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Stock Price Returns and Risk in the Saudi Stock Market

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Abstract. This study examines the relationship between stock returns and risk (volatility) using two models—the generalized autoregressive conditional heteroskedasticity in mean (GARCH-M) model and the exponential generalized autoregressive conditional heteroskedasticity (E-GARCH) model. The findings were mixed for the relationship between stock price returns and risk (volatility). In relation to the GARCH-M model, both the conditional variance and the conditional standard deviation were used as measures of risk (volatility). The empirical evidence suggests that returns and volatilities are significantly and negatively correlated for two of the six sectors and for the whole market, and no significant relationship was found for the remaining sectors. When using the E-GARCH model, the returns and volatilities are significantly and negatively correlated at one percent for the electricity and industry, and five percent for the whole market and for the service sectors. No significant relationship was found for the remaining sectors.

I. Introduction

Understanding the relationship between risk and returns is essential to the comprehension of why decision makers undertake some of the investment decisions that they do. The risk-return relationship is fundamental to be searched and understood. Many asset pricing models predict a positive relationship between the conditional variance (risk) and the expected return. The evidence for the risk-return relationship is, at best, mixed. Many studies has investigated the relationship between stock returns and the volatility (risk) for developed markets, while fewer studies have investigated such relationships for developing country markets. However, the volatility characteristics of the financial markets in Saudi Arabia are far from being thoroughly analyzed. Therefore, the purpose of this paper is to investigate and test the relationship between stock returns and the risk for Saudi stocks using two methodologies: the generalized autoregressive conditional heteroskedasticity (GARCH) in mean (or GARCH-M) and the exponential generalized autoregressive conditional heteroskedasticity (EGARCH). The paper continues as the follows. section II presents reviews of the previous theoretical and empirical studies, section III discusses the empirical methodology used, section IV provides a description of the data employed in the study, section V, lays out the empirical results, Finally section VI, presents the summary and conclusions.

II. Literature Review

The principle of this study is that potential returns rise with an increase in risk, whereas low levels of risk are associated with low potential returns. Therefore, economic decisions that subject stockholders to more risk must offer a higher expected return. If decisions are to lead to profit maximization, it is necessary that decision makers consider the combined influence on expected returns, as well as on risk. The requirement that expected returns be commensurate with risk is known as the "risk/return trade-off". This simple concept has a long history in economics.

Markowitz (1952), developed the basic portfolio theory, which derived a linear relationship between risk and returns. Thereafter, many studies have investigated the relationship between stock returns and volatility for developed markets. Tobin (1958) associated risk with the variance in the value of a portfolio. Sharpe (1964), in his Capital Asset Pricing Model (CAPM) revealed that there was a natural relationship between expected returns and variance, when all investors follow the same objectives with the same information. Black and Scholes (1972) and Merton (1973) developed a model to evaluate the pricing of options which consistent with the (CAPM).This model is used to demonstrate the risk/return trade-offs by relating the required returns on the firm's investments to its market risk.

Many studies have tested the relationship between returns and volatility(risk). The studies conducted by Baillie and DeGennaro (1990), Campbell and Hentschel (1992), Ghysels, Santa-Clara, and Valkanov (2005), Guo and Whitelaw (2006), and Pastor, Sinha, and Swaminathan (2006) are all examples of studies that determined a positive risk-return tradeoff. Positive or negative tradeoffs (depending on the approaches utilized) studies include: Cambpell (1987), Nelson (1991), Whitelaw (1994), Glosten, Jagannathan, and Runkle (1993), and Turner, Starz, and Nelson (1989).

Black (1976) studied the risk-return relationship, and found that stock prices declined for individual firms with increases in financial leverage. This resulted in an increase in an equity's volatility. French,. Schwert and Stambaugh (1986) found evidence that the expected market risk was positively related to the predictable volatility. Chiang and Doong (2001) investigated the time-series behavior of stock returns for seven Asian stock markets. For most cases, they determined that higher average returns appeared to be associated with a higher level of volatility. The relationship between stock returns and the unexpected volatility revealed that four out of seven Asian stock markets had significant results. A negative relationship between changes in volatility and stock returns was also found.

