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# Macroeconomic Sources of Market Risk in Iran

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**Abstract:** The main purpose of this paper is to find macroeconomic determinants of market risk premium in Iran. This is an important issue, because market risk premium reflects behavior of investors. To do so, first we have analyzed theoretical foundations of the problem.Afterward we have based our empirical analysis on a multivariate GARCH model method.Our findings indicate that macroeconomic variables have significant effects on equity market risk premium in Iran. We have also found that the effect of real variables on risk premium is greater than nominal variables and these effects have different signs, but the magnitude of nominal variables effects in Iran is more than the industrial countries shown in previous studies.

**Key words:** Risk Premium · Multivariate GARCH Model · Iran
JEL Classification: C320; E310

## INTRODUCTION

Financial theory predicts that risk premium - the extra returns that investors demand for holding risky assets - should reflect changing perceptions of risk. Iran has experienced considerable volatility in macroeconomic factors in recent decades, especially, after Iraq war. In this paper, we examine the effects of macroeconomic variables on the equity risk premium in Tehran Exchange Market. The main question is "Whether macroeconomic volatilities significantly affect market return risk premium? Second question is that "which factor is important?" Our theoretical model is based on the Stochastic Discount Factor (SDF) theory, which rules out arbitrage. We have used a multivariate GARCH-in-mean (MGARCH-M) process to model the volatility in real output growth, inflation and equity returns risk premium (considering short term interest rate in banks as risk free return) and analyze the effects of macroeconomic volatilities on expected risk premium, represented by the conditional mean returns on equity. Following this we use quarterly data for the period 1992:01 - 2007:02.

Our findings are useful for practitioners and academics in several respects. First, they throw light upon the 'convoluted' relation between equity risk premium and macroeconomic volatilities in Iran, which has not yet been studied. Second, they suggest that the asset markets are substitutions of equity market, because corporate financing is often based on equity market, but it can not be. Finally, our results may be useful for stock market investors who form expectations on the basis of macroeconomic information when evaluating their investment opportunities. In this connection, some studies are made and we have shown these in Table 1. In Section 2, we provide a literature review. In Section 3, we present the SDF model of the equity risk premium. In Section 4, we formulate our empirical model. In Section 5, we describe the data and report our empirical results. Finally, in Section 7, we produce paper conclusions.

**Literature Review:** The relationship between equity market returns and inflation has been extensively studied in the financial literature. There are many ways in which the rate of inflation can affect excess returns. For example, Arbitrage Pricing Theory (APT) model is formed by relation between equity risk premium and macroeconomic and financial variables. A number of authors have looked for a direct link between the mean of excess stock returns and macroeconomic variables. But, some other authors have studied effects of macroeconomic volatilities on stock or foreign exchange markets. In this paper, we will also study that "do volatility of inflation and real GDP growth affect equity risk premium [1]?" In this connection, Table 1 shows the most important related investigations.

**The SDF Model:** To study the relation between the equity risk premium and macroeconomic volatilities, we use the SDF model. The SDF model provides a general framework

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1. In this paper, we don't use interest rate as a nominal variable, because this variable is not determined in a free market.

Table 1: Main Studies on Risk Premium Determinants (Start With Capitals)

