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Investigating the relationship between product market competition and diversion of efficient investment using linear and nonlinear models

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Abstract

Usually, a set or combination of investments is maintained in a company along with investors in the financial markets often considering a reduction in the diversion of investment efficiency. In view of the factors affecting diversion of investment efficiency along with the use of linear and non-linear models (linear fractional, linear plus linear fractional), the relationship between product market competition and control variables with diversion from investment efficiency has been investigated to help reduce diversion of the investment efficiency. To achieve this objective, the data of 110 companies listed in Tehran Stock Exchange during the period 2010 to 2015 was used. The results obtained revealed that the non-linear models (linear plus linear fractional) provides a more precise explanation of the impact of the product market competition on the diversion of investment efficiency.

Keywords: Product market competition, Diversion of investment efficiency, Free cash flow.

1. Introduction

Diversion of investment efficiency refers to investments that either occurs abnormally or by chance. Furthermore, the net present value of these investments is either positive or negative (Richardson, [1]). Different factors are capable of affecting the diversion of investment efficiency, one of which is the conflict of interest between managers and owners. In this respect, there exists a conflict of interest according to agency theory, which often affects decisions and policies adopted by companies. During such a situation, managers may decide to invest the companys resources on projects in a bid

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to increase their interests, which reduces the wealth of shareholders. Alternatively, another factor that necessitates a deviation from investment efficiency is information asymmetry. If the degree of information asymmetry between the company and stakeholders is high, a corresponding increase will be observed in the level of the company's cash holding (Garcia et al., [2]). Myers and Majluf [3] suggest that in the imperfect capital market, due to the information asymmetry and high investment cost, companies do the financing, which is also limited. Thus, companies start investing bearing in mind sufficient cash flow as well as the cost of investment; this further renders the cash flow as a factor that is associated with the company's investments. Hubbard [4] affirms the existence of a significant positive relationship between the free cash flow and investment expenditures of companies. In a study titled Free cash flow and over-investment, Richardson [1] proposed a positive relationship between free cash flow and over-investment, which appears to be a diversion from the investment efficiency. In a study conducted in China, Jiang et al. [5] demonstrated the existence of a positive relationship between product market competition and companies' investment. John et al. [6] suggested that when investments are weakly protected, managers are more likely to divert the company's resources towards their own interests and investments in projects with negative net present value. In this regard, several researchers (e.g., Hart, [7]; Schmidt, [8]; Baggs and Bettignies, [9]) have argued that product market competition plays a controlling role in the protection of investment; however, competition reduces agency problems. In companies active amongst more competitive industries, managers have fewer opportunities and resources of these companies are more invested in high-risk and higher value projects. Laksmana and Yang [10] indicated that manipulation of accruals and income based on actual activities is more common in more concentrated industries. In a study titled "Product market competition and false reporting in financial accounting", Balakrishnan and Cohen [11] concluded that product market competition, as a disciplinary force, helps to organize managers' reports and reduces distortions in the financial reporting. Chhaochharia et al. [12] stated that the product market competition reduces the agency problems and expropriation of the company's owners by insiders.

2. Theoretical framework and hypothesis development

Optimum investment is one among the factors affecting socio-economic development of a society. Chen et al. [13] states that in an imperfect competition market, increased competition leads to increased efficiency and productivity in a particular company as well as in a particular industry. Nickell [14] states that increased competition in the product market is dependent on increase in the growth rate of total productivity growth factors in the UK. Schmidt [8] states that the competition increases awareness and supervision of shareholders towards actions of managers. In a study by Li [15], effectiveness of competition in the product market was evaluated on the voluntary disclosure decisions of companies and suggested that competition increases disclosure quality by reducing both earnings forecast optimism and investment forecast pessimism. Dhaliwal [16] demonstrated that product market competition, affects conditional conservatism. Chen [17] suggests that product market competition reduces the cost of equity in Chinese companies. Jensen [18] argues that instead of paying free cash flow in the form of dividends to shareholders, managers may invest them in projects with negative NPV. This challenge is highly prevalent in companies with low growth opportunities. Richardson [1] revealed that over-investment is observably more in companies with high free cash flow. Moreover, in this same research, by investigating the relationship between corporate governance structure with over-investment in free cash flow, some of the corporate governance mechanism were understood to reduce over-investment. Given the importance of investment and appropriate use of resources, assets and investment opportunities, along with the fact that so far no research has been conducted to describe the deviant behavior of investment efficiency using linear and nonlinear relationships; the present study thus aims to estimate the investment efficiency deviation in terms of factors affecting the deviation variables such as product market competition, firm size, free cash flow and investment opportunities using linear and non-linear models (linear fractional, linear plus linear fractional) in order to find the best method to describe the deviant behavior of investment efficiency. The framework for determining the research variables is subsequently presented in a normal mode.

