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Application of HS Metaheuristic Algorithm in Designing a Mathematical Model for Forecasting P/E in the Panel Data Approach

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ABSTRACT

In financial markets such as Tehran Stock Exchange, P/E coefficient, which is one of the most well-known instruments for evaluating stock prices in financial markets, is considered necessary for shareholders, investors, analysts and corporate executives. P/E is used as an important indicator in investment decisions. In this research, harmony search metaheuristic algorithm is used to select optimal variables affecting P/E and then, modelling is done through multivariate regression based on panel data. For this purpose, a sample of 87 companies has been selected from listed companies in the Tehran Stock Exchange during a 10-year period (2006-2015). The results indicate the effect of the variables of stock returns, stock price to book value ratio, price to net selling ratio, return on assets, earnings per share, market value to book value, money volume, operating return margin, return on capital, and current assets, as top ten variables, on P/E ratio, which estimates a total of 86% of the P/E ratio changes.

1 Introduction

Sustained and continuous economic growth in any economy requires the equipping and optimal allocation of resources at the national economy level. In the economic literature, capital is considered as the basis of economic system and great emphasis has been put on its formation as the most important determinant of economic growth and development. Basically, the amount of economic growth and development, on the one hand, is due to capital accumulation and, on the other, depends on the factor of efficiency in economic activities. These two basic factors depend on how the investment process works. Therefore, and considering that "one of the most important duties of financial markets is the facilitation of capital formation [24,8], capital markets, including the stock exchange, can well handle both of these duties (i.e. accumulation of capital and increase of economic efficiency).
Meanwhile, forecast, as one of the key elements of economic decision-making, estimates future developments with the goal of reducing risk [6]. On the other hand, one of the features necessary for the relevance of financial and economic information is usefulness of forecast. This means that accounting information should be prepared in such a way that users of financial statements are aided in forecast-

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ing future economic events. Forecasting is a key element of managerial decision-making. In a decision, a sequence of effective effects of this decision and events that may occur after a decision are considered [5]). The ability to estimate these irreversible effects will improve selection and decision-making. For this reason, management systems require forecast for designing and controlling their organizational operators. In general, it can be said that forecast is the estimation of future events and is intended to reduce risk in a decision. Forecasts are not usually correct and have some errors, which is reduced by having more information about the system. The value of forecasting information means using this information in the forecast process. In addition, the existence of a forecast error is natural in the application of various models and, therefore, a model with less forecast error is preferred, which requires more information about different components of the system under investigation. In many cases, access to this information is very difficult and sometimes impossible. In such a situation, having a proper forecast model leads to optimal allocation of resources in order to maintain the presence of investors as the main elements of the capital market, thereby increasing the efficiency of this market. Hence, the use of "univariate time series" models in the form of technical analysis can be a response to this limitation.

In financial affairs, information such as the P/E ratio, stock prices, profit, stock returns, bankruptcy and risk can be forecasted. Meanwhile, P/E forecast is of great importance, as it is one of the most influential factors in the decision making of stock market participants. Since the most important investment objective in the stock market is profit making; all investors need P/E forecast. Therefore, P/E forecast in the stock exchange can be one of the most important issues faced by shareholders. In general, an investor determines the time, place, and volume of his investments by forecasting future in a way that maximizes the return on his portfolio.

There are various methods and techniques for designing and explaining models for forecasting financial variables such as future price of stock, dividends, and P/E ratios. One of these methods that considers many variables is fundamental analysis. In addition, in economic research, most of the forecast models are econometric models [25, 28]

Time series data, cross-sectional data, and panel data are among these methods. In the meantime, panel data is one of the newest econometric methods that its use has been expanded daily among scholars [11].

Due to the newness of the model used in this research and its high efficiency and accuracy in forecast, the purpose of this research was to design and explain the P/E ratio forecast model using the harmony search (HS) algorithm using panel data. These models are used to increase the effectiveness, and reduce the cost and time of fundamental analysis for designing and explaining the P/E ratio forecast model.

