



Application of Nonlinear Mathematical Modeling in Panel data analyses of the pecking order theory in capital structure Using Multiple Regression: Evidence from the Tehran Stock Exchange

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Abstract

Financing decisions for investment are one of the important tasks of the company in determining the best composition. On the other hand, how to finance the company's assets for individuals and institutions is important, and how much debt and stocks the company has used to finance its assets, is important because it depends on the company's financing decisions will be affected. This study investigates the application of nonlinear mathematical modeling in panel data analyses of the pecking order theory in capital structure using multiple regression in the Tehran stock exchange. The research period is from 2014 to 2019. In this research, panel data regression has been used to test the hypotheses. To collect information and data, the library method, and to test the research hypotheses, panel data and panel analysis using multiple regression have been used. The main hypothesis of this research is based on the fact that in order to Management decisions about the optimal capital structure of the company can be based on the theory model of the pecking order. In the results of this study, it seems that the companies in question to finance themselves, in fact, follow the mathematical model used in the theory of pecking order.

Keywords: capital structure, financial deficit, Nonlinear statistical model of pecking order theory.

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1. Introduction

The environment in which companies operate today is a growing and highly competitive environment and companies have to compete with various factors at the national and international level and expand their activities through new investments in order to survive. They need financial resources to invest, but the financial resources and their use must be well determined in order for the company to be profitable, and it is the financial manager's job to determine the sources of financing and how to use them. The financing sources of companies are divided into two parts: domestic and foreign financial sources based on their financing. In domestic financial resources, the company finances from the profit earned, that is, instead of distributing profits among shareholders, the profits are used in the company's mainly operational activities, in order to obtain greater returns, and in external sources, the company from Debt borrowing and stock issuance. The main difference between debt and equity can be summed up in the obligation to pay and the tax benefits of debt. But the financial manager should always be careful that the financing method is compatible with the type of investment of the company and also use its leverage to a maximum to maximize the value of the company and prevent the adverse consequences of financial risk through the use of debt [1] Also, it seems that there should be an incentive in the business unit to make optimal use of this source of financing, which is also limited, and this optimal use is manifested in the form of increased profitability [2].

The ability of companies to determine the appropriate financial resources is one of the main factors for the survival and growth of any company. Management should pay attention to the goal of maximizing the wealth of shareholders when choosing the financing method and considering the cost of different financing sources and effects. These resources focus on the company's return and risk by selecting resources that minimize the cost of financing. For this reason, the capital structure that can maximize the value of the company or minimize the total cost of capital is called the optimal capital structure [3].

Capital structure is defined as a combination of debt and equity that are used to meet the company's financing needs. [4] They have turned their backs. The capital structure literature generally focuses on two research objectives. The first group has attempted to examine the consequences of capital structure [5]. Searching for the term capital structure, along with profitability and other related terms in the title, results in finding 1,210 studies, which show that studies on the relationship between financial leverage and performance have been numerous [6], given that the importance of capital structure is widely accepted. Finding the factors that affect it has also been an interesting topic for researchers. Therefore, the second group of studies have dealt with the factors that determine the capital structure [7].

The importance of discussing the structure of capital became more important after the studies of Modigliani and Miller (1958). They believed that there was no difference between equity financing and debt given the value of the company. Therefore, the various methods of financing for the company have no added value and therefore are not a limitation for management. But further empirical evidence showed that this was not the case in practice, and Modigliani and Miller's research in 1963 yielded new results, and the importance of corporate capital structure became increasingly clear. There is a lot of research in the field of corporate finance that tries to explain that the capital structure affects the value of the company [8].

Therefore, the present study seeks to investigate the model for the optimal capital structure based on theories of pecking order. In this study, considering the influential variables in the theory of pecking order, we have tried to examine the issue of whether the theory of pecking order also applies to companies listed on the Tehran Stock Exchange or not? In pecking order theory, various variables are examined, including the relationship between debt utilization and financial deficit. Assuming

that companies refuse to issue new shares after the initial public offering, the financial deficit should be equal to the net use of debt under normal operating conditions. [9] Changes in accumulated debts and profits and changes in equity are also used in pecking order theory to make decisions.

After the introduction, in the second part of this article, research literature and important theories are reviewed. In the third part of the research method, the method of measuring the selected variables and fitting the model are described. In the fourth section, the analysis of information and the model using multivariate regression on the selected model is presented. Finally, in the fifth section, the research findings are described in terms of the effect of each of the variables on the capital structure and the model is reviewed and concluded.

2. Theoretical foundations and research background

In this section, we first express the theoretical framework and new theories regarding the financing of the capital structure. Then we describe the research done on the financing theories of capital structure and the results of each separately.

2.1. Theoretical framework

Regarding the theories of financing the structure of capital, they can be divided into traditional and new theories in one category. This section describes the new theories of capital structure.

2.1.1. Theories of capital structure

Theories of capital structure There are different theories about corporate financing. New theories of capital structure financing can be divided into 1- Trade-off Theory, 2-Packing order Theory, 3-Agency cost theory, and 4-Timing Market Theory.

