MACROECONOMIC DETERMINANTS OF THE STOCK MARKET MOVEMENTS: EMPIRICAL EVIDENCE FROM THE SAUDI STOCK MARKET

By

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B.A., IMAM MUHAMMAD IBN SAUD ISLAMIC UNIVERSITY, 1988
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AN ABSTRACT OF A DISSERTATION

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Abstract

This dissertation investigates the long run and short run relationships between Saudi stock market returns and eight macroeconomic variables. We investigate the ability of these variables to predict the level and volatility of Saudi stock market returns. A wide range of Vector autoregression (VAR) and generalized autoregressive conditional heteroskedasticity (GARCH) models estimated and interpreted.

A Johansen-Juselius cointegration test indicates a positive long run relationship between the Saudi stock price index and the M2 money supply, bank credit, and the price of oil, and a negative long run relationship with the M1 money supply, the short term interest rate, inflation, and the U.S. stock market. An estimated vector error correction model (VECM) suggests significant unidirectional short run causal relationships between Saudi stock market returns and the money supply and inflation. The VECM also finds a significant long run causal relationship among the macroeconomic variables in the system. The estimated speed of adjustment indicates that the Saudi stock market converges to the equilibrium within half a year. Granger causality tests show no causal relationship between Saudi stock market returns and the exchange rate.

Impulse response function analysis shows no significant relationship between Saudi stock market returns and the macroeconomic variables. Forecast error variance decompositions suggest that 89% of the variation in Saudi stock market returns is attributable to its own shock, which implies that Saudi stock market returns are largely independent of the macroeconomic variables in the system. Finally, a GARCH-X model indicates a significant relationship between volatility of Saudi stock returns and short run movements of macroeconomic variables.

Implications of this study include the following. (i) Prediction of stock market returns becomes more difficult as the volatility of the macroeconomic variables increases in the short run. (ii) Investors should look at the systematic risks revealed by these macroeconomic variables when structuring their portfolios and diversification strategies. (iii) Policymakers should seek to minimize macroeconomic fluctuations considering the effect of macroeconomic variables changes on the stock market when formulating economic policy.

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Abbreviations

ACF: Autocorrelation function.

ADF: Augmented Dickey-Fuller (1979) unit root test.

AIC: Akaike Information Criterion.

AMFI: Arab Monetary Fund Index.

APT: Arbitrage price theory.

ARCH: Autoregressive conditional heteroskedasticity proposed by Engle (1982).

BC: Bank Credits in Saudi Economy.

BOP: Brent oil price.

CAPM: Capital asset price model.

CCFI: Consulting Centre for Finance and Investment.

CMA: Capital Market Authority in Saudi Arabia.

CML: Capital Market Law in Saudi Arabia.

CPI: Consumer Price Index (2005=100).

ECM: Error correction model.

ECT: Error-correction term.

EGX: Egyptian Exchange.

EMH: Efficient market hypothesis.

ESIS: Electronic Share Information System.

Ex: Exchange Rate.

FEVD: Forecast error variance decomposition.

FPE: Final prediction error.

GARCH: Generalized Autoregressive conditional heteroskedasticity model proposed by Bollerslev (1986).

GARCH-X: An extension of the Generalized Autoregressive conditional heteroskedasticity proposed by Lee (1994).

GCC: Gulf Cooperation Council, which consists of six Arab states including: Saudi Arabia, Kuwait, Bahrain, Qatar, the United Arab Emirates, and the Sultanate of Oman.

HQ: Hannan-Quinn information criterion.

IFS: International finical statistics.

IMF: International Monetary Fund.

IRF: Impulse response function.

Isa3: Three-month Saudi Short term interest rate.

ISE: Istanbul Stock Exchange.

LR: log likelihood ratio.

M1: Narrow Money Supply that consists of Currency outside banks and demand deposits.

M2: Narrow Money Supply that consists of M1and time and savings deposits.

MC: Market Capitalization.

NCFEI: National Center for Financial and Economic Information.

NEER: Nominal effective exchange rate index.

NYSE: New York Stock Exchange

PACF: Partial autocorrelation function.

PIF: Public Investment Fund in Saudi Arabia.

PP: Phillips-Perron (1988) unit root test.

PVM: Present Value Model.

S&P 500: Standard and Poor 500 Index

SABIC: Saudi Arabia Basic Industries Corporation.

SAIBOR: Saudi Arabia Interbank Offered Rate Interest Rate.

SAIF: Saudi Arabian Investment Fund.

SAMA: Saudi Arabian Monetary Agency, the central bank in Saudi Arabia.

SIC: Schwarz information criterion.

SSE: Saudi Stock Exchange.

SSRC: Saudi Share Registration Company.

TASI: Tadawul All Share Index, the general share price index of the Saudi stock market.

VAR: Vector autoregressive.

VECM: Vector Error Correction Model.

VST: Value of Shares Traded.

WTI: Western Texas intermediate oil price.

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Dedication

To the Soul of The founder of Saudi Arabia,

King Abdul-Aziz Al Saud

who endeavor to modernize my beloved country through many wonderful public ventures that allowed me among others to achieve our Dreams.

Chapter 1 : Introduction

The stock market plays a vital role in the modern economy since it acts as a mediator between lenders and borrowers. That is, a well-functioning stock market may assist the development process in an economy through two important channels: boosting savings and allowing for a more efficient allocation of resources. Savings are presumed to increase as the stock market provides households with assets that may satisfy their risk preferences and liquidity needs (Leigh, 1997). Also, based upon the idea of the price mechanism, a well-functioning stock market values profitable company's shares more than those of unsuccessful companies. That is, relative share prices in a well-functioning stock market may fundamentally reflect the status of a company compared to the other companies listed in the stock market, i.e., the expected dividend growth and discount rates. Therefore, the price mechanism ensures the efficiency of utilizing current and future economic resources available to the economy in the sense that the cost of capital to the profitable company will be lower compared to the cost that the unsuccessful companies would face (Lamin, 1997).

It is, also, well established that volatility characterizes the behavior of the stock market (Mandelbrot, 1963; Black, 1976). The most direct definition of volatility is the relative rate at which the price of a security moves up and down within a very short period of time (Taylor, 2007). Typically volatility is calculated by variance or the standard deviation of the price of stock market returns. A highly volatile market means that prices or stock returns have enormous swings over a specific time; i.e., day, week, month or year. In light of this definition, volatility can be considered as a measurement of the uncertainty or the risk that is associated with stock market investment decisions (Alexander, 2007 and Taylor, 2007).

Excessive volatility may prevent the smooth functioning of financial markets and adversely affect the performance of the economy. The Wall Street Crash of 1929, Black Monday on October 19, 1987, The Asian Crisis of 1997, and recently the Global Financial Crisis of 2008 are examples of the stock market's effects on the domestic and global economies[1]. Thus, understanding the dynamic behavior of the stock market is crucial for financial analysts, macroeconomists, and policymakers. Financial analysts and investors are interested in understanding the nature of volatility patterns of financial assets, and what events can alter and determine the persistence of volatility over time (Malik, 2004). This type of information is significant to build an accurate volatility model which may help to analyze the risk of holding an asset, and provide indicators for investors to diversify their portfolios. Also, volatility plays a central role in determining investment spending. That is, excessive volatility may cause investors in financial markets to shift their funds towards risk-free assets rather than investing in new, riskier assets.

From a different perspective, hand, Fischer and Merton (1985) argue that macroeconomists should follow the stock market because it is a good predictor of the business cycle and the components of the gross national product (GNP) [2]. Bernanke and Gertler (1999) and Bernanke and Kuttner (2005), discuss the implications of financial market volatility on

[1] For instance, in the stock market collapse of October 19, 1987, the Dow Jones lost 508 points in one day, which was the largest one-day percentage drop in United States (U.S) stock market history, and consequently, affected the global markets (Report of the U.S Presidential Task Force on Market Mechanisms, Washington, D.C. January 1988).

[2] According to Fischer and Merton (1985) there are other three possible explanations for why macroeconomists ignoring the stock market role compared to financial analysts: *"(1) the interest rate is the appropriate indicator of the cost of the capital, even in an uncertain environment; (2) in a general equilibrium sense, all prices are endogenous and such a narrow focus would, therefore, rule out interest in any financial market variables; and (3) widespread distrust of the reliability of the stock prices as indicators or causes of investment because it is believed the stock market participants are rather poorly informed and/or that stock prices are significantly influenced by irrational waves of optimism and pessimism among investors"*.

monetary policy. Garner (1988) found that the 1987 crash in the U.S. stock market reduced consumer spending in the American economy. In their 1985 study, Fischer and Merton use a simple regression model to distinguish between the functions of financial analysts and economists. According to them, macroeconomists care most about the effect of explanatory variables in their models, while the noise, or unforecastable component, is the primary interest of financial analysts. Policymakers, however, want to learn about the behavior of the stock market and, more importantly, discover how the behavior of the stock market is linked to the real economy. In fact, this type of information can be used to predict the path of an economy's growth and to enhance market rules and regulations (Krainer, 2002; Poon and Granger, 2003).

The existing literature provides a number of theories illustrating the link between stock market behavior and economic activity as proxied by different macroeconomic variables. Among these theories are the efficient market hypothesis (EMH) and asset pricing theory. The EMH implies that stock market prices fully and rationally incorporate all relevant information. Thus, past information is useless in predicting future asset prices. For that reason, only new, relevant information is used to explain stock market movements (Fama, 1965). Asset pricing theory such as the arbitrage price theory (APT), and the Present Value Model (PVM), illustrates the dynamic relationship between the stock market and economic activities (Ross, 1976, and Semmler, 2006).

In the last three decades, numerous empirical studies have examined the dynamic relationships between stock market behavior and economic activity, particularly for developed stock markets such as the U.S., United Kingdom (UK), Germany, and Japan; examples of pioneer studies are Fama (1981, 1990), Geske and Roll (1983), and Chen, Roll, and Ross (1986). Related studies are different in terms of their hypotheses and the methods used. Several studies

investigated the predictive power of stock returns for real economic activity[3]. These studies stress the issues of market efficiency[4], or the existence of the efficient market hypothesis. A large body of research focuses on the integration of stock markets across economies[5]. Other previous studies have examined the short and long run relationship between stock prices or returns and some macroeconomic and financial variables such as inflation, interest rate, output, etc. Within this group of studies, some studies seek to examine local and international economic factors that affect stock prices or returns, while others examine factors that determine stock return volatility (Semmler, 2006). Some other explores the role of monetary policy in responding to or altering the stock market (Sellin, 2001).

From the literature review conducted in this study, it is apparent that the research in all dimensions has been extensive for developed economies such as the U.S. However, research on the relationship between real economic activity and the stock market in developing countries, such as Latin American, Eastern Europe, Middle Eastern, and South Asian countries, is still ongoing.

With regard to the Saudi Arabian economy, little work has been done on the dynamic relationships between the stock market and real economic activity. To the best of this researcher's knowledge, there is no published work considering both the short and long run dynamic relationships between the Saudi stock market behavior and real economic activity. This serves as the primary motivation for this dissertation. The objective is to investigate macroeconomic determinants of the Saudi stock market movements in the long and short run

[3] Examples of these studies are Estrella, and Hardouvelis (1991); Estrella, and Mishkin (1996), and Domain, and Louton (1997).

[4] An early survey on the behavior of stock market price (return) from that prospective was done by Fama (1970).

[5] Examples of such studies are Arshanapalli and Doukas, J. (1993), Becker, Finnerty, and Friedman (1995); Jeon and Chiang (1991); Jeon, and Chiang (1991); Kasa (1992); and Longin, and Solnik (1995).

during the period from January, 1993 to December, 2009. We use vector autoregressive (VAR) and generalized autoregressive conditional heteroskedasticity (GARCH) model represented by Bollerslev's (1986), and Lee's (1994) GARCH-X model. All models will be discussed in further details in chapter 5. Some of the closest papers in the literature are Abdullah and Hayworth (1993), Abdullah (1998), Chaudhuri, and Smiles (2004), Gan et al. (2006), Gjerde and Saettem (1999), Gunasekarage et al. (2004), Hasan and Javed (2009), Hondroyiannis and Papapetrou (2001), Humpe and Macmillan (2009), Ibrahim (1999), Kapital (1998), Keung et al. (2006), Kim and Moreno (1994), Malik and Hammoudeh (2007), Maysami et al. (2004), Mukherjee and Naka (1995), Najand and Rahman (1991), Patra et al. (2006), Rahman and Mustafa (2008), Ratanapakorn and Sharma (2007), and Sadorsky (1999).

1.1. Statement of the Problem and Research Questions

The Saudi stock market was established formally in 1984 and is one of the leading emerging markets in the Arab world. In fact, the Saudi stock market ranked first in the Arab world with capital of 319 U.S. billion dollars or 35% of the total market capitalization of Arab stock markets at the end of 2009. From 1993-2009, Tadawul All Shares Index (TASI), the general price index of the Saudi stock market, witnessed six major collapses during the years 1986, 1990, 1993, 1994, 1998, 2006, and 2008. During these collapses, the TASI lost a tremendous amount of its value and wiped out tens of billions of Riyals[6]. For example, in the collapse of 2006, the TASI lost 8,779 points or 53% of its value compared to its value in 2005. The total assets of investment funds in domestic and foreign currencies decreased by 52.8 billion Riyals (or 38.5%) to end at 84.2 billion Riyals at the end of 2006 (SAMA Annual Report, 2007).

[6] Riyal is the home currency in Saudi Arabia.

In the most recent collapse of 2008, the TASI closed at 4802.99 at the end of 2008 compared to 11,038 at the end of 2007, a decrease of 56%. As a result, the total assets of investment funds decreased by 30.3 billion Riyals (or 29%) to end at 74.8 billion Riyals (SAMA Annual Report, 2009). In each collapse, thousands of stock market investors lost significant amounts of their personal wealth, and a large majority of them accumulated some degree of financial debt, which caused sizeable social complaints.

The Saudi authorities were neutral during the crash periods. It can be argued that this neutrality can be explained partially by identifying the problem's causes given that there were no fundamental changes in the Saudi economy associated with or preceding these collapses. Previous studies like Fama (1981, 1990), Geske and Roll (1983), and Chen, Roll, and Ross (1986), and Schwert (1989), among others, indicate a link between increased price volatility in the stock market to the movements of macroeconomic variables. Therefore, it is important to explore the relationship between the Saudi stock market and a set of macroeconomic variables to shed light on the relationship, if any, between real economic activity and the behavior of the stock market in Saudi Arabia. The objective is to observe whether macroeconomic factors individually and/or collectively contribute to the dynamics of the Saudi stock market. In particular, this work seeks to examine the long and short run dynamic relationships between TASI and eight macroeconomic variables over the period of time from January 1993 to December 2009[7]. These macroeconomic variables are: two different measures of the money supply (M1, M2); a proxy for short term interest rates on the Saudi Riyal, 3-month Saudi Arabia Interbank Offered Rate (SAIBOR or for simplicity Isa3); the Consumer Price Index (CPI) in the

[7] It is worth mentioning that GDP or IP and the Saudi government's spending were not included in the analysis because monthly data for these variables are not currently available. Inclusion of these variables would be a significant addition to future research to account for the impact of real activity and the effect of the public sector, given that the Saudi government owns all oil revenues, on the Saudi stock market behavior.