2 Theoretical Foundation

2.1 Research Background

Taheri [10] uses harmony search algorithm for optimization in a dynamic environment and showed that the algorithm is evaluated on the criterion of moving peaks, which are the most well-known criteria in a dynamic environment, and are compared with the results of several valid algorithms. The results of the experiments indicate the accuracy of the proposed method. He also used harmony search algorithm to optimize water distribution networks, which showed that the use of a balanced (harmony) search pattern lead to an average of 9% reduction in the cost of network pipes in comparison with the

models of traditional method. Considering that forecast accuracy is the most important factor in choosing any forecast method, Sureshkumar and Elango [19] used forecast algorithms and functions to forecast the stock price in the future of the Indian market and compared performance of these methods.

The collected data included the opening price, the closing price, the highest and the lowest stock prices during the period from October 1, 2007 to October 12, 2011. The results of the analysis showed that the isotonic regression function has the ability and precision to forecast stock prices in comparison to other techniques. Mashayekh et al. [12] examined the forecast ability of the PEG ratio compared to the P/E ratio for determining stock prices in companies listed in Tehran Stock Exchange. They come up with another criterion called the PEG ratio, which has emerged in recent years as a tool to identify good stocks. The PEG ratio is defined as the price factor to earnings per share divided by its expected growth rate. This ratio is based on the P/E ratio and considers the growth prospect of a share.

They showed that P/E ratio was more stable compared to PEG using 215 companies/year over the period of 2002-201. Stock price forecast using PEG model was more accurate.

Considering that different methods of stock price forecasting such as technical analysis, fundamental analysis, time series analysis and statistical analysis are not accepted as a continuous forecast tool, Budhani et al. [15] sought a method to replace these methods. In this regard, artificial intelligence and artificial neural networks are a promising way of identifying hidden and unknown patterns in the data and can be used as a suitable way to forecast stock markets. Martinez et al. [18] conducted a study entitled "stock pricing in Latin American financial markets using the Olsen model" and evaluated the efficiency of this model in forecasting Latin American stock prices using panel data for 1112 companies during 2002 -2009. They concluded that in Latin America, the Olsen model is highly efficient in stock price forecast. He carried out a study entitled "evaluation of accounting variables in determining the value of companies"; by examining 102 companies accepted in Tehran Stock Exchange during the years 1994 to 2004 with a hybrid approach, they concluded that the Olsen valuation model (1995) is a well-known dynamic technique able to forecast the value of a company.

2.2 The concept of forecast

Most management decisions at all levels of the organization depend, directly or indirectly, on the state of future forecast. In a general definition, forecast of future conditions and events and how of doing it is called forecast. Since forecasting future events plays a major role in the decision making process, forecast is of great importance for many organizations and institutions, and any organization must be able to forecast for making informed decisions.

An important factor in choosing a forecast method is its cost. Complexity and cost of various forecast methods are different. The availability of data is of particular importance because different forecast methods require different amounts of data. In addition, if the data is available, its accuracy, precision, and timing should be checked since using wrong data provides incorrect forecasts. Finally, the forecast model and method should be easy to understand by users and decision makers. The choice of a forecast method is used in situations where a combination of the above factors is taken into account. Obviously, the best way to forecast a specific condition is not the most accurate ones, it is a method that estimates the needs and desired accuracy at the lowest cost [13].

2.3 The concept of P/E

P/E is an abbreviation for the share price per share (ESP) of a company. By definition, the P/E coefficient measures the numerator of the fraction of eigenvalue of each share and the denominator of the fraction of earnings per share - as a measure of the profitability of the eigenvalue. To determine the price, the market price of each share is usually used. In some cases, the average share price throughout the year is used. Various values such as the earnings per share of the past fiscal year, the earnings per share of the twelve-month period, the profit forecast for each share of the current year, the earnings per share of the next year, the reduced earnings per share and the initial earnings per share can be used for earnings per share (EPS). Different methods of calculating the P/E coefficient, which is known as the largest problem of the P/E coefficient, cause significant differences in the application of the P/E coefficient, although there is no fundamental difference between these methods. Of course, it is important to know that the earnings of each share of the past fiscal year are, however, part of historical and real information, while other types of earnings per share are calculated based on an analyst's estimate and may not be accurate.[1]

From a theoretical point of view, P/E indicates that how much investors want to pay for each Rial of a profit, or, in other words, how much is the value of each Rial of a company's profit. That is why it is also called share multiple. In other words, the P/E coefficient equivalent to twenty indicates that investors are willing to pay 20 Rials per each Rial of profit made by the company.

