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DYNAMICS OF INVESTORS' RISK AVERSION IN EMERGING STOCK MARKETS: EVIDENCE FROM SAUDI ARABIA

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Dynamics of Investors' Risk Aversion in Emerging Stock Markets: Evidence from Saudi Arabia*

Abstract

Investors' attitude towards risk taking behavior is one of the key determinants of financial market volatility. The attitude itself, however, differs significantly between developed and developing markets, given the amount of uncertainty they face with regard to market imperfection and available information. This paper provides an in-depth study of the extent to which risk aversion behavior in a developing financial market contributes towards volatility. To this end, we employ a range of tests building on the basic GARCH-M procedure, estimate the risk aversion parameter and study its movement over time. Saudi Arabia's financial market has been taken as a case of empirical illustration. It is shown that the risk-aversion parameter is time-varying and embeds information from the changing economic environment. Moreover, we also argue that in such a market, given characteristic volatility with respect to imperfection and incomplete information, it is hard to predict the exact pattern of volatility.

Keywords: Emerging markets; Risk aversion; GARCH models; Kalman filter

JEL classification: G01; G11; G17; G32

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1. Introduction

During the first few years of this century, the rapid increase in investment in the largest stock market in the Middle East (viz., the Saudi stock market) and the dramatic losses following its collapse in 2006 raised serious questions about investors' perception towards risk in emerging markets. As a consequence, both economic theory and empirical models dealing with issues of risk aversion in financial markets developed analyses which accounted for factors like incomplete information, imperfect markets, and herding behavior under stochastic shocks. The broad questions that can be asked then are:

- How do risk-averse investors perceive risk?
- What is the level of risk aversion in the market?
- Does risk aversion evolve over time?
- How may market crashes affect investors' risk attitude?

These issues are critical to investors and policy makers in order to ensure sound investment strategies and stable financial markets. In this paper, we seek to understand the dynamics of risk aversion in a financial market which is in a transitional phase and is beset with greater degrees of market imperfection and incomplete information.

Indeed, the stability of financial systems is argued to be linked to many factors, including stability in share prices (e.g., Granville and Mallick, 2009), which in turn is linked to investor's risk attitude. We intend to investigate these issues in detail and study risk attitudes that prevail in emerging financial markets. The examination of individual risk behavior has been of interest to researchers since the mid-1940s. Friedman and Savage (1948), for instance, provided a utility analysis of choices involving risk. They argued that, under the law of diminishing marginal utility, utility maximization theory is not sufficient under risk choices. If the law of diminishing marginal utility stands, individuals should never engage in a fair gamble. Alternatively, risky choices should be studied within the framework of *expected* utility maximization. However the issue of risk aversion was directly tackled in the 60's when Pratt (1964) and Arrow (1971) derived expressions for risk aversion. Arrow (1971) defines a risk averter as "one who, starting from a position of certainty, is unwilling to take a bet which is actuarially fair". He showed theoretically that the coefficient of relative risk aversion (CRRA) should be around unity

Studies have differed widely with respect to their estimates of risk aversion (Table 1). Friend and Blume (1975) estimated the CRRA to be between 1.5 and 1.7 for the stock market and 2.3 for the bonds market. Mehra and Prescott (1985) argued that the CRRA should exceed 10 in order to reconcile the equity risk premium with theoretical models. Pindyck (1988) provided estimates of the index of relative risk aversion that ranged from 0.3 to slightly over 6. Alonso, Rubio and Tusell (1990) found that CRRA in the Spanish stock market is 3.88. French, Schwert and Stambaugh (1995) have estimated it to be equal to 2.41. More recently, others such as Brandt and Wang (2003) and Ghysels et al. (2005) estimated the CRRA to range from 1.5 to 2 on average. Guo and Whitelaw (2006) estimated a coefficient of around 5. Obviously, empirical studies have varied widely in terms of the sign of the estimated CRRA.

In contrast to the studies mentioned above, some studies found a negative return-risk relation. According to Glosten *et al*. (1993), the relationship between returns and risk can take either a positive or negative sign. Elyasiani and Mansur (1998) found a negative and significant effect of risk aversion on return in US data. Basher et al. (2007) reached the same result in the Bangladesh stock market. Others, such as Thomas (1995), found no evidence of a significant effect of risk on return at all.