| Authors | Year | Sample Region | period | Theoretical Basis | Methodology | Variables | Results |
|---|---|---|---|---|---|---|---|
| Malliaropulos [1] | 1997 | US | 1983:10-1993:10 | C-CAPM | MGARCH-M | Seven Foreign Exchange and stock market return. | The explanatory power of the model is significantly higher compared to the constant beta CAPM specification. Expected excess returns are less volatile in foreign exchange markets and including nominal dollar assets in international equity portfolios can reduce overall portfolio risk. |
| Patro, Wald & Wu [2] | 2002 | 16 OECD countries | 1979:12-1997:12 | CAPM | Panel Data | Country equity risk premium, imports, exports, inflation, dividend yields, market capitalization, government surplus, credit ratings, taxes, money supply & foreign exchange rate. | Significantly time varying betas and alphas-the effects of exports, taxes & market capitalization on beta are positive but the effects of other variables are negative. |
| Pesaran & Schuerman [3] | 2003 | 11 countries /regions | 1979:1-1999:1 | - | VAR | Logarithm of real GDP,CPI,Equity Price Index, Exchange Rate (US$), Interest Rate and Default Rate. | Effect of Inflation and real GDP on risk premium has been positive and negative, respectively. |
| Wickens & Balussia [4] | 2004 | US | 1970:01-1998:12 | SDF-CAPM | MGARCH-M | Inflation, real total personal consumption and bond risk premium. | Inflation is the largest source of risk premium. |
| Ludvigson & Ng [5] | 2005 | US | 1964:1-2003:12 | - | VAR | US Treasury Bond Prices, Real Output, Employment, RPI. | Real factors and inflation have important forecasting power for future excess returns on US government bonds. |
| Smith, Sorenson & Wickens [6] | 2007 | US-UK | 1975:1 -2007:12 | SDF-CAPM | MGARCH-M | US $-sterling rates, $CPI_{US}$, $RPI_{UK}$, Industrial Productions, Money Base & $M_{0\text{-}UK}$ | Positive risk premium emerge particularly in 1979-80 and 1985. US investors requiring a risk premium to compensate for higher UK output volatility. |
| Poghosyan & Koèenda [7] | 2007 | Several new EU countries | 1993:1-2006:12 | SDF-CAPM | MGARCH-M | Exchange risk premium, industrial production & inflation. | Real and nominal factors play small and high roles in determination of foreign exchange risk. |
| Kizys & Spencer [8] | 2008 | UK | 1964:1-2004:10 | SDF-CAPM -APT | VAR-MEGARCH | Industrial Production(IP),3-Month Treasury Bond Risk Premium and Retail Price Index (RPI). | The relationship between risk premium and industrial production is negative, but inflation has positive effect on risk premium. |

to asset pricing and is based on the no-arbitrage condition. The advantage of the SDF model is that it does not require knowledge about investors' preferences. The use and usefulness of the SDF model in macro-finance is surveyed by Smith and Wickens [9].

The stochastic discount factor (SDF) model is based on the notion that the price of an asset at the beginning of period *t*, $P_t$, is given by the expected (stochastically) discounted value of its payoff at the beginning of period $t+1$, $X_{t+1}$:

$$P_t = E_t[M_{t+1}\, X_{t+1}] \qquad (1)$$

where $M_{t+1}$ is the stochastic discount factor and $X_{t+1}$ is defined as

$$X_{t+1} = P_t + D_{t+1} \qquad (2)$$

where $X_{t+1}$ is a dividend payment to be received at the beginning of period $t+1$. Dividing equation (1) by $P_t$ gives:

$$1 = E_t\left[M_{t+1}\frac{X_{t+1}}{P_t}\right] = E_t\left[M_{t+1}R_{t+1}\right] \qquad (3)$$

where $R_{t+1} = 1 + r_{t+1}$ is the gross equity return ($r_{t+1}$ is the net equity return) and is defined as

$$R_{t+1} = 1 + r_{t+1} = \frac{P_{t+1} + D_{t+1}}{P_t} \quad (4)$$

Assuming log-normality and taking logarithms of equation (3) gives:

$$\ln E_t[M_{t+1}R_{t+1}] = E_t[\ln(M_{t+1}R_{t+1})] + \frac{1}{2}V_t[\ln(M_{t+1}R_{t+1})] = 0 \quad (5)$$

where $V_t$ denotes the variance conditional on time $t$. Further operating yields:

$$E_t(m_{t+1}) + E_t(r_{t+1}) + \frac{1}{2}V_t(m_{t+1}) + \frac{1}{2}V_t(r_{t+1}) + COV_t(m_{t+1}, r_{t+1}) = 0 \quad (6)$$

where $m_{t+1} = \ln(M_{t+1})$ and $COV_t$ denotes the covariance conditional on time $t$. From equation (6) and the no-arbitrage condition for a risk-free asset we obtain the risk premium:

$$E_t(r_{t+1} - r_t^f) + \frac{1}{2}V_t(r_{t+1}) = -COV_t(m_{t+1}, r_{t+1}) \quad (7)$$

where $r_t^f$ is the rate of return on a risk-free asset. Equation (7) tells us how the risk premium on an asset satisfies the no-arbitrage condition when its return and the SDF are log-normally distributed. The right-hand side is the equity premium and $\frac{1}{2}V_t(r_{t+1})$ is the time-varying Jensen effect arising from the assumed log-normality of the above variables. Our main objective is to study the role of macroeconomic volatilities and the risk premium.