Ercan and Aslı (2005) tested the relationship between stock market returns and their forecast volatility, derived from symmetric and asymmetric conditional heteroskedasticity models for fourteen countries. Expected volatility was derived from the autoregressive conditional heteroskedasticity (ARCH(p)), GARCH(1,1), GJR-GARCH(1,1) and EGARCH(1,1) forecast models. The expected volatility was found to have a significant negative or positive effect on country returns in a few cases. The unexpected volatility had a negative effect on weekly stock returns in six to seven countries, and on monthly returns in nine to eleven countries, depending upon the volatility forecasting model used. Ercan and Asli also found that the return variance may not be an appropriate measure of risk.

Koulakiotis, Papasyriopoulos and Molyneux (2006) studied the relationship between stock price returns and volatility for industrialized countries (Australia, Canada, France, Japan, the US, the UK, Germany, and Italy). Taking into account two models, the GARCH-M and the E-GARCHM, they found that the GARCH-M model had modeling limitations and yielded inconclusive results in comparison to the EGARCH-M model that provided more accurate results in testing the relationship between stock price returns and volatility. Their general finding, through the use of the two models, was that the relationship between stock price returns and volatility was weak for some of the stock markets in industrialized countries. Tabak and Guerra (2007) examined the relationship between stock returns and volatility over the period of June 1990 to April 2002 using seemingly unrelated regressions (SUR). The empirical evidence suggested that contemporaneous returns and volatilities were significantly and positively correlated, while there was a negative relationship between changes in volatility and stock returns. Finding of empirical studies may be described best by Hui and Whitelaw (2005):

In general, however, despite widely differing specifications and estimation techniques, most studies found a weak or negative relationship. Studies that made this conclusion include Campbell (1987), Glosten, Jagannathan and Runkle (1993), Whitelaw (1994), Goyal and Santa-Clara (2003), Lettau and Ludvigson (2003) and Brand and Kang (2004)[1].

III. Study Methodology

The ARCH and GARCH- family of models analyze the attitude towards expected returns and risk (or uncertainty), while classical econometric analysis views the variance of the disturbance terms as constant over time (assumption of homoskedasticity). However, the fact is that many economic time series models exhibit an unusually high volatility, followed by a low volatility. This suggests that the expected value of the disturbance terms can fluctuate up and down from one period to another. Higher values in the disturbance term mean a higher risk (higher volatility), and vice versa. Therefore, under

[1] Hui Guo and Robert F. Whitelaw (2005) "Uncovering the Risk–Return Relation in the Stock Market" Working Paper 2006. FEDERAL RESERVE BANK OF ST. LOUIS 411 Locust Street St. Louis, MO 63102

such a circumstance, the assumption of the constant variance of a disturbance term is very limiting.

An alternative approach is to examine patterns that allow the variance to depend upon its history. Engle (1982) was the first to propose the concept of autoregressive conditional heteroskedasticity (ARCH) model and the GARCH model.

In this study, we use a generalized autoregressive conditional heteroskedasticity (GARCH or GARCH-M model along with an EGARCH model. The EGARCH-M model was first developed by Nelson (1991). They allowed the conditional mean to depend on its own conditional variance (or conditional standard deviation). Investing with certain degree of risk requires premiums to compensate for a risky asset. When the risk is captured by the volatility conditional variance or conditional standard deviation, then the conditional variance or conditional standard deviation may be included in the mean equation of the return. Therefore, the GARCH -M(p, q) model has the following form:

$$R_t=\alpha_0+\alpha_1 R_{t-i} + \theta h_t + u_t \qquad (1)$$
$$U_t \mid \Omega_t \sim iid\ N(0,h_t)$$

$$h_t = \gamma_0 + \sum_{i=1}^{p} \delta_i h_{t-i} + \sum_{j=1}^{q} \gamma_j u_{t-j}^2 \qquad (2)$$

Where R_t is the logarithm of stock price returns at time t, h_t is the conditional heteroskedastic term at time t, u_t is the error term, and Ω_t is the information set at time t-1, with observations on lagged values of R_t and h_t, or Ω_t-1= (h_t-1,h_t-2,...,R_t-1,R_t-2,...).