Saudi economy; the claims on private sector or Bank credit (BC); a proxy for world crude oil prices; the UK Brent crude oil (BOP); the nominal effective exchange rate (NEER or for simplicity Ex); and Standard & Poor's stock price index 500 (S&P 500) as a proxy for the influence of the U.S. stock on the local stock market (see Table 1.1 for the specific definition of these variables).

These variables were selected for two important reasons. First, these variables are commonly used in the literature to examine the theoretical links between stock market and economic activity (see chapter three for the literature review). The specific motivation for each of the variables is discussed in detail in chapter four. Second, these variables are available at a monthly frequency. Overall, the goal of this study is to answer the following five questions:

Q1. Do the eight key macroeconomic variables included in this study share long-run equilibrium relationships with the Saudi stock market proxied by the general price index, TASI?

Q2. Do these nine key macroeconomic variables have causal relationships during the sample time period? If so, what is the direction of the causality between TASI and each of these variables?

Q3. How does TASI dynamically respond to a shock from any of these variables?

Q4. To what extent can innovations in each of the eight key macroeconomic variables explain the movements in the TASI?

Q5. Does the volatility of these eight macroeconomic variables influence the Saudi stock market return volatility?

Answers to these five questions will be obtained using different techniques. The first four questions will be answered using the Johansen and Juselius (1990) multivariate cointegration test, the Granger (1969) causality test and/or Engel-Granger (1987) causality tests, impulse response function (IRF) and forecast error variance decomposition (FEVD) analysis. The

standard Bollerslev (1986) GARCH (p, q) model, and Lee (1994) GARCH-X (p, q) and two other GARCH-X models will be employed to answer the final question. All of these techniques will be explained in detail later in the dissertation.

Table 1.1: Definitions and Sources of the Data

Variables Symbol	Definition	Source
Saudi Share Price Index (TASI)	Tadawul All Share Index (TASI), the general share price index of the Saudi stock market and calculated as:$\Delta TASI_t = TASI_t - TASI_{t-1}$	Database of Saudi Stock Exchange Company www.tadawul.com.sa
Money Supply (M1, M2)	M1: Currency outside banks + demand deposits. M2: M1+ time & savings deposits. The growth of these two figures is calculated as:$\Delta Mi_t = Mi_t - Mi_{t-1}$, $where\ i = 1,2$	Saudi Arabia Monetary Agency SAMA http://www.sama.gov.sa
Interest Rate (Isa3)	Three-month Saudi Arabia Interbank Offered Rate (SAIBOR) (henceforth (Isa3)) is the rate of interest at which banks offer to lend money to one another in the Saudi money market and calculated as: $\Delta Isa3_t = Isa3_t - Isa3_{t-1}$	Saudi Arabia Monetary Agency SAMA http://www.sama.gov.sa
Inflation (CPI)	Consumer Price Index (2005=100). This variable serves as a proxy for inflation in the Saudi economy, which is calculated as: $\Delta CPI_t = CPI_t - CPI_{t-1}$	IFS, Code 45664
Bank Credits (BC)	Claims on the private sector, which includes gross credit from the financial system to individuals, enterprises, and investments in private securities. $\Delta BC_t = BC_t - BC_{t-1}$	IFS, Code 45632DZF
World Oil Prices (BOP)	The Brent oil price is a price of oil and calculated as: $\Delta BOP_t = BOP_t - OPC_{t-1}$	IFS, Code 11276AAZZF
Exchange Rate (Ex)	Nominal effective exchange rate index (NEER) (henceforth (Ex)) of the Saudi Riyal is the weighted average of the nominal exchange rate of the home currency (Saudi Riyal) in terms of the major trade partner's currencies. If exchange rate (Ex) is above 100, then the local currency shows appreciation, otherwise, depreciation of the home currency exists against a basket of selected trade partner currencies. This index, used to reflect changes in exchange rate for the Saudi currency, is calculated as: $\Delta Ex_t = NEER_t - NEER_{t-1}$	IFS, Code 456NECZF
Standard and Poor 500 Index (S&P 500)	The Standard and Poor's price index (S&P 500) is a free-float capitalization-weighted index of 500 Large-Cap common stocks actively traded in the U.S. S&P 500 includes the stocks of the large publicly held companies that are traded on either of the two largest American stock market companies: the NYSE Euronext and the NASDAQ OMX. This index used as a representative stock return in the U.S. economy and calculated as: $\Delta S\&P500_t = S\&P500_t - S\&P500_{t-1}$	Yahoo, Finance http://finance.yahoo.com/

Notes: All series are monthly data transformed to natural logarithms except for the interest rate (Isa3). Δ indicates the first difference.

1.2. Significance of the Research

This dissertation is expected to add several primary contributions to the existing literature. First, it will extend the literature by examining the relationship of the stock market with a set of macroeconomic variables in a unique emerging market, the Saudi economy[8]. Second, this study will apply seven different econometric methods, which may provide insight for the existing literature if the analysis is sensitive to the methods employed. To the best of my knowledge, this is the first study to estimate a GARCH-X model using data on the Saudi economy. The importance of the GARCH-X model is that it allows for examination of the link between short-run deviations from a long-run cointegrating relationship and volatility. This study is expected to offer some insights for Saudi policymakers, shareholders, and portfolio managers. Policymakers are mainly interested in exploring the determinants of the stock market, and how stock market shocks spillover to real economic activity. The efficient market hypothesis (EMH) implies that portfolio diversification benefits from a low correlation between stock market indexes and all relevant information that is publicly available. In that sense, this study is also significant to shareholders and portfolio managers.

The remainder of this dissertation is organized in eight chapters. Chapter 2 will introduce the Saudi stock market, with a focus on its main characteristics and performance since its inception. Chapter 3 presents the theoretical background linking the stock market to economic theory and provides justification for the inclusion of the nine key macroeconomic variables in

[8] The uniqueness comes from the fact that the Saudi economy is commonly considered a small open oil based economy. In fact, oil revenue represents about 80-90% of total export earnings, which account for more than 75% of the government's annual budget. This, in particular, enables Saudi governments to play a significant role in all aspects of the local economy, which distinguishes the structure and institutional characteristics of the Saudi economy from other economies worldwide. Therefore, it is reasonable to presume that any shock to the global economy can have a tremendous impact on the structure of the Saudi economy and subsequently the stock market.

this analysis. Chapter 4 discusses related empirical studies available in the literature and highlights those studies that implemented the same methods adopted in this research. Chapter 5 outlines the methodology that will be utilized in addressing the five research questions. Chapter 6 describes the data and presents the empirical results by means of VAR models. Chapter 7 presents the empirical results by means of GARCH-family models. The final chapter provides conclusions and implications.

Chapter 2 : Saudi Stock Market Overview

This chapter aims to present a historical review of the development stages with respect to structural, operational, and regulatory characteristics of the Saudi stock market since its inception in 1935. A statistical review of the performance of the Saudi stock market over the sample period from 1993 to 2010 is also provided.

2.1: Historical Development of the Saudi Stock Market

The history of the Saudi stock market can be traced back to 1935 when the Arab Automobile company's shares were made available to the public (SAMA Annual Report, 1997). Since 1935, the Saudi stock market can be classified, for study purpose, into three development stages depending on its structure, operations, and regulation. The first stage, the initial stage, covers the period of time from 1935 to 1982. This stage started when the Arab Automobile company's shares were made available to the public for the first time in Saudi Arabia in 1935 and ended 1982 when the Ministerial Committee, which consists of the Ministry of Finance and National Economy, SAMA, and the Ministry of Commerce, was formed to regulate and govern the Saudi stock market (SAMA Annual Report, 1997). The second stage, the established stage, began when the Ministerial Committee started to formulate the Saudi Stock market in 1983 and ended in 2002 when the Capital Market Law (CML) issued by Royal Decree No (M/30) on July 31, 2003. The present stage, modernized stage, started when the Capital Market Authority began to enforce to the CML in 2003 to the present. In the following three subsections, we present some essential aspects of each of the three development stages.

2.1.1: Stage I: Initial Stage (1935-1982)

In the initial stage, developing the Saudi stock market was not a priority for the Saudi authorities. As a result, the Saudi stock market remained informal and primitive. Two factors hindered the advancement of the stock market during this phase. First, this initial stage coincided with the early economic development phase of the Saudi economy. During this time, the primary economic objectives were to build the infrastructure, develop human resources, and increase the standard of living for the Saudi citizens, and thus little effort was focused on developing the stock market. Second, the discovery of massive oil resources meant that Saudi Arabia was endowed with an enormous amount of wealth in a short period of time. Since the government in Saudi Arabia is the owner of the oil revenues, it created special credit institutions to channel interest-free loans to the corporate sectors[9]. Therefore, the stock market was not the main source of funds for the corporate sector, and consequently, little attention was placed on advancing the stock market (Molivor and Abbondante, 1980).

Abdeen and Shook (1984) extensively studied the initial stage and made several conclusions about the main characteristics of the Saudi stock market. First, there was no organized legal framework for the proposed stock market. Instead, there were three government agents that commanded the stock market independently: the Ministry of Finance and National Economy, Saudi Arabian Monetary Agency (SAMA)[10], and the Ministry of Commerce. Thus, there was no one official policy to regulate the stock market activities. Second, there were a

[9] Some of these special credit institutions are the Saudi Arabian Agricultural Bank, which was created in 1963 to provide credits and subsidies to the agricultural sector. The Public Investment Fund was created in 1973 to help finance large public ventures. The Saudi Industrial Development Fund was established in 1974 to provide interest-free, medium- and long-term financing of up to 50% of the cost of a private sector project. The Real Estate Development Fund, also founded in 1974, was designed to encourage low and medium income Saudi citizens to build their own homes and private sector to build commercial building.

[10] SAMA is the central bank of Saudi Arabia.

number of unprofessional and unlicensed brokers that have emerged to deal with shares in unhealthy operations and unproductive share ownership control[11]. Third, members of the board and/or its founding members owned a large percentage of the issued shares; however, they were in a position to set the market price depending on what the market would bear at any given point in time. Lastly, most of the Saudi citizens had little understanding of how the stock market functioned. As a result, most transactions were made without concern for the financial position or statements of the firm such as its stability or profitability status (Abdeen and Shook, 1984, Al-Dukheil, 2002).

In addition to these four main characteristics, the limited channels for investment in the local economy compared to the excess cash on hand enabled speculative behavior to dominate the Saudi stock market during its initial stage (Abdeen and Shook, 1984). Molivor and Abbondante (1980) argued that the stock market failed to encourage more public investment in the market; although, there were a few publicly owned enterprises. For example, until 1975 there were only fourteen companies listed on the stock market ("Development Stages", http://www.tadawul.com.sa). However, the oil boom in the late 1970s, the Saudization program for the foreign-owned commercial banks, and the government's privatization strategy for the public companies led to increase the number of listed companies in the saudi stock market to be 38 in 1983 (Molivor and Abbondante, 1980, Abdeen and Shook, 1984).

2.1.2: Stage II: Established Stage (1983 –2002)

Since 1970, the ultimate goal of economic policy adopted by all ongoing five-year development plans in Saudi Arabia has been to lessen the heavy dependence on oil as the main source of national income in Saudi Arabia by diversifying the economic base of the Saudi

[11] Azzam (1997) mentioned that there were about 80 unlicensed brokers in this initial stage.

economy. The first three ongoing development plans (1970-1975, 1976-1980, and 1981-1985) focused on the economic objectives in the initial phases: improving infrastructure, human resources development, and the standard of life for Saudi citizens. After 1986, the subsequent ongoing five-year development plans emphasized the involvement of the private sector in the economy and enticed foreign investment to form joint ventures with the public and private corporations (Niblock and Malik, 2007).

With this economic strategy in place, the Saudi stock market moved into the second development stage, the established stage. In this stage the Saudi government aims to regulate and modernize the capital market to ensure safe and efficient functioning of the stock market, which may help to accomplish the five-year development plan's goals. Although this stage was effective in 1985, the second stage actually began in early 1983 when the Ministerial Committee, which consists of the Ministry of Finance and National Economy, SAMA, and the Ministry of Commerce, was formed to regulate and govern the stock market. According to the SAMA Annual Report (1997), the Ministry of Commerce was directly responsible for the primary market offering and regulation and supervision of joint-stock companies. SAMA, however, was responsible for regulating, supervising, and operating day-to-day business for the stock market. The Ministry of Finance and National Economy worked as the overall government body for regulating and developing the Saudi stock market (Dukheil, 2002).

During the twenty years from 1983 to 2003, the Saudi stock market witnessed significant improvements in almost every aspect including the structure, operation, and regulation of the Saudi stock market. The SAMA Annual Report (1997), Ramady (2005), and Al-Dukheil (2002) reported some of these improvements as being:

1. Intermediation services for share trading were restricted to the 12 commercial banks with a maximum commission of 1%.

2. In 1984, the 12 commercial banks established the Saudi Share Registration Company (SSRC), which provides central registration facilities for joint stock companies and settles and clears all share transactions. From 1984 to 1989, SSRC used automated system for stock market transactions.

3. In 1989, the National Center for Financial and Economic Information (NCFEI)[12] created the general index to measure the performance of the Saudi stock market. The NCFEI index is a capitalization-weighted index with a base value of 100 and the starting date was February 28, 1985. Another general index was launched in 1995, the Consulting Centre for Finance and Investment (CCFI) index, which was created by a private consulting centre in Riyadh (Al-Dukheil, 2002).

4. In 1990, SAMA introduced an electronic system, Electronic Share Information System (ESIS). ESIS concentrates all multi-location equity trading into one single floorless market and processes buy-sell orders from order entry to transfer of ownership.

5. In October 2001, the ESIS was modified and renamed as Tadawul All Share Index (TASI). Unlike its predecessor, Tadawul facilitates a fully integrated trading, depository, clearing, and settlement system with T+0 settlements. It also handles online trading, and has increased the capacity for electronic trading and incorporate instruments other than equities like corporate bonds, government bonds, and mutual funds. TASI also enables all listed companies to report their announcements and their financial statements to the public, banks, and information vendor via the Tadawul website (Tadawul Annual Report, 2002).

6. Compared to the initial stage, participating in the Saudi stock market opened gradually in 1997 to the foreign investors through a wide range of local mutual funds operated by the commercial banks[13].

