least-squares optimization method of error terms (residual in the sample). Therefore, Particle Swarm Optimization (PSO) is used in this study. The group flight of birds inspires the particle swarm algorithm. Each bird or particle in the group follows a very simple behaviour, repeating and imitating the successful experience of neighbouring birds. The objective function here is the same as the linear pattern of the sum of squares of error (residual in the sample) which must be minimized; In other words, the goal is:

$$Min: pso \text{ Cost Function} = \sum_{i=1}^n \sum_{t=1}^T \varepsilon_{it}^2$$

In fact, instead of using least-squares optimization in the linear model, the present study uses a

particle swarm optimization algorithm to estimate the effect of each independent variable on the dependent variable. Each particle represents a credit rating index in companies operating on the Tehran Stock Exchange in this study.

**Table 1.** PSO algorithm parameters

Particle population	nPop=909;	% Population Size (Swarm Size)
Maximum repetition		MaxIt=2000
Personal learning factor	c1=2;	% Personal Learning Coefficient
Collective learning coefficient	c2=2.0;	% Global Learning Coefficient
Inertia weight	wdamp=0.99;	% Inertia Weight Damping Ratio
Initial particle velocity		Zero
Duplication function		Repmat

### 3.2. Research Variables

#### 3.2.1. Independent Variables - Tax Avoidance

In order to measure the variables of tax avoidance, two measures were used according to the studies conducted by Chen and Zolotoy (2014), Crabtree and Kubik (2014) and Arab Salehi and Hashemi (2015):

**The first measure of tax avoidance (BTD):** The tax-book difference is obtained through the difference between accounting profit (pre-tax profit) and corporate taxable profit, which is also calculated by dividing the tax cost by the legal tax rate. In order to homogenize, this variable was divided by the book value of the total assets.

**The second measure of tax avoidance (ETR):** is the effective tax rate, which is calculated as follows:

$$ETR_{it} = \frac{TTE_{it}}{PTE_{it}}$$

ETR: effective tax rate of the company i in company t.

TTE: Total tax cost of the company i in company t.

PTE: pre-tax profit i in company t.

Since the lower the effective tax rate of a company, the higher the tax avoidance, the calculated tax rates were multiplied by a negative number of one (1-) (Safari Grayli and Pudineh, 2016). Since two measures were used for the tax avoidance variable, the research hypothesis has been performed for each of these two criteria.

#### 3.2.2. Dependent Variable - Credit Rating

To determine the credit rating, a four-stage model called the emerging market scoring model has been used in the following order (Jafari and Ahmadvand, 2015):

**stage 1:** Determining the equivalent of the credit ratings of American companies

First, using the emerging market scoring model (Equation 1), the scores of the companies in the emerging market was calculated; These scores were then compared with the values in Table 2 to obtain their equivalent credit ratings. As mentioned, the cornerstone of the Emerging Market Scoring approach is the "Z" rating model, which is used in the process of analyzing the credit quality of a variety of companies, including public, private, manufacturing, non-manufacturing, American and non-American companies. Emerging market scores were obtained using the following model (Altman and Hotchkiss, 2005):

$$EMS = 3.25 + 6.56X_1 + 3.26X_2 + 6.72X_3 + 1.05X_4 \quad \text{Equation (1)}$$

## RESEARCH ARTICLE

X1: Ratio of working capital to total assets / X2: Ratio of accumulated profit to total assets

X3: Ratio of profit before interest and tax to total assets / X4: Ratio of the total book value of equity to book value of total liabilities

**Table 2.** "Z" rating and equivalent credit ratings

equivalent credit rating	"Z" rating		equivalent credit rating	"Z" rating	
AAA	≥ 8.15		B-	3.75-4.15	
AA+	7.60-8.15		CCC+	3.20-3.75	
AA	7.30-7.60		CCC	2.50-3.20	Financial distress area
AA-	7.00-7.30		CCC-	1.75-2.5	
A+	6.85-7.00		D	≤ 1.75	
A	6.65-6.85		BBB-	5.65-5.85	
A-	6.40-6.65	Financial health area	BB+	5.25-5.65	
BBB+	6.25-6.40		BB	4.95-5.25	
BBB	5.85-6.25		BB-	4.75-4.95	doubt area
B+	4.50-4.75				
B	4.15-4.50				