The coefficient of variance in the conditional mean equation is interpreted as investors' coefficient of relative risk aversion (Merton, 1980). In line with Merton, Lintner (1970) states in a theorem that the market price of risk is equivalent to the market risk aversion. Yet, empirical studies of the conditional mean-variance relationship seem to produce conflicting predictions in terms of the magnitude and sign of such a relationship. For example, Elyasiani and Mansur (1998) found a negative and significant relation while Chou (1988) reported that this relation is positive and significant. However, according to Merton (1980), a positive relation between expected return and risk is a reasonable assumption, although this assumption need not always be true.

If changes in preferences or in the distribution of wealth are such that aggregate risk aversion declines between one period and another, then higher market risk in the one period does not need to imply a correspondingly higher risk premium. At first glance, it would appear that risk-averse investors should require a larger risk premium during times when the volatility of returns increases. However, some (e.g., Glosten et al (1993) have argued that larger risk may not necessarily imply an increasing risk premium, because high volatility periods could coincide with times in which investors are more capable of bearing risk. Additionally, it may be the case that investors choose to increase their savings during risky periods, thus lowering the need for a larger risk premium. Glosten *et al.* also argued that, if transferring income to the future is risky and investment in risk free assets is not available, the price of a risky asset may increase considerably, hence reducing the risk premium. Abel (1988) claimed that, in general equilibrium, if investor's preference is not logarithmic, the mean-variance relationship will not necessarily be positive.

Therefore, either a positive or negative correlation between the conditional mean and conditional variance can be consistent with underlying theories. Barsky (1989) provides an extensive discussion on the risk return relationship. He makes a distinction between risk aversion and aversion to intertemporal substitution. Barsky shows that the effect of increased equity risk on required stock returns is ambiguous. The expression for change in expected return with respect to change in risk contains two terms. The first is represented by risk aversion and can be thought of as the substitution effect. This first term takes a positive sign. Increased riskiness of the capital asset exerts pressure toward greater first-period consumption in order to avoid the risk, causing a corresponding fall in the notional demand for equities. Since, in equilibrium, the representative consumer must hold his/her share of the fixed stock supply of capital, this tends to raise required returns. On the other hand, the second term, under decreasing absolute risk aversion, takes a negative sign and can be thought of as a precautionary saving effect. Increased risk raises the prospect of very low consumption in the second period, increasing asset demands and exerting downward pressure on required returns.

Thus, an increase in uncertainty can result in either a rise or fall in the required return to equity, depending on which effect dominates. In the case of constant risk aversion, equilibrium expected return on capital rises with increased uncertainty if and only if the CRRA is less than unity. Thereby, the effect of uncertainty is a function of risk aversion and the intertemporal rate of substitution. The degree of substitutability between first and second period consumption determines the sign of the risk-return relationship, while the risk aversion help determining the magnitude of the effect but not its sign. This conclusion by Barsky will be adopted in our interpretation of the results acquired here.

The rest of the paper is structured as follows. The model is set up and the coefficient of risk aversion is derived in section 2. Section 3 discusses the data and section 4 provides our empirical analysis and results. Section 5 discusses the policy implications of our results and, finally, section 6 concludes.

Table (1): Some estimates of risk aversion in the literature

	Estimated coefficient of risk aversion
Arrow (1971)	1
Friend and Blume (1975)[1]	2
Schluter and Mount (1976)	0.5 - 3
Bodice, Kane and Macdonald (1983)	3-4
Hansen and Singleton (1983)[2]	0 – 2
Ferson (1983)	-1.4 – 5.4
Mehra and Prescott (1985)	0 – 10 in theory, but over 10 in practice[3] (the equity premium puzzle)
Szpiro (1986)	1.2 – 1.8 (for U.S. market) 1 – 2 (for 15 developed countries)
Pindyck (1988)	0.3-6
Alonso et al. (1990)	3.88
Engle et al (1992)	3
Klock and Phillips (1992)	2.5
French et al.(1995)	2.41
Blake (1996)	47.6 for poor individuals 7.88 for rich individuals
Ait-Sahalia and LO (2000)	12.7
Engle and Rosenberg (2001)	7.36
Brandt and Wang (2003)	1.5 – 2
Eisenhauer and Ventura (2003)	0.187
Bliss and Panigirtzoglou (2004)	7 for one-week horizon 4.5 for two-week horizon
Ghysels et al. (2005)	1.5 - 2
Chetty (2006)	Theoretical upper bound = 2 Empirical estimate = 0.71

[1] Friend and Blume (1975) found different values for the coefficient of relative risk aversion using different variables and techniques. These values vary among each other but remain around 2. For example, using realized rates of return and interest rates, the coefficient is estimated at 1.5-1.7 for stocks and 2.3 for bonds. Using a geometric ex-ante expected return the estimated coefficient is 2.