As a result of these significant reforms, the Saudi stock market overcame some of its previous obstacles by utilizing technology and improving somewhat the regulatory regime. However, Al-Dukheil (2002) argued that the Saudi stock market during the established stage maintained a number of weaknesses that hindered its growth. For instance, the Saudi stock market lacked an independent regulatory authority (Al-Dukheil, 2002). That is, while SAMA

[12] A research center belonging to the Ministry of Finances and National Economy in Saudi Arabia.
[13] The Saudi Arabian Investment Fund (SAIF) established in 1997 by the Saudi-Americans Bank was the first closed-end country mutual fund issued in the market to serve foreign investments in the Saudi stock market.

directly controlled the stock market on a daily basis, the Ministry of Commerce and Ministry of Finance played a significant role in the primary market, i.e., the approval of new companies to be added to the stock market. Also, the Saudi stock market had a poor level of liquidity (29% as of 2002) measured by the turnover ratio, which is defined as value traded compared to market capitalization (Al-Dukheil, 2002). Another weakness is that the listed companies in the Saudi stock market were very small (68 companies as of 2002) compared to the economy size[14]. The shortage of free-floating shares available for trading due to large government holding, family-ownership business and other management groups was also a weakness (Niblock and Malik, 2007). For example, in 2002, the free-floating shares of the Saudi Arabia Basic Industries Corporation (SABIC)[15] are only 30%, while 70% is held by the government (Al-Dukheil, 2002). Transparency and corporate disclosure standards were not present in the early stages to meet the requirement of the international standard. For example, although the companies are by law required to declare their financial results on a quarterly basis, there is no penalty if they fail to fulfill the requirements (Niblock and Malik, 2007). Also, the companies are, in general, more conservative about providing necessary information that is important to investors, shareholders, and research analysts. The Saudi stock market witnessed cases where selective groups affected a particular stock using insider trading information (Niblock and Malik, 2007). Finally, given that trading intermediation was restricted completely to the commercial banks during this phase of development, the Saudi stock market lacked independent brokers and research houses.

[14] Ramady (2005) mentioned that there were 6000 limited companies operating in Saudi Arabia and 1,400 joint venture companies (Saudi-Non Saudi) with a combined 85.5 billion (22.8 billion in USD) shares of capital. This may indicate the potential opportunity for initial public offering (IPO) and for expansion of the stock market base.

[15] SABIC is one of the world's leading manufacturers of chemicals, fertilizers, plastics, and metals. It was established by the Saudi government in September, 1976.

2.1.3: Stage III: Modernized Stage (2003-Present)

In order to overcome the weaknesses associated with the established stage, the Saudi government continued to support the Saudi stock market to accomplish the goals of the ongoing five-year development plans. The establishment of the Capital Market Law (CML) by Royal Decree No (M/30) on July 31, 2003 marks the start of the third stage of the advancement of the Saudi stock market, the modernized stage.

Based on the CML, the Saudi government created the Capital Market Authority (CMA) in 2003. The CMA is an independent government entity that reports directly to the Prime Minister of the Saudi government. Therefore, the CMA has the full authority to enforce the CML and regulate all aspects of the Saudi capital market (CMA Annual Report, 2009). In particular, the CML defines the main functions of the CMA on its website being:

1. Regulate and develop the Exchange, seek to develop and improve methods of systems and entities trading in securities, and develop the procedures that would reduce the risks related to securities transactions

2. Regulate the issuance of securities and monitor and deal Securities

3. Regulate and monitor the works and activities of parties subject to the control and supervision of the Authority

4. Protect citizens and investors in securities from unfair and unsound practices or practices involving fraud, deceit, cheating, or manipulation

5. Seek to achieve fairness, efficiency, and transparency in securities transactions

6. Regulate and monitor the full disclosure of information regarding Securities and their issuers, regulate and monitor the dealings of informed persons and major shareholders and investors, and determine information which participants in the market should provide and disclose to shareholders and the public

7. Regulate proxy and purchase requests and public offers of shares

Ever since its inception, the CMA has continuously focused its efforts on changing the face of the Saudi stock market in order to support the privatization program that has been adopted by the government to diversify the economic base of the Saudi economy. The following points highlight some of the remarkable improvements that have been made to the Saudi stock market:

1. In 2007, the Saudi Stock Exchange (SSE) was established to be the sole entity authorized to carry out the trading of financial securities in Saudi Arabia. The SSE is an independent joint stock company called the "Tadawul" with a capital of 1.2 billion Riyals, and is owned by the Public Investment Fund (PIF). The objectives of the Tadawul Company are to (i) manage securities trading services; and (ii) provide settlement and clearing services of securities, depository and registration of securities ownership, and dissemination of securities information (Tadawul's website). By establishing the SSE, the supervisory and surveillance functions are segregated from the operating function, which was one of the main targets stressed in the CML (CMA Annual Report, 2007).

2. In order to offer high quality disclosure and dissemination of information for the participants, the CMA requires and monitors the following criteria:
   a. If the company plans to be offered on the market for public subscription, the CMA requires that the initial disclosure includes key information about the company[16].
   b. If the company is already listed in the market, the CMA requires that continuous disclosure includes the information and data that is important for participants in the market[17].

3. In order to establish and promote fairness and transparency principles within securities transactions, the CMA publicly shares the following information on the Tadawul website:
   a. The names of the shareholders who hold at least 5% of the company shares.

[16] The initial disclosure contains information such as the following: (1) an adequate description of the issuer, its business, the individuals in charge of its management including members of the board of directors, executive officers and senior officials, and major shareholders; (2) an adequate description of the securities to be issued or offered, in terms of their volume, price, relevant rights, privileges and priorities of the issuer's other securities, if any; (3) a clear statement of the financial position of the issuer and any relevant financial data, including audited balance sheet, profit and loss account, and cash flow statement, and (4) any other relevant information that may be required by the CMA (CMA Annual Report, 2009).

[17] The most important information for Continuous Disclosure contains (1) annual financial statements and reports on closing for the fiscal year; (2) quarterly interim financial statements; (3) any significant developments or events, e.g., material information, about listed companies that could be of importance to investors, and affect the price of a company's securities. Such information must be in full compliance with Tadawul's website prior to release to the press or any other websites; (4) any developments or events related to capital increase or decrease; (5) any changes in the details of the members of the board of directors, senior executives and their relatives, and (6) any changes in the company's articles of association, headquarters, or auditor (CMA Annual Report, 2009).

b. The trade restrict periods for the board of directors and senior executives, in which they are not allowed to buy or sell company shares.

4. To ensure the rights of all participants in the market, on January 23, 2011, the CMA adopted the Resolution of Securities Disputes, which aims to regulate the litigation procedures heard before the Committee of the Resolution of Securities Disputes and the Appeal Panel.

5. In April 2008, the CMA restructured the Saudi stock market sectors based on the nature of business of each listed company and its income and earnings structure. After the new market structure, the Saudi stock market consisted of 15 sectors and 16 indices instead of its previous eight sector and nine indices in the previous stage (CMA Annual Report, 2008).

6. Along with the previous advancement, the TASI and the new sector indices were calculated based on the actual tradable shares, and free-floating shares, (CMA Annual Report, 2008). This allocation will better reflect the price changes in the stock market since the free-floating shares in Tadawul are less than 41% of the issued shares in the previous development stages.

7. In hopes of deepening and liberating the Saudi stock market, the CMA adopted the following actions:
   a. In April 2006, the CMA split the nominal value of share of all listed companies to be ten Riyals per share instead of 50 Riyals (SAMA Annual Report, 2007).
   b. In 2007, the CMA granted the GCC[18] citizens to be treated like Saudi citizens in terms of owning and trading shares in the Saudi stock market (Tadawul Annual Report, 2007).
   c. In 2008, the CMA permitted foreign residents in Saudi Arabia to trade directly on the Saudi stock market (CMA Annual Report, 2009).
   d. In 2008, the CMA permitted foreign non-resident in Saudi Arabia to enter into the Saudi stock market through Swap Agreements, which are a type of financial derivatives in which two parties agree to exchange the cash flow generated from certain assets during a set period of time. Thus, an authorized person, e.g., an institution or individual, is allowed to sign a Swap Agreements with foreign non-resident investors, institutions or individuals, to transfer the economic benefits of the Saudi Companies' Shares listed on Tadawul while the authorized person retains the legal ownership of the shares (Tadawul Annual Report, 2008).

8. In accordance with the CML, commercial banks no longer offer intermediary services for the participants in the Saudi stock market. Since the end of 2009, the CMA authorized up to 110 independent brokers and research houses to offer the intermediary services and promote competition within the Saudi stock market.

9. On June 6, 2009, the CMA approved the trading of Sukuk[19] and bonds for the first time in Saudi Arabia. This is considered to be a step towards launching a second regulated market

[18] The Gulf Cooperation Council (GCC) consists of six Arab states, including Saudi Arabia, Kuwait, Bahrain, Qatar, the United Arab Emirates, and the Sultanate of Oman.

[19] Sukuk is the Arabic name for financial certificates; it commonly refers to Islamic bonds, since fixed

besides the equity stock market. According to the SAMA Annual Report (2010), the total amount of issued Sukuks and bonds was worth 28 billion Riyals (7.46 billion in USD). These Sukuks and bonds were issued by SABIC with a nominal issue value of 16 billion Riyals, and the rest were issued by the Saudi Electricity Company with a nominal issue value of 12 billion Riyals.

In the Modernized stage, the CMA's role is not restricted to supervising and monitoring participants in the capital market. The CMA has created many channels for increasing awareness and building a stock investment culture among Saudis and foreign residents in order to protect them from capital market risk (Tadawul Annual Report, 2009). In this regard, the CMA in 2009 launched three educational campaigns where more than one million copies of investor awareness booklets were distributed across Saudi Arabia. Also, the CMA trained media representatives on financial report writing and economic analysis to deepen their economic and financial knowledge. In 2009, the CMA held four training courses, in which 40 media representatives attended. Additionally, the CMA hosted students from all universities in Saudi Arabia to introduce them to the role that capital markets play in the local economy (CMA Annual Report, 2009).

2.2: Performance of the Saudi Stock Market

This section presents an overview of Saudi stock market activity from 1993 to the present. A comparison between the Saudi stock market and the major stock markets in the Arab world will be provided.

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income, interest bearing bonds are not permissible in Islam. Sukuk are structured to comply with the Islamic law and its investment principles, which prohibits the charging, or paying of interest. Sukuk can be classified in accordance with their tradability and non-tradability in the secondary markets, for more details see Wikipedia, the free encyclopedia,<http://en.wikipedia.org/wiki/Sukuk, and http://www.tadawul.com.sa>.

2.2.1: Market Activity of the Saudi Stock Market

Compared to other stock markets such as the London Stock Exchange, the New York Stock Exchange (NYSE), the Istanbul Stock Exchange (ISE), and the Egyptian Exchange (EGX), the Saudi stock market is very young; it was formally established in 1984 (SAMA, 1997). Ever since its beginning, the Saudi capital market has received a great deal of attention from the government because of its vital role in lessening Saudi Arabia's dependence on oil. Table 1.1 reports some summary statistics of the Saudi stock market, i.e., number of listed companies, the number of shares traded, value of shares traded, number of transactions, and the general share price index (TASI), from 1985 to the end of 2010.

In 1986, there were 46 listed companies in the market and by 2010 the number had increased to 146 (Table 2.1). The annual changes of the number of listed companies remained relatively low between 1986 and the end of 2005 (Figure 2.1). In the 19 years from 1986 to 2005, the Saudi stock market added only 31 new companies, for a total of 77 companies in 2005, and the number of listed companies decreased in 2002 as a result of a merger between the electricity companies into a single company (Table 2.1). This translates into less than two companies each year, on average, or a 3% average annual growth.

However, the total number of listed companies jumped from 77 in 2005 to 146 in 2010, representing an addition of 69 new companies or a 90% increase in only five years. The remarkable increase during those the last four years suggests that the CMA has succeeded in attracting funds for new investment, which has deepened the Saudi stock market by increasing the number of listed companies.

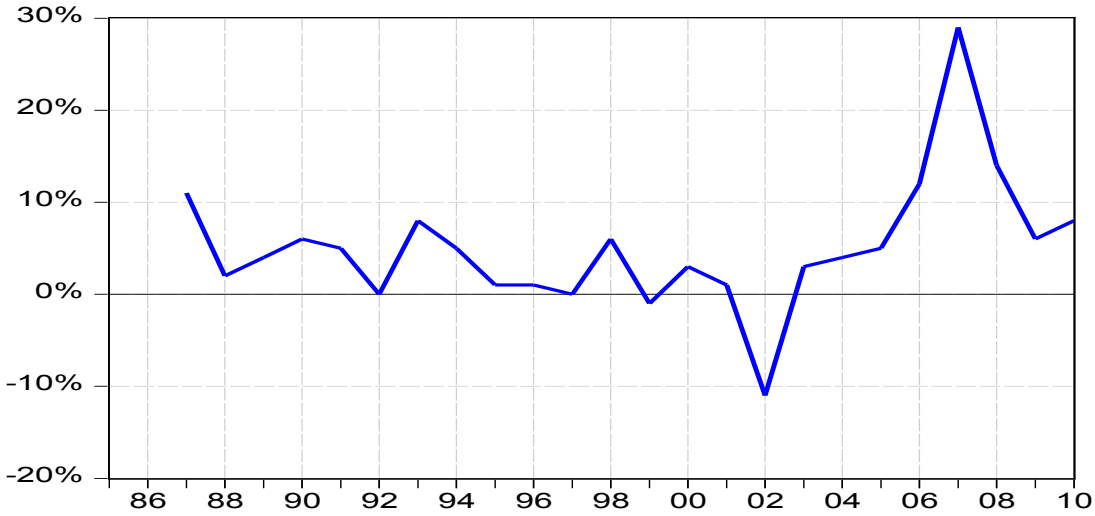
Table 2.1: Key Indicators of Saudi Stock Market Activity

End of Period	Listed Companies		Shares Traded (Million)		Value of Shares Traded (Billion RLs)		Transactions (Thousand)		Share Price Index (1985= 1000)	
	No.	%	No.	%	No.	%	No.	%	Index	%
1985[ii]	na.	na.	4	na.	0.76	na.	7.84	na.	690.88	na.
1986	46	na.	5	25	0.83	9	10.83	38	646.03	-6
1987	51	11	12	140	1.69	104	23.27	115	780.64	21
1988	52	2	15	25	2.04	21	41.96	80	892.00	14
1989	54	4	15	0	3.36	65	110.03	162	1086.83	22
1990	57	6	17	13	4.40	31	85.30	-22	979.80	-10
1991	60	5	31	82	8.53	94	90.60	6	1765.24	80
1992	60	0	35	13	13.70	61	272.08	200	1888.65	7
1993	65	8	60	71	17.36	27	319.58	17	1793.30	-5
1994	68	5	152	153	24.87	43	357.18	12	1282.90	-28
1995	69	1	117	-23	23.23	-7	291.74	-18	1367.60	7
1996	70	1	138	18	25.40	9	283.76	-3	1531.00	12
1997	70	0	312	126	62.06	144	460.06	62	1957.80	28
1998	74	6	293	-6	51.51	-17	376.62	-18	1413.10	-28
1999	73	-1	528	80	56.58	10	438.23	16	2028.53	44
2000	75	3	555	5	65.29	15	498.14	14	2258.29	11
2001	76	1	692	25	83.60	28	605.04	21	2430.11	8
2002[iii]	68	-11	1736	151	133.79	60	1,033.67	71	2518.08	4
2003	70	3	5566	221	596.51	346	3,763.40	264	4437.58	76
2004	73	4	10298	85	1773.86	197	13,319.52	254	8206.23	85
2005	77	5	12281	19	4138.70	133	46,607.95	250	16712.64	104
2006	86	12	68515[iv]	458	5261.85	27	96,095.92	106	7933.29	-53
2007	111	29	57829	-16	2557.71	-51	65,665.50	-32	11038.66	39
2008	127	14	58727	2	1962.95	-23	52,135.93	-21	4802.99	-56
2009	135	6	56685	-3	1264.01	-36	36,458.33	-30	6121.76	27
2010	146	8	33007	-42	759.18	-40	19,536.14	-46	6620.75	8

i. Annual Percentage changes calculated by the author.
ii. The first year that data was available for the Saudi stock market.
iii. The number of listed companies decreased as a result of a merger between the electricity companies into a single company.
iv. This large increase is due to the split nominal values of the listed company's shares to 10 Riyals per share instead of 50 Riyals.

