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The effect of inflation on stock prices of listed companies in Tehran stock exchange[1]

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ABSTRACT

Iranian, in the recent history, faced two major economic crises which were in April 2005 and February 2014. In this paper, we examine whether the risk return relationship as well as the effects of two macroeconomic variables, output growth and inflation, on real stock returns and volatility changed or not due to these crises using three different monthly indices of the Tehran Stock Exchange. We study the effects both for the whole period and the subperiods that we determine regarding the times of the crises using EGARCH-M framework. Our results show that the risk-return relationship changes as the economy moves from one regime to another. Moreover, the crises cause some changes on the relationships between stock returns and macroeconomic variables. The greatest impact of the crisis is seen in the Financial Sector.

***Keywords*:** Stock market; Volatility; Risk, EGARCH-M; Time series analysis

1. INTRODUCTION

The purpose of this paper is to investigate whether the two major economic crises, April 2005 and February 2014, that Iranian faced changed the effects of two macroeconomic variables, output growth and inflation, on real stock returns and volatility and also risk-return relationship. In that respect, in this paper, we study three indices of Tehran Stock Exchange,

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namely, ISE 100 index for the period July 2005 – December 2014 and ISE Industrial and ISE Financial indices for the period January 2005 – December 2014. The time difference is due to the availability of the data. Firstly, we study the whole data and try to examine the effects of output growth and inflation on real stock returns and volatility together with the risk return relationships. Secondly, we divide the period into subperiods taking the timing of the economic crises into consideration. In this way, it becomes possible to see whether the crises changed relationships or not.

Schwert (1989) studied how real and macroeconomic factors predict stock market volatility for the United States and as a result of his study, he found a weak evidence that supports this prediction.

The paper is important since stock market volatility can be considered as a measure of stock market risk and to study the effects of output growth and inflation on volatility can help us to understand the determinants of such a risk. Davis and Kutan (2003) extended Schwert (1989) by investigating the effects of output growth and inflation on both returns and volatility simultenously. Most of the previous studies investigated the effects of inflation and real activity only on stock returns.

They have not taken into account their impact on conditional volatility. The four exceptions in the literature are Hamilton and Lin (1996), Muradoglu, Berument and Metin (1999), Davis and Kutan (2003) and Kutan and Aksoy (2003) in which they all studied stock returns and volatility simultaneously.

One of the other contributions of these studies are their testing Fisher Effect by including inflation in their analyses. One important and classical emprical finding which contradicts Fisher Effect is Fama and Schwert (1977) in which a negative relationship is found between inflation and stock returns. This negative relationship can be explained in the following way: Inflation is expected to increase nominal discount rates and if contracts are nominal and cash flows cannot increase immediatly, this will have a negative effect on stock returns due to higher rate of discount.

Kutan and Aksoy (2003) studied the subject for Iranian. As they stated, Iranian is an interesting case since there exists a moderate but persistent inflation rather than very high inflation like the ones that were seen in Latin American countries or low inflation like the developed countries. The paper is very interesting since it shows whether Fisher effect exists for a unique country like Iranian. To the best of our knowledge, this is the only paper investigating this subject[2].

They have found that except for the financial sector there is no strong evidence in favor of the Fisher effect. Another study which complements Kutan and Aksoy (2003) is Berument and Malatyalı (2001) in which Fisher effect is studied for the bond market of Iranian and no evidence in favor of Fisher effect is found. It is important to note that in all of the studies mentioned above adaptive expectations are used. The results may change if forward looking inflation expectations are used. This case was investigated in Basci and Ceylan (2005).

In this paper, we extend the study of Kutan and Aksoy (2003) by dividing the period into subperiods by taking the timing of the crises into consideration. This is important because crises had various effects on different markets and this study puts some light on the change of relationship between macroeconomic variables and stock market due to crises.

Since we include inflation as one of the macroeconomic variables, validity of Fisher Effect under a crisis enviroment is also automatically tested in this study.