2.1.1.1 Trade-off Theory

In this model, it is assumed that the business unit has a predetermined goal in the capital structure, which is to balance the benefits (debt benefits including tax cuts as well as reducing free cash flow problems) and financing costs. Debt includes the costs of the financial crisis - the financial crisis refers to the costs of bankruptcy, reorganization, and agency costs that result from compromising the creditworthiness of the lending company - and the costs of representing shareholders and creditors. Optimal use of this method requires a full understanding of the costs associated with different financing methods[10].

2.1.1.2 Packing order Theory

Managers or people inside the company have more information about the future prospects and the real value of the company than outside investors, which is called information asymmetry. The possibility of information asymmetry has given rise to several approaches to explaining the existence of an optimal capital structure.

The first approach states that determining the capital structure is a kind of signaling to people outside the company about the information that is available to people inside the company. Debt financing indicates the good future of the company, but if the company finances the issuance of new shares, it is considered a negative sign about the future of the company. Research in this area was started by Ross in 1977 [11].

The second approach is designed to moderate the inefficiency of the company's investment decisions. Myers and Majloff 1984 showed that if investors had less information about the true value of

the company than people inside the company, they might not be pricing the company's stock correctly. If the company is forced to finance its new projects from the place of issuance of shares, the pricing may be so severe that the new investors gain more value than the net present value of the new project and, as a result, the current shareholders lose. [11] In such cases, companies prefer in-house financing to external financing. In order to compensate for the slight deviation from the expected cash flow of their investments, companies first use the sale of short-term securities and finally, in determining their financing methods, cheaper methods (borrowing) and finally to The issue stocks and more expensive methods [10].

2.1.1.3 Agency cost theory

The agency cost theory, first proposed by Jensen and McLing in 1976, states that the optimal capital structure is determined by agency costs, which include the issuance of shares and debt. [12] Jensen and McLing in a single framework Economics identifies two types of conflict of interest: a) conflict of interest between managers and shareholders and b) conflict of interest between shareholders and holders of corporate bonds [12]. Due to the divergence of the directors' decisions from the shareholders' decisions of Jensen and McLean in 1976, they stated that the costs of stock representation arise from the separation of ownership and control of the company; Therefore, managers are not able to capture non-operating profits from activities they have done to increase operating profits, and accordingly, managers tend to maximize their benefits (desirability) instead of increasing the value of the company [13]. Lenders also want to exercise supervision over the lending company to protect their rights. Supervision requires cost, and this is one of the forms of agency costs. As the share of debts in the capital structure increases, agency costs also increase, and if agency costs exceed a certain amount, the value of the company decreases. But due to the tax advantage, increasing debts leads to increasing the value of the company [14]. Thus, according to Jensen and McLing, 1976, a favorable capital structure could be achieved by balancing the benefits of debt with the costs of representing debt.

2.1.1.4 Timing Market Theory

One of the theories that has recently been expressed in explaining firm capital structure decisions using the problem of asymmetric information is the Timing Market Theory by Baker and Wergler 2002.

Baker and Wergler formulated the theory of timing simply as follows:

The capital structure is formed as a result of the accumulated results of past efforts to schedule the securities market [13]. Market scheduling theory has been widely used in financial texts. For example, Lucas and McDonald 1990 proposed a stock release scheduling model based on information asymmetries between management and investors. In this model, it is assumed that companies will issue shares after experiencing an unusual and significant increase in stock prices. Managers also try to schedule stock markets based on private information related to the firm's future value and debt markets based on public information. If managers do not have more general information than investors when scheduling the debt market, the scheduling strategy can not create value. In addition, corporate management may schedule debt markets based on private information related to the firm's future credit rating. Corporate executives may have better information about future changes in a company's credit rating than investors. In this case, when the manager expects the company's credit rating to improve over future periods, they resort to issuing short-term liabilities and otherwise to issuing long-term debt securities [15].

In practice, scheduling the proprietary securities market seems to be one of the most important aspects of the financial policy of joint stock companies. The importance of this factor depends on the fluctuations of the stock market and bonds, and the more severe these fluctuations, the greater the importance of the scheduling factor [16].

According to Timing Market Theory, companies issue stocks after stock prices rise because they can easily increase their stock-based capital, so stock returns and debt market conditions play an important role in capital structure decisions. The company plays [17]. Salman and Alti 2012 also believe that companies issue shares when their returns are high. They found that corporate stock returns better describe stock issuance behavior than other factors influencing fiscal policy. [18] In other words, the main result of market scheduling theory is that the first determinant of firm capital structure decisions is incorrect pricing of debt and equity instruments when the firm needs financing [19].

2.1.2. Comparison of different theories of capital structure

Based on their financing policy, companies' financial resources are divided into two parts: internal financial resources (accumulated profit) and external financial resources, short-term and long-term debts and the issuance of new shares. The heading of operational activities in case of cash flow shows the amount of internal resources provided. But a lot of resources are provided by outsiders, especially shareholders and creditors. The heading of financing activities in case of cash flow shows information about cash inflows and outflows in relation to external financing [20], so financing methods fall into three general categories: financing through financial resources. Domestic, financing through borrowing and financing through capital increase are classified. Farlex culture describes the capital structure as a combination of different financial resources to finance the company's operations to grow [21]. According to the preferred theory, companies go through a certain hierarchy in financing their required funds. Thus, managers prefer financing from within the company to sources outside the company. That is, in the beginning, companies prefer to use internal funds, ie funds from their activities (accumulated profits or savings). Then, if the internal financial resources are not sufficient for the required purposes, they turn to external sources. Among outsourced companies, they prefer borrowing to issuing shares. Finally, if the borrowing capacity is completed, they will provide resources from the place of capital increase. According to the preferential theory, what causes companies to borrow or finance them by increasing capital is not an attempt to achieve the optimal capital structure, but to meet their financial needs [22]. Donaldson (1961) first observed that companies finance their investment opportunities in a particular order, first from domestic sources, then from borrowing, and finally from the issuance of equity.