[2] Hansen and Singleton clarified that the value of risk aversion coefficient is sensitive to the number of lags included in their model. The estimated coefficient increases in value as the number of lags is increased. Thus, the coefficient of relative risk aversion ranges from 0 to 2, depending on the number of lags in the model.

[3] This variability between results in theory and those in practice represent the well-known equity premium puzzle proposed by Mehra and Prescott (1985).

2. Model Setup

There are several factors that motivate the use of GARCH models in the analysis procedure. As often found in the financial literature, the distribution of stock returns is leptokurtic. Hence, standard linear regression cannot capture the fat tail and heteroscedasticity properties of the data. Also, in contrast to the standard time series regression models, the ARCH model proposed by Engle (1982) allows the variance of the errors to change over time. Additionally, the different types of GARCH models allow estimation of volatility without assuming a functional form of volatility that depends on returns, unlike other time series models. Moreover, with the shortage of high frequency return data for emerging financial markets, it is difficult to model daily volatility using standard time series models (e.g. ARIMA models). Even if weekly returns are used, this will come at the cost of losing observations, resulting in fewer degrees of freedom. This is not a problem in a GARCH framework as it uses an iterative process in estimating daily volatility.

Bollerslev (1986) proposed a generalization of the Engle's ARCH model in what is now known as a GARCH model. The GARCH process allows for a lag structure for the variance and models the conditional variance as a function of prior periods' squared errors and conditional variances. One of the major advantages of GARCH models, which make them very popular in financial data analysis, is that they are capable of capturing the tendency for volatility clustering in the data. For example, large (small) changes in stock returns are most likely to be followed by large (small) stock returns in the next period. Engle et al. (1987) extended the GARCH structure to explicitly model the conditional mean of the data as a function of its conditional variance, in what is known as the GARCH in mean or GARCH-M model. This approach allows for assessing the relationship between return and risk in financial data and for taking into account the leptokurtosis and volatility clustering feature, especially in emerging markets data. The GARCH-M(p,q) model is represented as follows:

$$R_t = \mu + \delta\sigma_t^2 + \epsilon_t \quad (1)$$

$$\sigma_t^2 = \omega + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^2 + \sum_{i=1}^{q} \beta_i \sigma_{t-i}^2 \quad (2)$$

where R_t and σ_t^2 are the conditional return and variance at time t.

The obvious limitations of the GARCH model can be solved by adopting the EGARCH model as was proposed by Nelson (1991). Basically, Nelson proposed to relax the non-negativity constraints assumed in the original GARCH specification to allow for asymmetry in conditional variance. Nelson included a leverage effect in the variance equation and applied the log of the conditional variance rather than the conditional variance itself. Using the log implies that the leverage effect is exponential, rather than quadratic and the forecasts of the conditional variance are guaranteed to be non-negative. The variance equation for the EGARCH(1,1) model is specified as follows:

$$\ln(\sigma_t^2) = \omega + \beta \ln(\sigma_{t-1}^2) + \alpha_1 \left|\frac{\varepsilon_{t-1}}{\sigma_{t-1}}\right| + \gamma \frac{\varepsilon_{t-1}}{\sigma_{t-1}} \quad (3)$$

EGARCH has several advantages over the basic GARCH model. First, using the natural logarithm in the variance equation ensures that the conditional variance, σ_t^2 , is always non-negative, even if the parameters are negative. Thus, there is no need to artificially impose any non-negativity constraints on the model's parameters. Second, it allows for asymmetry in response to volatility. The standard GARCH model does not distinguish between positive and negative shocks to volatility. Since it is a function of the *squared* lagged error, the conditional variance in the basic GARCH model is a function of the magnitudes of the lagged residuals but not their signs. Accordingly, it assumes that the response to negative shocks is just the same as the response to positive shocks. It has been argued, however, that a negative shock to financial time series causes volatility to rise by more than a positive shock of the same magnitude, a phenomenon known as the "leverage effect". EGARCH accounts for asymmetric shock response by including the last term in the equation above[4].