**Step 2:** Moderating the equivalent credit rating, based on the company's vulnerability to exchange rate fluctuations

At this step, the equivalent credit rating determined in the previous step is moderated based on the company's vulnerability to exchange rate fluctuations and the difficulty in repaying foreign currency debts. Currency liabilities are measured at interest expense on foreign currency liabilities and foreign exchange earnings on foreign currency liabilities. Finally, the amount of liquidity available is compared to the amount of short-term debt that will mature next year. If the company in question is weak and highly vulnerable, that is, if it has no foreign exchange earnings, or the ratio of foreign exchange earnings to foreign exchange liabilities is very low, or a significant amount of foreign currency debts close to maturity and has little liquidity, in this case, the equivalent credit rating (determined in the first step) will be reduced by three degrees; for example: from BB + to B +.

If the company's vulnerability is neutral, a one-point decrease in the equivalent credit rating occurs (for example, from BB + to BB), and if the risk of value reduction due to exchange rate fluctuations is negligible for the company, a change occurs. It is not created in the equivalent credit rating. To moderate this step, according to Jafari and Ahmadvand (2015), the effect of exchange rate changes on the financing activity in the case of cash flow and also the amount of liquidity in comparison with its current liabilities has been used.

**Stage 3:** Moderating the equivalent credit rating based on the industry

In the third stage, the equivalent rating determined in the first stage is compared with the credit industry security rating (Table 3); for a difference of one to three degrees between the two ranks, the equivalent credit rating calculated in the second stage changes by one degree. For example, if the credit rating obtained from the first stage is BBB and the industry rating is BB +, BBB- or BB, then the equivalent credit rating calculated in the second stage is negatively moderated by one degree. If the difference between the equivalent rating determined in the first stage and the equivalent value of the relevant industry credit security rating is more than three and less than six degrees, a two-point moderation in the credit rating equivalent to the second stage occurs. If there is a difference of six degrees or more, the equivalent credit rating calculated in the second stage is moderated by three degrees (positive or negative). Thus, the industrial environment of the emerging country under study is considered in analysing the company's credit quality.



**Table 3.** Industry average credit rating

Industry	Average credit rating	Industry	Average credit rating
Telecommunications	A+	Energy	A-
Investments	A+	Paper products	BBB
Oil and gas extraction	A+	Insurance and pension	BBB
Electrical devices	A+	Computer	BBB
Transportation	A+	Communication vehicles	BB+
Foodstuffs	A	Auto Parts	BB+
Sugar	A	Textiles	BB+
Pharmaceutical products	A	Hotel and restaurant	BB
Banks	A-	Mass production	BB
Multidisciplinary industry	A-	Cement	BB
Leasing	A-	Metal ores	BB
Car	A-	Non-metallic ores	BB
Chemical products	A-	Ceramic Tile	BB
Oil products	A-	Basic metals	B+

**Stage 4:** Moderating the equivalent credit rating based on competitiveness

At this stage, attention is paid to the company's competitiveness; depending on whether the company is dominant and possesses internal power in its industry in terms of size, political influence and management quality, its rating stage changes one degree. In addition, the company's competitiveness may be neutral, in which case there will be no change in its credit rating. In this study, Jafari and Ahmadvand (2015) have been followed to examine the competitiveness of the company in the industry, the company's market share (ratio of company sales to total industry sales per year). Finally, credit ratings are reported by categories (i.e., AA, AAA, etc.). Since these rates are discrete sequential variables, they can be considered the result of a continuous scale called "debt repayment ability". A number of researchers have converted credit ratings into numerical values in order to use information in ranking regressions. By doing so, a discrete sequential variable is obtained. Converting credit ratings to numerical values balances the ratings published by various institutions. In some previous studies, scores assigned to credit ratings have been placed in seven categories (Murcia et al., 2014). The same classification has been used (Ahmadvand, Rezaei and Tamliki; 2017) (Vazifeh Doost et al., 2016).