2.4 Research Questions

The main question of this research is how to use meta-intuitive patterns such as harmony search in explaining and presenting models of forecasting financial and economic variables such as P/E in the econometric approach of panel data. In order to answer the research question, the following hypothesis is presented: The first hypothesis: there is the possibility of designing and explaining the P/E price forecast model using harmony search algorithm in optimizing the panel-based econometric model

3 Metaheuristic Algorithms

The process of designing and implementing metaheuristic algorithms has three successive stages, each of which has different steps. In each step, activities must be done to complete that step. Step 1 is preparation, in which a clear understanding of the problem we want to solve should be got, and the objectives of the design of the metaheuristic algorithm for it must be clearly identified in terms of the solutions available for this problem. The next step is called construction.

The most important goals of this stage are choosing a solution strategy, defining performance measurement metrics, and designing an algorithm for the selected solution strategy.

The final stage is implementation, in which the algorithm designed in the previous step, including parameter setting, performance analysis, and, finally, the compilation and preparation of the results report should be done [26].

[1] Investopedia. "P/E Ratio Tutorial." 2002, PP.1-5. Available at: www.Investopedia.com/ University/Peratio.

3.1 Harmony Search Algorithm

The harmony search algorithm is a new evolutionary metaheuristic process based on the process of music that begins to search for the problem's solution space with a generation of solving vectors in the form of the algorithm memory and moves to the optimal spaces based on the probability approach. Each process has the potential for optimization and complex problems in the fields of engineering, economics and business can be modelled as optimization problems.
The purpose of modelling optimization problems is to minimize time, cost, and risk, or maximize profit, quality, and effectiveness.
Some of the optimization problems are complex, and it is difficult to obtain optimal solutions in a reasonable time using a precise method such as dynamic planning, and branch and bound planning. Hence, the development of solving methods in these types of problems that can attain optimal or nearly optimal solutions in reasonable time is more economic. In recent years, researchers have achieved good results in most complicated optimization issues by implementing metaheuristic methods [23].
The harmony search algorithm is one of the simplest and most recent metaheuristic methods that has been inspired by the process of simultaneous play of the orchestra of music in the optimal response search process in optimization problems.
In other words, there is a similarity between finding an optimal solution to a complex problem and the process of performing music.
This method of solving was first presented by Game in 2001. In keeping with the logic of this metaheuristic approach, attempting to achieve harmony in a music process is similar to finding an optimal solution to optimization problems.
A balanced search, such as the genetic algorithm, is among the improvisation algorithms.
In other words, it starts with a generation of solution vectors and is used to create new generations of selection process.
But unlike the genetic algorithm, which uses two chromosomes to produce a chromosome or a new solution vector, this method uses all improvises of solution vectors in the memory for production. One of the advantages of this algorithm is its rapid convergence due to its proper structure.
The pseudocode of this algorithm is shown in Fig. 1 [14,16].

Harmony Search

```
begin
  Define objective function f(x), x=(x1,x2, ...,xd)^T
  Define harmony memory accepting rate (r_accept)
  Define pitch adjusting rate (r_pa) and other parameters
  Generate Harmony Memory with random harmonies
  while ( t<max number of iterations )
    while ( i<=number of variables)
      if (rand<r_accept), Choose a value from HM for the variable i
        if (rand<r_pa), Adjust the value by adding certain amount
        end if
      else Choose a random value
      end if
    end while
    Accept the new harmony (solution) if better
  end while
  Find the current best solution
end
```

Fig. 1: Pseudo-code of the harmony search algorithm

3.2 Solve the Problem by Harmony Search Algorithm

In this algorithm, each solution is called a harmony and is represented by an N-dimensional vector. This algorithm has three main phases:

