An investigation on the relationship between arbitrage and macro-economic indicators: A case study of Tehran Stock Exchange

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CHRONICLE	ABSTRACT
	This paper presents an empirical investigation to study the effects of macro-economic factors on the performance of stocks listed on Tehran Stock Exchange (TSE). The proposed study considers the effects of money supply, inflation rate, oil price, unforeseen changes in the course structure of interest rates as well as unanticipated changes in industrial production on stock price. Using seasonal information of stock price over the period 1997-2007 as well as regression analysis, the study has determined that risk premium of unforeseen changes in the course structure of interest rates, money supply, inflation rate and unanticipated changes in industrial production are meaningful when the level of significance is five percent. In other words, Arbitrage pricing theory model describing the expected return per share is reasonable and macro-level variables explain systematic risk on TSE.

1. Introduction

For years, stock market plays essential role on attracting investors who are looking for bigger return but there is always a concern on how macro-economic factors influence the performance of stock exchanges (Black, 1972; Cox et al., 1985; Berry et al., 1988; Cuthbertson, 1996; Brealey et al., 2006). Breeden (1979) is believed one of the pioneers who presented an intertemporal asset pricing model with stochastic consumption and investment opportunities. Anatolyev (2008) studied various factors impacting returns at the Russian stock market over the period 1995-2004, placing emphasis on how these changed over time. They reported that the relationship was highly unstable and this instability was not confined to financial crises alone. In recent years, the impact of oil prices and foreign exchange rates has disappeared, the effect of US stock prices and international and domestic interest rates have increased, while the impact of monetary aggregated such as gold reserves and credit balances has fallen to virtually zero. Antoniou et al. (1998) investigated the performance of the arbiterag pricing theory (APT) (Cho, 1984, 1986; Burmeister & McElroy, 1988) for securities traded

on the London Stock Exchange. They analyzed performance based on the presence of common pervasive factors across two various samples permitting for the fact that returns could exhibit an approximate factor structure. They reported that for two subsamples of assets we may reach at a unique return generating process in the sense that three factors associated with the money supply, inflation and excess returns on the stock market are priced and carry the same prices of risk in both samples.

Azeez and Yonezawa (2006) studied the empirical evidence of the pricing of macroeconomic factors in the Japanese stock market during the bubble period using APT model. They also investigated pre- and post-bubble periods to compare the robustness of priced factors over the bubble period. They repotred that the empirical content of the APT, namely the implied across-equation pricing restrictions, was not rejected in any of the sample period. Bilson et al. (2001) performed an investigation to see whether local macroeconomic variables had explanatory power over stock returns in emerging markets. They reported moderate evidence to support this contention. Connor and Korajczyk (1986) proposed a comprehensive overview on performance measurement with the APM technique.

Dhankar and Singh (2005) applied principal components analysis to estimate the factors influencing stock returns. Analysis of the Indian stock market using monthly and weekly returns for 1991-2002 indicated that APT with multiple factors could provide a better indication of asset risk and it could estimate of required rate of return than capital asset pricing model (Fama & MacBeth, 1973; Eltom, 2003; Merton, 1973; Gehr, 1978; Groenewold & Fraser, 1997; Josev et al., 2001), which uses beta as the single measure of risk. Morel (2001) constructed an equity premium model based on three sets of factors including accounting variables, stock market characteristics and sector indicators based on a Bayesian method corrected for heteroscedasticity to predict risk premiums and reporting some positive relationship between these two variables similar to the results of Roll and Ross (1980). Van Rensburg (2000) used APT identification on the Johannesburg Stock Exchange (JSE) and observed that the dichotomy in the return generating processes underlying South African mining and industrial shares could lead to cross-sectional correlations in the residual errors of linear factor models that had not employ factor analytically extracted explanatory variables.

2. The proposed study

This paper presents an empirical investigation to study the effects of macro-economic factors on the performance of stocks listed on Tehran Stock Exchange (TSE). The proposed study considers the effects of money supply, inflation rate, oil price, unforeseen changes in the course structure of interest rates as well as unanticipated changes in industrial production on stock price. Table 1 demonstrates the summary of the variables of the proposed study.

Table 1
The macro level variables and their description

Row	Variable	Macro variable	Description
1	INF	Inflation rate	Consumer price index (CPI)
2	M_2	Money	Money (M_2)
3	EX	Currency rate	US currency exchange versus Iranian Rials
4	OIL	Oil price	European Oil price in US currency
5	LBR	Interest rates on long-term government bonds	5-year investment rate
6	SBR	Interest rates on short-term government bonds	Short term investment rate
7	TS	Term structure of interest rates	$LBR_t - SBR_{t-1}$
8	IP	Industrial product	Value added in industry

As we can observe from the results of Table 1, there are eight macro-economic factors associated with the proposed study of this paper. In addition, Table 2 shows details of other important variables associated with the proposed study of this paper.