Source: SAMA Annual Report, 2010; and Tadawul Annual Report, 2002-2010.

Figure 2.1: Annual Percentage Change in Total Number of Listed Companies,1986 to 2010



Along with the growing number of listed companies in the Saudi stock market, the number of shares traded also increased significantly. Table 2.1 indicated that the number of shares traded grew remarkably from four million shares in 1985 to 33 billion in 2010. It should be noted, however, that the growth trend line displayed in Figure 2.2 indicates volatile positive movements from 1986 until the end of 2010 with the few expectations of 1995, 1998, 2007, 2009, and 2010. Following the introduction of the Tadawul trading system in October 2001, there was an increase in the volume of traded shares, especially from 2002 to 2006. This suggests a positive effect associated with the advancement in technology as represented by the new trading system. From 2001 to 2006, the volume of shares traded grew at an average rate of 187% each year.

However, the volume of shares traded experienced an extraordinary growth rate of 458% in 2006 compared to the previous year. This may have contributed to the split of the nominal values of the listed company's shares to be ten Riyals per share instead of 50 Riyals. The reduction in the price of shares helped deepen the market by allowing more participants to enter the market. However, because the collapse of the Saudi stock market occurred at the end of 2006

and again in 2008, the volume of shares traded decreased by 16% in 2007, 3% in 2009, and 42% in 2010.

Figure 2.2: Annual Percentage Change in Shares Traded, 1986 to 2010

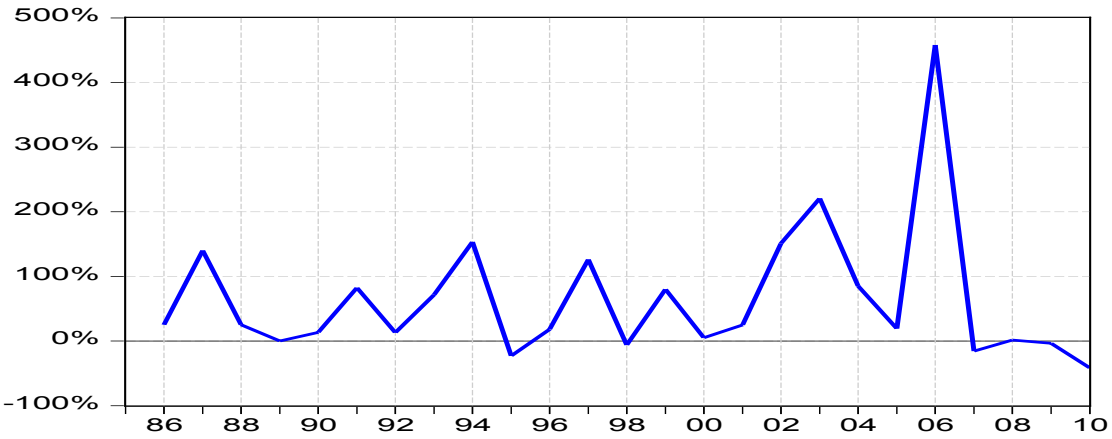
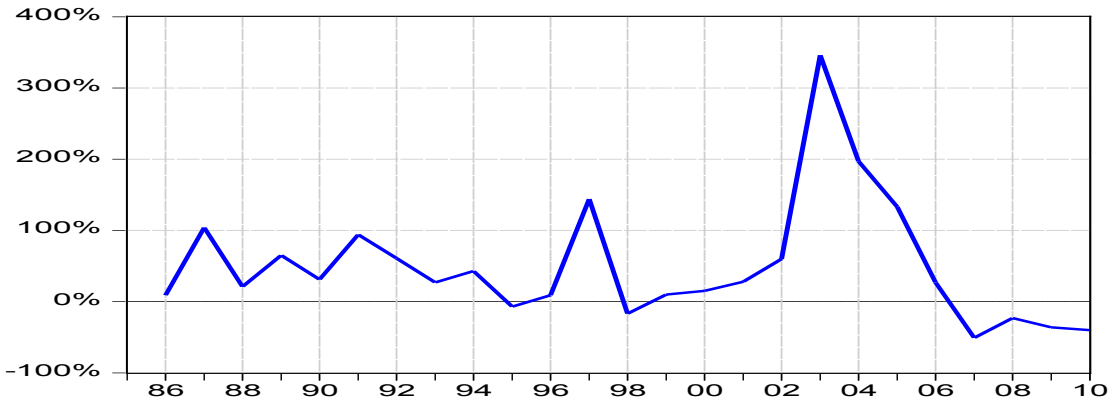


Figure 2.3: Annual Percentage Change in Value of Shares Traded in the Saudi Stock Market, 1986 to 2010



Based on Table 2.1, Figure 2.3 and Figure 2.4, the data suggest that the Saudi stock market was active with respect to the value of shares traded and the number of executed transactions. The value of traded shares significantly increased to 5261.85 billion Riyals in 2006, from 760 million Riyals in 1985 (Table 2.1). The number of executed transactions also greatly increased to 96 million in 2006 from only 784,000 in 1985, which suggests an increase in investor confidence during this time period. Given that the 2006 and 2008 collapses in the Saudi stock market were followed by a sharp decline in the number of executed transactions, on

average a 30% decrease, the Saudi stock market failed to maintain its tremendous level of growth in its activities (Figure 2.3 and Figure 2.4).

As can be seen in Figure 2.5, the Saudi stock market, Tadawul, witnessed constant price appreciation after 1986, and experienced an unprecedented price appreciation between 2002 and 2006. Table 2.1 illustrates that the lowest annual appreciation percentage change was 4%, and its highest growth rate of 104% occurred in 2005. During the time period under consideration, the TASI witnessed six major collapses that resulted in significant depreciation of the general price index during the years of 1986, 1990, 1993, 1994, 1998, 2006, and 2008 (Figure 2.6). At the end of 1986, the TASI lost 6% of its value compared with the previous year. After that, the TASI gained an average of 19% per year for the following three years.

In 1990, the TASI decreased by 10% compared to the previous year due to Gulf War II[20]. Immediately following the end of Gulf War II, the TASI grew sharply by 80% but then decreased by 5% and 28% in 1993 and 1994, respectively. In the three years following 1994, the TASI witnessed notable improvements compared to the previous years. This can be attributed to the positive development in the Saudi economy, including an increase GDP growth rate, i.e., 7% on average, a rise in government expenditure, declines in the average returns rates on deposits, and a balance of payments (SAMA Annual Report, 1997). In particular, the TASI made up its losses by increasing 17%, on average, each year. From the data, it appears that the TASI was not immediately affected by the Asian financial crisis that affected most of Asia in July 1997 (figure 2.6). Instead, TASI increased by 28% during 1997 compared to its value in 1996, which suggests that the Saudi stock market was not linked to the international stock market.

[20] Gulf War II refers to the war authorized by the United Nations (UN) and led by the United States against Iraq after Iraq invaded Kuwait on August 2, 1990. Gulf War I refers to the war between Iraq and Iran that occurred in the early 1980's.

Figure 2.4: Annual Percentage Change in Transactions on the Saudi Stock Market

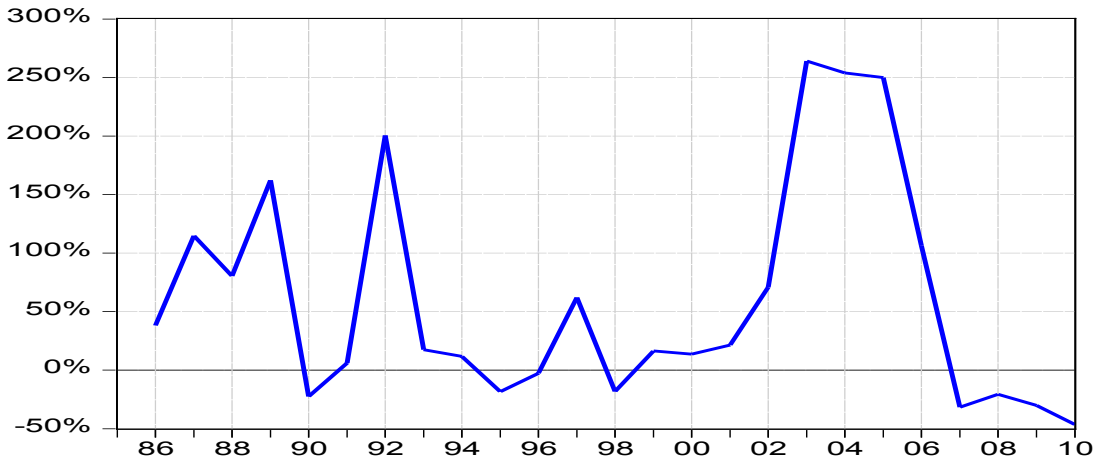


Figure 2.5: Tadawul All Share Index, 1985 to 2010

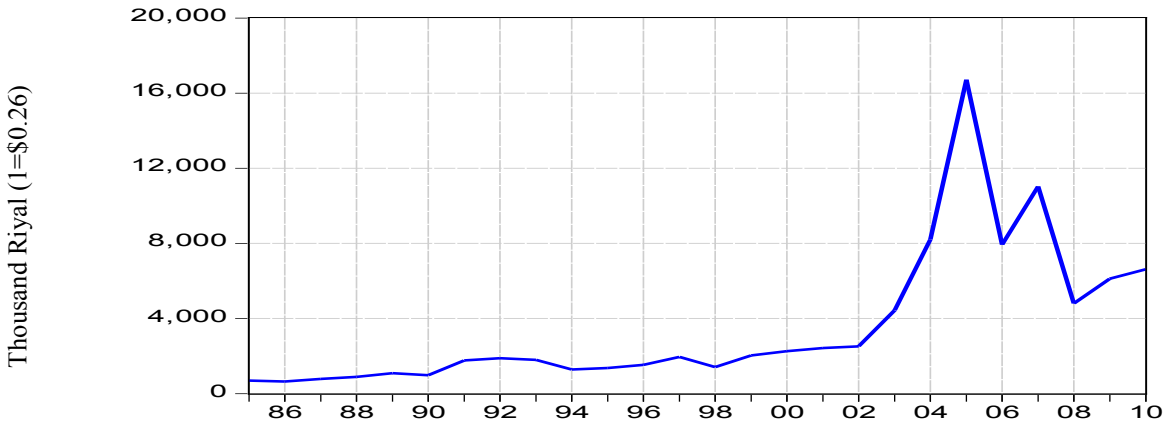
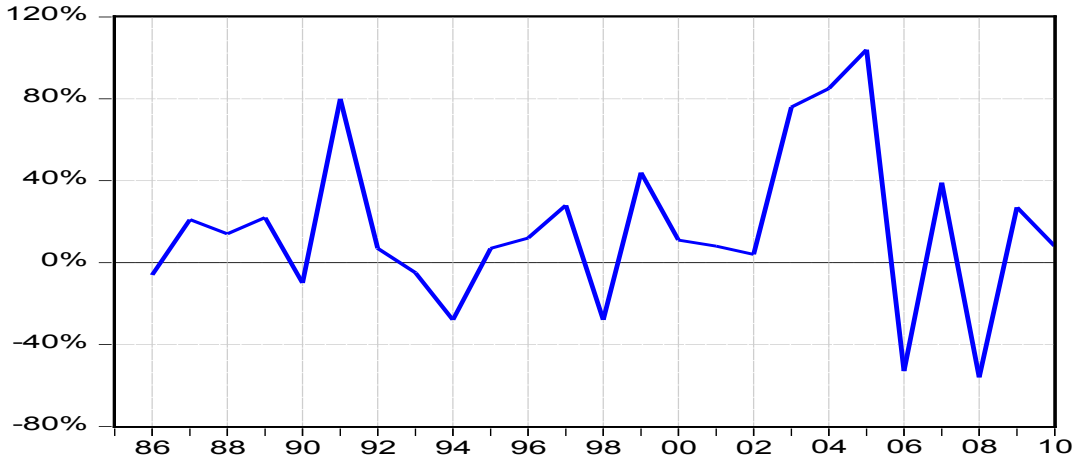


Figure 2.6: Annual Percentage Change in TASI, 1986 to 2010



While the TASI lost 28% of its value in 1998 compared to 1997, it maintained a remarkably high growth rate of 35%, on average, each year for the next seven years. Figures 2.5 and 2.6 indicate that the growth rate of the TASI was not constant from 1999 to 2005. By the end of 2002, the TASI had mostly stabilized and had an average growth rate of 22%, but from 2003 to 2005, the TASI's average growth rate significantly increased by 88%, each year.

According to the SAMA Annual Report (2006), this robust performance, especially from 2003 to 2005, may have been attributed to a number of factors such as (1) continued growth of the non-oil private sector due to structural reforms recently adopted by the government; (2) strong financial performance of most joint-stock companies; (3) strong the price of oil, and (4) the rise in the number of investors entering the market. Al-Twaijry Abdulrahman (date unknown) argued that this boom was due to the large increase in shares' demand caused by the large number of people investing in the stock market either directly or indirectly through various types of portfolios provided mainly by banks. This argument is justified because of the low percentage of the free-floating shares in the Saudi stock market; at most 35% during the period from 2002 to 2005, compared to the total number of issued shares in the market.