Step 1: Definition of the problem and parameters of the algorithm

Each optimization problem can be minimized as follows:

$$\boldsymbol{Min\ F}\left(\vec{\boldsymbol{X}}\right), \vec{\boldsymbol{X}} = \left(\boldsymbol{x}(\mathbf{1}), \ldots, \boldsymbol{x}(\boldsymbol{n})\right), \boldsymbol{x}(\boldsymbol{j}) \in [\boldsymbol{LB}(\boldsymbol{j}), \boldsymbol{UB}(\boldsymbol{j})] \quad (1)$$

In which, $F\left(\vec{X}\right)$ is the objective function, $\vec{X}$ is the set of design variables, LB(j) and UB(j) are lower and upper limits for the variable x(j). The parameters of the HS algorithm include harmony memory size (HMS) or the number of vector of harmony memory responses, harmony memory considering rate (HMCR), the pitch adjustment rate (PAR), bandwidth (BW), and the total number of improvisations (NIs).

Step 2: Initialization to harmonic memory

The harmony memory has an HMS vector of the answer. Assuming that $\overrightarrow{X_i} = \left(x_i(1), \ldots, x_i(n)\right)$ is the i^{th} vector of the HM response, then the vectors of the HM response are randomly generated using the following equation:

$$x_i(j) = [LB(j), UB(j)] \times r \quad \text{for j = 1, …, n and i = 1, …, HMS} \quad (4)$$

In which, r is a random number between zero and one. Therefore, HM matrix is written using HMS response vector and is displayed as follows:

$$\begin{bmatrix} x_1(1) & x_1(2) & \cdots & x_1(n-1) & x_1(n) \\ x_2(1) & x_2(2) & \cdots & x_2(n-1) & x_2(n) \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ x_{HMS}(1) & x_{HMS}(2) & \cdots & x_{HMS}(n-1) & x_{HMS}(n) \end{bmatrix} \quad (3)$$

Step 3: Improvising a new harmony

A New Harmony vector is improvised using 3 commands, which consist of memory consideration, pitch change and random selection. At first, a random number (r_1) is selected between zero and one. If (r_1) is smaller than HMCR, $X_{new}(j)$ is selected from memory; otherwise, $X_{new}(j)$ is selected randomly (that is, it is randomly selected between the upper and lower limit of the search space). Choosing HM is based on the following equation, in which a is randomly selected from the set {1, HMS}.

$$X_{new}(j) = X_a(j) \quad , \quad a \in \{1, \ldots, HMS\} \quad (4)$$

If parameter $X_{new}(j)$ is selected, parameter PAR is used. Therefore, another random number (r_2) is chosen between zero and one, and if r_2 is smaller than PAR, then $X_{new}(j)$ changes as follows, in which r is a random number between zero and one. (Yadav et al 2013)

$$X_{new}(j) = X_{new}(j) + BW(j) \times r \quad (5)$$

Step 4: Updating memory

After generating a New Harmony vector $\vec{X}_{new}$, HM should be updated. In this way, the objective function related to $\vec{X}_{new}$ is compared with the objective function of the worst member of the memory ($\vec{X}_w$). If the objective function related to $\vec{X}_{new}$ is better than the objective function related to$\vec{X}_w$, $\vec{X}_{new}$ is replaced by$\vec{X}_w$. Therefore, $\vec{X}_w$ is removed from the memory and $\vec{X}_{new}$ is considered as the new member of the memory. Finally, steps 3 and 4 are iterated until the stopping condition is achieved in order to obtain the optimal solution [4,22].

Step 5: Panel data

The term "panel data" refers to a kind of econometric analysis that considers cross-sectional data over time. Panel data is a combination of cross-sectional data and time series, i.e. information on cross-sectional data is observed over time. Such data have two dimensions, one dimension of which is related to different units at each specific time point, and the other dimension is related to time.
In the time series data, the values of one or more variables are observed over a period of time (For example, GDP in a few years).
In cross-sectional data, the values of one or more variables are collected for several units or sample instances at the same time (for example, the stock price for 50 companies in a stock exchange for a given year), but in panel data, sectional units (for example, a particular industry) are reviewed and measured over time [11].