In general, the SDF model incorporates any potential source of risk into an explanation of the risk premium as long as the no-arbitrage condition is satisfied (Smith and Wickens [9]). One way to introduce macroeconomic volatilities in our framework is to assume that the SDF can be expressed as a linear combination of macroeconomic factors:

$$-m_{t+1} = \beta' z_{t+1} \quad (8)$$

where $z_{t+1}$ denotes a vector of $N$ macroeconomic factors. Therefore, the no-arbitrage condition can now be written as:

$$E_t(r_{t+1} - r_t^f) + \frac{1}{2}V_t(r_{t+1}) = \sum_{i=1}^{N}\beta_i COV_t(z_{t+1}, r_{t+1}) \quad (9)$$

Assuming that the only macroeconomic factors that affect the equity risk premium are the real industrial production growth rate $f¢y_t$ and inflation $f\hat{I}_t$, the unrestricted version of equation (9) can be expressed as:

$$E_t(r_{t+1} - r_t^f) = \beta_0 V_t(r_{t+1}) + \beta_1 COV_t(\Delta y_{t+1}, r_{t+1}) + \beta_2 COV_t(\Delta\pi_{t+1}, r_{t+1}) \quad (10)$$

In equation (10), the equity risk premium consists of two parts: the output growth risk premium defined by $\beta_1 COV_t(\Delta y_{t+1}, r_{t+1})$ and the inflation risk premium $\beta_2 COV_t(\Delta\pi_{t+1}, r_{t+1})$.

The exact direction of the relation between the equity risk premium and macroeconomic factors is determined by the signs of the parameters $\beta_1$ and $\beta_2$. The SDF model does not place any restriction on these parameters. In the literature of macro-finance, a consensus has not yet emerged on what sign the relation between equity risk premium and macroeconomic volatilities should take. Although conventional wisdom suggests that equity market investors will require a higher reward or a higher inflation risk premium, Chen, Roll and Ross [10] argued that since changes in inflation have the general effect of shifting wealth among investors, there is no prior presumption that would sign the risk premium for inflation. The negative signs on equity risk premium would probably mean that equity market assets are generally perceived to be hedges against the adverse influence on other assets that are, presumably, more fixed in nominal terms.

## Empirical Methodology and Data

**Multivariate GARCH-in-mean Nodel:** Our aim is to model the distribution of the excess return in the foreign exchange market jointly with the macroeconomic factors in such a way that the conditional mean of the excess return in period $t+1$ given the information available at time $t$ satisfies the no-arbitrage condition given by equation (11). Since the conditional mean of the excess return depends on time varying second moments of the joint distribution, we require an econometric specification that allows for a time-varying variance-covariance matrix. A convenient choice in this setting is the multivariate GARCH-in-mean model (see Smith, Soresen and Wickens [6]). The general specification of the multivariate GARCH model with mean effects can be written as:

$$\begin{aligned} X_{t+1} &= \mu + \Phi\, \text{vech}\{H_t\} + \varepsilon_{t+1} \\ \varepsilon_{t+1} \mid I_t &\sim N[0, H_{t+1}] \\ H_{t+1} &= C'C + A'H_tA + B'\varepsilon_t\varepsilon_t'B \end{aligned} \quad (11)$$