**Table 4.** Scores assigned to credit ratings

Scores	Credit rating		Scores	Credit rating	
۷	AAA		3	BB+	
۶	AA+		3	BB	
۶	AA		3	BB-	
۶	AA-		2	B+	Low level of investment (doubtful area)
۵	A+		2	B	
۵	A	Good investment level (financial health area)	2	B-	
۵	A-		1	CCC+	Merchant level (financial distress zone)
۴	BBB+		1	CCC	
۴	BBB	1	CCC-		
۴	BBB-		1	D	

(Adapted from, Ashbaug-skaife, Collins and Lafond, 2006)

#### 4. Research Findings

Table 5 provides descriptive statistics of the companies in the sample. The tax avoidance variable (tax-book difference) with a value of 0.280 shows that the average accounting profit of companies is more than their taxable profit and the minimum difference between accounting profit and taxable

## RESEARCH ARTICLE

profit indicates -2.237 indicates that in some companies, accounting profit is less than taxable profit. The tax avoidance variable (effective tax rate) of -0.216 indicates that some companies do not pay taxes even though they report profits. According to the calculated average for the credit rating of 2.364, it can be concluded that the average credit rating of companies is in the second category (B +, B, B-). In other words, on average, companies are in the area of financial doubt.

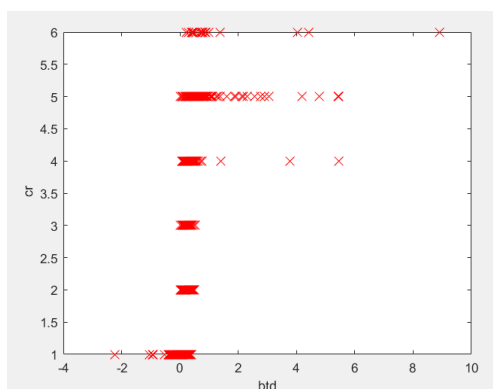
**Table 5.** Descriptive statistics of research variables

Variable	symbol	average	Standard deviation	kurtosis	skewness	max	min
Credit rank	6	1	0.714	1.974	0.618	2.364	CR
Tax avoidance (tax book difference)	8.909	-2.237	1.745	8.337	0.169	0.280	BTD
Tax avoidance (effective tax rate)	0.865	-5.693	-1.847	8.740	0.659	-	ETR

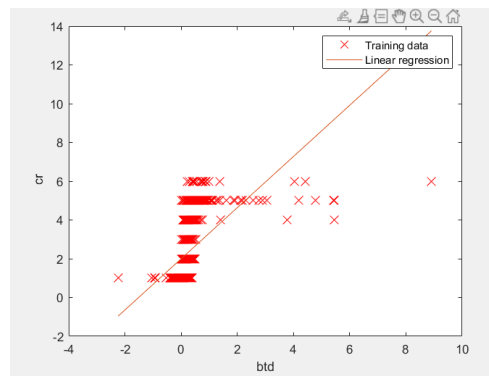
Number of visits: 909

### Results of Particle Swam Optimization (PSO)

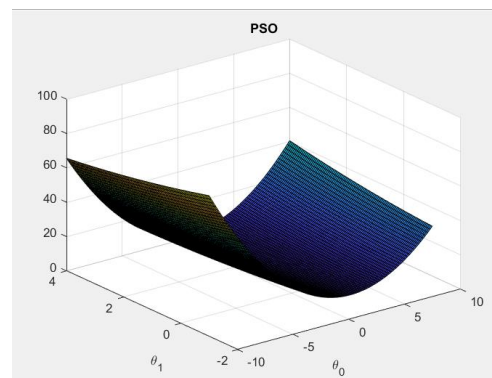
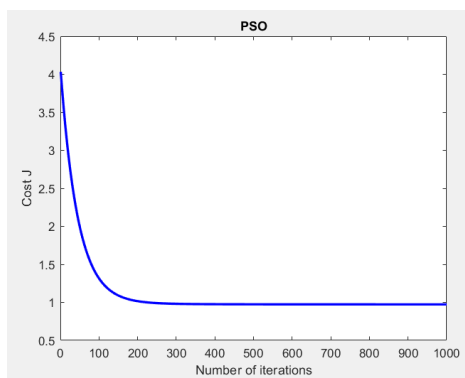
In this study, the least-squares optimization of error terms (residues in the sample) based on the particle swarm algorithm is used to estimate the effect of each independent variable on the dependent variable. The following results were obtained by implementing the particle swarm algorithm. The results obtained by presenting the algorithm after the number of repetitions of 2000 generations caused the appropriate convergence. Diagrams (1), (2) and (3) display the path travelled by the evaluation function to reach the optimal point by particle swarm algorithm. As the number of repetitions increases, the amount of error decreases, but in the final repetitions, almost no improvement is achieved, and there is so-called overfitting in these areas. In Figure (2), the line drawn by the width regression pattern is obtained from the origin  $0\beta$  and the slope of line  $1\beta$ . This line is the best line that can minimize the remaining errors. As shown in Figure (3), the optimization has been done optimally.