4 Research Methodology

The present study applied in terms of its objective and it is analytical-mathematical in terms of its method. In this study, the techniques of the harmony search algorithm are used to identify and rank the factors affecting the price/earnings ratio. To collect the required data, the financial statements of the companies listed in Tehran Stock Exchange between the years 2006-2015 have been used for a period of 10 years.
The reason for choosing companies accepted in Tehran stock exchange is that there is more access to the financial information of these companies and that information of the financial statements of these companies are more homogeneous due to the regulations and standards of the Tehran Stock Exchange. In this study, for the selection of the sample, some companies have been eliminated through systematic elimination method.
According to the Cochran formula for calculating sample at the error level of 5%, the sample size turned out to be 87 companies from among 112 companies that are available.

4.1 Research Variables

In this research, the following variables are used to optimize and choose the best ones for forecast and application in the neural network. Variables that are related to P/E ratio in numerous articles like Yildiz and Yezegel [20] have been used. In cases where there is a high correlation between the variables, the combined variable (factor analysis) is used based on the eigenvalues [9,17]. The macroeconomic variables used in the research include oil revenue, exchange rate, coin rate, inflation rate and money volume [1,2,3,7,8] that have been collected from economic reports, balance sheets and economic indicators provided on the Central Bank site during 2006 to 2015.

Table 1: Research variables

Total current assets	Current assets include cash and other items and assets that can be converted into cash.
Sum of liabilities	(Sum of current liabilities + long-term debt).
P/E	Earning / price
Book value	Number of shares / equity
P/S	(Net sales / price)
P/BV	Book value / price
BV/M	Market value / book value
Stock returns	100 × (base price / ((base price-price of the day) + dividend profit per share + priority + bonus shares)
Current ratio	Current debt / current assets
Instantaneous ratio	Current Debt / instantaneous Assets
Current debt ratio to equity	Equity / Current Debt
Debt to capital ratio	Equity / sum of Debt
Debt to asset ratio	Total Assets / Total Debt
Interest coverage ratio	Cost of interest / profit before interest and taxes
Cash Flow Turnover	Instantaneous asset / net sales
Current asset turnover	Current asset / net sales
Tangible fixed asset turnover	Tangible fixed assets / net sales
Gross profit margin	Net sales / Gross profit
Operating profit margin	Net sales / operating profit
Net profit margin	Net sales / net profit
ROE	Equity / net sales
ROA	Total Assets / Net Sales
EPS	Number of shares / net profit
Oil revenue[2]	It is the income from oil exports.
Coin price[3]	The price of Iranian gold coins
Money volume[4]	Banknotes and coins + demand deposit + non-demand deposits
Free market exchange rate[5]	It is the rate used in the informal (non-governmental) markets for exchanging Iranian rials and different types of currencies.
Inflation rate based on consumer index[6]	It is the measure of price changes of fixed and definite amount of consumer goods and services for urban households.

[2] Annual oil revenues (million rials)
[3] Mean annual price of Iranian gold coin (thousand rials)
[4] Annual money volume (Billion rials)
[5] Annual mean (Dollar-rials)
[6] Annual mean (percentage of annual mean change compared to the base year)

4.2 Research Findings

The optimal variable is a variable that forecasts the target variable with the highest probability and least error.
The method of displaying the answer in a harmony search is numerically between zero and one, so that each variable that can more forecast the target will be closer to one.

Table 2: results of harmony search algorithm in data optimization

No.	Variable	Forecast possibility	Rank
1	Total current assets	.222	20
2	Sum of debts	.258	16
3	Book value	.364	11
4	P/S	.655	3
5	P/BV	.727	2
6	BV/M	.552	6
7	Stock returns	.731	1
8	Current ratio	.311	14
9	Instantaneous ratio	.307	15
10	Current debt ratio to equity	.316	13
11	Debt to capital ratio	.238	18
12	Debt to asset ratio	.321	12
13	Interest coverage ratio	.157	25
14	Cash Flow Turnover	.235	19
15	Current asset turnover	.372	10
16	Tangible fixed asset turnover	.217	21
17	Gross profit margin	.178	23
18	Operating profit margin	.423	8
19	Net profit margin	.188	22
20	ROE	.401	9
21	ROA	.631	4
22	EPS	.561	5
23	Oil revenue	.114	26
24	Coin price	.015	27
25	Money volume	.529	7
26	Free market exchange rates	.245	17
27	Inflation rate based on consumer index	.164	24

According to the results of harmony search testing, the variables with the highest forecasted power of the target variable ranked first to fifth priorities are stock returns, stock price to book value, price to net sales, ROA, and EPS.
Variables of market value/book value, the macroeconomic variable of the volume of money, the operating profit margin, the ROE, and the current assets turnover are respectively in priorities six to tenth.
Of the available variables, 10 variables that are of high power in forecasting the target variable (price to profit ratio) according to harmony search algorithm are used.