Capital structure theory offers two competing models for corporate financing decisions; Trade-off Theory and Packing order Theory. In the Packing order Theory model, companies finance financing first with accumulated profits, then with debts and finally with stocks [23]. This theory states that companies go through a certain hierarchy in financing themselves.

In the Trade-off Theory, companies identify the optimal leverage by balancing the benefits and costs of debt. This theory states that the tax advantage of debt increases the value of the debtor company. On the other hand, the costs of financial crisis and possible bankruptcy due to non-fulfillment of debt obligations on time, reduce the value of the debtor company. Therefore, the company's capital structure can be considered as a balance between the tax benefits of debt and the costs of the financial crisis and possible bankruptcy due to debt. Hence, these two factors offset each other (balance of benefits and costs due to debt) lead to the optimal use of debt in the capital structure [24].

From another point of view, theories of capital structure can be divided into two categories in a

general format; The first category deals with theories related to the choice between debt and stocks and the second category deals with theories related to the choice between private and public debt. One of the most common decision models for corporate financing in the financial literature is Myers Packing order Theory (1984), which is a subset of the first category of theories related to capital structure [25].

According to the findings of Myers and Mageloff (1984), the factor that leads to the formation of capital structure is the desire of companies to finance; Information asymmetry problems also affect the capital structure of companies. Myers (1984) argues that the result of asymmetric information is hierarchical theory. According to this theory, companies go through a hierarchy in financing themselves. In other words, in cases where there is information asymmetry between managers and external investors, managers prefer financing from the company's internal resources to sources outside the company [26].

On the other hand, this theory predicts that companies should use the stock issue policy to cover the financial deficit, as a last resort after using other financing options that have the least problem of reverse selection and sensitivity to information.

Working capital management In order to achieve the optimal level, attention needs to be paid to the factors that affect working capital management. Many internal and external factors can influence a company's decisions about the optimal level of current assets and liabilities. Among these factors, how the company decides on financing can affect working capital.

One of the theories related to the structure of capital is the theory of Packing order Theory. According to this theory, firms tend to increase and increase intra-organizational capital before raising financial leverage by borrowing money from outside the company or issuing new stock[26]. The use of internal funds requires the management of working capital at the level of current assets and liabilities. When there is no active working capital in a capital management company, the tendency to use external funds (extinction) increases.

Shiam, Sander and Myers (1999) first used the financial deficit variable as an important and influential factor on capital structure; Financial deficit is the sum of the funds that companies provide from external sources. They found that companies that use more external resources are more likely to increase their debt ratios [9].

2.2. Research background

Bani Mahd and Farahanifard 2010 examined the relationship between capital structure and competitiveness of companies listed on the Tehran Stock Exchange. The results of this study showed that capital structure and competitiveness have a significant and positive relationship with each other and affect each other. Profitability ratio has a significant negative relationship with capital structure, but sales growth and company size have a significant positive relationship with capital structure [27].

Abzari et al. 2007 in a study entitled "Study and analysis of financing methods of companies listed on the Tehran Stock Exchange", examined the different methods of financing companies listed on the Tehran Stock Exchange and the type of relationship between how to finance companies And characteristics of company size, fixed assets and profitability, and based on the findings of this study, despite the lack of significant differences between the use of different financing methods (profit, stocks and debt) between the companies under study, between how to finance the company And their size there is a significant relationship. As the size of companies expands, the use of accumulated profits and stocks for financing increases [28].

Kashanipour and Momeni Yansari 2012 examined the role of information asymmetry in the capital structure decisions of companies listed on the Tehran Stock Exchange. The results showed that there is a significant relationship between information asymmetry with the ratio of total debt to total equity,

the ratio of total debt to total assets and the ratio of short-term debt to total positive assets, while between information asymmetry and There is no significant relationship between long-term debt to total assets [29].

Kurdistani and Najafi Omran 2010 in a study entitled "Study of the impact of financing methods on future stock returns", to examine the impact of different financing methods and how to use the proceeds of these methods on future stock returns in companies listed on the stock exchange Tehran Stock Exchange paid during the period, 1999-2006. Based on these assumptions, different methods of external financing have a negative effect on future stock returns. Also, based on cross-sectional data, the relationship between net change in domestic financing and change in net operating assets financed from domestic sources with abnormal returns on stock accumulation is positive and significant [30].

Farhad Touski et al. 2020 in a study examined the relationship between informed business and the cost of capital with an emphasis on family ownership during the period 2012 to 2016 in 113 companies. Findings show that there is a direct, positive and significant relationship between the probability of conscious trading with stock cost and the weighted average weight of capital. They demand more and as a result the cost of the company's capital increases. This increases the cost of financing through bonds [31].