In this study, we will estimate the GARCHM-M(1,1) in two ways. One way will allow the conditional mean to depend on its conditional variance, and the other way will let the conditional mean to depend on the conditional standard deviation. When using the conditional variance, the mean equation takes the following form:

$$R_t=\alpha_0+ \alpha_1 R_{t-i}+ u_t + \theta h_t \qquad (3)$$

When using the conditional standard deviation, the mean equation takes the following form:

$$R_t= \alpha_0+ \alpha_1 R_{t-i} + u_t + \theta \sqrt{h_t} \qquad (4)$$

The last model we will use in this study is the EGARCH model. This model will be used to capture the asymmetric impact of shocks on volatilities and avoid imposing non-negativity restrictions on the values of the GARCH-M parameters to be estimated. The variance equation is as follows:

$$\log(h_t) = \gamma + \sum_{j=1}^{q} \kappa_j \left| \frac{u_{t-j}}{\sqrt{h_{t-j}}} \right| + \sum_{j=1}^{q} \eta_j \frac{u_{t-j}}{\sqrt{h_{t-j}}} + \sum_{j=1}^{p} \Pi_i \log(h_{t-i}) \qquad (5)$$

With the main equation to be estimated :

$$R_t=\alpha_0+ \alpha_1 R_{t-i}+ u_t + \theta h_t \qquad (6)$$

IV. Description and properties of the data

The data employed in the study consists of the mean of daily closing prices for every sector of the Saudi stock market. The period lasted from 1/1/2005 to 11/28/2007. There were seventy-three listed companies during the estimation period. The market was composed of six sectors, plus the whole market. The natural log of the relative price was computed for the daily closing price, such that $R = \log(\frac{p_t}{p_{t-1}})$, where p_t and p_t-1 represents the stock index price at time t and t-1.

Table 1 presents a summary of the descriptive statistics of the daily returns. Sample means, maximums, minimums, standard deviations, skewness, kurtosis , Jacque-Bera statistics and p-values are reported. The highest mean returns were in the area of Agriculture (0.0011) and services (0.0005), while the lowest mean returns were in banking (0.0001). The lowest minimum returns were in Cement (-0.1060), and the highest maximum returns were in banking (0.0968) . On the basis of standard deviations, the least volatile was the banking sectors (0.0185) with agriculture (0.0392) and services (0.0352) being the most volatile.

All sectors were negatively skewed, indicating a greater probability of large decreases in returns rather than rises. The kurtosis ranged from (3.5398) for agriculture to (8.2312) for banking, thereby indicating leptokurtic distributions. The Jarque-Bera statistics with its p-values were used to test the null hypotheses of a normal distribution. With all p-values being equal to zero, the null hypothesis of a normal distribution will be rejected. Thus, all returns were not well approximated by the normal distribution.

V. Empirical Results

Table 2 reports the results of the GARCH-M model with a conditional variance for the six sectors of the Saudi stock market and the market as a whole. The coefficient (θ) in the fourth column of Table 2

Table 1. Descriptive statistics for the Saudi Stock Market

Sectors	Whole Market	Banks	Industry	Cement	Agriculture	Electricity	Service
Mean	0.0001	0.0001	0.0005	0.0002	0.0011	-0.0002	0.0005
Median	0.0005	0.0001	0.0038	0.0004	0.0033	0.0000	0.0040
Maximum	0.0117	0.0968	0.0945	0.0953	0.0940	0.0941	0.0933
Minimum	-0.0176	-0.0943	-0.1041	-0.1060	-0.1045	-0.1047	-0.1050
Std. Dev.	0.0036	0.0185	0.0301	0.0259	0.0392	0.0241	0.0352
Skewness	-1.1008	-0.6332	-0.7665	-0.4408	-0.3917	-0.5444	-0.6448
Kurtosis	6.4202	8.2312	4.9023	6.7782	3.5398	6.8783	3.9925
Jarque-bera	546.669	957.185	197.2232	497.3331	29.90614	536.1609	87.49485
Probability	0	0	0	0	0	0	0

Table 2. GARCH-M (1,1) with a conditional variance

Sector	α_0	α_1	θ	γ_0	δ_i	γ_j
Agriculture	.0034 (2.69)	.065 (1.75)	-.99 (.82)	.0007 (5.26)	.28 (5.75)	.68 (17.32)
Banking	.0009 (1.08)	.2 (.2)	-.95 (-.33)	.00009 (6.47)	.11 (6.7)	.86 (62)
Cement	.0002 (2.6)	.03 (.68)	.-1.42 (-.99)	.000077 (4.36)	.25 (8.3)	.77 (39)
Electricity	.0026 (2.9)	.05 (1.26)	-4.5 (-2.4)**	.000015 (4)	.125 (5.7)	.845 (37)
Industry	.004 (4.9)	.45 (1.33)	-3.5 (-2.46)**	.000015 (4.5)	-.2 (6.7)	.79 (32.9)
Service	.004 (4)	.068 (1.94)	-2.2 (-1.66)	.000014 (4)	.26 (6.66)	.74 (24)
Whole Market	.0004 (6)	.48 (1.56)	-29 (-2.98)**	.000026 (6.17)	.26 (7.5)	.74 (28)

Parentheses include the z-values for the estimates.
**Statistically significant at the 1% level.
*Statistically significant at the 5% level.

shows the relationship between stock price returns and volatility for the agriculture, banking, cement, electricity, industry, and service sectors, as well as for the whole market.