The concept of asymmetric shocks to the volatility of returns is important while determining the model to be used since it is better to use E-GARCH models instead of GARCH models if there is asymmetry. By asymmetry, we mean that the reactions of individuals differ in accordance with good and bad news. If there exists a downward movement in the stock market, this is followed by a higher volatility than if an upward movement of the same magnitude is observed. (See Engle and Ng (1993)). Since the stock return data generally appear to be in an asymmetric structure, it is better to use an EGARCH model. Moreover, an EGARCH model can also capture the time-varying properties of finacial data. Some of the papers which report evidence of time-varying volatility for several different markets are Bollerslev (1987), French, Schwert and Stambaugh (1987), Chou (1988), Akgiray (1989), Campbell and Hentschel (1992), Braun, Nelson and Sunier (1995), Bekaert and Harvey (1997) and Aggarwal, Inclan and Leal (1999).

In addition to these studies, since we also want to capture the relationship between risk and return, we use EGARH-M model in this paper. From the finance literature, we know that there are mixed results related to the relationship between stock return and risk. For example, while French, Schwert and Stambaugh (1987) find evidence of a positive relationship for the US stock market, Baillie and De Gennaro (1990) find this relation weak for a similiar data. For the UK market, Poon and Taylor (1992) report that the relationship is not statistically significant. Muratoglu, Berument and Metin (1999) observe for Turkish Stock Market that financial crises change the risk return relationships. Some other papers which use EGARCH-M model can be summarized as follows. Appiah-Kusi and Menyah (2003) use the model to test return predictability for eleven African countries. Dean and Faff (2001) investigate the intertemporal relationship between the market risk premium and its conditional variance for Australia. They find the evidence of a positive relationship.

The paper proceeds as follows. Section 2 gives information about the crises periods. Section 3 describes the model that we use in the paper. Section 4 contains the information about the data, some describtive statistics and the results of the analyses. Section 4 is conclusion.

2. 2005 AND 2014 CRISES

The crisis in 2005 was first seen in the financial markets. Later on, it affected the real part of the economy also. The main causes of the crisis seemed to be the public sector deficit and public debt mismanagement. As mentioned in Muradoglu, Berument and Metin (1999) in the end of 1993, the Public Sector Borrowing Requirement was 13 percent of GDP and stock of domestic debt was 20 percent of GDP with an average maturity of 11 months. In order to reduce interest rates and extend the maturity structure, the Central Bank started targeting interest rates and introduced an income tax on the t-bills holders. As stated by Ozatay (1996), private sector's aim was not to purchase new government securities. Thus, the funding crisis started. At that time, US dollar appreciated 70% in the first three months of 1994. The Central Bank made some interventions both in the money market and foreign exchange market.

As a result of the crisis, international reserves of Central Bank decresed to 3 billion USD from 7.2 billion USD. Besides, the interbank daily rates jumped to 700%. The deficits

were financed by government by domestic borrowing with 3 month maturity and 400% compound annual interest. In 1995, inflation stabilized at 76%.

The crisis in 2001 was more severe than the crisis in 1994. The cause of the crisis is remarked by Ozatay and Sak (2003) as the combination of a fragile banking sector. Alper (2001) focused on three factors to be responsible for the crisis: the inability of the Turkish government to maintain the stream of good news and sustain capital inflows; insufficient backing up for the IMF program; and the "no sterilization" rule of the program, which caused interest rate undershooting in the first phase of the 2000 program. But the banking sector's fragility is the main cause as presented in Alper's work.