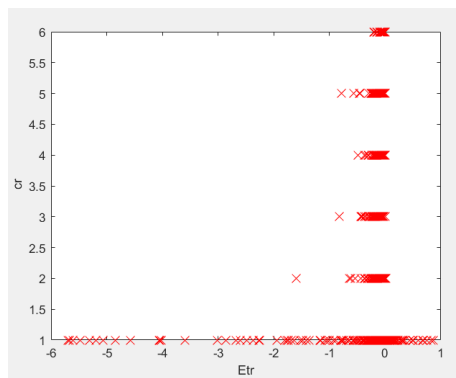
**Figure 1.** Results of the data values of the pattern (1)



**Figure 2.** The process of learning data values with PSO algorithm based on the width of the origin and the slope of the pattern line (1)



**Figure 3.** Results of credit rating convergence level based on the tax-book difference (Model 1)



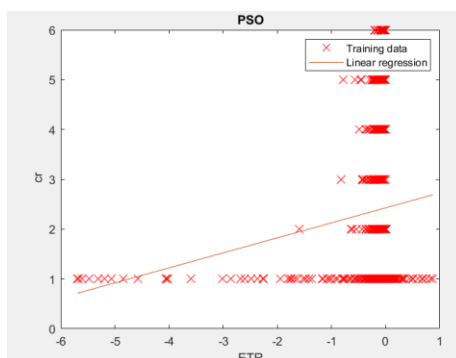
**Figure 4.** Results of the data values of the pattern (2)

### Evaluation Criteria

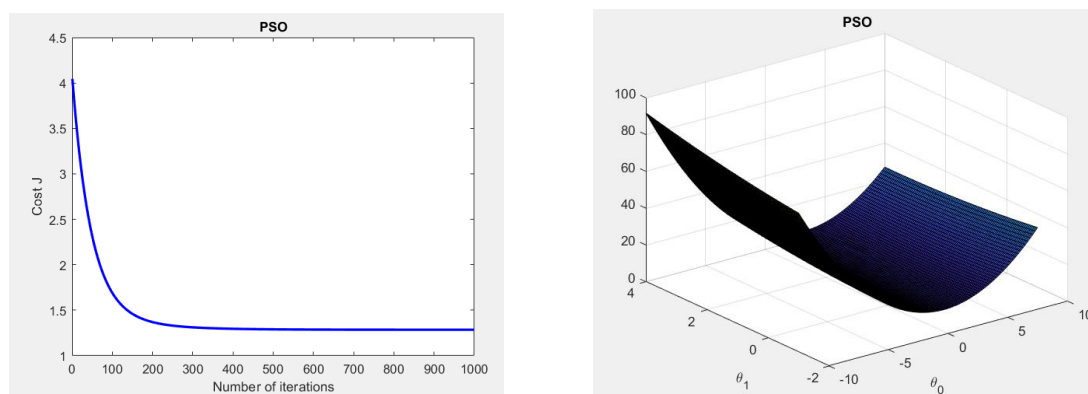
In order to evaluate the accuracy and precision of the prediction, the indices of the coefficient of explanation ( $R^2$ ) and the square root mean square error (RMSE) have been used. The low value of RMSE and the high coefficient of  $R^2$  indicate the acceptable accuracy of the model and its superiority over other models. The ability to predict that pattern is better according to that criterion. The (RMSE) and ( $R^2$ ) values are described in Table 6 for the mentioned patterns. The research hypothesis dealt with the effect of tax avoidance on credit rating by taking into consideration the ability of the particle swarm optimization algorithm to predict the credit rating of companies listed on the Tehran Stock Exchange. Given that the results obtained from the performance test of models show that model (1)

