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An Investigation of the Relationship Between the Accounting Variables and Stock Return Based on the Arbitrage Pricing Theory Based on the Downside Risk (D-APT) in Tehran Stock Exchange

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Abstract: In the present study, the relationship between the accounting variables of margin of profit ratio, equity to market value ratio, dividends per share to earnings per share ratio and stock return based on the Arbitrage Pricing Theory Based on the Downside Risk (D-APT) was investigated. This study investigated the relationship by considereing 160 dealing stocks in Tehran Stock Exchange during the period between 1384-1393. The findings of the study indicate that margin of profit ratio, equity to market value ratio, dividends per share to earnings per share ratio have a positive and significant relationship with stock return which they collectively explain 66.2% of return changes. As a result, all accounting variables of margin of profit ratio, equity to market value ratio, dividends per share to earnings per share ratio are able to price the stock which this fact confirms the D-APT Model. Therefore, it is suggested to the investors to notice on the changes related to the accounting variables on their decisions.

Key words: Arbitrage pricing theory, accounting variables, downside standard deviation, downside beta, model

INTRODUCTION

One of the most important research in financial markets is explaining the behavior of stock returns. The achievement of this research is the presentation of a model that has been subjected to various criticism and financial support. One of the most important model in these models is the Capital Asset Pricing Model (CAPM). The results of the last two decades in America, Japan and other countries have shown that this model does not have the ability to predict stock returns. These findings show that variables such as the size, the profits to stock prices, the ratio of cash flow to share price and the ratio of book value to market value of equity, predicts stock return better than the CAPM Model. Arbitrage pricing theory as an alternative to the presented mean-variance capital asset pricing model was introduced by Sharpe, Lintner and Trainer.

This model is a powerful analytical tool to explain the observed phenomena in the risky assets (Ross, 1976). The arbitrage pricing theory by Ross is based on the absence of arbitrage opportunities in financial markets and its main condition is a linear relationship between the actual return and a set of common factors in the sense that the expected returns are the linear functions of the common factors weight while the root of such a theory which states that the absence of arbitrage opportunities is an essential condition for balance can be seen in the Arrow's general equilibrium model (Kallio and Ziemba, 2007). It is logical that the desired changes and changes above the average and each return target not be considered as risk and the only adverse changes and less than the average or any target other than the average be calculated as risk. Using half variance and half beta in risk calculation is one of the new approaches which is more fit by this definition (Estrada, 2002, 2007). Therefore, in this study we seek to investigate the relationship between the accounting variables and stock returns with arbitrage pricing theory model based on downside risk.

Significance and purpose of the study: The significance of this research is due to the defects which in multifactorial model (APT) describe the relationship between risk and return. This research attempts to investigate and test the relationship between the accounting variables and stock return by using the Arbitrage Pricing Theory Model based on the downside risk (D-APT). The objectives of this study can be expressed as follows:

- Designing and testing the arbitrage pricing theory based on the downside risk (D-APT) in order to determine the rate of return in Tehran Stock Exchange

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- Investigating the significance of the relationship between the variables and return and studying the effectiveness of the returns of companies based on the downside risk approach in Tehran Stock Exchange

Review of literature: In the past decades, numerous studies examining the relationship between accounting variables affecting the stock returns in the financial markets were done.

Most of these studies investigated the sensitivity of stock returns to common factors (beta factor) in a model using the variance and standard deviation of asset and the covariance between the returns of each asset and factorts' return and no research considering half SD and half beta investigated this relationship. In the following, some of the of the conducted research will be mentioned. Stratopoulos (1995) examined the relationship between APT risk criteria and accounting variables and found that accounting variables are able to differently explain the APT risk criteria in different samples and different time periods. The results also indicated that the company size, business risk, financial risk and market power of the company are significant. Yli-Olli and Virtanen (1992) conducted a study to test the arbitrage pricing theory using time series data of the Finland companies in Helsinki Stock Exchange as a part of the country through using transformation (stability factor structure over time) analysis. They concluded that the hypothesis of the normal distribution return among the tested companies can be rejected. For experimental verification of this model, firstly, they investigated the systematic risk of each asset using factor analysis. In the second phase, they used the transformation analysis. To analyze the stability, they divided the whole period (from February 1970-December 1986) into three parts: 1970-1975, 1976-1980 and 1981-1986. Factor and transformation analysis showed that at least three factors are stable. In the next step, the effect of the factors on the balanced return was tested. Sectional regression analysis showed that at least two different factors were significantly greater than zero and the third and fourth factors had little additional explanatory power in comparison to the two-factor solution. Bernard (1995) in his research investigated the relationship between the stock market value and accountig variables of the book value per share and earnings per share of payments. The results of his research showed that accounting variables can explain 68% of the changes in stock market value. Yang *et al.* (2010) tested the arbitrage pricing theory in China's securities market. In the regression model designed for experimental test, data panel in pricing model as well as the three variables of company size, the ratio of the market value to book value and the ratio of price to earnings were used as the effective factors on return. The results showed that these factors had no no effect on the security returns, meaning that arbitrage pricing theory in China's securities market is not applicable and testable. Liu and Shrestha (2008) analyzed the relationship between the long-term China stock market indices and a set of macroeconomic variables such as money supply, industrial production, inflation, exchange rates and interest rates. The results indicated a relationship between the stock prices and macroeconomic variables and also showed a positive relationship between the stock market performance and macroeconomic variables in a long time.