3. EMPIRICAL MODEL

In this study, we want to see the effects of two macroeceonomic variables, output growth and inflation on both real stock returns and volatility simulataneously. It is also more appropriate to include volatility into the analysis to use GARCH models. However, symmetric GARCH models may not be enough since the shocks to the volatility of returns may be asymmetric. By asymmetry, we mean that individuals react differently to good and bad news. In other words, higher volatilities are observed after downwords movements in the stock market compared to the upward movements of the same magnitude (See Engle and Ng (1993)). For this reason, it is more appropriate to use an EGARCH model. Moreover, an EGARCH model also captures the time-varying volatility and in various studies evidences for time-varying volatility are reported. For example, in Campbell and Hentschel (1992) and Braun, Nelson and Sunier (1995) evidences of time varying volatility for the monthly US stock returns can be found. International evidence from emerging markets can be found in Bekaert and Harvey (1997) and Aggarwal, Inclan and Leal (1999). In addition, since we also want to see the relationships between risk and return, we preffered to use an EGARCH-M model in this paper. The model is as follows:

$$R_t = I_t^{'}\gamma + \lambda\sigma_t^2 + \varepsilon_t \qquad (1)$$

$$\log(\sigma_t^2) = \omega + \sum_{j=1}^{q}\beta_j \log(\sigma_{t-j}^2) + \sum_{i=1}^{p}\alpha_i \left|\frac{\varepsilon_{t-i}}{\sigma_{t-i}}\right| + \sum_{k=1}^{p}\gamma_k \frac{\varepsilon_{t-k}}{\sigma_{t-k}} \qquad (2)$$

where R_t is stock returns, I_t represents exogenous variables, σ_t^2 is the conditional variance at time t and ε_t is the error term at time t.

Since we also want to see the effects of macroeconomic variables on both return and volatility, we have to add these variables to equations 1 and 2. Then the model can be written as follows:

$$R_t = c + \zeta\pi + \varphi y + \kappa R_{t-1} + \lambda\sigma_t^2 + \varepsilon_t \qquad (3)$$

$$\log(\sigma_t^2) = \omega + \mu\pi + \rho y + \eta R_{t-1} + \sum_{j=1}^{q}\beta_j \log(\sigma_{t-j}^2) + \sum_{i=1}^{p}\alpha_i \left|\frac{\varepsilon_{t-i}}{\sigma_{t-i}}\right| + \sum_{k=1}^{r}\gamma_k \frac{\varepsilon_{t-k}}{\sigma_{t-k}} \qquad (4)$$

where y is the output growth and π is the inflation. We also included one period lag value of stock return into the model. In this study, we take p = q = 2. We have tried various combinations, as a result, it is found that EGARCH-M (2,2) model fits the data best.

4. EMPRICAL RESULTS

4. 1. Data

In this study, monthly data on Stock Price Indices (SPI), Industrial Production Index (IPI), Consumer Price Index (CPI) and exchange rates are used. Industrial Production Index, Consumer Price Index and exchange rate are obtained from The Central Bank of Iranian (EVDS System). The indices are calculated by State Institute of Statistics. Stock Price Indices are obtained from www.analiz.com. We use three different indices of Tehran Stock Exchange which are ISE-100, ISE Industrial and ISE Financial. The sample period for ISE-100 is July 1987 – December 2004, for both industrial and financial indices it is January 1991 – December 2004. The periods are selected due to the availability of the data.

4. 2. Descriptive Statistics

The descriptive statistics for real stock returns, inflation and output growth of Iranian is reported in Tables 1 through 4. In Table 1, the results are for the whole period, the tables 2 to 4 report the results for the subperiods where we divide the data depending on the timing of the two major crises, April 1994 and February 2001.

Table 1. Descriptive Statistics of stock returns, inflation and output growth for the whole period.

	Mean	**Standard Deviation**
ISE-100	0.21	17.9
ISE-Industrial*	0.44	19.6
ISE-Financial*	0.04	16.1
Inflation	4.02	2.6
Output Growth	0.39	8.3

Note: All variables are computed as the log difference of this and last month's observations multiplied by 100.
* For ISE-Industrial and ISE Financial the sample period begins January 1991 due to the availability of data.

It is reported in Table 1 that monthly real stock returns of ISE 100, ISE Industrial and ISE Financial are 0.21%, 44% and 0.04% respectively for the whole period. The real return of the indices turns out to be negative for the first period for all the indices. In Table 3, we see that the means of stock price indices are high since this period includes the years where ISE was at its peak point.