Namazi and Azimi 2012 in a study sought to determine the key performance evaluation criteria related to each of the balanced evaluation perspectives by type of activity and based on industry group classification. These criteria were ranked by the subjects based on the AHP model. Finally, a comparison was made between the available rankings before and after the use of AHP. The results of testing the hypotheses showed that there is a significant difference between ranking through AHP and ranking without using this model in evaluating the company's performance in each of the BSC perspectives. In addition, it was found that almost none of the companies surveyed use specific criteria specific to their company or industry group [32].

Barzegar et al. 2012 in one study proposed algorithm for timing free stores. The study used the hybrid genetic algorithm as a way to solve timing problems and compare the proposed algorithm with dga[33].

Chen et al. 2013 examined the evidence of market timing theory for the Taiwan stock market, especially for the period 1990 to 2001. The results of this theory show that companies do not support the financing Packing order Theory. However, the market timing theory has not been reviewed in the period 2002-2005. In other words, businesses in Taiwan prefer to issue debt more than stocks [34].

Using data from small and medium-sized German companies from 2003 to 2005, Degris et al. Studied the effect of industry characteristics on the capital structure of these companies. The results showed that capital structure decisions in the studied companies are in line with Packing order Theory; Among other things, the companies in question, by increasing profitability, reduce their debt levels and growing companies to borrow to provide the financial resources they need [35].

In a 1994 study, Corbett and Jenkinson examined the financing methods of developed countries during the period 1970-1989. The most important results of this study include: The most important method of financing in companies of all countries under study is domestic resources, the issuance of securities and bonds is a small amount of funding sources in the countries under study, the most important source of foreign financing, loans Banks' mortgages to the companies under study. Domestic sources of financing are more important in the United States and the United Kingdom than in Japan [36].

Singh 1995 and in another study, Singh and Hamid 1992 examined the financing methods of fifty developing countries. The main results of this study included: Companies located in developing countries use more foreign sources for financing. In developing countries, they are increasingly

releasing new stocks to increase their net assets [37].

This study examines the role of different theories of capital structure in decision making. Financing Pecking order Theory: This review includes the fundamental work of Modigliani and Miller (1958), a new study. Its type is in the field of capital structure. The purpose of this study is to examine three theories. Balance theory, Pecking order Theory and Trade-off Theory. The literature shows that balance and Pecking order Theory always dominate decisions about capital structure, but recent theoretical and empirical work shows that market timing theory has also challenged fundamental theories because managers are always eager to use, they are [38].

3. Research Methodology

This research is of applied and correlational research. The research method used is quasi-experimental. This means that by using the past information related to the companies listed on the Tehran Stock Exchange, the relationship between the independent variables and the dependent variable should be examined. Multivariate regression models were used in this research using the theoretical foundations of the subject. In this research, composite data is used to test the hypotheses.

To collect the data, library resources and rahavard novin software and the site of the stock exchange organization have been used. EViews 10 software has also been used to analyze the data.

3.1. Society and statistical sample

The sample will be selected through the method of systematic removal from the statistical population. Thus, the sample consists of all companies in the statistical community that meet the following criteria:

1. They have been accepted in Tehran Stock Exchange at least since March 3, 2014.
2. The sample companies are not investment and financial companies (banks);
3. Sample companies have not been suspended during 2014 to 2019 to get conventional stock price.
4. Ending of their financial year is March 20.
5. Financial year of sample companies has not been changed during 2014 to 2019.
6. The information required to do the research should be reported to the stock exchange organization by the end of the fiscal year 2019 and it should be available

Considering the mentioned conditions, led to the selection of 184 companies as a statistical sample of this research.

3.2. Research hypothesis

In this research, using the statistical model, we evaluate the research hypothesis as follows: In order for management to decide on the optimal capital structure of the company, a model based on the theory of financing pecking order can be presented.

3.3. Statistical model of research

To test the research hypotheses, various statistical models are used as follows. The method of Shiam-Sander and Myers (1999) [9] is used to test the theory of financing pecking order. The original designed model of the financing pecking order theory will be equation 3.1:

$$NTD_{i,t} = \beta_0 + \beta_{PO}DEF_{i,t} + \epsilon_{i,t} \quad (3.1)$$

Where $NTD_{i,t}$ is equal to the amount of debt used (new debt); β_0 is equal to the width of the origin of the model; β_{PO} is the pecking order that should be equal to one under the financing pecking order, and $\epsilon_{i,t}$ is the model error, the deficit of the company's funds ($DEF_{i,t}$), is the change in total assets minus the change in retained earnings by Fama and French (2005) [39] presented. The variables $NTD_{i,t}$ and $DEF_{i,t}$ is normalized by dividing by the total number of assets at the beginning of the year ($t-1$).