Table 2
Research variables

Row	Variable	Description
1	UINF	Unexpected inflation rate
2	UMS	Unanticipated changes in the money supply
3	UEX	Unanticipated changes in exchange rates
4	UOIL	Unanticipated changes in oil prices
5	UTS	Unforeseen changes in the course structure of interest rates
6	UIP	Unanticipated changes in industrial production

The proposed Arbitrage pricing theory model consists of three stages; for the first stage, the proposed study performs ordinary least square (OLS) technique on the following regression model,

$$\rho_{it} \equiv R_{it} - \lambda_{0t} = \alpha_i + b_{i1}UINF_t + b_{i2}UMS_t + b_{i3}UEX_t + b_{i4}UOIL_t + b_{i5}UTS_t + b_{i6}UIP_t + u_{it} . \tag{1}$$

During the second stage, Arbitrage Pricing Theory of constraints are imposed on the unconstrained linear model and the model is estimated using nonlinear seemingly unrelated regressions as follows,

$$\alpha_i = b_{i1}\lambda_1 + b_{i2}\lambda_2 + b_{i3}\lambda_3 + b_{i4}\lambda_4 + b_{i5}\lambda_5 + b_{i6}\lambda_6. \tag{2}$$

Finally, during the last stage, variance-covariance residues (sludge) are compared with restricted and unrestricted systems as follows,

$$\chi^2 = -2ln\,\lambda = T\left(ln\left|\hat{\sum} r\right| - ln\left|\hat{\sum} u\right| \right). \tag{3}$$

The results of this phase will determine the validity of the arbitrage pricing theory. In addition, the variables affecting expected stock returns are identified. We remove the meaningless variables in the next stage. Accordingly, the first phase tests the arbitrage pricing theory, the relationship between excess stock return over the risk-free interest rates and macroeconomic variables for each participant (30 participants) were studied (McElroy & Buremeister, 1988). Using these results, non-linear and iterative seemingly unrelated regression method of risk through effective test is estimated. The validity of the proposed model is verified in this stage.

3. The results

In this section, we present details of our findings on applying regression analysis. The implementation of regression on Eq. (2) yields the following results

$$\alpha_i = -0.09179\lambda_1 - 6437.60\lambda_2 - 96.9153\lambda_3 + 0.30264\lambda_4 + 0.03216\lambda_5 - 489.493\lambda_6 \tag{4}$$

t-value -0.58554   -6.27773   -5.34348   0.45474   2.34283   -489.493

P-value 0.5583   0.00000   0.00000   0.6494   0.0193   0.0000 $\chi^2_{24} = 34.7 < 36.42 \ (\alpha = 0.05)$

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Based on the results of Eq. (4), Arbitrage pricing theory (Gilles & Leroy, 1991) model describing the expected return per share is reasonable and macro-level variables explain systematic risk on TSE. As we can observe from the results of Eq. (4), the sign of some variables are not significant, we need to remove them from our model, and the results are as follows,

$$\alpha_i = \ \ -6569.89\lambda_2 - 96.1102\lambda_3 + 0.02916\lambda_4 - 478.037\lambda_5 \tag{5}$$

t-value   -6.44310   -5.38503   2.20660   -4.28675

P-value   0.00000   0.00000   0.0275   0.0000   0.0000 $\chi^2_{24} = 35.5 < 36.42 \ (\alpha = 0.05)$

The first independent variable in Eq. (5) is associated with unexpected money supply and as expected, the increase in the amount of money injected into the market has negative influences on TSE. The second variable is associated with unexpected change on currency exchange, which maintains a negative influence on market. The third variable is associated with unforeseen changes in the course structure of interest rates and it influences on market, positively. Finally, the last variable is associated with unanticipated changes in industrial production with negative impact.

4. Conclusion

This paper presents an empirical investigation to study the effects of macro-economic factors on the performance of stocks listed on Tehran Stock Exchange (TSE). The study has determined that risk premium of unforeseen changes in the course structure of interest rates, money supply, inflation rate and unanticipated changes in industrial production are meaningful when the level of significance is five percent. In other words, Arbitrage pricing theory (Connor & Korajczyk, 1986) model describing the expected return per share is reasonable and macro-level variables explain systematic risk on TSE. In our survey, inflation has no meaningful impact and the result of this survey is not consistent with findings Chen (1983) and Hamao (1988). The second finding is associated with the relationship between money supply and return of stock market and the results of our survey are consistent with Beenstock and Chan (1988), Antoniou et al. (1988) and Azeez and Yonezawa (2006).

In our survey, unexpected change on currency influenced TSE performance and the results are consistent with findings of Priestley, 1996. Oil price was another variable of our survey, the results of our survey did not confirm any involvement of this variable on TSE performance, and the results are consistent with findings of Chen et al. (1986), Beenstock and Chan (1988), Choi et al. (1988) and Priestley (1996). The other finding of this paper is associated with the effects of the unanticipated changes in industrial production and the impacts were meaningful. The results are also consistent with Chen et al. (1986), Beenstock and Chan (1988), Lintner (1965).

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