3. Product market competition

Product market competition is calculated as the sum of squared market share based on the 9 industry classification for listed firms in Tehran Stock Exchange, the Herfindahl-Hirschman Index (HHI), a measure that is commonly used by researchers in the literature on industrial organization. The Herfindahl Index is defined as the sum of squared market shares:

$$HHI_{j,t} = \sum_{i=1}^{N_{jt}} S_{ijt}^2, \tag{3.1}$$

where $S_{i,j,t}$;t the market share of firm i in industry j in year t, N_{jt} is the number of firm in industry j in year t, HHI_{jt} is the Herfindahl Index of industry j in year t. The market share of an individual firm is calculated by using the firm‘s net sales (Compustat annual item SALE) divided by the total sales of value of the entire industry. Following Hou and Robinson [19], Gu [20], Jiang et al [5].

4. Diversion of investment efficiency

Consistent with Richardson [1], Diversion of investment efficiency is define over-investment and underinvestment as the investment expenditure beyond that required to maintain assets in place and to finance expected new investments projects. free cash flow (FCF) is defined as cash flow beyond what is necessary to maintain assets in place $I_{MAINTENANS}$ and to finance expected (optimal) new investments $I_{NEW,t}$. Total investment 4 (I_{TOTAL}) is calculated as the sum of capital expenditure (CAPEX) and acquisition expenditure (Acquisitions), and then subtracts receipts from the sale of property, plant and equipment (SalePPE). Also, total investment can be decomposed into two components: (1) investment expenditure to maintain assets in place $I_{MAINTENANS}$ and (2) investment expenditure on new projects $I_{NEW,t}$ (Meyer et al, [3]). Investment expenditure on new projects can then be split into two components: (2a) expected investment expenditure in new positive NPV projects($I^*_{NEW,t}$), and (2b) abnormal (or unexpected) investment ($I^{\varepsilon}_{NEW,t}$), the abnormal component of investment can be positive or negative. Positive values correspond to over investment, and negative values correspond to underinvestment.The($I^{\varepsilon}_{NEW,t}$), is called inefficient investment. The relations among those components are as follows:

$$I_{TOTAL,t} = CAPEX_t + Acquisitions_t - SalePPE_t, \tag{4.1}$$

$$I_{TOTAL,t} = I_{MAINTENANCE} + I_{NEW,t}, \tag{4.2}$$

$$I_{NEW,t} = I^*_{NEW,t} + I^{\varepsilon}_{NEW,t}, \tag{4.3}$$

$$CF_{AIP,t} = CFO + I_{MAINTENANCE,t}, \tag{4.4}$$

$$FCF_t = CF_{AIP,t} - I^*_{NEW,t}, \tag{4.5}$$

Where $CF_{AIP,t}$ is the cash flow generated from assets in place, which is the difference between cash flow from operating activities (CFO) and investment expenditure necessary to maintain assets in

cumulative error	Euclidean error	coefficient of determination	adjusted coefficient of determination
234.0905	21.7180	0.8285	0.8275

Table 1: Estimation results in linear mode

place ($I_{MAINTENANCE,t}$) $I_{MAINTENANCE,t}$ is measured as reported depreciation and amortization. All investment expenditure variables divided by total assets. Decomposition of Investment Expenditures The investment expenditure model Following Richardson[1], stated that inefficient investment as the investment expenditure beyond that required to maintain assets in place and to finance expected new investments projects. The estimation models are as follows:

$$I_{NEW,t} = \alpha_0 + \alpha_1 cash_{i,t-1} + \alpha_2^* Grow_{i,t-1} + \alpha_3^* ROA_{i,t-1} + \alpha_4^\star Lev_{i,t-1} + \alpha_5^\star size_{i,t-1} + \varepsilon_{i,t}, \tag{4.6}$$

Where cash is the balance of cash and short-term investment divided by total assets at the start of the year. Grow is the measure of growth opportunities and is calculated as the ratio of the market value to book value of assets at the start of the year. ROA is calculated by dividing a company's net income by total assets at the start of the year .Lev is the debt divided by total assets. Size is the log of total assets. The residual is denoted by ε,the positive or negative residual denotes the deviation from the investment efficiency. Finally, the amount of deviation from the inefficiency of the investment is divided by the total assets of the company at the end of the period.