Chirinko and Sinia (2000) [40] argued that due to debt capacity constraints, the relationship between new net debt and financing deficit would be concave. In order to control the nature of the quadratic and identify the differences in financing choices between small and large fractions, Equation One is completed using the quadratic fraction of the deficit ($DEF^2_{i,t}$) [41] Therefore, the modified model of the financing pecking order is as follows:

$$NTD_{i,t} = \beta_0 + \beta_{PO}DEF_{i,t} + \beta_{PO,sq}DEF^2_{i,t} + \epsilon_{i,t} \quad (3.2)$$

Companies listed on the Tehran Stock Exchange are expected to follow the theory of financing pecking order, but due to concerns about debt capacity, the β_{POsq} coefficient is expected to be negative and significant, and the β_{PO} coefficient and Increase the modeling coefficient.

According to the revised model of financing pecking order theory, equity is the preferred source of external financing. Thus, a significant correlation is expected between net equity increase and the financial deficit. Therefore, in order to test the revised version of the financing pecking order, according to the approach of Chen et al. (2013) [35], the variable $NNQ_{i,t}$ replaces the variable $NTD_{i,t}$.

$$NNQ_{i,t} = \beta_0 + \beta_{PO}DEF_{i,t} + \epsilon_{i,t} \quad (3.3)$$

Where $NNQ_{i,t}$ is the amount of equity increase and stock issue (new stock). Variables are normalized by dividing the total assets at the beginning of the year ($t-1$). As described for the original pecking order model, a quadratic variable is added to the model to include the financing constraint. Thus, the revised model will be as follows:

$$NNQ_{i,t} = \beta_0 + \beta_{PO}DEF_{i,t} + \beta_{PO,sq}DEF^2_{i,t} + \epsilon_{i,t} \quad (3.4)$$

4. Analysis of Data and statistical models used

In this section, first we describe the methods used to analyze data and statistical models, and at the end, the results of the analysis are presented.

4.1. Tests and statistics used in data analysis and hypotheses

Before performing data analysis, we first describe the tests and statistics used in this research.

4.1.1. Descriptive statistics

Descriptive statistical indicators used in this study are mean, mean, standard deviation, maximum and minimum.

4.1.2. *Chav test or F bound*

In the study of cross-sectional data and time series, if the coefficients of cross-sectional effects and time effects are not significant, we can combine the data together and estimate the ordinary least squares by a regression. Since in most composite data, the coefficients of sections or time series are often significant, this model, known as the combined regression model, is less used [42] in order to determine whether the data Combined Hits To estimate whether the desired function will be more efficient or not, we test a hypothesis in which all the fixed expressions of the estimate are equal. The null hypothesis of this test, known as the Chow or F-bound test, is as follows:

$$\begin{cases} H_0 : \alpha_i = \alpha \\ H_1 : \alpha_i \neq \alpha \end{cases} \quad (4.1)$$

To test this hypothesis, the F statistic is used as follows:

$$F(N - 1, NT - N - K) = \frac{(RRSS - URSS)/(N - 1)}{URSS/(NT - N - K)} \quad (4.2)$$

Where N is equal to the number of cross-sectional units, T is the length of the period, K is the number of explanatory variables, RRSS is the square of the regression estimation squared virtual least variable, and URSS is the square of the regression estimation squared is the regular squared minimum squared. Be. In this test, Hypothesis H0, which means that the width of the origins is the same, is opposed to Hypothesis H1, which means that the width of the origins is heterogeneous. If the H0 hypothesis is not rejected, it means that the slopes are the same for different sections and the ability to combine data and use the combined regression model is statistically confirmed. However, if the H0 hypothesis is rejected, the combined data method is accepted and the combined data method can be used [43].

4.1.3. *Hausman test*

In order to determine which method (fixed effects or random effects) is more suitable for estimation (detection of fixed or random differences of cross-sectional units), Hausman test is used. In the random effects' method, the deleted variables are placed on the perturbation sentence, but this is provided that there is no correlation between the independent variables and the cross-sectional error component. The Hausmann test examines the existence of this correlation. This test is based on the initial assumption that if there is a correlation, the fixed effects method is compatible and the random effects method is incompatible. If the estimator is a random effects method, the statistics of this test, which has a chi-square distribution with a degree of freedom equal to the number of independent variables, can be defined as follows:

$$W = [\beta_{RE} - \beta_{FE}]^T [\text{var}(\beta_{RE} - \beta_{FE})]^{-1} (\beta_{RE} - \beta_{FE}) \quad (4.3)$$

Hypothesis zero in Hausmann test will be as follows:

$$\begin{cases} H_0 : E(u_{it}|X_{it}) = 0 \\ H_1 : E(u_{it}|X_{it}) \neq 0 \end{cases} \quad (4.4)$$

Hypothesis zero means that there is no relationship between the disturbance component related to the width of the origin and the explanatory variables, and they are independent of each other. While the opposite hypothesis means that there is a correlation between the component of the disorder and the explanatory variables. Since there is a problem of bias and incompatibility when there is a correlation between the components of the disturbance and the explanatory variable, it is better to use the fixed effects method if it is accepted (rejected). When there is no correlation between the components of the disturbance and the explanatory variable (acceptance), both fixed effects and random effects methods are compatible, but the fixed effects method is inefficient and the random effects method should be used. [43]