The TASI registered its highest close ever at 20,634.86 on February 25, 2006. However, by the end of 2006 the Saudi stock market had collapsed, dropping by 12,701.57 points to its final level of 7,933.29 (a 61.6% decrease). During this time, the Saudi stock market eliminated tens of billions of Riyals. Also, by the end of 2006 the total assets of investment funds in domestic and foreign currencies decreased by 52.8 billion Riyals (or 38.5%) to 84.2 billion Riyals (SAMA Annual Report, 2007). Consequently, thousands of stock market investors lost substantial amounts of their personal wealth, and a large majority of them accumulated some degree of financial debt.

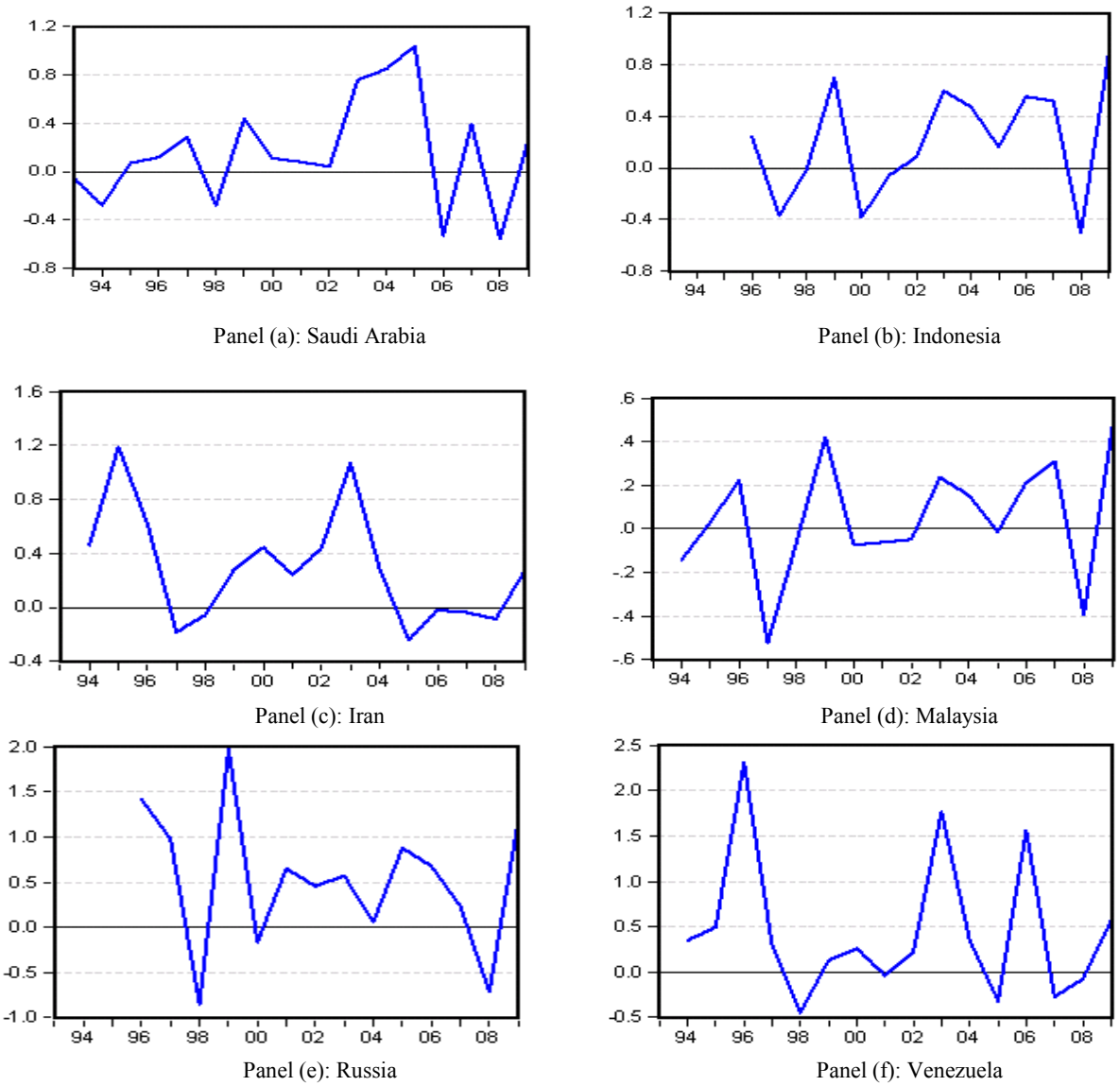
In 2007, the Saudi stock market experienced a rise in most of its indicators and recovered some of its losses from 2006. For instance, the TASI increased by 3105.37, or 39%, to 11038.66. Also, total assets of investment funds went up by 21 billion Riyals, or 25%, to 105.1 billion Riyals (SAMA Annual Report, 2008). At the end of 2008, the Saudi stock market experienced another collapse as the TASI closed at 4802.99 compared to 11038.66 at the end of 2007; decreasing by 56%. As a result, the total assets of investment funds decreased by 30.3 billion Riyals, or 29%, to 74.8 billion Riyals (SAMA Annual Report, 2009). The global financial crisis in 2008 may have contributed to the collapse of the Saudi stock market. In fact, most of the global financial markets indices declined by more than 30% in 2008, and the Saudi stock market was no exception.

In the last two years, the Saudi stock market has recovered some of its losses from the 2006 and 2008 financial collapses (Table 2.1 and Figure 2.6), but it is far from being fully recovered. The collapse of 2006 may have been a type of normal correction or adjustment for the great appreciation of the Saudi stock market in the preceding years, 2003-2005, as opposed to an actual collapse given that the Saudi Authority was in the early phase of regulating and enhancing the operating conditions of the stock market.

It should be noted that collapses in the Saudi stock market are not surprising since it well established that emerging markets are more volatile than developed markets (Harvey, 1995). For instant, Indonesia, Iran, Malaysia, Russia, and Venezuela experienced at least three collapses during the same sample of period, 1993 to 2009 as can be seen in Figure 6.7 panel (b), panel (c) panel (d), panel (e), and panel (f), respectively. These five graphs show no evidence that these collapses were contemporaneously occurred with the collapses happened in the Saudi stock market (Penal (a) in Figure 6.7). This may illustrate the fact that emerging stock market not only

segmented from developed markets but also segmented from one another and affected more by local rather than global economic factors (Harvey, 1995).

Figure 2.7: Annual Percentage Changes of Stock Market Returns in some Middle –Income Oil Exporting Countries, 1993 to 2009



Panel (a): Saudi Arabia

Panel (b): Indonesia

Panel (c): Iran

Panel (d): Malaysia

Panel (e): Russia

Panel (f): Venezuela

Source: Data for TASI obtained from SAMA Annual Report, 2010; and Tadawul Annual Report, 2002-2010. Data for other countries were obtained from International Financial Statistics Data Base, available at: <http://www.imf.org>.

2.2.2: Size and Liquidity of the Saudi Stock Market

In the literature there is no consensus about which financial indicator is best to use to measure the maturity of the stock market. For the purpose of this research, we use three

indicators that have been suggested in the literature. These indicators are (1) the ratio of market capitalization to gross domestic product (GDP); (2) the ratio of the value of shares traded to market capitalization, and (3) the ratio of the value of shares traded to GDP. While the first indicator is usually used to measure the size of the stock market, the last two indicators are commonly used to measure the liquidity of the stock market (Levine and Zervos, 1996, and Victor, 2006).

Table 2.2: Market Size and Market Liquidity of the Saudi Stock Market, 1985-2009

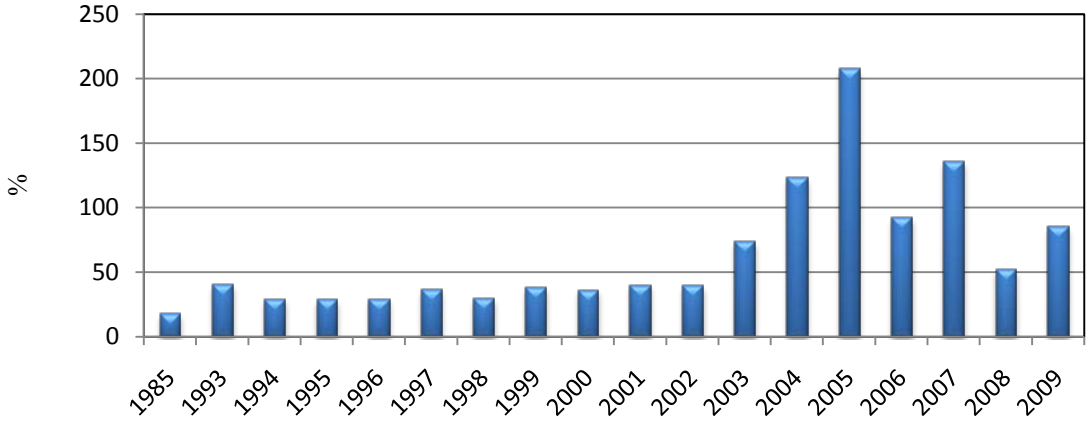
End of Period	(1) Market Capitalization (MC) (Billion Riyals)	(2) Value of Shares Traded (VST) (Billion Riyals)	(3) GDP (Billion Riyals)	(4) Market Size (Depth) (%) (1) ÷ (3)	(5) Market Liquidity Indicators (%) VST/MC (2) ÷ (1)	(5) Market Liquidity Indicators (%) VST/GDP (2) ÷ (3)
1985*	67.00**	00.76	372.41	18	1.13	0.20
1993	197.90	17.36	485.63	41	8.77	3.57
1994	145.10	24.87	494.77	29	17.14	5.03
1995	153.39	23.23	526.00	29	15.14	4.42
1996	171.98	25.40	581.87	30	14.77	4.37
1997	222.70	62.06	608.80	37	27.87	10.19
1998	159.91	51.51	536.64	30	32.21	9.60
1999	228.59	56.58	593.96	38	24.75	9.53
2000	254.46	65.29	697.01	37	25.66	9.37
2001	274.53	83.60	679.16	40	30.45	12.31
2002	280.73	133.79	699.68	40	47.66	19.12
2003	589.93	596.51	796.56	74	101.12	74.89
2004	1148.60	1773.86	929.95	124	154.44	190.75
2005	2438.20	4138.70	1172.40	208	169.74	353.01
2006	1225.86	5261.85	1324.56	93	429.24	397.25
2007	1946.35	2557.71	1430.77	136	131.41	178.76
2008	924.53	1962.95	1771.20	52	212.32	110.83
2009	1195.51	1264.01	1396.23	86	105.73	90.53
2010	1325.39	759.18	Na.	Na.	57.27	Na.

* The first year that data was available for the Saudi stock market.
** Aldukheil (2002).
Source: Tadawul Annual Statistical Report, 2002; 2010, and SAMA Annual Report, 2010.

Table 2.2 and Figure 2.8 show the size of the Saudi stock market. The market capitalization ratio has increased from 18% of GDP in 1985 to 41% of GDP in 1993, and it maintained, to some extent, this ratio until 2002. Compared to developed markets such as U.S. stock market and UK stock market, this ratio is very low, since market capitalization usually exceeds GDP in these markets (Victor, 2006). However, this low average rate may be justified by the fact that from 1994 to 2002 there were only seven new companies that entered the stock market. In 2003, the Saudi stock market size suddenly increased to 74% of GDP.

This increase in market size coincided with the announcement of a new capital law for the Saudi stock market. In fact, by establishing a new capital law for the Saudi stock market, new participants were motivated to join, and the trading mechanisms, central securities registries, and depositories were helped along. Therefore, over the next seven years, the market capitalization ratio increased at 110% of GDP, on average, each year, with an incredible increase of 208% in 2005.

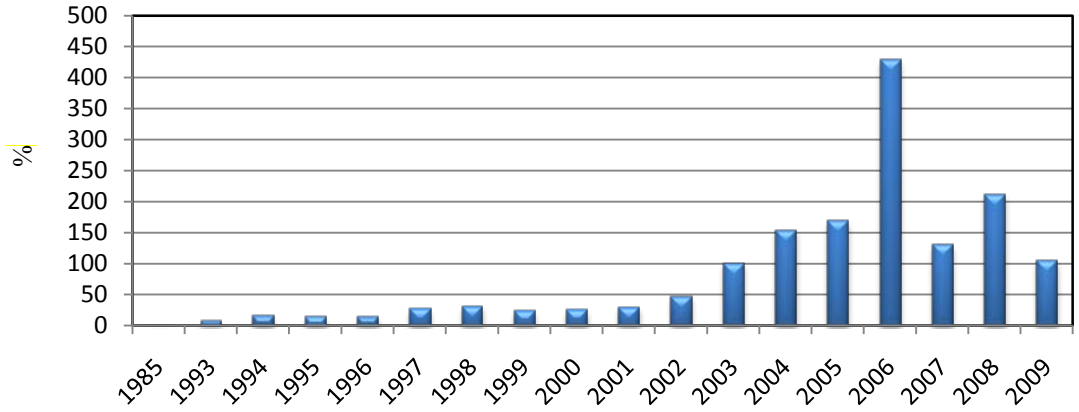
Figure 2.8: Saudi Stock Market Depth, 1985 to 2009



The remarkable cumulative increase of the Saudi stock market size occurred along with an increase in new companies added to the market, and GDP showed a considerable annual

growth rate of 10%, on average, during this time period. As of 2009, the capitalization ratio was 86% of GDP, which is comparable to other main stock markets in the Arab world (Table 2.3).

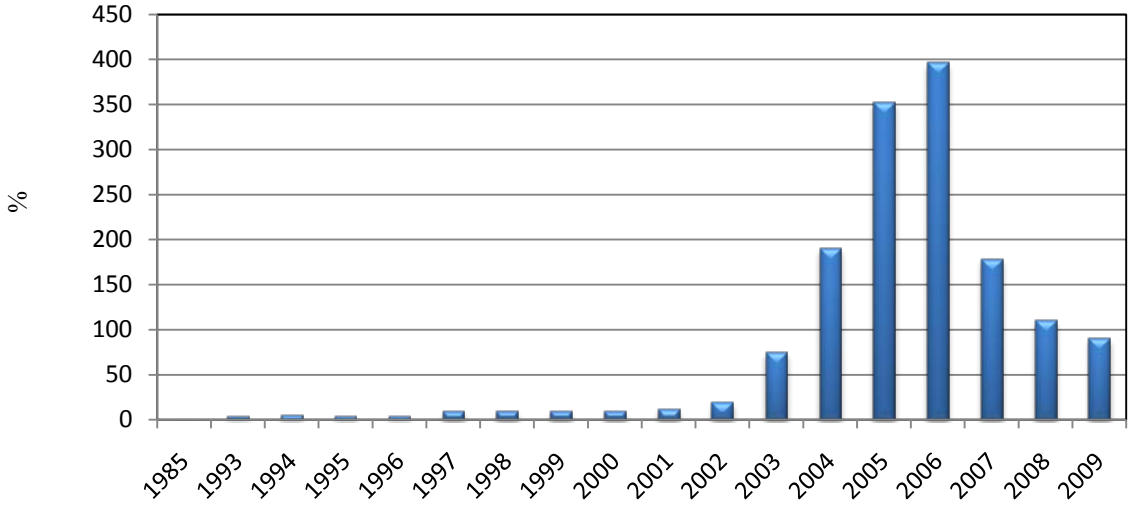
Figure 2.9: Market Liquidity (VST/MC) of the Saudi Stock Market, 1985 to 2009.