5. Research methodology

This is an applied research with quasi-experimental design using ex post facto approach. The study sample includes all companies that are listed in Tehran Stock Exchange during the period from 2010 to 2015. In this study, the following criteria were taken into consideration while selecting the sample and the study sample was chosen as follows:

1. Must be listed in the Stock Exchange by the end of 2009 fiscal year.
2. Fiscal year ended March of each year.
3. Company's financial period must not be changed during the financial period of 2010 to 2015.
4. Financial information necessary to extract the required data must be available.
5. The company does not belong to financial institutions simply because disclosure of financial information is different between them.

Based on the above-mentioned conditions and restrictions, 110 companies were selected as the sample. Thereafter, the data were prepared and analyzed using Excel 2013 and MATLAB software version 14, respectively.

6. Study pattern

This study is aimed at determining the best approach in predicting the diversion from investment efficiency in such a way that the error rate is minimized. Based on this, linear and nonlinear relationships were employed in the study; linear fractional, and linear plus linear fractional functions were used for approximation. The linear fractional function is a special type of pade approximation. In the linear fraction, linear functions are used both in the numerator and denominator. It is noteworthy too that finding coefficients in this approximation is not as easy as in the linear method, hence researchers have turned to use of a technique called PSO or the congestion method. The Euclidean norm was used in order to solve the study problem:

$$\|x-y\| = \sqrt{(x_1-y_1)^2+(x_2-y_2)^2+\cdots+(x_n-y_n)^2} \tag{6.1}$$

$$\min = \left\| I^{\varepsilon}_{NEW,t} - (a_0 + a_1 HHI_{i,t} + a_2 FCF_{i,t} + a_3 MB_{it} + a_4 SIZE_{i,t}) \right\|_2 \tag{6.2}$$

To perform the linear estimation, initially, any variable must be multiplied by the constant number

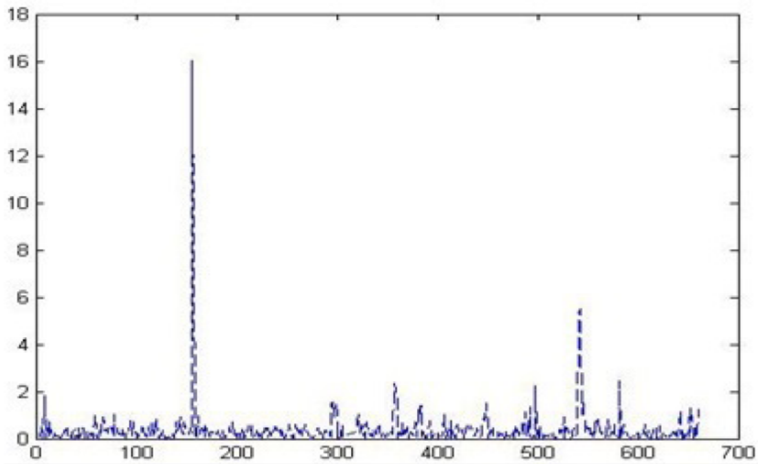

Figure 1:

and summed up with a constant number; thereafter the coefficients are calculated. Thus, the following equation was used: The following problem has been solved with linear approximation:

$$I^{\varepsilon}_{NEW,t} \simeq -0.099 + 13.96HHI + 2.376FCF + 0.021MB + 0.072SIZE \tag{6.3}$$

In Table 1, R and (R^2) respectively relates to the coefficient of determination and adjusted coefficient of determination of the model, which indicates the percentage of changes of the dependent variable that can be expressed by other variables used in the model. Given that the adjusted coefficient of the model is equal to 0.8275, therefore, 0.8275 of the dependent variable behavior is shown by product market competition, investment opportunities, firm size, and free cash flow. The values of R and (R^2) are estimated using the following equation:

$$\bar{y} = \sum_{t=1}^{T} \frac{y_t}{T}, \qquad R^2 = 1 - \frac{\varepsilon^T \varepsilon}{(y-\bar{y})^T (y-\bar{y})}. \tag{6.4}$$

In relationship (6.4), ε represents the discrepancy, while ε^T denotes the transpose of ε. Furthermore, in the above equation, $\bar{y}$ is the average dependent variable, y is the dependent variable and $(y-\bar{y})^T$ denotes the transpose of $(y-\bar{y})$. The linear mode diagram is as shown below. According to the linear test results, the cumulative and Euclidean errors are 234.0905 and 21.7180 respectively. Figure 1 reveals the approximation error in the linear mode.