2.1 Risk Aversion and Utility Functions

To reconcile our empirical models with the underlying theory in finance, we start by showing how investors' aggregate risk-return is linked to his/her utility function where the latter is drawn from consumer preference theory. By utilizing the theoretical underpinning of the derived empirical model (as will be described in the next section), we also shed light on the important aspects of risk aversion and its interrelationships with market structure. As argued before, the environment in which investors are adopting

[4] It is worth mentioning that the original formulation for EGARCH model assumed a Generalized Error Distribution (GED), which is a broad family of distributions that can be used for many types or series. Nevertheless, rather than using GED, we stick to the conditional normal error assumption originally suggested by Engle (1982).

strategies of risk aversion or risk taking behavior has enormous influence on their psychology. For instance, under a volatile market and incomplete information, investors may depict ‘herding’ behavior, as they would not be able to predict the exact pattern of the economy at period *t+1*. In this case, they may follow a market leader. Similarly, if the market is relatively less volatile and information dissemination is more or less perfect, then investors may wish to take some risks and play strategic games in relation with other investors.

Market risk premium is defined as the return on a portfolio of assets that is required to compensate for systematic risk (Cotter & Hanly 2009). Within the asset pricing framework, the size of the risk premium of the market portfolio is determined by the aggregate risk aversion of investors and by the volatility of the market return as expressed by the variance.

$$E(r_m) - r_f = \delta\sigma_m^2 \tag{4}$$

$$\frac{E(r_m)-r_f}{\sigma_m^2} = \delta \tag{5}$$

where δ is the coefficient of relative risk aversion (CRRA). Equation (5) implies that δ is the risk premium per unit of risk. Investors maximize their utility which is defined as a function of conditional expectation and conditional variance of wealth:

$$Max \quad U[E_t(W_{t+1}), \sigma_t^2(W_{t+1})] \tag{6}$$

$Subject\ to$:

$$E_t(W_{t+1}) = W_t x_t' E_t(r_{t+1}) + W_t(1 - x_t' I) r_{f,t} \tag{7}$$

$$\sigma_t^2(W_{t+1}) = W_t^2 x_t' V_t(r_{t+1}) x_t \tag{8}$$

where W represents investor's wealth, x is a vector of investment shares in each risky asset, $E_t(r_{t+1})$ and $V_t(r_{t+1})$ are the conditional expected return and variance-covariance matrix of asset returns, respectively. I is a unit vector and $r_{f,t}$ is the risk free return.

Solving the problem above with respect to x_t , the following first order conditions are obtained:

$$\frac{dU}{dx_t} = U_1 W_t\left(E_t r_{t+1} - r_f\right) + U_2 W_t^2 V_t(r_{t+1})x_t = 0 \qquad (9)$$

Upon rearrangement of terms this can be written as

$$E_t r_{t+1} - r_f = -\frac{U_2}{U_1} W_t V_t(r_{t+1})x_t \qquad (10)$$

If we define CRRA as $= -\frac{U_2}{U_1}W$, we obtain the equilibrium expected returns:

$$E_t(r_{t+1}) - r_{f,t} = \delta_t V_t(r_{t+1})x_t \qquad (11)$$

And since $E_t(r_{t+1})$ is equal to the actual return less a forecast error, we have,

$$r_{t+1} = r_{f,t} + \delta_t V_t(r_{t+1})x_t + \varepsilon_t \qquad (12)$$

Assuming that stocks are the only relevant risky asset (or equivalently, covariance between stocks and other risky assets is zero) and since the variance of market portfolio is simply the variance weighted average of the assets comprising the portfolio, we can write equation 12 above as:

$$r_{s,t} = r_{f,t} + \delta_t \sigma_{s,t}^2 + \varepsilon_t \quad (13)$$

where $r_{s,t}$ is return on the stock index, and $\sigma_{s,t}^2$ is the variance of stock index returns. Therefore, a rational, utility maximizing consumer/investor will regard the excess return on his/her portfolio as a function of risk.

3. Data

For our empirical analysis, we use daily closing prices from the Saudi Arabian Stock Exchange. The data are obtained from the Saudi Stock Exchange (Tadawul) and constitutes of 2161 observations on the Tadawul All Share Index (TASI) prices. The data covers the period from January 1st, 2003 to December 31st, 2010. The sample is subdivided into two periods: January 1st, 2003 to Feb 28th, 2006 with 943 observations, and March 1st, 2006 to December 31st, 2010 with 1218 observations. The estimation process covered the two periods in addition to the full sample size. The subdivision of the sample is necessary to investigate whether investor's attitude towards risk has changed after the market crash in February 26th, 2006, or not. Daily TASI return series are generated from the index closing prices. Index return at time "t" is calculated as the difference between the natural logarithm of its price at time "t" and its price for the day before (i.e. at time "t-1").