The coefficients were statistically significant (negative)at the one percent level for two of the sectors (electricity, industry) and for the market as whole with a negative sign. This means that the relationship between stock price returns and volatility was strong for the two sectors and for the market. On the other hand, the coefficients were not statistically significant (negative) for the remaining four sectors. Conflicting findings indicate mixed results for the relationship between stock price returns and volatility.

Table 3 reports (the coefficient θ in the fourth column of the table) the results of the GARCH-M model with a conditional standard deviation. The findings were not different from that of the conditional variance for every sectors and for the whole market. One exception is the Service sectors where the finding is significant (negative) at five percent.

The results of the E-GARCH are reported in Table 4 (the coefficient θ in the fourth column of the table). The estimates were slightly different from that of the GARCH-M model. In contrast to the GARCH in mean model estimates, it was found to have a significant negative relationship between volatility and stock price returns for the service sector and for the market as a whole at the five percent level of significance and at the one percent level of significance for electricity and industry.

The stability condition for GARCH-M models require that:

Table 3. GARCH-M(1,1) with Conditional Standard Deviation

Sector	α_0	α_1	θ	γ_0	δ_i	γ_j
Agriculture	.0024 (1.84)	.067 (1.83)	-.068 (-.78)	-..00007 (.5.2)	.28 (5.7)	-.69 (-17)
Banking	.0012 (.69)	.2 (5.29)	-.035 (-.31)	.00009 (6.4)	.11 (6.7)	.86 (61)
Cement	.0002 (2.2)	.028 (.7)	-.082 (-1.2)	.000078 (4.3)	.25 (8.2)	.77 (39)
Electricity	.005 (3.3)	.046 (1.2)	-.28 (-2.7)**	.00015 (3.89)	.127 (5.7)	.84 (36)
Industry	.007 (4.2)	.048 (1.4)	-.22 (-2.6)**	.00016 (4.5)	-.2 (6.5)	.79 (30)
Service	.006 (3.3)	.07 (2) *	-.16 (-1.97)*	.00015 (4)	.27 (6.7)	.73 (24)
Whole Market	.0006 (5.2)	.06 (1.8)	-.18 (-2.74)**	.027 (6.3)	.26 (6.3)	.75 (27)

Parentheses include the z-values for the estimates.
**Statistically significant at the 1% level.
*Statistically significant at the 5% level.

Table 4. EGARCH (1,1)

Sector	β_0	β_1	θ	γ	κ	η	$\prod$
Agriculture	.0029 (2.567)	.062 (1.59)	-1.28 (-1.07)	-.96 (-6.3)	.43 (7.35)	.32 (1.03)	.91 (52)
Banking	.0001 (1.5)	.19 (4.9)	-1.95 (-.67)	-.4 (8.9)	.21 (7.7)	.04 (2.4)	.96 (190)
Cement	.0017 (3.2)	.006 (.16)	-2.6 (-1.8)	-.6 (-8)	.4 (11)	-.02 (-1.2)	.96 (117)
Electricity	.002 (3.22)	.03 (.86)	-5.3 (-2.67)**	-.4 (-5.5)	.22 (6.8)	-.03 (2)	.969 (125)
Industry	.004 (5)	..053 (1.8)	-4.35 (-2.91) **	-.59 (-7)	.37 (8.8)	-.013 (-.54)	.96 (108)
Service	.004 (4)	.066 (1.77)	-3 (-2.3) *	-.67 (-6.6)	.4 (7.97)	-.023 (-.86)	.95 (86)
Whole Market	.0003 (7)	.07 (1.8)	-21 (-2)*	(-.75) (-6.44)	.39 (9.5)	.24 (.88)	.96 (121)

Parentheses include the z-values for the estimates.
**Statistically significant at the 1% level.
*Statistically significant at the 5% level.

that

$$\gamma_0 > 0,\ \delta > 0,\ \gamma_j \geq 0 \text{ and } \delta + \gamma_j \leq 1$$

And in EGARCH-model required that:

$$\gamma > 0,\ \eta > 0,\ \kappa > 0,\ \prod \geq 0 \text{ and } \eta + \kappa + \prod \leq 1$$

Therefore, the stability condition is granted in the GARCH-M model (with a conditional variance) in the agriculture, banking, electricity and industry sectors. In the GARCH-M model (with a conditional variance) the stability condition is met in the banking, electricity and industriay sectors. However, in the EGARCH model (1,1) all estimations are non stable since $\eta + \kappa + \prod > 1$ for all sectors and for whole market.