Pad'e Approximants are used to estimate the study problem in the non-linear mode. In this mode, the linear functions are used in the numerator and denominator. Determining the coefficients in this approximation method is not as easy as in the linear method; hence an innovative method called PSO or congestion method is used in the study. In this method, an initial population must first be created. The initial population in the present study refers to good random solutions. For this purpose, the linear method solutions are used in such way that the numerator coefficients are considered as the linear problem solutions and denominator variables are equal to zero. Additionally, a series of other initial population was randomly generated. Here, the solution obtained from this method is certainly better than the linear method and in the worst case scenario is the same as the solution obtained in the linear problem. As can be observed, the cumulative error is reduced and the (R^2) value has reached to 0.9635, indicating more favorable results in comparison with the linear mode. The interesting thing here is that isolated outliers are not omitted in this method and the solution is obtained with the same outliners in the data. Also, definitely better solution will be

cumulative error	Euclidean error	coefficient of determination	adjusted coefficient of determination
175.5655	13.1212	0.94000	0.9392

Table 2: Estimation results in the linear fractional mode

obtained if these outliers are removed from the problem.

$$I^{\varepsilon}_{NEW,t} \simeq \frac{-0.1364 - 13.9643HHI + 2.4126FCF + 0.0506SIZE + 0.1392MB}{1 - 0.0003HHI + 0.0296FCF + 0.03758SIZE - 0.0164MB} \tag{6.5}$$

Relationship (6.5) was solved using PSO. Kennedy [21] stated that PSO is a social search algorithm, taken from the social behavior as well as regular and collective movement of birds and fishes. He pointed out that the collective behavior of birds and fishes is of immense assistance in the determination of the best solution in optimization problems because a change in the position of each particle is based on the experience of the particle in previous movements and the experience of neighboring particles. In this algorithm, every particle is actually aware of the superiority or non-superiority over the neighboring particles as well as the entire group. To model using this algorithm, two dimensions are considered. First, each particle must change its position following the best person in the group. Secondly, each particle must remember the best position ever experienced because the particle itself may serve as the group leader. In the search space, each particle represents a solution and changes its velocity based on the best solution obtained in the group. This change depends on the position of each particle compared with the best particle in the group. In this study, the optimal solution obtained in the linear method is used as the best particle. Accordingly, some of the initial population is close to the linear model solution. Moreover, in addition to a population that has been formed in this way, another part of the population is randomly created in this study. In PSO method, the position vector for the ith particle with dimension D is as follows: $X_i = [x_{(i,1)}, x_{(i,2)}, \cdots, x_{(i,d)}]$ and the speed vector is defined as $V_i = [v_{(i,1)}, v_{(i,2)}, \cdots, v_{(i,d)}]$. Moreover, the best position gained by each particle is defined in the implementation phase of algorithm as follows:$pbest = [P_{(b,1)}, P_{(b,2)}, \cdots, x_{(b,d)}]$; And the best position gained by particles during the implementation of the algorithm is as follows: $gbest = [g_{(b,1)}, g_{(b,2)}, \cdots, g_{(b,d)}]$ Furthermore, the position and velocity vectors of every particle are as follows:

$$v_{i,d}(t+1) = w_{t_0} v_{i,d}(t) + c_1 rand_1 \big(pbest_{i,d}(t) - c_2 x_{i,d}(t+1)\big) + c_2 x_{i,d}(t+1) = x_{i,d}(t) + v_{i,d}(t+1). \tag{6.6}$$

In Relationship (6.6), c_1 and c_2 are respectively, coefficients related to the personal experiences of each particle and the coefficient of collective experience of the group. Numbers of ($rand_1$) are random numbers between $[0, 1]$, which creates a variety in solutions. And w_t (inertia coefficient) is a control parameter that controls the impact of the current speed of particle on the next speed and creates a balance between the ability of algorithm in both local and global search. Also, $V_{\max}$ and inertia coefficient are two factors that control speed (Kennedy, [21]). W, as a $v_{(i,d)}(t)$ coefficient, can assess

cumulative error	Euclidean error	coefficient of determination	adjusted coefficient of determination
163.6298	10.7468	0.9639	0.9635

Table 3: Estimation results in linear mode

the local position to the global one.To get the solution in a non-linear approximation, the value of β_1, β_2, β_3, β_4 variables is set equal to 0 so as to obtain solutions related to 0, 1, 2, 3, 4. Thus, the solution obtained in the Pad'e Approximants problem is definitely better than the linear mode. Results of the non-linear model are presented in Table 2 by using the host research (2013). The results presented in Table 2 reveal that in the review mode, results of linear fractional relations among variables are better, because on the one hand, the accumulated error and the Euclidean error are respectively 175.5658 and 13.1212, which is less than the linear error. And on the other hand, coefficient