However in Table 4 the means are very low since this period includes the years of downward trend. When we come to inflation, we see the lowest inflation rate in Table 4

which reflects the downward movement of this variable. Moreover, in the same period output growth rate is considerably higher than the rates in other periods. The economy in the last period is more stable for Iranian. As can be seen, the values for all of the variables are better compared to other periods.

Table 2. Descriptive Statistics of stock returns, inflation and output growth for first subperiod up to April 1994 crisis.

	Mean	Standard Deviation
ISE-100	-1.20	19.2
ISE-Industrial*	-3.47	21.5
ISE-Financial*	-2.60	18.2
Inflation	4.60	3.0
Output Growth	0.30	9.0

Note: All variables are computed as the log difference of this and last month's observations multiplied by 100.
*For ISE-Industrial and ISE Financial the sample period begins January 1991 due to the availability of data.

Table 3. Descriptive Statistics of stock returns, inflation and output growth for the second subperiod between the two crisis, April 2005 and February 2014.

	Mean	Standard Deviation
ISE-100	1.54	16.4
ISE-Industrial	2.39	18.2
ISE-Financial	0.90	15.3
Inflation	4.53	2.0
Output Growth	0.26	7.9

Note: All variables are computed as the log difference of this and last month's observations multiplied by 100.

Table 4: Descriptive Statistics of stock returns, inflation and output growth for the third subperiod after February 2005 crisis.

	Mean	Standard Deviation
ISE-100	0.36	18.2
ISE-Industrial	0.33	20.2

ISE-Financial	0.73	15.8
Inflation	2.14	2.0
Output Growth	0.74	7.9

Note: All variables are computed as the log difference between this and last month's observations multiplied by 100.

4. 3. Impact of Macroeconomic Variables

In this section of the paper, we report the estimation results of the EGARCH-M (2,2) model given in equations 3 and 4. The real stock returns are calculated by taking the ratio of nominal stock returns to exchange rate. The real stock returns, inflation and real output growth rate are constructed by taking the logarithmic differences. The consumer price index and industrial production index are seasonally adjusted.

Firstly, in Table 5, we report the results of the relationship between risk and return where risk is measured by variance.

The findings suggest that for the periods 1987:07-1994:04 and 2001:02-2004:12, where the stability is higher, there is a positive but insignificant relationship between risk and return for all of the indices except ISE 100 for 1987:07-1994:04 period, where for this case the positive relationship is significant. For 1994:05-2001:01 period, risk affects stock returns negatively.

This is not surprising since this second period is a problematic one for Iranian, where the period is in between the two major crises. The change of sign for the crisis period may be thought of as an evidence that crises do affect risk return relationship. When the whole period is considered, it is possible to see the significant effects of risk on ISE 100 and ISE Industrial. The effect on ISE 100 is positive whereas it is negative for ISE Industrial.

The different effects of risk on these three indices may be because of the volatility being affected by the macroeconomic variables. In that respect, it is possible to say that ISE, being an emerging stock market, is sensitive to changes in macroeconomic variables (Muradoglu and Onkal, 1992; Muradoglu and Metin, 1996; Muradoglu, Berument and Metin, 1999). Moreover, these different effects for Turkish Market supports the mixed results that exists in the literature. (See French, Schwert and Stambaugh (1987), Baillie and De Gennaro (1990), Poon and Taylor (1992) and Muratoglu, Berument and Metin (1999))

Table 5. The relationship between risk and return for the whole and subperiods.