4.3 Hypothesis Testing

Table 3: standard error testing

Variable	Number	Standard error of skewness	Standard error of kurtosis
var1	870	.087	.195
var2	870	.087	.195
var3	870	.087	.195
var4	870	.087	.195
var5	870	.087	.195
var6	870	.087	.195
var7	870	.087	.195
var8	870	.087	.195
var9	870	.087	.195
var10	870	.087	.195

Table 4: statistical indices for values of forecasted residuals

Statistics	No. of observations	SD	Mean	Max.	Min.
Forecasted value	870	4173.55574	3918.7824	37715.9570	-17632.4219
Residual	870	3813.46724	.00000	35285.08891	-1883.19727
Standardized forecasted value	870	1.000	.000	7.373	-5.335
Standardized residual	870	.973	.000	9.034	-3.820

4.4 Forecast Based on Econometric Model of Panel Data

The forecasted results based on the econometric model of panel data are shown in the graphs below.

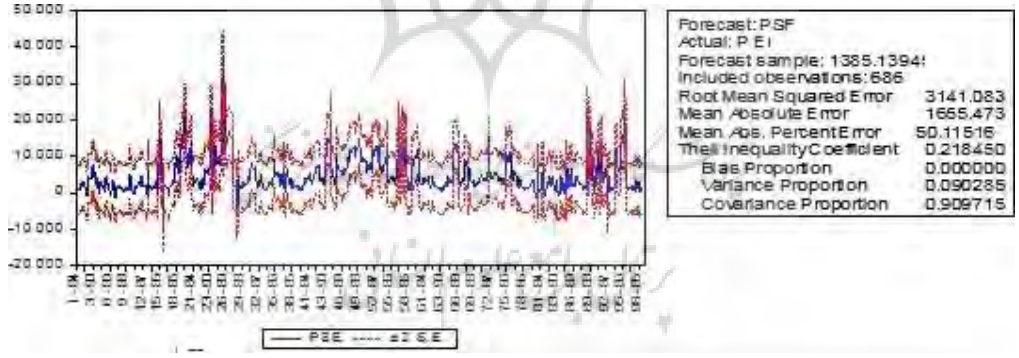

Fig. 2: Forecast based on econometric model

Fig. 2 is a forecast with the smallest distance from actual values. The upper and lower lines are the actual values of the P/E ratio, and the error rate based on the calculated error rates is shown on the right side of the graph.

In order to estimate the research model, firstly, fixed effect model was accepted using the Chow test between the combined model and the fixed effects. Then, the fixed effects pattern was accepted using the Hausman test between the fixed effects model and the random effects model. It is presented in more detail below.

Output of the forecast of the price-to-earnings ratio is the econometric model of panel data. Intermediate chart represents the P/E ratio.

4.4 Chow Test (F-Limer) for the Research Model

The Chow test is used to determine the use of a combined model against fixed effects model. The hypotheses of this test are as follows:

$$\begin{cases} H_0: & \text{The combined model is appropriate.} \\ H_1: & \text{Panel data model is appropriate.} \end{cases}$$

Table 5: Chow (F-Limer) test

Null hypothesis	F	P-value	Result
The combined model is appropriate.	12.714	.000	Null hypothesis is rejected and fixed effect model (panel data) is accepted.

Since the F-Limer probability is less than .05, data from the panel is used. The Hausman test has been used here to determine the appropriate model, and the results are presented below.