## RESEARCH ARTICLE

with 76% accuracy and model (2) with 81% accuracy predicts the credit rating of companies, the research hypothesis is thus confirmed. It can be concluded that tax avoidance (tax-book difference and effective tax rate) has a significant effect on the credit rating of companies listed on the Tehran Stock Exchange, and also the use of particle swarm optimization algorithm possesses an acceptable accuracy for predicting credit rating.



**Figure 5.** The process of learning data values with PSO algorithm based on the width of the origin and the slope of the pattern line (2)



**Figure 6.** Results of credit rating convergence level based on an effective tax rate (Model 2)

**Table 6.** Statistical parameters studied by PSO algorithm based on the effect of tax avoidance

Title	R <sup>2</sup>	RMSE
Tax book difference (pattern 1)	0.765	0.313
Effective tax rate (pattern 2)	0.806	0.614

## 5. Conclusions and Suggestions

Credit rating agencies play a key role in debt markets. Credit ratings are crucial for borrowers because the borrower's credit rating often determines debt agreements and, most importantly, interest rates. Despite the inherent importance of the credit rating process, little is known about the specific information used by credit analysts in providing credit ratings. Given the importance of this issue, the present study sought to provide credit ratings of companies listed on the Tehran Stock Exchange and analyze the impact of tax avoidance on it by using the particle swarm algorithm between 101 companies listed on the Tehran Stock Exchange during the years 2011 to 2019. Specifically, this study addressed the issue of whether changes in tax-book differences are related to credit ratings. According to the statistical analysis results, tax avoidance (the difference between accounting profit and taxable profit) has a significant effect on credit rating. The tax-book difference seems to provide

useful information for credit rating agencies for two reasons; First, with tax-book differences, credit rating agencies may interpret this divergence as a sign of declining profit quality. Second, off-balance-sheet financing is one of the positive sources of the tax-book difference (i.e., accounting profit is higher than taxable profit), which can yield useful information for credit rating agencies. The results of the present study are in line with the results of Ma, Stice and Wang (2020), Aires et al. (2010) and opposite with the result of Lopez Miller and Lopo Martinez (2016).

Credit ratings are affected by effective tax rates. Corporate tax disclosure appears to play an important role in the ranking process, and rating agencies are likely to respond to changes in tax disclosure transparency. A reduction in the effective tax rate indicates a high level of tax avoidance. By reducing the effective tax rate, the net profit after tax increases in the current period and thus reduces the risk of default, quality and transparency of financial statements. But the uncertainty increases future cash flows and affects the leverage and liquidity of the company. On the other hand, this rate provides relevant information and a summary of the cumulative effects of various tax exemptions and changes in corporate tax rates. Therefore, changing the effective tax rate can lead to a review of the ratings set by the rating agencies. The results of this study are consistent with the results of Bensal et al. (2017).

According to the research results regarding the impact of tax avoidance on credit rating, it is suggested that rating agencies apply the effect of tax-book differences and effective tax rates in their rankings. Managers are advised to pay attention to the possible effects of tax avoidance to avoid financing problems and reduce investor confidence in the reported financial information, thereby reducing their credit risk. Credit ratings can reflect the potential impact of expected future events and help predict and review future results. Therefore, credit rating is one of the most reliable tools for investors to decide and buy bonds. Potential shareholders are also advised always to consider credit rating to reduce the negative effects of tax avoidance in their decisions when choosing their portfolios.