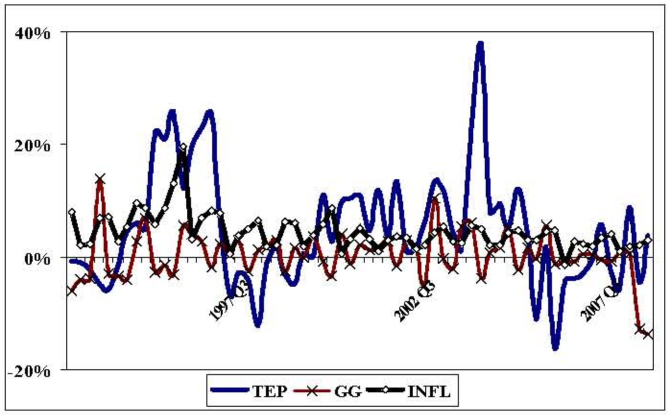


Fig. 1: Exhibition of Data

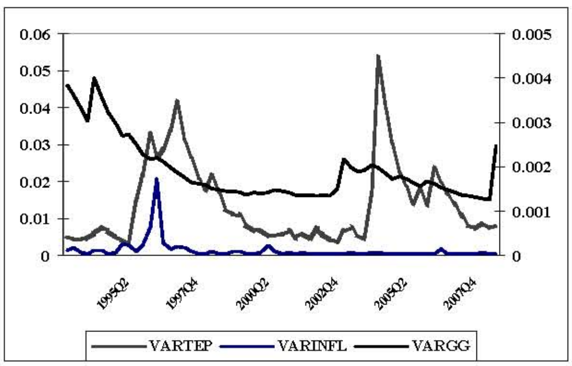


Fig. 2-a: Conditional Variances

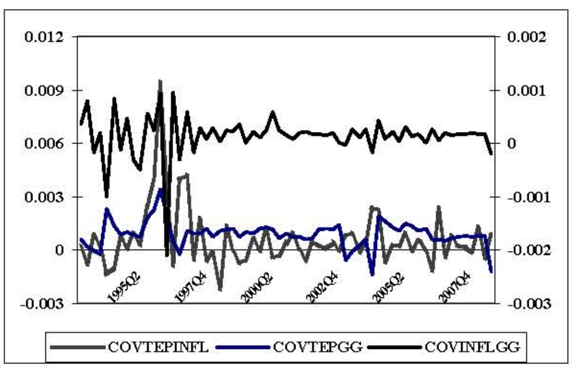


Fig. 2-b: Conditional Co variances

where $X_t = [RP_{t+1}, inf_{t+1}, y_{t+1}]$ is a vector of excess returns and $K$ (observable) macroeconomic factors used in the estimations, $H_{t+1}$ is a conditional variance-covariance matrix, $I_t$ is the information space at time $t$ and vec{.} is a mathematical operator which converts the lower triangular component of a matrix into a vector. The first equation of the model is restricted to satisfy the no-arbitrage condition[2], which restricts the first row of matrix $f^3$ to a vector of $\beta i$'s. Since there is no theoretical reason for the conditional means of macroeconomic variables to be affected by the conditional second moments, the other rows in matrix $f^3$ are restricted to zero. Despite its convenience, the multivariate GARCH-in-mean model is not easy to estimate. First, it is heavily parameterized, which creates computational difficulties and convergence problems. Second, returns in the financial market are excessively volatile, which affects the conditional variance process. In trying to fit the extreme values in financial returns, the variance process may become unstable and therefore needs to be modeled with special care.

Our specification of the variance-covariance process in (11) is the so-called BEKK formulation proposed by Baba, Engle, Kraft & Kroner [11]. The BEKK specification guarantees the positive definiteness of the variance-covariance matrix and still remains quite general in the sense that it does not impose too many restrictions. In particular, the BEKK specification is more general than the constant correlation Coefficient (CCC) model of Bollerslev.

**The Data:** In order to model equity risk premium in the Iran, we use a number of different sources for macroeconomic data. We have used equity risk premium based on TEPIX[3] growth rate, real national output growth rate as real variable and inflation (growth of the consumer price index) as the nominal variable. These data were

2. Notice that specification (11) also drops the restriction on the coefficient of the variance being 1/2. Also, the coefficient $\hat{a}$ of the covariance with the consumption factor is no longer interpreted as a coefficient of relative risk aversion.
3. Tehran Exchange Price Index.

Table 2: ADF test for series

| Series | Statistic | Critical Value 1% | Critical Value 5% |
|---|---|---|---|
| TEP | -3.142 | -3.5398 | -2.9092 |
| INFL | -4.284 | -3.5398 | -2.9092 |
| GG | -5.494 | -3.5398 | -2.9092 |