4.1.4. Test of model significance

F-statistic was used to evaluate the significance of the regression model. Hypothesis zero in F test will be as follows:

$$\begin{cases} H_0 : \beta_1 = \beta_2 = \dots = \beta_k = 0 \\ H_1 : \beta_1 \neq \beta_2 \neq \dots \neq \beta_k \neq 0 \end{cases} \tag{4.5}$$

Which is checked by the following statistics:

$$F = \frac{ESS/(K - 1)}{RSS/(N - k)} \tag{4.6}$$

To decide whether to accept or reject the null hypothesis, the statistic F is compared to the table F, which is calculated with degrees of face freedom and denominators K-1 and N-K at the error level (α) of 5%, if F is calculated more From table F ($F > F_{\alpha(K-1, N-K)}$) the numerical value of the test function is in the critical region and the null hypothesis (H_0) is rejected. In this case, with 95% confidence, the whole model will be significant. If the calculated value of F is less than F in the table, the hypothesis H_0 is accepted and the significance of the model at the 95% confidence level is not confirmed.

4.1.5. Test the significance of research variables

To evaluate the significance of the coefficients of the independent variables in each model, t-statistic has been used. Hypothesis zero in t test will be as follows:

$$\begin{cases} H_0 : \beta_1 = 0 \\ H_1 : \beta_1 \neq 0 \end{cases} \tag{4.7}$$

Which is checked by the following statistics:

$$T = \frac{\hat{\beta}_1 - \beta_1}{SE(\hat{\beta}_1)} \sim t_{\frac{\alpha}{2}, N-k} \tag{4.8}$$

t To decide whether to accept the null hypothesis, compare the obtained T statistic with the table t ($|T| > t_{\frac{\alpha}{2}, N-k}$), calculated with the degree of freedom NK at 95% confidence level, if the absolute value of T calculated is greater than table t, The numeric value of the test function is in the critical region and the null hypothesis (H_0) is rejected. In this case, with a 95% confidence interval, the desired coefficient (β_1) will be significant, which indicates the existence of a relationship between the independent and dependent variables.

4.1.6. *Self-correlation test*

Sentence disorder sentences are different, unrelated, or independent of each other. That is, $Cov(et\ es) = 0, t \neq s$. If the latter assumption is violated, a problem called self-correlation or serial correlation or autoregression arises, all of which means that the disorder sentences are correlated. In general, whenever ets follow a certain order, the assumption of etches being correlated is violated and a positive or negative correlation is created. The Durbin-Watson Test is used to investigate this issue.

4.1.7. *Analysis of variance*

The variance of the perturbation sentences is all equal to a fixed number such as δ^2 , ie $V(et) = \delta^2$. Whenever the latter assumption is violated, the so-called inequality of variance or inequality of variance occurs. The Arch test is used for this purpose. If the calculated sig value is greater than the significance level of 0.05, assumption H1 is rejected and assumption H0 is accepted. This means that the model has variance homogeneity, otherwise if the calculated sig value is less than the significance level of 0.05, we reject the H0 hypothesis and accept the H1 hypothesis. This means that the model has variance inequality. The use of the generalized least squares method of estimation solves this problem, if any.

4.2. *Performing hypothesis test and statistical model of research*

In this section, we analyze the data using the stated statistical methods.

4.2.1. *Descriptive analysis*

Some of the concepts of descriptive statistics of variables are represented in Table 1.

Table 1: Descriptive statistics of research variables

variable	Mean	Median	Maximum	Minimum	Std. Dev.	J-B test	Probability	Obs
NTD/A	0.0928	0.0695	0.9696	-0.6007	0.1771	710	0.0000	912
NNQ/A	0.0638	0.0026	1.5173	-0.0071	0.1604	28568	0.0000	911
DEF/A	0.1618	0.1041	2.3520	-0.3423	0.2567	9083	0.0000	914
(DEF/A)^2	0.0861	0.0146	4.7354	0.0000	0.2772	451003	0.0000	913

4.2.2. *Test of the first statistical model*

As explained in the Statistical Models section, we use the following statistical model(4.9) to evaluate the application of the financing pecking order theory.

$$NTD_{i,t} = \beta_0 + \beta_{PO}DEF_{i,t} + \beta_{PO,sq}DEF^2_{i,t} + \epsilon_{i,t} \tag{4.9}$$

4.2.2.1 *Data integration capability test (Chao test) - the First model*

When dealing with panel data, the question arises, can the data be merged or not? Hypothesis zero of this test indicates the use of a hybrid regression model (ordinary least squares regression model) and in this case, there is no need to use panel analysis. It can be seen in Table 2 that the probability value is equal to 0.851, which is bigger than the significant level $\alpha= 0.05$. As a result, the null hypothesis of this test is accepted. Therefore, the data are integral and composite data should be used instead of panel data.