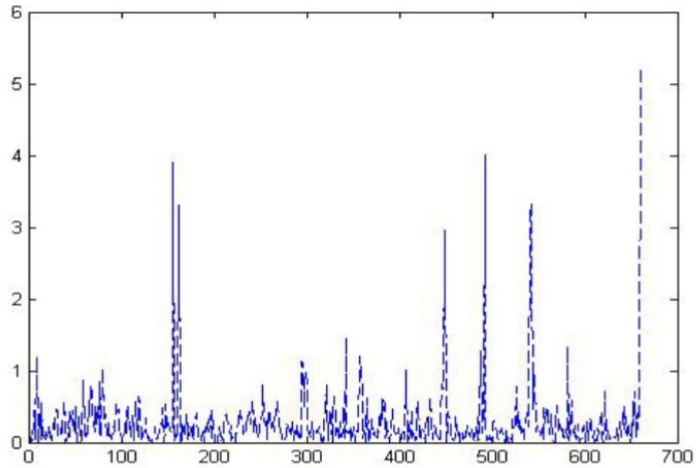

Figure 2: Linear fractional approximation error

of the determination and adjusted coefficient of determination are higher in the non-linear mode, which indicates that it is more likely to predict the behavior of the dependent variable (diversion of investment efficiency) using variables of product market competition, investment opportunities, free cash flow and firm size in this mode. The following model is used to estimate the studied problem using the linear plus linear fractional.

$$I^{\varepsilon}_{NEW,t} \simeq \frac{-0.0939 - 11.6755HHI + 2:3801FCF - 0.0221SIZE + 0.0071MB}{1 - 0.0449HHI + 0.0075FCF + 0.0119SIZE - 0.01310MB} + 0.0632 - 0:01708HHI - 0.3403FCF + 0.0919SIZE - 0.0279MB. \qquad (6.7)$$

The estimation results are presented in Table 3 using the linear plus linear fractional model. The results of Relationship (6.7), presented in Table 3, reveal that the coefficient of determination and the adjusted coefficient of determination of the model are respectively 0.9639 and in the sense that 0.9635 of changes in the diversion of investment efficiency can be described by product market competition, free cash flow, investment opportunities and firm size. The error in the linear plus linear fractional mode is presented in Figure 3.

7. Results

As can be observed, the purpose of the present study was to compare linear and non-linear models (linear fractional and linear plus linear fractional) so as to explain the relationship between the product market competition and the diversion from the investment efficiency. The summary of

cumulative error	Euclidean error	coefficient of determination	adjusted coefficient of determination
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175.5658	13.1212	0.94000	0.9392
163.6298	10.7468	0.9639	0.9635

Table 4: Estimation results in the linear fractional mode

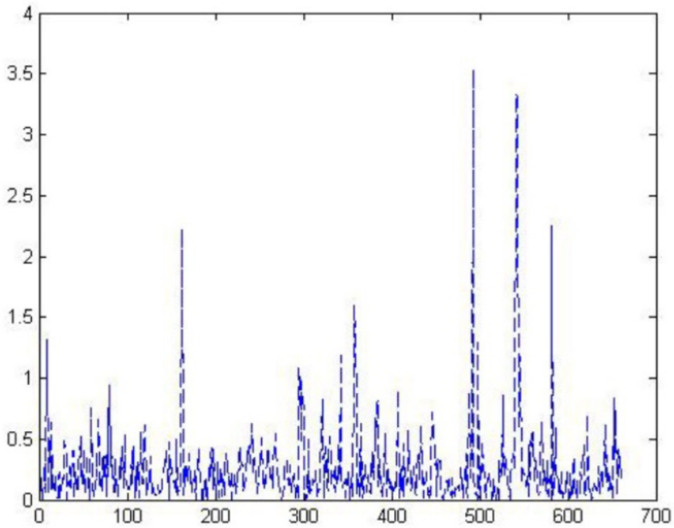

Figure 3: Error approximation in the linear plus linear fractional mode

the results can be seen in Table 4. These results indicate that both the cumulative and Euclidean errors in linear plus linear fractional model are less than the other two models and have the highest coefficient of determination. This means that more than 96% of the changes in the dependent variable can be explained by independent and control variables. Thus, the explanatory accuracy of nonlinear models can be said to be conclusively higher than the linear models in such cases. Based on this, it is recommended that the problem be approximated using linear relationships approximations of linear relations, which is solved by least squares. In fact, since no close linear relationship could be found between variables, it was then necessary to use the approximation method. The aim of the least squares method is to minimize the Euclidean distance between dependent and independent variables with the control variables. The results is an indication that high error value (R^2) is equivalent to 0.8275, hence the relationship between I^{ε}_{NEW} and the independent and control variables must be non-linear.

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