Table 3: Estimated Diagonal BEKK Coefficients

| Conditional Mean Coefficients | | | | |
|---|---|---|---|---|
| | Coefficient | Std. Error | z-Statistic | Prob. |
| $\mu_1$ | 0.08541 | 0.02058 | 4.1495 | 0.0000 |
| $\mu_2$ | 0.03243 | 0.00285 | 11.371 | 0.0000 |
| $\mu_3$ | 0.00283 | 0.00527 | 0.5369 | 0.5913 |
| $\hat{a}_1$ | -1.09218 | 1.44779 | -0.7543 | 0.4506 |
| $\hat{a}_2$ | 21.5002 | 10.1692 | 2.1142 | 0.0345 |
| $\hat{a}_3$ | -40.6006 | 11.834 | -3.4308 | 0.0006 |
| Conditional Variance Coefficients | | | | |
| | Coefficient | Std. Error | z-Statistic | Prob. |
| C (Scalar) | 0.0002 | 0.0001 | 2.6099 | 0.0091 |
| $A_{11}$ | 0.4334 | 0.1189 | 3.6425 | 0.0003 |
| $A_{22}$ | 0.8537 | 0.1726 | 4.9450 | 0.0000 |
| $A_{33}$ | -0.2674 | 0.1069 | -2.5001 | 0.0124 |
| $B_{11}$ | 0.9039 | 0.0486 | 18.603 | 0.0000 |
| $B_{22}$ | -0.3851 | 0.1643 | -2.3441 | 0.0191 |
| $B_{33}$ | 0.9040 | 0.0359 | 25.178 | 0.0000 |

obtained from IFS. Therefore, we based our sample for the period 1992:2 to 2008:1. The data are depicted in Figure 1. In this figure, it is important that stock market risk premium (TEP) almost has moved with inflation (INFL), but its movement has been against output growth rate (GG).

**Estimation Results:** Considering table 2, all series have been examined by ADF test for study of stationary specification. According to this test all series are stationary on 5% significant level.

The estimation results for different specifications of the model are displayed in Table 3. Conditional variance-covariance series are shown in figure 2. As we see, all the intercept coefficients except $\mu_3$, are statistically significant and positive. The positive sign of the intercept coefficient indicates that, excluding the impact of macroeconomic factors, investors on average require a higher premium for investing in post-transition economies relative to a similar investment in asset market or productive activities. In fact, because of lower attractiveness in stock market (and perhaps to be small of this), investors require to higher risk premium for transaction of equities.

The "in-mean" effects are represented by the coefficients $\beta$. These coefficients indicate the importance of a particular macroeconomic factor for explaining the behavior of the risk premium. It is important to notice that the coefficient $\beta_1$ is negative, but not significant. This implies that the risk of the equity market as an explanatory variable for the variation in excess returns seems to be unimportant in the economies under research, although says that higher risk decrease risk premium. This finding is in contrast to the outcomes of Kizys and Spencer [8] for UK.

$\beta 2$ which is effect of inflation risk premium on stock risk premium, is positive and so we can say that asset market is not an substitution for stock market. Note that, as it is said in pre-previous section, although traditional financial theories suggest that there is an inverse relation between inflation risk premium and stock risk premium, but, in this model, we found results which are against them. In the other words, our results show that the equity market assets are generally a hedger for the adverse influence on other assets.

Considering Table 2, when output growth rise, economic conditions will be suitable to invest in productive activities, consequently, motivation of investors will decrease to transact in second stock market. As a result of decreasing in demand for second equities, this cause that risk premium decrease too.

In our findings, although results of other researches is confirmed, but effect of inflation risk premium is higher than these results, because the market of other assets such as residence, gold and etc. are very greater than stock market. Therefore, if we imagine inflation and output growth as indices of nominal and real macroeconomic variables, our findings show that, algebraically, effects of real variables on stock risk premium have been greater than nominal variables.

## CONCLUSION

In this paper we presented the impact of macroeconomic factors to explain the equity risk premium based on SDF model in Iran. The estimation results suggest that nominal factors play a smaller role in explaining the variability in stock market returns. This finding is in line to the results of Patro, Wald and Wu [2], Pesaran and Schuerman [3] and Kizys and Spencer [8]. The inflation factor, which is representative for nominal factors, has significant and positive explanatory power for the equity market. This implies that nominal variables have an important effect on the behavior of stock market return in Iran and investors make usage of this information in pricing contingent claims. Furthermore, we can say that effect of inflation on risk premium is very higher than industrial economies for example US, because transactions in other asset markets are more profitable than stock market. The output growth rate, which is representative for real variables in supply side, has significant and negative effects on the equity market like previous studies. The impacts of various factors have different magnitudes and even different signs. In any case, like other related studies, real variables affect the equity risk premium more than nominal variables.

Our findings also have straightforward policy recommendations. In Iran, although nominal and real effects on stock market are the same as industrial countries such as US and UK, but nominal variables are more affective on construction of investing behavior. In other words, the nominal factors play a crucial role in explaining the variance of the risk premium.