Liquidity commonly refers to the ability to easily buy and sell assets in a financial market without causing a substantial effect on the asset's price (Victor, 2006, Levine and Zervos 1996). Following the approach used by Levine and Zervos (1996), we will use two comprehensive, yet indirect, indicators to measure the level of liquidity of the Saudi stock market. The first indicator is calculated by dividing the value of shares traded in the Saudi stock market (VST) by its market capitalization (MC). The second indicator of market liquidity is calculated by dividing the value of shares traded in the Saudi stock market by GDP, i.e., VST/GDP. Levine and Zervos (1996) suggested that a high value of either of these two indicators implies low transactions costs.

Table 2.2 and Figures 2.9 and 2.10 demonstrate the liquidity of the Saudi stock market with respect to the two chosen comprehensive indicators. Based on these indicators, the Saudi stock market clearly became much more liquid after 2002. Since the highest value of the first indicator (VST/MC) was 48% and the highest value of the second indicator (VST)/GDP) was 19%, the argument of Levine and Zervos (1996) implies that transactions costs were high in the Saudi stock market and therefore has high risk during the time period of 1985-2002.

Figure 2.10: Market Liquidity in Terms of (VST /GDP) of the Saudi Stock Market, 1985 to 2009



The liquidity level of the Saudi stock market based on VST/MC and VST)/GDP indicators drastically increased during 2003 to 2008 with an average rate of increase of 200% and 218%, respectively (Figures 2.9 and 2.10). Recall that during this time period, the Saudi stock market collapsed twice. In the 2006 collapse, the market lost 53% of its value compared to 2005, and in the 2008 collapse, the market lost 56% of its 2007 value. Although these collapses occurred at a time when the Saudi stock market maintained a high level of liquidity, we argue that the low percentage of free-floating shares compared to the issued share, among other factors, created an ideal environment for speculative activities to occur in the market during 2003 to 2008. Compared to 2008, the liquidity level of the Saudi stock market measured by the VST/MC indicator dropped by 50% in 2009 and 73% in 2010 to a level of 57% in 2010 (Table 2.2).

2.3: Saudi Stock Market Rank in the Arab World

Based on market capitalization, the Saudi stock market ranks first in the Arab world with 319 billion U.S. dollars compared to an average of 65 billion dollars for the Arab countries

participating in the Arab Monetary Fund Index (AMFI) (Table 2.3). As depicted in Figure 2.11, the market capitalization of the Saudi stock market represents 35% of the total market capitalization of Arab stock markets at the end of 2009.

With respect to the number of listed companies, the Saudi stock market ranked fourth in 2009, following the Egyptian stock market (306 companies), the Jordanian stock market (272 companies), and the Kuwaiti stock market (205 companies) (Figure 2.12). However, the Saudi stock market ranked first among the Arab countries in terms of the average company size. The average company size in Saudi Arabia was 2.4 billion U.S. dollars compared to an average market capitalization of 690 million dollars per company in the AMFI countries (Table 2.3 and Figure 2.13). These rankings indicate that the class of companies listed on the Saudi stock market is significantly different from the rest of the Arab countries, particularly those in the AMFI.

Table 2.3: Key Indicators of Arab World Share Markets, End of 2009

Capital Market	(1) No. of listed companies	(2)* Average company size	(3)* Market capitalization	(4) Ratio to Total (%)	(5)* Value of shares Traded	(6) GDP at current Prices	(7) Market depth (3) ÷ (6)	(8) Turnover Ratio (5) ÷ (6)
Saudi Arabia	135	2,361.5	318,803	35.29	337,070	369.5	86.3	105.7
Kuwait	205	457.7	93,824	10.38	103,772	127.7	73.5	110.6
Egypt	306	297.7	91,092	10.08	81,173	189.2	48.1	89.1
Qatar	44	1,998.4	87,930	9.73	25,317	82.4	106.8	28.8
Abu Dhabi	67	1,197.0	80,201	8.88	18,766	224.9	35.7	23.4
Morocco	73	1,016.2	74,186	8.21	16,226	92.7	80.0	21.9
Dubai	67	867.1	58,095	6.43	47,239	224.9	25.8	81.3
Jordan	272	117.2	31,889	3.53	13,641	21.1	150.8	42.8
Oman	120	196.8	23,616	2.61	5,905	53.1	44.5	25.0
Bahrain	49	331.9	16,263	1.80	473.0	21.6	75.2	2.9
Lebanon	11	1,167.5	12,843	1.42	1,038	32.2	39.9	8.1
Tunisia	52	177.6	9,237	1.02	1,360	37.7	24.5	14.7
Sudan	53	57.2	3,033	0.34	1,006	54.9	5.5	33.2
Palestine	39	60.9	2,377	0.26	500.0	Na.	Na.	21.0
Algeria	2	45.5	91	0.01	187.5	162.1	0.1	206.1

* Million of U.S. dollars.
Source: Quarterly Bulletin, Arab Monetary Fund, 2009.

Figure 2.11: Market Capitalization of Stock Markets, End of 2009

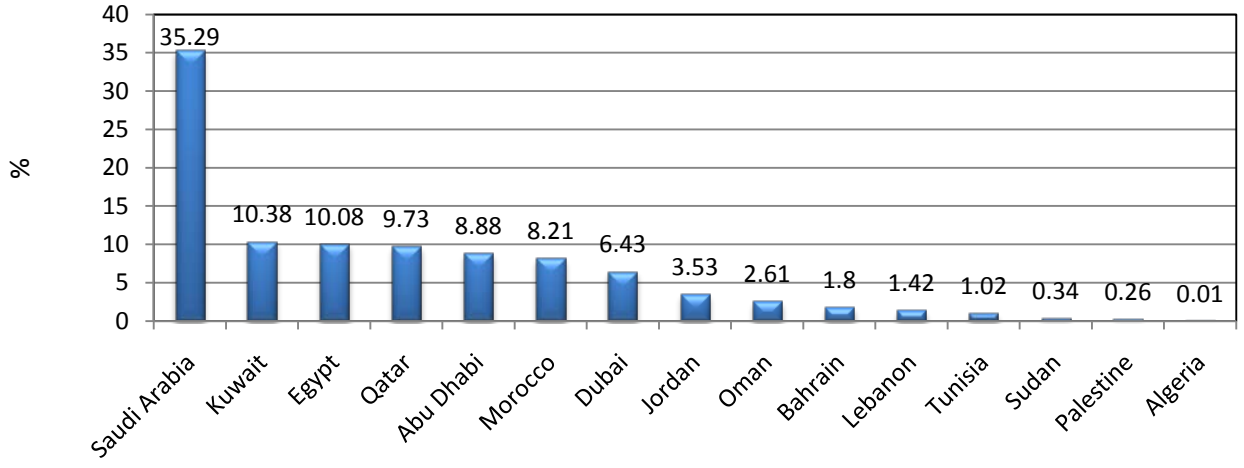


Figure 2.12: Companies Listed on Stock Markets, End of 2009

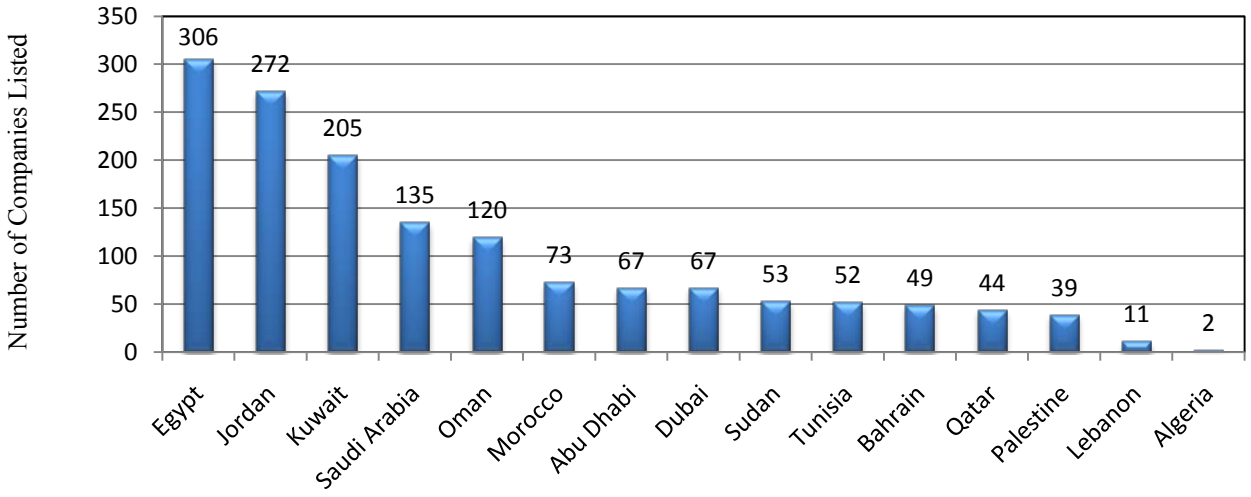
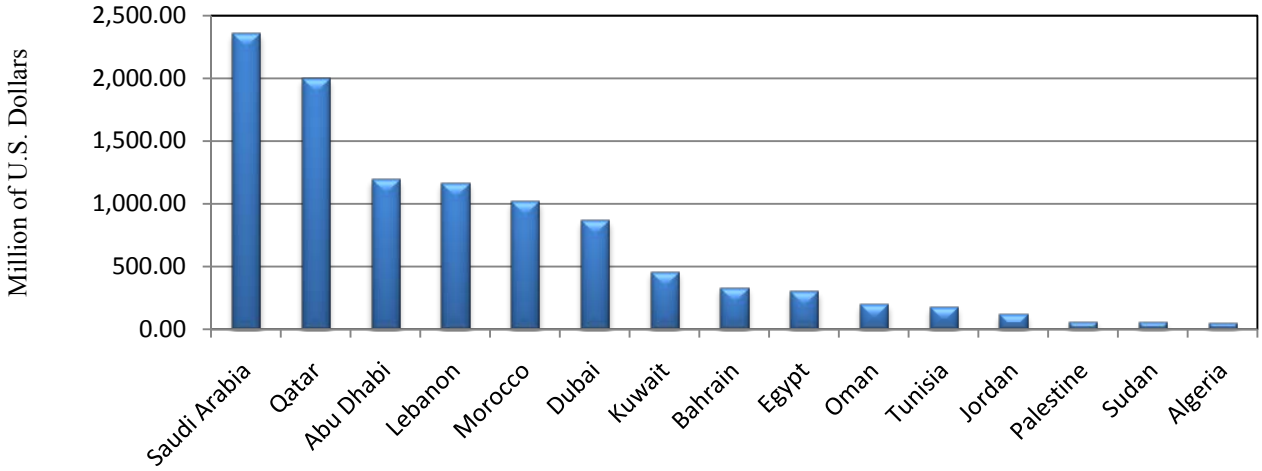


Figure 2.13: Average Size of Listed Companies, End of 2009



Compared to the other Arab stock markets in the AMFI, the Saudi stock market had by far the largest market, with its value of shares traded amounting to 337 U.S. billion dollars in 2009 (Table 2.3). The second largest stock market is the Kuwaiti stock market, at 104 billion U.S. dollars.

Figure 2.14: Market Depth of Stock Markets, End of 2009

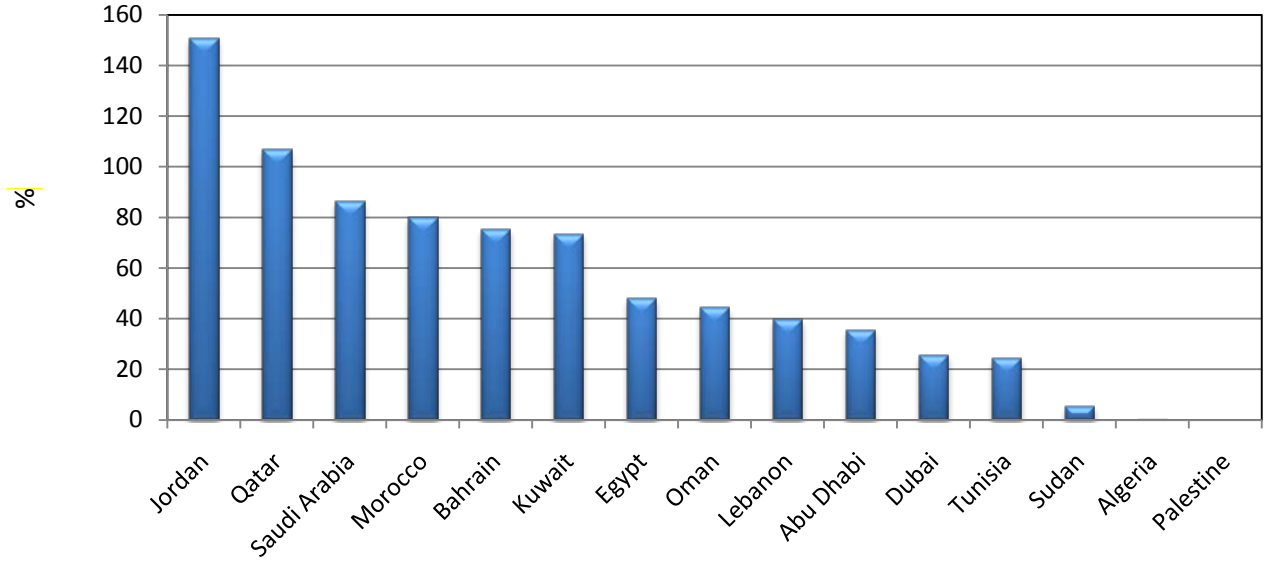
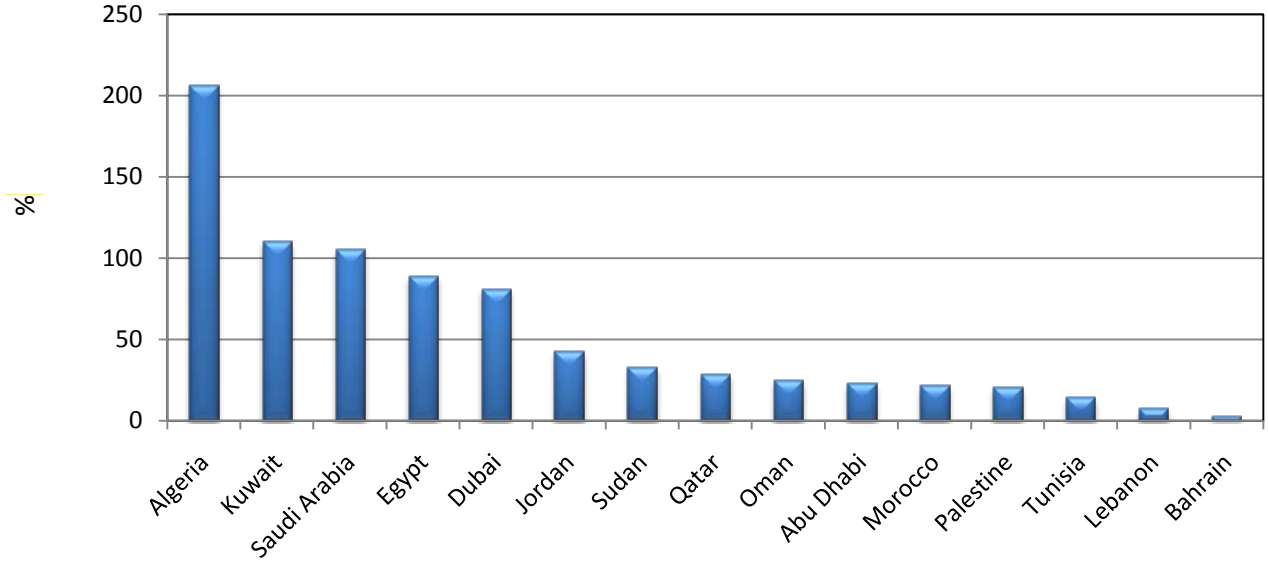