4.5 Hausman Test for Research Model

After it has been determined that the intercept is not the same for different years, the method used to estimate the model (fixed or random effects) should be determined using the Hausman test. Hausman test is used to determine the use of a fixed effect model against random effects one. Hausman test is based on the existence or absence of a correlation between estimated regression errors and independent variables of the model. If there is such a relationship, the fixed effect model is used and if this relationship does not exist, then the random effects model will be used. The H_0 indicates that there is no relationship between independent variables and estimation error and the H_1 indicates the existence of the relationship.

$$\begin{cases} H_0: & \text{Random effect model is appropriate.} \\ H_1: & \text{Fixed effect model is appropriate.} \end{cases}$$

Table 6: Chow (F-Limer) test

Null hypothesis	F	P-value	Result
The random effects model is appropriate.	18.331	.000	Null hypothesis is rejected and fixed effect model (panel data) is accepted.

4.6 Estimation of Forecast Model Using Panel Data Econometrics

The results of estimating panel data patterns based on the proposed hypothesis are in the following table. In this hypothesis, after performing factor analysis and identifying the combined variables, the

model was analysed using all the variables obtained from harmony search to find the best model with meaningful variables. In the factor analysis, variables that have high correlation are combined with their eigenvalues and a composite variable is obtained.

Table 7: Results of estimates of the panel data model

	Variable	Estimated coefficient	t-statistics	Prob.
Constant variable	C	-38.09313	-9.81839	.000
Stock returns	var1	14.8315	14.54303	.000
Stock price to book value	var2	13.63541	9.225992	.000
Price to net sales	var3	4.798732	3.29748	.0131
ROA	var4	18.44206	1.57639	.000
EPS	var5	-39.5120	-13.9023	.000
Market value / book value	var6	12.22451	9.64392	.001
Money volume	var7	-2.44206	-2.74220	.0153
Operating profit margin	var8	18.4338	14.33355	.000
ROE	var9	12.61152	16.9023	.000
Current assets	var10	-14.14552	-11.41506	.003
Other important test statistics	R^2 =.86467		$\overline{R^2}$ = .82433	
	F =.000		D.W =2.103	

As shown in Table 7, according to t-statistic at a significant level of 95% of the coefficients, all variables are significant and have the expected sign. The adjusted coefficient of determination is 82%, which expresses the appropriate explanatory power (prediction, explanation) of the model. In other words, this model has been able to predict 82% of the price-to-earnings change. In addition, the value of the F statistic and its probability level signifies the significance of the whole pattern. The Durbin-Watson statistics is also between 1.5 and 2.5, which confirms the independence of errors. The designed model for explaining and forecasting the price-to-earnings ratio using the panel data econometrics method is as follows:

P/E= -38.09313+ 14.8315 Var1+ 13.63541 Var2+ 4.798732 Var3+ 18.44206 Var4-39.5120 Var5+ 12.22451 Var6-2.44206 Var7+ 18.4338 Var8+12.61152 Var9-14.14552 Var10 + ε

5 Discussion and Conclusion

In this research, metaheuristic harmony search (HS) algorithm and advanced econometric models were used to design and explain the P/E ratio forecasting model and to increase the effectiveness, cost and time reduction. The results of the research indicated that the prediction model of this sensitive ratio in the decision making of shareholders and investors is much more accurate than previous models and algorithms with high predictive power by combining the harmony search algorithm with neural network. The test statistics were designed, estimated and calculated for forecasting. In this study, data from the ten-year period of 2006-2015 were used. It is worth mentioning that the best model is the one that has a high degree of accuracy in forecasting. In fact, the closer the estimation of a model is to the reality, the less error is expected; therefore, the mean square error rate was used which, ac-

cording to the researchers, is an acceptable criterion.
The results of this research are in line with the research of Taheri [10], Martinez et al. [18]. Their results indicated that the model has the ability to predict with high precision. In order to understand the behaviour of the stock market, this research has used a fundamental analysis. In order to better understand the behaviour of stock prices in future research, a combination of fundamental and technical analysis, as well as intelligent algorithms such as Cuckoo algorithm, Bird Algorithm and the growth of the bacteria are suggested to be used to forecast the P/E ratio and compare their performance with harmony search neural network. The combination of neural network harmony search algorithm with other intelligent algorithms and creation of a hybrid algorithm to forecast the price-to-earnings ratio should be tested, especially in various industries, which can provide guidance on the state and differences of factors affecting the P/E forecast.

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