D-APT Model: D-APT Model for the first time by Baghdadabad and Glabadanidis (2014) was presented. This model uses the semi-variance (semi-standard deviation) in place of the variance (standard deviation). they extend the same concept to factors' betas and the factors' downside betas in place of factors' betas. They refer to this model as the D-APT and state it more formally as follows:

$$R_{it} = E(R_{it}) + (\overline{\delta_{11}} - R_f)b_{i1}^d + \ldots + (\overline{\delta_{k1}} - R_f)b_{ik}^d + \mu_{it},\ i = 1, \ldots, N \quad (1)$$

where, $E(R_{it})$, R_{it}, $\overline{\delta}_k$, R_f and b_{ik}^d are respectively, the ex ante expected return of ith asset, the return on asset i in time t, the expected return on a portfolio with unit sensitivity to the kth factor and zero sensitivity to all other factors or the kth factor with $E(u_{it}) = 0$, $E(\delta_{kt}, u_{it}) = 0$ and $E(u_{it}, u_{jt}) =$ when $i \neq j$ or σ^2 when $i = j$, the risk-free rate and the sensitivity of lower returns than average on the ith security to the kth factor (downside risk).

If Eq. 2 is interpreted as a linear regression equation, then the coefficients b_{ik}^d are defined more formally as follows:

$$b_{ik}^d = \frac{SEICOV(R_i, \delta_k)}{SEMIVAR(\delta_k)} = \frac{E\{\min[(R_i - \mu_i), 0] \times \min[(R_k - \mu_k), 0]\}}{E\{\min[(R_k - \mu_k), 0]^2\}} \quad (2)$$

where, b_{ik}^d, $SEMICOV(R_i, \delta_k)$, $SEMIVAR(\delta_k)$, R_i, R_k, μ_i and μ_k are the downside risk, the semi-covariance between the ith asset returns and linear transformation of the kth factor, the semi-variance of linear transformation of the kth factor, return of ith asset, return of kth factor, return average of ith asset during the estimation period and return average of kth factor during the estimation period, respectively.

Equation 3 posits that the forecast errors of stock returns are composed of K factors which are common to all securities $\overline{\delta}_k - R_f$ as well as an idiosyncratic term (u) which is specific to security i. Thus, according to the approach by Ross (1976), the equilibrium expected return on security i is linearly related to the factor loadings as follows:

$$E(R_{it}) = [\lambda_0 + [\lambda_1 - \lambda_0]b_{i1}^d + ... + [\lambda_k - \lambda_0]b_{ik}^d \quad (3)$$

where, λ_0 and λ_1 are respectively, the return on riskless asset (R_f) and sensitivity of the market price to the kth variable. Eq. 3 is the D-APT Model and it describes the expected return of an asset as a linear function of the downside risk premia on systematic factors in the economy. If k = 1, this would be similar to the D-CAPM specification of expected returns as linear functions of securities' downside betas (Strada, 2002). Finally, if there is a riskless asset with a rate of return R_F, then by assuming $R_F = \lambda_0$, Eq. 3 can be rephrased in term of excess returns as follows:

$$E(R_{it}) - R_f = \lambda_1 b_{i1}^d + ... + \lambda_k b_{ik}^d \quad (4)$$

In order to test the D-APT empirically, we allow R_f to change over time. Thus, a non-linear regression over the t-time period gets by substituting Eq. 4 into Eq. 3, they get a non-linear regression model:

$$R_{it} - \lambda_{0t} = \sum_{j=1}^{k} b_{ij}^d (\lambda_j + \delta_{jt}) + u_{it} \quad (5)$$