Overall, the results revealed that the relationship between stock price returns and volatility was negative for some sectors and non significant for other sectors which contradict the theoretical model.

One explanation for the finding is that a positive relationship between returns and risk is built on the assumption of rationality. Rationality implies that economic decisions which subject stockholders to more risk must offer a higher expected return.

However, findings from behavioral organization theory, behavioral decision theory, survey research, and experimental economics leave no doubt about the failure of rational choice as a descriptive model of human behavior.[2]

Therefore, the findings of this study provide further evidence of the failure of rational choice as a useful model for describing human behavior. The alternative assumption is that the economic agent is bonded rational, meaning they can only make the best decisions within their available knowledge and resources, as Simon (1996) theorizes. Thus, traders in the Saudi stock market make many investment decisions with less information. The natural outcome is higher risk and lower rates of return.

VI. Conclusions

In this paper, we estimated the relationship between stock returns and volatility over the period of January 2005 to November 2007 for the Saudi stock market. We investigated all sectors of the Saudi stock market and the market as whole. These sectors consisted of agriculture, banking, cement, electricity, industry, service and the whole market. Using two models, the GARCH-M and the E-GARCH, we found a mixed relationship between stock price returns and volatility.

The findings of the GARCH-M model with both a conditional variance and a conditional standard deviation were almost the same. The empirical evidence suggests that returns and volatilities were significantly and negatively correlated for two out of six sectors, and for the whole market. When using the E-GARCH model, the returns and volatilities were significantly and negatively correlated at the one percent level for the electricity industry and at the five percent level for the whole market and service sectors. The negative, or weak, relationship finding of this paper is in accordance with results obtained by French and Campbell (1987), Glosten, Jagannathan and Runkle (1993), Whitelaw (1994), Goyal and Santa-Clara (2003), Lettau and Ludvigson (2003) and Brandt and Kang (2004).

[2] Bryan D. Jones, (1999) ''Bounded Rationality, '' p. 297 Annual Review of Political Science 1999. 2:297–321

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العلاقة بين العائد وحجم المخاطرة في سوق الأسهم السعودية

فوزان عبدالعزيز الفوزان

استاذ مشارك — كلية الملك فهد الأمنية — الرياض

(قدم للنشر في ٢٠/٥/ ١٤٣٠هـ؛ وقبل للنشر في ٢٩/٣/ ١٤٣١هـ)

الكلمات الدالة الرئيسية: درجة التعقيدات في تصميم أنظمة التكاليف، درجة التنويع بالمنتجات، درجة المنافسة.

ملخص البحث. تهدف هذه الدراسة إلى قياس درجة التعقيدات في تصميم أنظمة التكاليف في الشركات الصناعية الأردنية. وتهدف هذه الدراسة أيضا إلى تحديد العلاقة بين درجة التنويع بالمنتجات، درجة المنافسة في الأسواق، حجم الشركات ودرجة التعقيدات في تصميم أنظمة التكاليف. ولتحقيق أهداف هذه الدراسة تم جمع البيانات المطلوبة بواسطة استبانة وزعت على عينة من الشركات الصناعية الأردنية. بعد الرجوع إلى أدبيات الدراسة تبين أن معظم الشركات تصنف أنظمة التكاليف الخاصة بها إلى أنظمة تحميل تقليدية أو أنظمة تحميل بناءا على الأنشطة (ABC). وهذه الدراسة تقدم إجابات لعدة أسئلة طرحت من قبل مجموعة من الباحثين في المحاسبة الإدارية لتطوير وتبني منهج عام لقياس درجة التعقيدات في تصميم أنظمة تكاليف المنتج. وقد بينت النتائج باستخدام (Multiple Regression) أن درجة التنويع بالمنتجات وحجم الشركات تؤثر إيجابيا على درجة التعقيدات في تصميم أنظمة التكاليف.