4. Empirical Analysis

4.1. Model with Fixed Risk Aversion

Within the model of capital market equilibrium, the excess return on investing in risky asset is modelled as a function of the standard deviation of that return. In financial terms, the risk premium, defined as the excess return of an investment, is approximately proportional to the amount of risk being born by investors where risk is measured by the volatility of return in the market. Thus, the econometric model can be presented as follows:

$$r_{s,t} = r_{f,t} + \delta_t \sigma_{s,t}^2 + \varepsilon_t \qquad (14)$$

The parameter δ can be thought of as the price of risk in the market. It is the price of an extra unit of risk an investor would charge to take that unit of risk. Thus, it is the representative investor's coefficient of relative risk aversion. We use EGARCH-M models to estimate the econometric model above. To start, and to justify the use of GARCH type models in our estimation, we perform Engle's Lagrange Multiplier (LM) test to check for ARCH effects in the data. Table 2 reports the ARCH LM test statistics and p-values for the three samples we have. The LM test is significant for all the three indices. This implies that there is a strong ARCH effect in the residuals and calls for using GARCH process.

Table (2): ARCH-LM test for the three sample periods:

Sample period	test statistic	p- value
Jan 1st, 2003 – Feb 28th, 2006	165.55	0.000
Mar 1st, 2006 – Dec 31st, 2010	221.95	0.000
Jan 1st, 2003 – Dec. 31st, 2010	393.87	0.000

As the ARCH LM test results clearly suggest the presence of ARCH effect on the data, we estimate the coefficient of risk aversion within the GARCH framework. The Box-Jenkins method suggests that stock returns for all the three indices follow an AR(1) process. Once the AR(1) term is included in the model specification, residuals show no more correlation, which indicates that the inclusion of one autoregressive term is sufficient to capture autocorrelation in the data. Therefore, to estimate the coefficient of risk aversion, we fit an AR(1)-GARCH(1,1)-M model,

$$R_t = \mu + \varphi R_{t-1} + \delta\sigma_t^2 + \epsilon_t \tag{15}$$

$$\sigma_t^2 = \omega + \alpha\varepsilon_{t-1}^2 + \beta\sigma_{t-1}^2 \tag{16}$$

where R_t denotes stock return at time "t", ϵ_t is the prediction error assumed to be normally distributed with mean zero and conditional variance σ_t^2 that is changing each day. δ denotes investors' coefficient of risk aversion. Note that the time subscript "t" drops out as we assume a constant risk aversion over time. Additionally, the restrictions $\alpha + \beta \geq 1$ for i = 0, 1 and 2 is imposed to ensure a positive conditional variance, σ_t^2.

As demonstrated in Engle and Bollerslev (1986), Chou (1988), Bollerslev et al. (1992), the persistence of the shocks to volatility depends on the sum of $\alpha + \beta$. If $\alpha + \beta > 1$, the effect of shocks on volatility tends to vanish over time. On the other hand, $\alpha + \beta > 1$ implies increasing, or indefinite volatility persistence. As proposed by Poterba and Summers (1987), a significant impact of volatility on stock prices requires the persistence of shock to volatility for a long time.

We also extend our estimation methodology by employing an AR(1)-EGARCH(1,1)-M model. This model extension provides a robust estimation, as it allows for asymmetric response to volatility. Table 3 presents the empirical results from AR(1)-GARCH(1,1)-M and AR(1)-EGARCH(1,1)-M models for the three periods. From the EGARCH model the estimated price of risk for the first period is 3.49, but appears to be insignificant implying that risk was not a primary determinant factor for returns before the market crash in February 2006.

However, the situation changes after the market collapse. The estimated risk coefficient for the post-crash period is 3.66 (in absolute value) and is also significant. The coefficient for the full sample is 3.24 (in absolute value) and is also statistically significant. These results indicate that, after the market crash, investors have become more aware of the risk involved in their investments.