Table 2: Data integration test results for the first model

Chow test for the first model	
Test statistics	0.880
Probability of test statistics	0.851

4.2.2.2 Fitting the regression model and its analysis - the first model

F test was used to evaluate the linearity and significance of the regression model. Hypothesis zero test, F indicates the significance and linearity of the regression model. It can be seen in Table 3 that the probability value of F statistic is equal to zero, which is less than the significant level of $\alpha = 0.05$. As a result, the null hypothesis of the test, F, is rejected. Therefore, the model is significant and there is a linear relationship between the independent and dependent variables. T-test was used to evaluate the significance of the estimated coefficients. Hypothesis zero test, t indicates that the coefficients of the model are zero. The probability values of the fixed coefficient and the independent variable coefficient of the financial deficit are equal to zero, which is less than the significant level of $\alpha = 0.05$. As a result, the null hypothesis of the test, t, is rejected. Therefore, both opposite coefficients are zero and significant. The deficit ratio in the model shows that a unit increase in the deficit increases the net debt by 97%. The value of the R coefficient is equal to 88.6%, which means that the independent variable of the financial deficit explains 88.5% of the changes in the dependent variable of published debt. Therefore, this model is suitable for data and is statistically robust. Also, the value of the Durbin-Watson statistic is equal to 1.780, which is at an acceptable level between 1.5 and 2.5. This indicates that the error components are independent of each other and do not interfere with the model.

Table 3: Results of fitting the first model, based on the Method: Panel EGLS (Cross-section weights)

Independent variables and findings	Coefficient values in the model	t statistics	P-value values
Financial deficit	0.976	81.337	0.0000
The second power of the financial deficit	-0.530	-29.920	0.0000
Constant	-0.0059	-4.396	0.0000
Determination coefficient R2	0.886	-	-
Adjusted coefficient of determination	0.885	-	-
Durbin-Watson	1.780	-	-
F statistics	3529.03	-	-
Statistical probability F	0.0000	-	-

The results in the table show that the financial deficit has a significant relationship with changes in corporate debt, which is a direct direction for this relationship due to the positive value of the coefficient. The positive coefficient of the financial deficit variable means that increasing the company’s financial deficit increases the company’s debt changes. According to Table (3), the regression fits as follows.

$$NTDi, t = - 0.0059 + 0.976DEF_{i,t} - -0.530DEF^2_{i,t} + \epsilon_{i, t} \tag{4.10}$$

The first-order derivative of debt changes in terms of financial deficit is positive, and this means the positive effect of the financial deficit on changes in corporate debt. Mathematically, this indicates that the quadratic function of the relationship between changes in debt and the company’s financial

deficit is initially bullish. The quadratic derivative, however, is negative, and this mathematically indicates that the concavity of the quadratic function is downward. In other words, the relationship between the financial deficit and changes in the company's debt is initially positive and upward, but from one point onwards this relationship changes and becomes negative, which indicates the same nonlinear relationship that exists between the financial deficit and changes in the company's debt. The diagram shows the relationship between the financial deficit and changes in the company's debt.

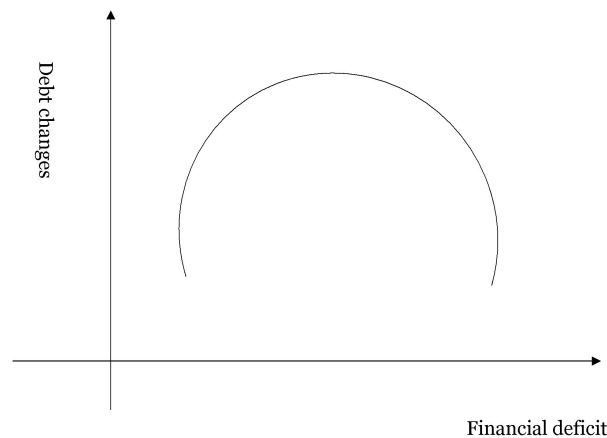


Figure 1: Relationship between financial deficit and debt changes

This study focuses on the nonlinear relationship between the deficit financial and changes in corporate debt. To achieve this relationship, it is necessary to calculate the first and second order derivatives of debt changes in terms of financial deficit according to what follows.

$$\frac{\partial(NTD_{i,t})}{\partial(DEF_{i,t})} = 0.976 - 1.06DEF_{i,t} \quad (4.11)$$

$$\frac{\partial^2(NTD_{i,t})}{\partial(DEF_{i,t})^2} = -1.06 \quad (4.12)$$

According to what was mentioned in the theoretical foundations of the study and the results obtained from estimating the model, initially with the increase in the company's financial deficit, debt changes also increase. But the larger the deficit, the lower the rate of change in debt, and ultimately from a certain point onwards, the deficit will not only not increase the change in debt, but will reduce the change in debt.

4.2.2.3 Test of lack of multicollinearity of independent variables:

in the model To check the presence or absence of multicollinearity between independent variables, the correlation coefficient table was used. However, since only double multicollinearity can be examined with correlation coefficients, the criterion of variance inflation is used to detect multiple alignments. The test results in Eviews software are as follows: In Table 4, since the VIF values are less than 5, it is concluded that there is no multicollinearity.

Table 4: VIF test for the first model

Variable	Centered VIF
DEF/A	3.62
(DEF ²)/A	3.62
C	–

4.2.2.4 Execution of variance heterogeneity test of the first model

The problem of variance heterogeneity refers to a situation in which the components of the error in the regression model do not have the same variance at all stages of companies and over time. The null hypothesis of this test shows that the variance of the error components of all cross-sectional units is constant and the same.

It can be seen in Table 5 that the probability value is equal to 0.00, which is smaller than the significant level $\alpha = 0.05$. As a result, the null hypothesis of this test is rejected. Therefore, there is variance inequality problem in the model.