Equation 5 can be tested using T observations on N portfolio returns in which NK parameters in b_{ij}^d and K parameters in λ_j need to be estimated. The empirical specification is as follows:

$$R_{it} - \lambda_{0t} = \alpha_i + \sum_{j=1}^{k} b_{ij}^d f_{jt} + e_{it} \quad (6)$$

where, α_i is a constant vector equal to Eq. 7:

$$\sum_{j=1}^{k} b_{ij}^d \lambda_j \quad (7)$$

It is clear that the D-APT has three distinct advantages, namely, testable, it incorporates cross equation non-linear restrictions of the linear factor pricing model and it incorporates the pricing restrictions of Eq. 7, namely, the price of risk of the jth factor must be the same for all assets. These pricing restrictions provide a necessary condition for the empirical test of the validity of the D-APT. First, Eq. 6 can be estimated. Second, it can be estimated using the APT restriction, Eq. 7. Imposing the pricing restriction in Eq. 7 and comparing the results with the unconstrained version in Eq. 5 allows us to test whether imposing the D-APT pricing restrictions in a multi-factor model framework leads to a statistically significant decrease in explanatory power. The constraint in Eq. 5 can be estimated using ITNLSUR. In terms of obtaining the estimations of sensitivities and risk premia, rewrite Eq. 5 as:

$$\rho_i = R_i - \lambda_0 = \sum_{j=1}^{k} (\lambda_j 1_T + \delta_j) b_{ij} + u_i \quad (8)$$

where, L_T as a T vector is one and the T*1 vectors are defined by Eq. 9:

$$\begin{aligned} R_i &= [R_i(1), ..., R_i(T)]', i = 1, ..., N, \\ \lambda_0 &= [\lambda_0(1), ..., \lambda_0(T)]', \\ \delta_i &= [\delta_i(1), ..., \delta_j(T)]', j = 1, ..., K, \\ u_i &= [u_i(1), ..., u_i(T)]', i = 1, ..., N \end{aligned} \quad (9)$$

The dependent variable in Eq. 8 is the excess return, $\rho_i = R_i - \lambda_0$ which requires an observable λ_0. Rewrite Eq. 8 as:

$$\rho_i = [\lambda' \otimes 1_T) + \delta] b_i^d + u_i = X(\lambda) b_i^d + u_i, i = 1, ..., N \quad (10)$$

where, $\otimes$ denotes a Kronecker product and $X(\lambda)_{T*K} = (\lambda' \otimes 1_T) + \delta$. Stacking the N equations yields:

$$\begin{pmatrix} \rho_1 \\ \rho_2 \\ . \\ . \\ \rho_N \end{pmatrix} = \begin{bmatrix} X(\lambda) & 0 & 0... & 0 \\ 0 & X(\lambda) & 0... & 0 \\ . & . & . & . \\ . & . & . & . \\ 0 & 0 & 0... & X(\lambda) \end{bmatrix} \times \begin{pmatrix} b_1^d \\ b_2^d \\ . \\ . \\ b_N^d \end{pmatrix} + \begin{pmatrix} u_1 \\ u_2 \\ . \\ . \\ u_N \end{pmatrix} \quad (11)$$

Re-writing Eq. 11 more compactly leads to:

$$\rho = [I_N \otimes X(\lambda)] b^d + u \quad (12)$$

as the stacked system by replacing $X(\lambda) = (\lambda' \otimes 1_T) + \delta$. where, ρ is a NT*1 vector of excess security returns λ is a k*1 vector of downside prices of risk is a matrix of observations on the K factors, b^d is a NT*1 vector of sensitivities and I_N is a N*N matrix.

Research hypothese:

- There is a significant relationship between the book value, earnings per share and dividend per share and stock returns based on the arbitrage pricing theory model with the downside risk approach
- Arbitrage pricing theory based on the downside risk approach is efficient enough

MATERIALS AND METHODS

This research is an experimental quantitative research based on the regression of combined panel through using the returns of 160 stocks traded in Tehran Stock Exchange as the dependent variable and three accounting variables as the independent variables in the period from 1384-393 so that these firms are among the major industries and they didn't interrupt their work during the course and their fiscal year lead to the 29/12 of each year. The dependent variable in the D-APT Model is the annual stock return calculated in the form of [min (R_i-R_F, 0)]. For calculating the stock returns derived from the application of the Rahavord Novin 3 Software, necessary adjustments for dividends, bonus stocks, priority and stock splits were done. Independent variables are margin of profit ratio, equity to market value ratio, dividends per share to earnings per share ratio which are calculated in the form of [min (r_i^f-R_F, 0)].