Figure 2.15: Turnover Ratio of Stock Markets, End of 2009



Additionally, the Saudi stock market is active and relatively liquid compared to the other markets in the AMFI as measured by market depth ratio and the turnover ratio respectively[21]. At the end of 2009, the depth of the Saudi Stock Market was 86% of GDP compared to an average of 57% of GDP for Arab share markets (Table 2.3 and Figures 2.14), and was one of the most liquid markets in the Arab world with a turnover ratio of 106% compared to an average of 54% for Arab share markets in 2009 (Table 2.3 and Figure 2.15).

2.4.: Summary and Remarks

Despite the fact that the Saudi stock market has witnessed significant developments since its inception in 1984, particularly over the last seven years, there is still significant room for improvement. First, the number of companies listed on the Saudi stock market is small by international or regional terms and, more importantly, compared to the size of the local economy. For instance, Table 2.4 indicates that the existing number of Joint-stock companies is 575, 146 of which are listed in the Saudi stock market (Table 2.1), which implies that 75% of the existing Joint-stock companies are not included in the Saudi stock market. This shows that the Saudi authorities have a large task to do to attract new companies to be listed in the market.

Table 2.4: Existing Companies by Type of Capital, 2009

Type of company	Number	Capital (Billion Riyals)
Joint-stock companies	575	569.40
Limited liability partnerships	10437	200.03
Joint-liability partnerships	3126	3.77
Mixed liability partnerships	1245	8.82
Mixed liability partnerships by shares	4	2.9
Total	15387	782.01

Source: SAMA Annual Report, 2010.

[21] Market Depth ratio is defined by MC divided by the GDP and Turnover ratio is defined by VST divided by MC.

The second area for improvement is the number of free-floating shares available for trading in the Saudi stock market; they are very low compared to the actual issued shares. That is, the Saudi stock market is characterized by a high level of shareholder concentration with a considerable number of companies' shares being held by government, families, and just a few owners. Table 2.5 lists the total issued shares and free-floating shares for each sector of the Saudi Stock market at the end of 2010. Of the 39.6 billion issued shares, there were only 16.2 billion free-floating shares available for trade, or 41% of the issued shares.

Table 2.5: Total Issued Shares and Free-Floating Shares in the Saudi Stock Market, End of 2010)

No.	Sector	Number of companies	Issued Shares*	Floating shares*	Percentage
1	Banks & Financial Services	11	8903.96	4760.41	53
2	Petrochemical Industries	14	8710.81	3619.78	42
3	Cement	9	1009.00	686.00	68
4	Retail	9	302.50	220.29	73
5	Energy & Utilities	2	4241.59	766.95	18
6	Agriculture & Food Industries	15	1081.47	715.75	66
7	Telecommunication & Information Technology	4	4200.00	1400.21	33
8	Insurance	31	801.50	342.17	43
9	Multi-Investment	7	4022.47	422.92	11
10	Industrial Investment	13	1422.40	626.54	44
11	Building & Construction	14	723.67	478.57	66
12	Real Estate Development	8	3475.52	1700.54	49
13	Transport Sector	4	476.30	340.26	71
14	Media and Publishing	3	155.00	88.96	57
15	Hotel & Tourism	2	79.16	46.50	59
	Total	146	39605.35	16215.86	41

* Million of Shares.
Source: Tadawul Quarterly Report November, 2010.

This phenomenon is common across all the sectors that constitute the Saudi stock market (Table 2.5). However, the multi-investment sector appears to be the most highly concentrated sector, with only 11% of its issued shares free for trade in the market. The Retail sector is the most tradable sector with 73% of its issued shares available for trade.

Finally, the Saudi stock market is not yet fully open to direct foreign investment. As we mentioned before, foreign investors from outside the country must enter into SAWP Agreements

or hold mutual funds that are offered by commercial banks. In fact, non-resident foreign and resident foreign participation levels have been weak ever since the market was open to them. For example, the Trading by Nationality Report published on the Tadawul website indicated that of the 2.8 billion total numbers of shares sold in 2010, the number of shares sold and purchased by foreigner's residence in Saudi Arabia represented nearly 4%, respectively Meanwhile, the percentage of shares sold and purchased in SAWP Agreements by of foreigners' non-residence in Saudi Arabia contributed only 0.92% and 1.42%, respectively to the total shares being sold and purchased in the market (Trading by Nationality Report, 2011).Therefore, the correlation between the Saudi stock market and international markets is weak, which makes the Saudi stock market a unique place to take advantage of portfolio diversification.

Chapter 3 : Literature Review

3.1: Introduction

The existing economics and finance literature provides a number of theories explaining the link between macroeconomic variables and the stock market. Among these theories are the efficient market hypothesis (EMH) and asset pricing theory. The EMH advocates that stock market prices fully and rationally incorporate all relevant information. Thus, past information is useless in predicting future asset prices. For that reason, new relevant information is only used to explain stock market movements (Fama, 1965). Asset pricing theory such as the arbitrage price theory (APT), and the Present Value Model (PVM), however, illustrates the dynamic relationship between the stock market and economic activity. This chapter presents a brief theoretical background of the EMH and one of the most prominent asset pricing theories, the APT theory. Additionally, we will discuss some of the related empirical studies.

3.2: Theoretical Background

3.2.1: Theory of Efficient Market Hypothesis (EMH)

The basic idea underlying the EMH developed by Fama (1965, 1970) is that asset prices promptly reflect all available information such that abnormal profits cannot be produced regardless of the investment strategies utilized. Formally, the EMH can be explained using the following equation:

$$\Omega_t^* = \Omega_t \tag{3.1}$$

The left side represents a set of relevant information available to the investors, at time *"t"*. The right side is the set of information used to price assets, at time *"t"*. The equivalence of these two sides implies that the EMH is true, and the market is efficient. Fama (1970) distinguished between three forms of market efficiency based upon the level of information used by the market: weak form, semi-strong, and strong form market efficiency[22].

The weak form of the EMH stresses that asset prices today incorporate all relevant past information, i.e., past asset prices, security dividends, and trading volume. Knowing the past behavior of stock prices provides no indication of future stock prices. In other words, the EMH theory hypothesizes that asset prices evolve according to a random walk. Thus, asset prices cannot be predicted, and investors cannot beat the market.

The semi-strong form of the EMH states that current asset prices fully reflect all available public information. Public information includes not only information about an asset's past price, but includes all information related to the company's performance, expectations regarding macroeconomic factors, and any other relevant public information such as GDP, the money supply, interest rates, and the exchange rate. In addition to relevant past information and public information, the strong form of the EMH requires that asset prices fully incorporate more than past and public information. In particular, the strong form of the EMH declares that asset prices reflect private information, i.e. insider information, related to the assets of a specific company.

The implications of the EMH are broad. From an investor's perspective, participants in the stock market should not be able to generate an abnormal profit regardless of the level of information they may possess. As mentioned before, in the world of a perfect capital market, investors cannot consistently beat the market. This is consistent with the financial idea that the

[22] Fama (1991) revised these three terms to be predictability, event studies, and inside information for the weak form, semi-strong form, and strong form, respectively.

maximum price that investors are willing to pay is the current value of future cash flows. The current value of a future cash flows is usually evaluate by a discount rate, which represents the degree of uncertainty associated with the investment, considering all relevant available information.

From an economic standpoint, an efficient stock market will assist with the efficient allocation of economic resources. For instance, if the shares of a financially poor company are not priced correctly, new savings will not be used within the financially poor industry. In the world of the EMH, the level of asset price fluctuations, or volatility, fairly reflects underlying economic fundamentals. Along these lines, Levich (2001) argues that policymaker's interventions may disrupt the market, and cause it to be inefficient. In the literature, the three forms of the EMH are usually used as guidelines rather than strict facts (Fama, 1991). Also, most empirical studies have examined the EMH in its weak or semi-strong forms, partly because the strong form is difficult to measure, and there is a high cost associated with acquiring private information (Timmermann and Granger, 2004).

3.3.2: Arbitrage Price Theory (APT)

The theory of asset pricing, in general, demonstrates how assets are priced given the associated risks. The Arbitrage Price Theory (APT) suggested by Ross (1976) has been an influential form of asset price theory. APT is a general form of Sharpe's (1964) capital asset price model (CAPM)[23]. While the CAPM suggests that asset prices or expected returns are

[23] We restrict our analysis to the APT theory since empirical studies on the CAPM fail to support the assumptions theory (Semmler, 2006). However, CAPM is a single linear equation that links the expected return of an asset or a portfolio to its expected risk. In the world of CAMP, there are two types of risk: non-diversification risk and diversification risk. Diversification risk or systematic influences are a management technique where the risk can be reduced by including a wide variety of investments within a portfolio. The non-diversification risks, or idiosyncratic influences, are associated with the

driven by a single common factor, the APT advocates that they are driven by multiple macroeconomic factors. Mathematically APT can be expressed as:

$$R_{it} = r_i^f + \beta_i X_t + \varepsilon_t \tag{3.2}$$

Where R_{it} is the return of the stock i at time t, r_i^f is the risk free interest rate or the expected return at time t. X_t is a vector of the predetermined economic factors or the systematic risks while β_i measures the sensitivity of the stock to each economic factor included in X_t. ε_t , the error term, represents unsystematic risk[24] or the premium for risk associated with assets that cannot be diversified where $E(\varepsilon_t|X_t) = 0$, $E(X_t) = 0$, and $E(\varepsilon_t\ \varepsilon_t'|X_t) = \Sigma$.

Ross (1976) shows that there is an approximate relationship between the expected returns and the estimated $\hat{\beta}_{ik}$ in the first step provided that the no arbitrage condition is satisfied, i.e., the expected return $E(R_i)$ increases as investors accept more risk, assuming all assets in the market are priced competitively. This relationship can be represented as a cross-sectional equation where the estimated $\hat{\beta}_{ik}$ are used as explanatory variables:

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stock itself, and therefore, cannot be avoided by considering portfolio technique. According to CAPM, the non-diversification risk is the only risk that should be rewarded as the investors can insure against diversification risk. Semmler (2006) states that the beta coefficient represents the rewarded risks in the standard form of the CAPM and it can presented mathematically as follows:

$$E(r_i/p) = r_F + \beta_i[E(r_M) - r_F]$$

$$\beta_i = (cov\ (r\_(i/p), r\_M\ ))/(\sigma\_(r\_M)\text{^}2\ )$$

where r_F is the risk-free interest rate that the investor would expect to receive from a risk-free investment i.e. U.S. Treasury Bills. r_M is the expected market return that the investor would expect to receive from a broad stock market indicator such as the S&P 500 Index during a period of time. β_i is the covariance of the risk with market portfolio or the price of risks for a security, r_i, or a portfolio, r_p , considering the relationship between the movements of an individual stock versus the market itself. Based on this formula investors expect a higher rate of return on the risky asset to inspire them to include more of risky asset in their portfolios. In fact, the rewarded return must be enough to compensate them for the risk-free interest rate, the stock market's risk, and the risk associated with the asset of particular interest.

24 Unsystematic risk refers to the investment risk that can be reduced through appropriate diversification, ("Unsystematic Risk", http://www.investopedia.com/terms/u/unsystematicrisk.asp)

$$E(\bar{R}_i) = \lambda_0 + \lambda_1\hat{\beta}_{1i} + \lambda_2\hat{\beta}_{2i} + \cdots + \lambda_n\hat{\beta}_{nk} + \mu_i \quad (3.3)$$

where $\bar{R}_i$ is the mean excess return for asset i and the $\beta's$ represent the sensitivity of a security's return n to the risk factor k. The λ_n's represent the reward for bearing risk associated with the economic factor fluctuations. Equation (3.3) simply says that the expected return of an asset is a function of many factors and the sensitivity of the stock to these factors.

Interestingly, APT does not specify the type or the number of macroeconomic factors for researchers to include in their study. For example, although Ross, et al. (1986) examined the effect of four factors including inflation, gross national product (GNP), investor confidence, and the shifts in the yield curve, they suggested that the APT should not be limited to these factors. Therefore, there is a large body of empirical studies that have included a large number of different macroeconomic factors, depending on the stock market they studied. In this study, eight macroeconomic factors will be included to examine their impacts on the Saudi stock market. Also, analysts face the challenge of identifying factors that play a significant role in explaining fluctuations of individual stock markets. Even though analysts can predetermine some economic factors, their selection must be based upon reasonable theory (Chen et al., 1986).