## References

1. Ahmadvand, M., Rezaei, Sh. and Tamliki, H. (2017). Identifying and explaining the factors that determine credit rating. *Monthly of Applied Studies in Management and Development Sciences*, No. 1, pp. 154-135. (In Persian).
2. Alkhawaldeh, A. A., Jaber, J. J., Boughaci, D., & Ismail, N. (2021). A novel investigation of the influence of corporate governance on firms' credit ratings. *Plos one*, 16(5), e0250242. <https://doi.org/10.1371/journal.pone.0250242>
3. Ahmed, A. S., Billings, B. K., Morton, R. M., and Stanford-Harris, M. (2002). The role of accounting conservatism in mitigating bondholder-shareholder conflicts over dividend policy and in reducing debt costs. *The Accounting Review*, 77(4), pp. 867-890. <https://doi.org/10.2308/accr.2002.77.4.867>
4. Akins, B. (2018). Financial reporting quality and uncertainty about credit risk among ratings agencies. *The Accounting Review*, 93(4), pp. 1-22. <https://doi.org/10.2308/accr-51944>
5. Alizadeh, A., Khadem Khanjari, S., Amini, M. A. and Rasaeian, A. (2015). Stock liquidity and tax avoidance given the importance of corporate governance and financial constraints. *Accounting and Auditing Reviews*, 22(4), pp. 478-461. <https://www.sid.ir/En/Journal/ViewPaper.aspx?ID=515345>
6. Altman, E., and Hotchkiss, E. (2005). *Corporate Financial Distress and Bankruptcy: Predict and Avoid Bankruptcy, Analyze and Invest in Distressed Debt*. New York: John Wiley and Sons. <https://doi.org/10.1002/9781118267806>



7. Arab Salehi, Mehdi; Hashemi, Majid (2015). The effect of managerial overconfidence on tax avoidance. *Accounting and auditing reviews*, 22(1), pp. 85-104. <https://doi.org/10.22059/acctgrev.2015.53669>
8. Ashbaugh-Skaife, H., Collins, D. W., and LaFond, R. (2006). The effects of corporate governance on firms' credit ratings. *Journal of accounting and economics*, 42(1-2), pp. 203-243. <https://doi.org/10.1016/j.jacceco.2006.02.003>.
9. Ayers, B. C., Laplante, S. K., and McGuire, S. T. (2010). Credit ratings and taxes: The effect of book-tax differences on ratings changes. *Contemporary Accounting Research*, 27(2), pp. 359-402. <https://doi.org/10.1111/j.1911-3846.2010.01011.x>
10. Blouin, J. L., Krull, L. K. and Robinson, L. A., (2014). The location, composition, and investment implications of permanently reinvested earnings. Working paper. <http://dx.doi.org/10.2139/ssrn.2154662>
11. Bonsall IV, S. B., Koharki, K. and Watson, L. (2017). Deciphering tax avoidance: Evidence from credit rating disagreements. *Contemporary Accounting Research*, 34(2), pp. 818-848. <https://doi.org/10.1111/1911-3846.12287>
12. Chen, Y. and Zolotoy, L. (2014). Stock Liquidity and Corporate Tax-Avoidance: The Tale of Two Tails. Available at: <https://www.uts.edu.au/sites/default/files/ACCconf14LZolotoy.pdf>
13. Cheng, M. and Subramanyam, K.R. (2008). Analyst following and credit ratings. *Contemporary Accounting Research*, 25(4), pp. 1007-1044. <https://doi.org/10.1506/car.25.4.3>
14. Crabtree, A. D. and Kubick, T. R. (2014). Corporate tax avoidance and the timeliness of annual earnings announcements. *Review of Quantitative Finance and Accounting*, 42(1), pp. 51-67. <https://doi.org/10.1007/s11156-012-0333-9>
15. Desai, M. A., Foley, C. F. and Hines, J. R., (2003). Dividend policy inside the multinational firm, in: EFA 2002 Berlin Meetings Presented Paper. Available at <http://dx.doi.org/10.2139/ssrn.317040>
16. Dhaliwal, D. S., Huang, S. X., Moser, W. J., & Pereira, R. (2011). Corporate tax avoidance and the level and valuation of firm cash holdings. In 2011 American Accounting Association Annual Meeting-Tax Concurrent Sessions Available at SSRN: <https://ssrn.com/abstract=1905076>
17. Donahoe, M. and Knechel, W. R. (2014). Does corporate tax aggressiveness influence audit pricing? *Contemporary Accounting Research*, 31 (1), pp. 284-308. <https://doi.org/10.1111/1911-3846.12027>
18. Fadah, I., Ayuningtyas, A., Puspitasari, N. and Yuswanto, I. B. (2020, May). Analysis of financial and non-financial factors affecting bond ratings. In IOP Conference Series: Earth and Environmental Science, 485(1), pp. 012019. <https://doi.org/10.1088/1755-1315/485/1/012019>
19. Formigoni, H., Antunes, M. T. P. and Paulo, E. (2009). Diferença entre o lucro contábil e lucro tributável: uma análise sobre o gerenciamento de resultados contábeis e gerenciamento tributário nas companhias abertas brasileiras. *BBR-Brazilian Business Review*, 6(1), pp. 44-61.
20. Francis, J.R., Khurana, I.K., Pereira, R. (2005). Disclosure incentives and effects on cost of capital around the world. *The Accounting Review*, 80(4), pp 1125-1162. <https://doi.org/10.2308/accr.2005.80.4.1125>
21. Frost, C. A. (2007). Credit rating agencies in capital markets: A review of research evidence on selected criticisms of the agencies. *Journal of Accounting, Auditing & Finance*, 22(3), pp.