**Appendix 1: results of ADF test**

Augmented Dickey-Fuller Unit Root Test on TEP

| | | | |
|---|---|---|---|
| ADF Test Statistic | -3.141775 | 1% Critical Value | -3.5398 |
| | | 5% Critical Value | -2.9092 |
| | | 10% Critical Value | -2.5919 |

*Mackinnon critical value for rejection of hypothesis of a unit root.
Augmented Dickey-Fuller Test Equation
Dependent Variable: D(TEP)
Method: Least Squares
Date: 12/21/08 Time: 15:31
Sample (adjusted): 1993: 1 2008:1
Included observations: 61 after adjusting endpoints

| Variable | Coefficient | Std. Error | t-Statistic | Prob |
|---|---|---|---|---|
| TEP(-1) | -0.378729 | 0.120546 | -3.141775 | 0.0026 |
| D(TEP(-1) | -0.201821 | 0.131108 | -0.932775 | 0.3548 |
| C | 0.019773 | 0.012462 | 1.586732 | 0.118 |
| R-sqyared | 0.228427 | Mean dependent var | | 0.000787 |
| Adjusted R-squared | 0.201821 | S.D. dependent var | | 0.094976 |
| S.E of regression | 0.084853 | Akalike info criterion | | -2.047871 |
| Sum squared resid | 0.417599 | Schwarz criterion | | -1.944057 |
| Log likelihood | 65.46005 | F-statistic | | 8.585552 |
| Durbin-Watson stat | 2.002526 | Prob(F-statistic) | | 0.000542 |

Augmented Dickey-Fuller Unit Root Test on INFL

| | | | |
|---|---|---|---|
| ADF Test Statistic | -4.284224 | 1% Critical Value | -3.5398 |
| | | 5% Critical Value | -2.9092 |
| | | 10% Critical Value | -2.5919 |

*Mackinnon critical value for rejection of hypothesis of a unit root.
Augmented Dickey-Fuller Test Equation
Dependent Variable: D(TEP) D(INFL)
Method: Least Squares
Date: 12/21/08 Time: 15:31
Sample (adjusted): 1993: 1 2008:1
Included observations: 61 after adjusting endpoints

| Variable | Coefficient | Std. Error | t-Statistic | Prob |
|---|---|---|---|---|
| INFL(-1) | -0.617974 | 0.144244 | -4.284224 | 0.0001 |
| D(INFL(-1) | 0.02642 | 0.128831 | 0.205074 | 0.8382 |
| C | 0.02745 | 0.007517 | 3.651696 | 0.0006 |
| R-sqyared | 0.30251 | Mean dependent var | | 0.000131 |
| Adjusted R-squared | 0.278459 | S.D. dependent var | | 0.035611 |
| S.E of regression | 0.030249 | Akalike info criterion | | -4.110785 |
| Sum squared resid | 0.05307 | Schwarz criterion | | -4.006972 |
| Log likelihood | 128.3789 | F-statistic | | 12.57767 |
| Durbin-Watson stat | 1.993456 | Prob(F-statistic) | | 0.000029 |

Augmented Dickey-Fuller Unit Root Test on GG

| | | | |
|---|---|---|---|
| ADF Test Statistic | -5.493931 | 1% Critical Value* | -3.5398 |
| | | 5% Critical Value | -2.9092 |
| | | 10% Critical Value | -2.5919 |

*Mackinnon critical value for rejection of hypothesis of a unit root.
Augmented Dickey-Fuller Test Equation
Dependent Variable: D(TEP)
Method: Least Squares
Date: 12/21/08 Time: 15:31
Sample (adjusted): 1993: 1 2008:1
Included observations: 61 after adjusting endpoints

| Variable | Coefficient | Std. Error | t-Statistic | Prob |
|---|---|---|---|---|
| GG(-1) | -1.27045 | 0.231246 | -5.493931 | 0.0000 |
| D(GG(-1) | 0.223042 | 0.155493 | 1.434424 | 0.1568 |
| C | 0.006663 | 0.005762 | 1.156447 | 0.2522 |
| R-sqyared | 0.478204 | Mean dependent var | | -0.001578 |
| Adjusted R-squared | 0.460211 | S.D. dependent var | | 0.058852 |
| S.E of regression | 0.043239 | Akalike info criterion | | -3.396234 |
| Sum squared resid | 0.108436 | Schwarz criterion | | -3.29242 |
| Log likelihood | 106.5851 | F-statistic | | 26.57726 |
| Durbin-Watson stat | 1.888756 | Prob(F-statistic) | | 0.000000 |