Table (3): Parameter estimation under two model specifications for the three sample periods:

Parameter	**Model specification**	
	AR(1)-GARCH(1,1)-M	AR(1)-EGARCH(1,1)-M
Jan 1st, 2003 – Feb 28th, 2006		
	Mean Equation:	
μ	0.0025 (0.00)	0.001 (0.00)
δ	2.028 (0.50)	3.49 (0.27)
φ	0.021 (0.59)	0.056 (0.11)
	Variance Equation:	
ω	0.00 (0.00)	-1.25 (0.00)
α	0.33 (0.00)	0.49 (0.00)
β	0.67 (0.00)	0.9 (0.00)
γ	-	-0.11 (0.00)
Mar 1st , 2006 – Dec 31st , 2010		
	Mean equation:	
μ	0.001 (0.03)	0.0007 (0.085)
δ	-2.19 (0.18)	-3.66 (0.023)

φ	0.1 (0.006)	0.09 (0.004)
	Variance Equation:	
ω	0.000002 (0.0003)	-0.34 (0.00)
α	0.122 (0.00)	0.253 (0.00)
β	0.88 (0.00)	0.98 (0.00)
γ	-	-0.09 (0.00)
Jan 1st, 2003 – Dec 31st, 2010		
	Mean Equation:	
μ	0.002 (0.00)	0.002 (0.00)
δ	-2.14 (0.10)	-3.24 (0.016)
φ	0.076 (0.002)	0.083 (0.0003)
	Variance Equation:	
ω	0.000004 (0.00)	-0.54 (0.00)
α	0.19 (0.00)	0.34 (0.00)
β	0.82 (0.00)	0.96 (0.00)
γ	-	-0.09 (0.00)

*P-values in brackets.

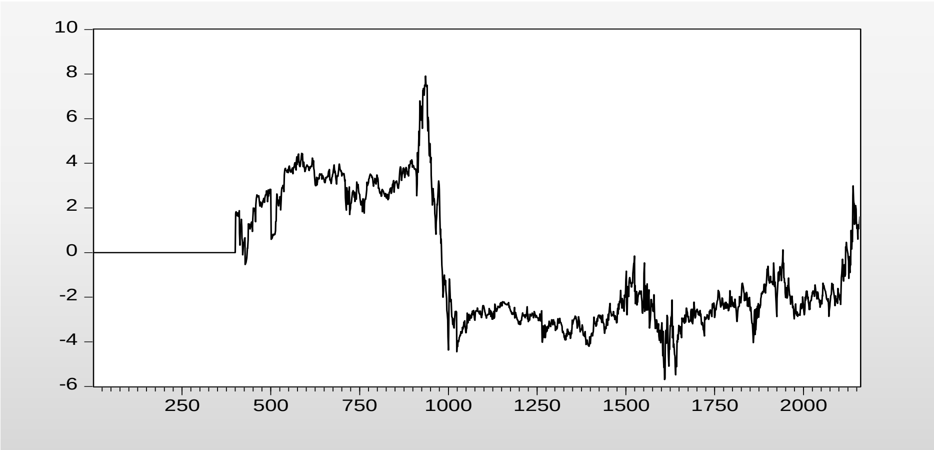
4.2. Models with Time Varying Risk Aversion

In the extant literature, there is profound evidence which suggests that risk aversion is time varying (e.g., Campbell and Cochrane (1999)). Drawing on the main implications in this regard from the recent literature, we employ the GARCH-M framework in an attempt to estimate the time-varying risk parameter for equity market participants. Although a standard GARCH model assumes time varying risk represented by volatility, it also assumes a constant coefficient of risk aversion (i.e., constant δ) across time. This implies that an investor's attitude towards risk does not change over time even if market characteristics change. This assumption has been questioned by many researchers. Chou, Engle and Kane (1992), Li (2007), Ahn and Shrestha (2009) have all argued that the price of risk is time-varying. Indeed, many studies have shown different estimated values for the price of risk across different sample periods. French, Schwert, and Stambaugh (1987), for example, reported different estimates for the parameter of risk across the different subsamples they used. Their estimates ranged from 1.5 for the period 1928-1952 to 7.2 for the period 1952-1984. In fact, the different estimates of risk aversion we find between the two sub-samples give initial evidence that risk aversion has changed over time. Thus, we next propose modeling this time variation in risk aversion.

4.2.1. Rolling Sample Estimation

To examine the behavior of the coefficient of risk aversion over time, we perform a rolling sample regression. The AR(1)-GARCH(1,1)-M coefficients are estimated for each day in the sample. The estimation procedure is to estimate each day's risk aversion coefficient by rolling a sample of 400 observations. We start by taking a window size that contains the first 400 observations, estimating the coefficient for the observation number 401, and then rolling the sample one step ahead to estimate the observation 402, and so on. The estimation procedure yields a series of estimated risk/return coefficients. Figure 1 illustrates the daily movement of investor's risk aversion through the sample period excluding the first 400 observations, which account for about a two-year period.