- 469-492. <https://doi.org/10.1177/0148558X0702200306>
22. Ganguin, B., & Bilardello, J. (2005). Fundamentals of corporate credit analysis. New York: McGraw-Hill. <https://www.amazon.com/Standard-Fundamentals-Corporate-Credit-Analysis-ebook/dp/B00938Y862>
23. Graham, J. R. and Harvey, C. R. (2001). The theory and practice of corporate finance: Evidence from the field. *Journal of Financial Economics*. 60(2-3). pp. 187-243. [https://doi.org/10.1016/S0304-405X\(01\)00044-7](https://doi.org/10.1016/S0304-405X(01)00044-7)
24. Grunert, J., Norden, L. and Weber, M. (2005). The role of non-financial factors in internal credit ratings. *Journal of banking & finance*. 29(2), pp. 509-531. <https://doi.org/10.1016/j.jbankfin.2004.05.017>
25. Hanlon, M. and Heitzman, S. (2010). A review of tax research. *Journal of Accounting and Economics*, 50(2-3), pp. 127-178. <https://doi.org/10.1016/j.jacceco.2010.09.002>
26. Hasan, I., Hoi, C. K. S., Wu, Q. and Zhang, H. (2014). Beauty is in the eye of the beholder: The effect of corporate tax avoidance on the cost of bank loans. *Journal of Financial Economics*, 113(1), pp. 109-130. <https://doi.org/10.1016/j.jfineco.2014.03.004>
27. Jackson, M. (2015). Book-Tax Differences and Future Earnings Changes. *The Journal of the American Taxation Association*, 37(2), pp. 49-73. <https://doi.org/10.2308/atax-51164>
28. Jafari, S. M. and Ahmadvand, M. (2015). The credit rating of companies listed at Tehran stock exchange using the emerging market scoring model. *Economic and business bulletin of the business*, 6(10), pp. 56-37. (In Persian) [http://jebr.azad.ac.ir/mobile/article\\_526598.html?lang=en](http://jebr.azad.ac.ir/mobile/article_526598.html?lang=en)
29. Kraft, P. (2015). Rating agency adjustments to GAAP financial statements and their effect on ratings and credit spreads. *The Accounting Review*, 90(2), pp. 641-674. <https://doi.org/10.2308/accr-50858>
30. Lopes Miiller, D., Lopo Martinez, A. (2016). Book-Tax Difference, Earnings Management and Bind Ratings in The Brazilian Market. *Revista Universo Contábil*, ISSN 1809-333, 12(3), pp. 91-109. <https://doi.org/10.4270/ruc.2016323>
31. Ma, Z., Stice, D. and Wang, D. (2020). Do Credit Rating Agencies Care About Our International Tax Planning Strategy When Assigning Credit Ratings? *Tax Notes Federal*, 169 (6), Available to <http://dx.doi.org/10.2139/ssrn.3759423>
32. Mahmoud Abadi, H., Ghayouri Moghaddam, A. (2011). Credit Rating in Terms of Financial Ability to Pay the Principle and Interest on Debts, Using Data Envelopment Analysis Techniques (Case Study: Companies Listed in Tehran Stock Exchange). *Journal of Accounting Knowledge*, 2(4), 125-145. [Doi: 10.22103/jak.2011.37](https://doi.org/10.22103/jak.2011.37)
33. Martinez, A. L. and Passamani, R. R. (2014). Book-tax differences e sua relevância informacional no mercado de capitais no Brasil. *Revista de Gestão, Finanças e Contabilidade*, 4(2), pp. 20-37. [Doi:10.18028/rgfc.v4i2.615](https://doi.org/10.18028/rgfc.v4i2.615)
34. McClure, R., Lanis, R., Govendir, B. (2016). Analysis of Tax Avoidance Strategies of Top Foreign Multinationals Operating in Australia: An Expose. Sydney. Australia. Available at <http://cdn.getup.org.au/1507-Aggressive-Tax-Avoidance-By-Top-Foreign-Multinationals.pdf>
35. MurciaI, F. C. D. S., Dal-Ri Murcia, F., Rover, S. and Borba, J. A. (2014). The determinants of credit rating: Brazilian evidence. *BAR-Brazilian Administration Review*, 11(2), pp. 188-209. <https://doi.org/10.1590/S1807-76922014000200005>
36. Rafay, A., Chen, Y., Naeem, M. and Ijaz, M. (2018). Analyzing the Impact of Credit Ratings