## Appendix 2: Multivariate GARCH

System: SYS01
Estimation Method: Arch Maximum likelihood (Marquardt)
Converiance Specification: BEKK
Date: 12/18/08 Time: 19:59
Sample: 1992Q3 2008
Included Observation: 63
Total System (Balanced) Observation 189
Presample covariance: back (parameter=0.7)
Convergence achieved after 76 iterations

| | Ceoffient | Std. Error | z-Statistic | Prob |
|---|---|---|---|---|
| c(1) | 0.085412 | 0.020584 | 4.149452 | 0.0000 |
| c(4) | -1.092187 | 1.447795 | -0.754380 | 0.4506 |
| c(5) | 21.50023 | 10.16927 | 2.114236 | 0.0345 |
| c(6) | -40.60060 | 11.83400 | -3.430842 | 0.0006 |
| c(2) | 0.032431 | 0.002852 | 11.37177 | 0.000 |
| c(3) | 0.002830 | 0.005271 | 0.536937 | 0.5913 |
| | Variance Equation Ceofficients | | | |
| C(7) | 0.000212 | 8.11E-05 | 2.609947 | 0.0091 |
| C(8) | 0.433424 | 0.118990 | 3.642535 | 0.0003 |
| C(9) | 0.853707 | 0.172639 | 4.945033 | 0.0000 |
| C(10) | -0.67415 | 0.106958 | -2.500182 | 0.0124 |
| C(11) | 0.903976 | 0.048591 | 18.60365 | 0.0000 |
| C(12) | -0.385117 | 0.164290 | -2.344134 | 0.0191 |
| C(13) | 0.904027 | 0.035905 | 25.17833 | 0.0000 |
| Log likelihood | 315.3219 | Schwarz criterion | | -9.155288 |
| Avg. Log likelihood | 1.668370 | Hannan-Quinn Criter. | | -9.423589 |
| Akaike Info Criterion | -9.597522 | | | |

Equation: TEP= C(1) + C(4)* VARTEP + C(5)* COVTEPINFL + C(6)* COVTEP

| | | | |
|---|---|---|---|
| R-squared | 0.152527 | Mean dependent var | 0.049222 |
| Adjusted R-squared | 0.109435 | S.D. dependent var | 0.101230 |
| S.E. of regression | 0.095531 | Sum Squared var | 0.538439 |
| Prob (F-statistics) | 0.958024 | | |

Equation: INFL = C(2)

| | | | |
|---|---|---|---|
| R-squared | -0.141259 | Mean dependent var | 0.044513 |
| Adjusted R-squared | -0.141259 | S.D. dependent var | 0.032404 |
| S.E. of regression | 0.095531 | Sum Squared var | 0.074296 |
| Prob (F-statistics) | 0.958024 | | |
| R-squared | -0.000010 | Mean dependent var | 0.044513 |
| Adjusted R-squared | -0.000010 | S.D. dependent var | 0.032404 |
| S.E. of regression | 0.034617 | Sum Squared var | 0.074296 |
| Prob (F-statistics) | 1.761053 | | |

Coveriance specification: BEKK
GARCH = M + A1*RESID (-1) *RESID(-1)'*A1 + B1GARCH(-1)* B1
M is a scalar
A1 is diagonal Matrix
B1 is diagonal Matrix

Tranformed Variance Coeficients

| | Coeficient | Std.Error | z-Statistic | Prob. |
|---|---|---|---|---|
| M | 0.000212 | 8.11E-05 | 2.609947 | 0.0091 |
| A1(1, 1) | 0.433424 | 0.118990 | 3.642535 | 0.0003 |
| A1(2, 2) | 0.853707 | 0.172639 | 4.945033 | 0.0000 |
| A1(3, 3) | -0.267415 | 0.106958 | -20500182 | 0.0124 |
| B1(1, 1) | 0.903976 | 0.048591 | 18.60365 | 0.0000 |
| B1(2, 2) | -0.385117 | 0.164290 | -20344134 | 0.0191 |
| B1(3, 3) | 0.904027 | 0.035905 | 25.17833 | 0.0000 |

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