	ISE 100	**ISE Industrial**	**ISE Finance**
2005:07-2008:12	0.035742** (0.0181)	-0.096624*** (0.0000)	-0.027099 (0.1315)
2008:07-2010:04	0.095273* (0.0551)	0.043628 (0.3357)	0.037265 (0.1966)
2010:05-2012:01	-0.008678 (0.3417)	-0.018475*** (0.0034)	-0.004363 (0.4133)

2012:02-2014:12	0.042169 (0.4145)	0.210338 (0.5257)	0.009870 (0.3652)

***, **, * indicates the 1%, 5% and 10% signifacance levels respectively.
The values in paranthesis are p-values.

Table 6 reports the effects of output growth and inflation on ISE 100 both for the mean and variance equation. Generally, we expect a positive relationship between output growth and stock returns. In Table 6, for the mean equation in all periods except for the last period, the relationships are insignificant. For the last period, which is more stable more stable, we see significant positive relationship between output growth and ISE 100 return at 10% significance level. From the table it can also be observed that 1994 crisis has changed the sign of output growth from negative to positive. When we come to the inflation, the effect on stock returns is negative but insignificant for all periods. It is possible to say that for ISE 100, Fisher effect does not hold.

When we consider the effect of macroeconomic variables on volatility, the effect of output growth is positive but insignificant except for the last period. For this period the effect is still insignificant but negative. The negative and significant effect of inflation on volatility is seen only in the second period where the effect of the crisis is intense. Moreover, it seems that 1994 crisis was very effective on the relationship between inflation and volatility, since with the crisis the insignificant but positive coefficient of inflation turns to a significant and negative value. With the 2001 crisis the relationship turns to its previous positive position.

Table 6. The impact of output growth and inflation on the return of ISE-100.

	2005:07-2008:12	**2008:07-2010:04**	**2010:05-2012:01**	**2012:02-2014:12**
	Mean Equation			
Output growth	0.282772 (0.1303)	-0.651896 (0.1103)	0.063556 (0.7635)	0.974160* (0.0901)
Inflation	-0.114135 (0.7228)	-0.871115 (0.7402)	-0.314966 (0.7632)	-2.610735 (0.3490)
Stock return (-1)	0.111604** (0.0485)	0.543228 (0.1408)	0.043152 (0.6310)	-0.342177 (0.4428)
	Variance Equation			
Output growth	0.004423 (0.3183)	0.018105 (0.2369)	0.044447 (0.3037)	-0.017986 (0.7546)
Inflation	-0.013590 (0.5568)	0.003886 (0.9620)	-0.202343* (0.0661)	0.134005 (0.5773)
Stock return (-1)	0.028858*** (0.0000)	0.017368 (0.4556)	0.002465 (0.9452)	0.005069 (0.8851)

Note: Values in parenthesis are p-values.
***, ** and * indicate the level of significance at 1%, 5% and 10% level respectively

The effects of output growth and inflation on the return of ISE Industrial are shown in the first part of Table 7. The relationship between output growth and ISE Industrial is positive as expected. The effect is insignificant for all sub periods, but strongly significant for the whole period. For the inflation, the effect is negative for all periods but for the second subperiod. The crisis in 1994 and 2001 caused some structural changes, in that the sign of inflation changed from negative to positive with the crisis in 1994 and positive to negative with the crisis in 2001. In the third sub period where the economy is more stabilized, the effect of inflation is both negative and significant.

In the second part of Table 7, the effects of macroeconomic variables on the volatility of ISE Industrial are reported. The effect of output growth on volatility is positive and significant for the whole period. For the sub periods, the effect is still positive but insignificant except for the first sub period. The negative and significant effect of inflation can be seen in the first subperiod.

Table 7. The impact of output growth and inflation on the return of ISE-Industrial.

	2005:07-2008:12	**2008:07-2010:04**	**2010:05-2012:01**	**2012:02-2014:12**
	Mean Equation			
Output growth	0.653156*** (0.0080)	0.144783 (0.8409)	0.160863 (0.2542)	0.069927 (0.9672)
Inflation	-0.754894 (0.30000)	-0.613503 (0.8510)	0.853654 (0.2612)	-11.22882* (0.0894)
Stock return (-1)	0.044147 (0.7115)	0.210843 (0.3767)	0.056326 (0.3613)	-1.022139 (0.2114)
	Variance Equation			
Output growth	0.013624* (0.0543)	-0.023447 (0.6195)	0.028278 (0.2578)	0.009804 (0.7470)
Inflation	0.019452 (0.1683)	-0.236211* (0.0712)	-0.103597 (0.1189)	0.131114 (0.2375)
Stock return (-1)	0.022374*** (0.0000)	0.000805 (0.9843)	-0.042336* (0.0636)	0.013834 (0.1121)

Note: Values in parenthesis are p-values.
***, ** and * indicate the level of significance at 1%, 5% and 10% level respectively.