Figure 1: Rolling regression for the movement in the price of risk (2003 - 2010)



The risk/return coefficient appears to be strongly varying during the sample period, ranging from around -6 to 8. It is interesting to notice how the risk/return relation dramatically changed around the observation number 1000, which coincides with the time when the equity market collapsed on February 26th, 2006. This dramatic change gives a preliminary view on how investors changed their perspective on pricing the risk they bear.

4.2.2. Estimation Using the Kalman Filter

The rolling sample estimation, however, has its drawbacks. First, the estimation still assumes a fixed parameter during the window sample size of 400 observations. Additionally, the rolling sample results show large changes in the parameter's estimate which are unlikely to occur on a daily basis. And last but not least, using the Kalman filter provides a much more robust estimation method as it incorporates the arrival of new information in the estimation procedure. We represent our model in state space form, where price of risk is assumed to follow a random walk process.

$$R_t = \mu_t + \delta_t \sigma_t^2 + \epsilon_t \qquad (17)$$

$$\sigma_t^2 = \omega + \alpha \varepsilon_{t-1}^2 + \beta \sigma_{t-1}^2 \qquad (18)$$

$$\mu_t = \mu_{t-1} + n_t \qquad (19)$$

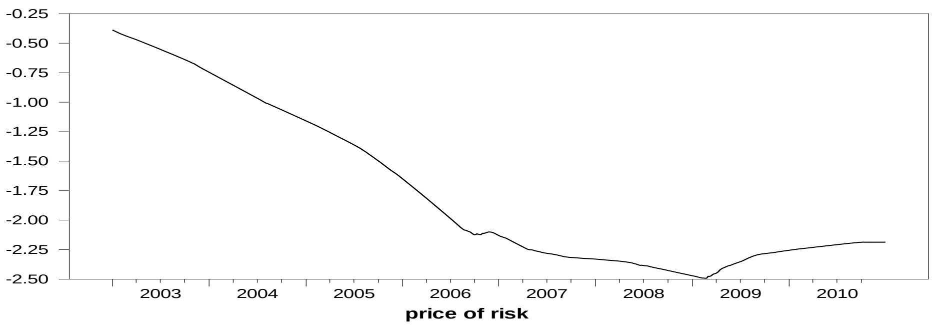
$$\delta_t = \delta_{t-1} + v_t \qquad (20)$$

In this model, the risk aversion coefficient follows a stochastic process. Figure 2 illustrates the behavior of the price of risk estimated through Kalman filtering. The price of risk ranges in absolute value from around 0.3 to 2.5. It increases during the sample period up to the third quarter of 2008, but starts to decline afterwards. Barsky's (1989) analysis of the return/risk relation can shed good light on explaining why our estimated parameters behave in such a way. The sign of the coefficient is determined by investors' aversion towards intertemporal substitution known as the precautionary saving effect. According to the precautionary saving effect, the increase in volatility induces investors to save more, which increases asset demand and, thus, lowers its required return. The magnitude, however, is determined by investor's aversion towards risk.

Therefore, looking at our results, we see how investor's risk aversion has been increasing during most of the sample period reflecting the increase in investor's awareness of the risk factor involved in his/her investment. This, in turn, shows how investors developed more sophisticated skills in managing their investments, as opposed to the relatively less sophisticated skills they started with. Our results from fixed parameter estimation confirm this conclusion, as the estimated pre-crash price of the risk coefficient is insignificant, indicating that risk was not a primary factor in investor’s decision-making process. This result is in line with other results found by other studies that conclude there is an insignificant risk-return relationship in emerging markets (see for example, Patel and Patel, 2011, Kovacic, 2008). As time goes on, however, the coefficient becomes more and more significant, especially during the post-crash period.

These findings provide support towards the existence of herding behavior in the market. Avery and Zemsky (1998), show that the level of uncertainty in imperfect markets is positively related to “short run” herding behavior. Thus, in an emerging market that is characterized by market imperfection, and with our findings of increasing risk aversion, Saudi investors are tempted to react in a herding behavior to shocks of either signs in the market. This can be seen in the Saudi market bubble and collapse in 2006. An increase in risk aversion coupled with market imperfection led investors to enter the market in large groups, causing a bubble. However, once the major investors foresaw the riskiness of their investments due to speculative behavior, they started exiting the market. This market exit again led to a herding reaction by other investors, which in turn led to the collapse in February 2006.