- on Firm Performance and Stock Returns: An Evidence from Taiwan. *Iranian Economic Review* 22(3), pp. 767-786. [https://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=3258268](https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3258268)
37. Rao, R.P. and Yu, T.R. (2013). Corporate Tax Avoidance and Debt Policy, *SSRN Electronic Journal*. Available at <https://doi.org/10.2139/ssm.2352646>
38. Safari Graili, M., Pudineh, S. (2015). Tax avoidance and timely announcement of profits: An experimental test of the Tehran Stock Exchange. *Tax Research Letter*, 24(31), pp. 101-118. [http://taxjournal.ir/browse.php?a\\_id=983&sid=1&slc\\_lang=en](http://taxjournal.ir/browse.php?a_id=983&sid=1&slc_lang=en)
39. Standard and Poor's Corporate Rating Criteria. (2006). <http://www.corporatecriteria.standardandpoors.com>.
40. Tarigan, C. K. and Fitriany, F. (2017). Impact of corporate governance on credit rating. In *The 6th International Accounting Conference (IAC 2017)*. Atlantis Press <https://doi.org/10.2991/iac-17.2018>.
41. Vazifeh Doost, H., Ahmadvand, M. and Sadevand, M. J. (2016). Test of the effect of corporate governance factors on credit rating in the form of emerging market score model (Case study: Tehran Stock Exchange). *Financial Knowledge of Securities Analysis*, 9(30), pp. 95-113. (In Persian). [https://jfksa.srbiau.ac.ir/article\\_9199.html?lang=en](https://jfksa.srbiau.ac.ir/article_9199.html?lang=en)
42. Weber, D.P. (2005). Book-tax differences, analysts' forecast errors, and stock returns. Thesis. The University of Colorado at Boulder. The USA. <http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.476.1231>



#### COPYRIGHTS

© 2021 by the author(s). This article is an open access article distributed under the terms of The Creative Commons Attribution (CC BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, as long as the original authors and source are cited.

#### How to cite this article:

Gharavi Ahangar, H., Naslemousavi, S., Ramezani, A. (2021). Credit Rating of Companies listed on the Tehran Stock Exchange and the Effect of Tax Avoidance Using PSO Algorithm. *Iranian Journal of Accounting, Auditing and Finance*, 5(4), 119-134. doi: 10.22067/ijaaf.2021.41397  
URL: [https://ijaaf.um.ac.ir/article\\_41397.html](https://ijaaf.um.ac.ir/article_41397.html)