RESULTS AND DISCUSSION

For data analysis EViews Software Version 9 was used. Since, the study period is very low, there is no need to test the stability and the Chow test is estimated directly. For conducting the Chow test, firstly, the model should be estimated based on the fixed effects. Chow test is used to determine the pool or panel of the model. If the panel model is confirmed, then the Hausman test will be used to determine the fixed or random effects but if the pool model is confirmed, we will estimate the model based on the consolidated data.

Chow test: In Chow test, the fixed effects model is estimated and then based on the F Limer statistics it will be judged whether the model is pool or panel. In F Limer test the hypothesis of the same intercept (pooling method or combination) is placed against the opposite hypothesis, inconsistency intercept (panel method):

- H_0: absence of the fixed effects (confirmation of the pool model)
- H_1: presence of the fixed effects (confirmation of the panel model)

The results related to Table 1 show that H_0 hypothesis is confirmed and as a result, the consolidated data (pool) are confirmed in comparison to the combined data (panel). It means that combination of data does not estimate the model correctly, because the probability value is greater than 0.05. Therefore, with considering the effects, we estimate the model randomly.

Table 1: Result of fixed effects test

Redundant fixed effects test	Statistic	df	Prob.
Cross-section F	0.7542	45.621	0.85364

Table 2: Results of D-APT Model estimation-POOLING data

Variables	Coefficient	SD	t-statistic	p-values
Constant	53.68	4.680	21.740	0.0000
Margin of profit ratio	0.87	0.076	6.188	0.0000
Equity to market value ratio	8.85	0.300	14.020	0.0000
Dividends to earnings per share ratio	0.91	0.745	8.540	0.0000

R^2 = 0.674; Adjusted R^2 = 0.662; Durbin Watson-statistic = 2.21; F-statistic 51.2; p-value (F-statistic) = 0.0000

The final estimate of the model based on the consolidated data (pool): According to Chow test results, the model was estimated based on the pool model once again. The estimation results are presented in Table 2.

The results presented in Table 2 show that all variables are statistically significant at 99% level because all p-values are below 0.01; hence the significance of more than one factor confirms D-APT Model. This means that more than a factor explain the stock return changes; so that margin of profit ratio, equity to market value ratio, dividends per share to earnings per share ratio have a positive relationship with stock returns. It means that with an increase of one percent of margin of profit ratio, equity to market value ratio, dividends per share to earnings per share ratio, the rate of return increases 0.87, 8.85 and 0.91%, respectively. On the other hand, the adjusted coefficient of determination is equal to 0.662, meaning that 66.2% of the dependent variable (rate of return) changes is explained by the independent variables. Durbin-Watson statistic is 2.21 and since it is between 1.5-2.5, it shows lack of correlation between the residuals in the regression. F-statistic value equals to 51.2 and since the possibility of F<0.01, it indicates the correct fit of the model.

CONCLUSION

Discussion and conclusion as one of the most important parts plays an important role in any scientific research. In this study, we sought to find the relationship between stock returns of the listed companies and the accounting variables using the arbitrage pricing theory with downside risk approach. In calculating the extracted return of the Rahavard Novin Software, the necessary adjustments for dividends, bonus shares, priority and stock splits were done. The results confirm the arbitrage pricing theory with risk approach; so that the 66.2% of the returns variations are explained by the accounting variables studied in this research but 33.8% of the returns variations can be indicative of the unsystematic risk that this value of the stocks' return variation of the companies

in the portfolio acts as the systematic variance that is specific to each company which has reasons other than of the systematicones. So, it can be concluded that 33.8% of the variance of the return of each of the companies in the portfolio has an unknown reason that the market does not pay any compensation to investment for this type of risk. Therefore it is recommended to the real and legal investors, companies and investment funds to pay attention to the accounting variables of margin of profit ratio, equity to market value ratio, dividends per share to earnings per share ratio as the effective factors on the stock return when they want to make decisions related to the the investme in stocks of the listed companies and do not easily ignore the variations of these variables in the economy. It is also suggested that in addition to these variables, the other accounting variables can be investigated too.

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