Figure 2: Kalman filter estimation for price of risk



5. Policy Implications

These findings have important implications for risk analysis. First, they provide supporting evidence that risk aversion is time variant. This evidence is new for an emerging market. Second, they explain the dynamic nature of risk aversion and investors' risk perception during financial crises. Third, the results can form a guideline to regulators and central banks. A clear understanding of investors' risk preference is vital for central banks in order to set appropriate monetary policy that builds central bank credibility and eliminates macroeconomic ambiguity. To illustrate this point further, consider the Japanese liquidity trap. Even though the Japanese central bank has cut interest rates down to its zero lower bound, investors are still reluctant to invest and are holding onto their money. This can be attributed to high levels of risk aversion within the Japanese economy, which led banks to keep the cash in their vaults in fear of bank runs, and caused investors to prefer holding the cash as a liquid asset to protect themselves against the uncertain future. This liquidity trap has limited the central bank's ability to stimulate the economy which weakened its credibility among economic agents. This credibility is, as argued by Granville and Mallick (2009), crucial to ensure stability in financial markets. Furthermore, prospective future research can be built upon these findings to study investors' reaction towards any announced structural changes in imperfect and incomplete markets other than the Saudi Stock Exchange.

Investors' risk aversion has its implications for macroeconomic policies. Governments that plan to expand their fiscal policies must be fully aware of the level of risk aversion that prevails domestically. Fiscal expansions are normally financed through relying on the credit market where governments can sell their bonds. If aggregate risk aversion is at high levels, governments may find it difficult to sell their bonds to finance their fiscal expansion plans. Consequently, they will have to go through one of two costly channels to acquire the fund needed. The first is to offer high yields on their bonds to attract the highly risk-averse investors in the domestic market. This may impose a downward pressure on their bond prices leading to some undesirable consequences on the financial system and the real economy putting fiscal sustainability at risk. The other channel is to turn to the international credit market, which is a riskier alternative and more restrictive. Therefore, it is important that policy makers be aware of the prevailing level of risk aversion in the market and ensure that it is kept within a sustainable level.

Last but not least, the results can be generalized to provide policy implications to hypothetical situations that may occur in other markets that share similar characteristics. For instance, as China and Saudi Arabia share similar monetary policy arrangements and are export-driven economies but differ only in the restriction on capital flow, our economic inference can provide a good guide to Chinese policy makers on how the market may behave if their capital flow restriction were relaxed.

6. Conclusion

There are few studies that have attempted to explain the behavior of stock returns in Saudi Arabia. However, to the best of our knowledge, none has related the movement in return's to investor's behavior towards financial risk. In this paper, we have studied the effect of investor's price of risk in the stock market of Saudi Arabia. Our data consisted of two periods: a pre-market crash and a post-market crash period. We started our analysis by assuming a fixed price of risk over time. We found that, in an EGARCH-M model specification, risk did not have a significant effect on return for the pre-crash period. This indicates that investors, during that period, did not consider risk to be a major factor for their required return. Yet, the situation changes after the market collapse on February 26, 2006, after which the price of risk becomes statistically significant and investors become more risk avert. When relaxing the assumption of constant risk aversion over time, these results were confirmed. The price of risk increases in absolute value as time goes on, except for the last year in the sample, where volatility seemed to stabilize relatively.

This result shows how investors have become more aware of the risk involved in their investments as time goes on. These results have some significant implications for policy makers. First, they emphasize the importance of transparent information in the financial system. Authorities should make sure that all information is available for investors to allow them to account for any possible risk they may encounter in their investments and reduce the possibility of herding behavior. They also should put emphasis on educating investors in the risk prospects of the investment and how to account for risk when making investments. Knowledge of some risk analysis tools such as portfolio diversification will ensure lowering volatility and thus stabilize the financial market. Additionally, the results will help market legislators in their mission of keeping the market stable and under control. Additionally, understanding investors' behavior towards risk can help those legislators implement effective laws to curb any aggressive behavior from the investor side. It also helps understand the implications and cost of introducing new macroeconomic policies such as fiscal expansions.

Finally, the results have their implications on policy maker decisions in developing economies that face the same circumstances as Saudi Arabia. Having an economy that is export driven and a pegged currency exchange rate to the dollar makes Saudi Arabia a good case study for other emerging countries in the region. GCC countries can be a good example as well. They share similar aspects with Saudi Arabia when it comes to the level of market development, monetary policy and dependence on exports. The major difference though is the variation in the level of capital flow control. So, for policy makers or researchers, one can draw a conclusion of the effect of changing the restrictions on capital flow in GCC countries on their stock markets and financial systems by considering a case study such as the one at hand.

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