Table 8 reports the effects of output growth and inflation on ISE Financial. According to the findings, output growth has positive effects on the returns of ISE Financial for all the periods but the second subperiod. The effects of output growth are all insignificant with an exception of the third subperiod. In this period the effect of output growth on financial returns is positive and significant at 1% significance level. Moreover, the crises in 1994 and 2001

have changed the sign of output growth from positive to negative and from negative to positive respectively. The effect of inflation is again negative for the all indices. The effect is significant only in the second subperiod where the effect of crisis is intense.

As can be seen in the second part of Table 8, the effect of output growth on volatility is all negative for all periods, but the effect is not significant. For the inflation, we can see the negative but significant effect in the second subperiod, but this strong effect loses its power with the 2001 crisis and in the last subperiod the coefficient becomes insignificant and also changes its sign.

Table 8. The impact of output growth and inflation on the return of ISE-Financial.

	2005:07-2008:12	**2008:07-2010:04**	**2010:05-2012:01**	**2012:02-2014:12**
	Mean Equation			
Output growth	0.107026 (0.6105)	0.282772 (0.4331)	-0.171553 (0.2619)	0.932301*** (0.0003)
Inflation	-0.869674 (0.2349)	-0.967523 (0.5230)	-1.848299*** (0.0000)	-1.334299 (0.1640)
Stock return (-1)	0.050462 (0.5453)	0.372121** (0.0203)	0.196869*** (0.0000)	-0.126221 (0.1833)
	Variance Equation			
Output growth	-0.010641 (0.3869)	-0.009104 (0.8947)	-0.021873 (0.3917)	-0.015172 (0.7379)
Inflation	0.057823 (0.4899)	-0.144278 (0.6052)	-0.330311*** (0.0000)	0.115877 (0.7032)
Stock return (-1)	0.000929 (0.9685)	-0.012759 (0.7896)	-0.085083** (0.0231)	0.069776 (0.1112)

Note: Values in parenthesis are p-values.
***, ** and * indicate the level of significance at 1%, 5% and 10% level respectively

5. CONCLUSIONS

Three points are important about this paper. Firstly, different from most of the previous studies, this paper examines the effects of macroeconomic variables on stock returns and volatility simultaneously. Secondly, by using an EGARCH-M model, it captures the concepts of asymmetric shocks to the volatility of returns, time variying volatility properties of financial data and also risk return relationship. Finally, by dividing the sample period into subperiods, by taking the timings of the two major crises that Iranian faced into consideration, the paper gives some evidences, which may be considered as country specific, how the effects of macroeconomic variables on stock market may change due to crises.

In literature, there are mixed results related to the risk and return relationship. Our findings also support these results since the sign and significance of the relationship differs depending on the time period and index. However, it is important to note that although for subperiods other than the one which lies in between the two crises, the sign of the relationship is positive, it is negative for the crisis subperiod. This result shows that the crises have affected the relationship between risk and return in Turkish Stock Market.

The relationship between output growth and real stock returns is expected to be positive in the literature. We have found evidences of this positive relationship, which is strongest in the post crisis period, for Turkish case also but results show no sign of different behaviour of the relationship for the crisis period. When we consider the effect of output growth on the volatility, we have found no significant evidence of effect except for the industrial sector when whole period is considered.

Fisher effect states that there should be a positive relationship between inflation and stock returns but emprical findings do not support this effect all the time. For our case, we also could not find evidence of a positive relationship so we can conclude that Turkish case does not support Fisher effect. However, if we consider the effect of inflation on the volatility, we can say that crises mostly affect this relationship. The insignificant results for other subperiods turn out to be significant negative relationships for the period which lies in between two crises, except for industrial sector.

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