Table 5: white test for the first model

white test for the first model	
F statistics	73.31
Statistical probability F	0.000

Therefore, it is necessary to apply the necessary correction in this model. That this has been done (in the model estimated in Table 3). Thus, in the method of calculating the coefficient of covariance matrix (Coef covariance method) in the settings during the execution of the panel model, the option of Cross-section weights (PCSE) has been selected. t statics and corresponding significance levels are corrected for existing variance heterogeneity.

4.2.3. Test of the second statistical model

As explained in the Statistical Models section, the extended model of financing pecking order theory is as follows(4-13):

$$NNQ_{i,t} = \beta_0 + \beta_{PO}DEF_{i,t} + \beta_{PO,sq}DEF^2_{i,t} + \epsilon_{i,t} \tag{4.13}$$

4.2.3.1 Data integration capability test (Chao test) Model 2

Table 6 shows that the probability value is 0.692, which means that the data cannot be merged and panel data should be used instead of composite data.

Table 6: Data integration capability test results for the second model

Chow test for the second model	
Test statistics	0.939
Probability of test statistics	0.692

4.2.3.2 *Fitting the regression model and its analysis - the second model*

Table 7 shows that the probability value of F statistic is zero, which means that the model can be presented. Accordingly, it can be said that there is a nonlinear relationship between the independent and dependent variables. The probability values of the fixed coefficient and the independent variable coefficient of the financial deficit are equal to zero, which means that both opposite coefficients are zero and significant. The deficit coefficient in the model shows that a unit increase in the financial deficit increases the issued shares by 13%. The value of the coefficient of determination R2 is equal to 0.419, which means that the independent variable of the financial deficit explains 41.7% of the changes in the dependent variable of issued shares. Also, since the value of the Durbin-Watson statistic is equal to 1.782, the error components are independent of each other and do not disturb the model.

Table 7: Results of fitting the second model: Panel EGLS (Cross-section weights)

Independent variables and findings	Coefficient values in the model	t statistics	P-value values
Financial deficit	0.128	10.846	0.0000
The second power of the financial deficit	0.072	0.072	0.0000
Constant	0.010	0.010	0.0000
The coefficient of determination	0.419	-	-
Adjusted coefficient of determination	0.417	-	-
Durbin-Watson	1.782	-	-
F statistics	327.074	-	-
Statistical probability F	0.0000	-	-

The results in the table show that the financial deficit has a significant relationship with changes in the company’s capital, which is inverted due to the positive value of the coefficient. The positive coefficient of the financial deficit variable means that increasing the company’s financial deficit increases the company’s capital changes. According to Table (7), the fitted regression is as follows.

$$NNQ_{i,t} = 0.010 - 0.128DEF_{i,t} + 0.072DEF^2_{i,t} + \epsilon_{i,t} \tag{4.14}$$

4.2.3.3 *Test of lack of multicollinearity of independent variables:*

in the model To check the presence or absence of multicollinearity between independent variables, the correlation coefficient table was used. However, since only double multicollinearity can be examined with correlation coefficients, the criterion of variance inflation is used to detect multiple alignments. The test results in Eviews software are as follows: In Table 8, since the VIF values are less than 5, it is concluded that there is no multicollinearity

Table 8: VIF test for the Second model

VIF test for the first model	
Variable	Centered VIF
DEF/A	3.2990
(DEF^2)/A	3.2990
C	—

4.2.3.4 Execution of variance heterogeneity test of the second model

It can be seen in Table 9 that the probability value is equal to 0.00, which is smaller than the significant level $\alpha = 0.05$. As a result, the null hypothesis of this test is rejected. Therefore, there is variance inequality problem in the model.

Table 9: white test for the second model

white test for the second model	
F statistics	590.3
Statistical probability F	0.0000

Therefore, it is necessary to apply the necessary correction in this model. That this has been done (in the model estimated in Table 7). Thus, in the Coef covariance method, the Cross-section weights (PCSE) option has been selected in the settings during the execution of the panel model. This changes the method of calculating the standard error of the coefficients and, consequently, the Student's statistics and the corresponding significance levels are corrected for the existing variance heterogeneity.

5. Conclusion

The hypothesis was designed to evaluate the ability to describe the capital structure of manufacturing companies listed on the Tehran Stock Exchange through the theory of financing pecking order. The results of testing the hypothesis indicate a significant positive relationship between financial deficit and debt changes, financial deficit and equity changes in the companies under study. Therefore, the hypothesis of this study is confirmed and indicates that the capital structure model of the companies under study is consistent with the theory of financing pecking order. In other words, Iranian companies follow the theory of financing pecking order.

According to the results of the research, Despite some restrictions on data collection that were not available in the Rahavard novin software, extracted these items from the companies' financial statements from the stock exchange site, and the following suggestions are presented for further studies:

- 1- Examining other theories of capital structure and comparing it with the theory of financing-pecking order.
- 2- It is suggested that the research be done separately for each industry and the results be compared with the results of this research.
- 3- Financial and service companies have been excluded from the statistical population due to the difference in their capital structure with other companies. Therefore, a study is proposed to study the capital structure pattern of this type of companies and compare them with the results of this study.

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