3.3: Related Empirical Studies

In the last three decades, numerous studies have examined the dynamic relationships between stock market behavior and economic activity, particularly for developed stock markets such as the U.S., United Kingdom (UK), Germany, and Japan. Examples of pioneering studies are Fama (1981, 1990), Geske and Roll (1983), and Chen, Roll, and Ross (1986). However, studies in this area are different in terms of their hypotheses and the methods used. Several studies investigated the predictability of stock returns for real economic activity. Examples of

these studies are Estrella and Hardouvelis (1991), Estrella and Mishkin (1996), and Domain and Louton (1997). A large body of research focuses on the integration of stock markets across economies. Examples of these studies are Arshanapalli and Doukas (1993), Becker, Finnerty and Friedman (1995), Jeon and Chiang (1991), Kasa (1992), and Longin and Solnik (1995). Another dimension in previous studies examined the short and long run relationship between stock prices and macroeconomic and financial variables such as inflation, the interest rate, and output. Within this group of studies, some studies examined economic factors that affect stock prices, while others examined factors that determine stock return volatility (Semmler, 2006).

For this study, it is not feasible to survey all the literature in every dimension. However, this study is most closely related to studies in the last dimension: determining the economic factors that influence stock prices (returns) and stock return volatility. Given this similarity, we will discuss some published studies in this dimension that satisfied the following two conditions (1) the study must consider the relationship between stock prices and at least two of the eight macroeconomic variables that are included in this analysis[25]; and (2) the study must utilize a comparable methodology[26]. This will be addressed in the following subsections. The first section will discuss studies related to developed economies, studies related to developing economies will be provided in the second section,[27] and the third section will discuss studies that include more than one economy.

[25] We discuss a few studies that considered only one variable since they used very close method to the method that we use in this dissertation, i.e., Kim and Moreno (1994), Léon (2008), Wenshwo (2002), and Zafar et al. (2008).

[26] Examples of studies that examine saudi economy but either out of the scope of this dissertation or did not meet the criteria for a study to be included in our survey include: Bely (2007), Abraham et al. (2002), Elfakhani et al.(2008), Hammoudeh (2004), and Alzahrani (2010).

[27] The IMF Advanced Economies List (October 2010) is used to determine whether a country is a developed economy or a developing economy. For more details see: International Monetary Fund (IMF), (October, 2010), World Economic Outlook (WEO): Recovery, Risk, and Rebalancing, Available at:< http://www.imf.org/external/pubs/ft/weo/2010/02/index.htm>.

3.3.1: Studies Related to Developed Economies

Hashemzadeh and Taylor (1988) examined the relationships between the S&P 500, the money supply (M1), and the return on U.S. Treasury bills. They conducted Granger-Sims's causality tests (1969; 1972) using weekly U.S. data covering the week ending January 2, 1980 to July 4, 1986, and found a feedback relationship between M1 and the S&P 500. The relationship between the S&P 500 and the U.S. Treasury bills was not conclusive, and the causality relationship appeared to start with the U.S. Treasury bills and move to stock prices, not the other direction. Hashemzadeh and Taylor also concluded that U.S. Treasury bills and M1 are not highly successful in predicting U.S. stock prices. This finding implies that U.S. stock prices incorporate all information available in the stock market.

Malliaris and Urrutia (1991) examined the linkage between industrial production (IP), the money supply (M1), and the S&P 500, using U.S. monthly data from January 1970 to June 1989. Based on the Granger causality tests, the authors concluded that: (i) there is a causal relationship between M1 and the S&P 500 where M1 seems to lead the S&P 500, and (ii) the S&P 500 appears to affect IP. These findings confirmed that the stock return's fluctuations were a leading indicator of future real economic activity. However, the causal relationships among IP, M1, and the S&P 500 were not statistically significant.

Using the same data set as Malliaris and Urrutia (1991), Darrat and Dickens (1999) examined multivariate cointegration and error-correction models. Consistent with conventional wisdom, but contradicting Malliaris and Urrutia's (1991) findings, Darrat and Dickens found strong evidence that IP, M1, and the S&P 500 were integrated and found causal interrelationships between these variables. Darrat and Dickens' results indicated that the stock

market was a key leading indicator of monetary policy and real economic activity. These interrelationships were strengthened when inflation and interest rates were included in the model.

Abdullah and Hayworth (1993) used seven macroeconomic variables to explain fluctuations of monthly stock returns in the U.S. stock market using a vector Autoregressions, Granger causality tests, and impulse response analysis. The macroeconomic variables were M1, budget deficits, trade deficits, inflation, IP, short-term interest rates, and the S&P 500. The results indicated that money growth, budget deficits, trade deficits, inflation, and both short-term and long-term interest rates Granger-cause stock returns. Additionally, stock returns were positively related to inflation and money growth, but, consistent with economic theory, stock returns were negatively related to budget deficits, trade deficits, and both short-term and long-term interest rates.

Dhakal, Kandil, and Subhash (1993) explored the links between five macroeconomic variables: the money supply, the short-term interest rate, the price level, real output, and share prices in the U.S. stock market from 1973 to 1991. It was argued that this study was of particular interest to policymakers to understand share market volatility. The results of the VAR estimation indicated that changes in the money supply have direct significant impacts on share price changes, and indirect impacts on share prices through the effect on the interest rate and the inflation rate. The results also suggested that share price volatility causes real output fluctuations, which is a relationship that monetary policy had not previously considered.

Serletis (1993) analyzed the relationships between eight different measures of the money supply[28] and the S&P 500 using monthly data from January 1970 to May 1988. Serletis concluded that the U.S. stock market satisfied the efficient market hypothesis (EMH) since the S&P 500 did not cointegrate with any of the eight money supplies during the sample period.

[28] The eight different measures of the money supply have been defined in Serletis (1991).

Sadorsky (1999) investigated the impact of the price of oil shocks, IP, and the interest rate on U.S. stock market returns using monthly data from January 1947 to April 1996. Results from the VAR approach suggested that positive oil shocks depress real stock returns, while stock returns have a positive impact on interest rates and IP. Also, this study showed evidence that the effect of the price of oil on U.S. stock market returns was not constant over time, compared to the effect of interest rate changes, and that oil price movements explain a large portion of the forecast error variance in real stock returns, particularly after 1986.

Ratanapakorn and Sharma (2007) investigated the long and short run relationships between the S&P 500 and six macroeconomic variables using monthly data from January 1975 to April 1999. The study observed that the stock prices were negatively related to the long-term interest rate, but were positively related to the money supply, IP, inflation, the exchange rate, and the short-term interest rate. The inconsistent results of the effect of long and short run interest rate on the S&P 500 suggested that the long-term interest rate was behaving more like the S&P 500 than the short-term interest rate. This result coincides with the findings from Abdullah and Hayworth (1993). Also, each macroeconomic variable included in the study Granger caused stock prices in the long run but not in the short run. Results from the variance decomposition also support the finding that the S&P 500 is exogenous in relation to the other macroeconomic variables in the study. That is, even after 24 months, 87% of the S&P 500 variance was explained by its own shocks.

Thornton (1993) investigated the lead-lag relationships between stock prices in the UK, namely the Financial Times Stock Exchange 100 index (FTSE 100), and real GDP and two definitions of the money supply - the monetary base (M0) and the broadest definition of the money supply (M5) - using quarterly data from 1963 to 1990. The results of Granger causality

tests suggested that: (i) stock prices tend to lead M5; (ii) stock prices tend to lead real GDP; (iii) there were feedback effects between M0 and M5 volatility and stock price volatility; and (iv) real GDP tends to lead stock price volatility. Thornton suggested that the causal relationship among real and monetary variables in the UK was not statistically significant in contrast to the literature on the US economy.

Abdullah (1998) employed Sims (1980) forecast error variance decompositions to analyze the effects of six macroeconomic variable changes on UK stock returns, proxied by the London share price index. The macroeconomic variables were M1, budget deficits and surpluses, IP, the consumer price index (CPI), and a long term interest rate. The results suggested that money growth variability accounts for 22.82% and 19.53% of the variance in interests' rates and stock returns, respectively. Therefore, money growth variability contributed to the uncertainty associated with returns on investments in stocks and other financial assets. The other variables included in the model were statistically significant in explaining the variance of UK stock returns.

Thornton (1998) utilized the Johansen cointegration test and Granger-causality tests to observe the long and short run dynamic relationships between real M1, real income, interest rates, and real stock prices in Germany for 1960 to 1989. The results of the study indicated that: (i) real stock prices have a significant and positive wealth effect on the long-run demand for M1; and (ii) there was a unidirectional Granger-causality effect from interest rates to real stock prices.

Mukherjee and Naka (1995) employed Johansen's (1991) vector error correction model (VECM) to examine the impact of six macroeconomic variables on the Japanese stock market. The six variables were the exchange rate, inflation, the money supply, IP, the long-term government bond rate, the call money rate, and the Tokyo Stock Exchange index. The results

indicated that these variables were integrated with stock prices for the whole sample period spanning from January 1971 to December 1990, and for two additional sub-periods examined.

Kim and Moreno (1994) investigated whether stock price movements contributed to fluctuations in bank lending in Japan over January 1970 to May 1993 using a VAR model. Three important results were found in their study. First, the response of Japanese bank lending to an increase in stock prices was positive in two subsamples (Jan. 1970 to Dec. 1983, and Jan. 1984 to May, 1993). Second, fluctuations in bank lending in Japan contributed significantly to fluctuations in the Nikkei stock price. In particular, the Nikkei stock price played an important role in accounting for the recent sluggish growth in lending in Japan. Lastly, the historical relationship between stock prices and bank lending was not steady over the whole period. That is, until the mid 1980s the relationship was weak but became significant after the mid-1980's.

Chaudhuri and Smiles (2004) utilized Johansen's (1990) methodology, impulse response function analysis and forecast error variance decomposition analysis to examine the relationship between the Australian real stock price index and real measures of aggregate economic activity, including the most broad money supply (M3), GDP, private personal consumption expenditures, and the world oil price index. The analysis used quarterly data from 1960 to 1998. The study showed evidence of a long-run relationship between all variables. Also, the error correction mechanism indicated that real returns are, in general, related to changes in real macroeconomic variables along with deviations from the observed long-run relationships. However, IRF and VDC analyses revealed weak evidence for the relationship between the Australian real stock price index and all variables included in the analysis.

Darrat (1990) employed Akaike's final prediction error (FPE) criteria in conjunction with multivariate Granger causality tests to examine whether changes in Canadian stock returns are

predicted by several economic variables including the money base, interest rates, interest rate volatility, real income, inflation, exchange rates, and fiscal deficits. The empirical study used monthly data from January 1972 to February 1987. Results indicated that current stock prices in Canada fully incorporate all available information from monetary policy instruments, and that stock returns are Granger-caused by lagged changes in fiscal deficits. This conclusion held even when interest rates, interest rate volatility, real income, inflation, monetary policy, and exchange rates are excluded from the estimation. Under the assumption of constant expected stock returns, such findings appear inconsistent with the stock market efficiency hypothesis.

Gan et al. (2006) employed Johansen's (1990) cointegration approach, Granger causality tests, and impulse response analysis to determine whether the New Zealand Stock Index is a leading indicator for a set of seven macroeconomic variables that include M1, the short term interest rate, the long term interest rate, the inflation rate, the CPI, exchange rates, GDP, and the domestic retail the price of oil. This analysis was conducted using monthly data spanning from January 1990 to January 2003. Evidence from the study suggested that a long run relationship exists between New Zealand's stock index and all seven examined macroeconomic variables. Based on the sample period used in the study, the New Zealand stock index was predicted by M1, interest rate, and real GDP during the sample period. In addition, the New Zealand stock index was not a leading indicator of New Zealand's economy.

Maysami et al. (2004) used monthly data from January 1989 to December 2001 to examine the relationship between Singapore's composite stock index, three Singapore sector indexes (the finance index, the property index, and the hotel index), and a set of macroeconomic variables. These variables are the CPI, IP, proxies for long and short-run interest rates, the money supply (M2), and exchange rates. Based on the results of Johansen's cointegration test,

the Singapore stock market and property index showed a significant long-run relationship with all macroeconomic variables included in the analysis. On the other hand, the finance sector index indicated a significant relationship with all macroeconomic variables included in the analysis with the exception of real economic activity, and the money supply. Also, the hotel index showed no significant relationship with the money supply and short and long term interest rates but significant relationships with all macroeconomic variables included in the analysis. These results questioned the efficiency of Singapore's market in the sense that stock prices do not incorporate all information available in the market promptly.

Gjerde and Saettem (1999) used a VAR model and monthly data from 1974 to 1994 to investigate the relationship between stock market returns and a set of macroeconomic variables in the small open economy of Norway. The set of variables consisted of interest rates, inflation, IP, consumption, the OECD industrial production index, the foreign exchange rate, and the price of oil. Consistent with Humpe and Macmillan's (2009) findings about the U.S. and Japanese stock markets, Gjerde and Saettem established several significant links between stock market returns and the investigated macroeconomic variables. In particular, changes in the real interest rate affected both stock returns and inflation, and the stock market responded significantly to the price of oil changes. The stock market also displayed a delayed response to changes in domestic real activity. For instance, after two years, the industrial production shock only explained 8% of the variance of real stock returns while innovations in real stock returns contributed only 1% to the variance of changes in IP. On the other hand, there was no evidence that real economic activity responded to real stock return shocks. This finding may be attributed to the difference in size and type of companies listed on developed stock markets compared to companies in the domestic industry. That is, if most companies listed on the stock exchange are large exporting

companies while the industrial production index contains a substantial amount of small companies, then stock market should not lead industrial production.

Hondroyiannis and Papapetrou (2001) investigated the dynamic relationships in the Greek economy between stock returns and a set of macroeconomic indicators consisting of IP, interest rates, exchange rates, real foreign stock returns as represented by the S&P 500, and real oil prices. They used a multivariate vector autoregressive VAR model to examine monthly data from January 1984 to September 1999. Results from their study suggested that stock returns did not lead changes in real economic activity, and macroeconomic activity and foreign stock market changes only partially explained stock market movements. The price of oil changes, however, explained stock price movements and had a negative impact on macroeconomic activity.

In 2006, Patra et al. applied different econometric approaches[29] and used monthly data from 1990 to 1999 to examine the short and long run equilibrium relationship between the Greek price index and a set of macroeconomic variables including the money supply, inflation, the exchange rate, and trading volume. Based on the results from these different techniques, all of the investigated variables except the exchange rate consistently exhibit both short and long run relationships with stock prices. These findings suggested that the Greek stock market was informationally inefficient during this time period.

Rahman and Mustafa (2008) studied the long-run and short-run dynamic effects of the broad money supply (M2) and the price of oil on the S&P 500 the using monthly data from January 1974 to April 2006. The results provided support in favor of the three variables being cointegrated. The vector error-correction model revealed no causal relationships in the long run although feedback relationships existed in the short run. Also, the results indicated that the

[29] These econometrics methods included Granger causality tests, vector error correction models, and Johansen, cointegration tests.

current volatility of the U.S. stock market was fueled by its past volatility, and negative monetary and oil price shocks initially depressed the U.S. stock market.

Another stream of research examined the impact of economic factors on stock return volatility. The studies usually consider the conditional variance process in financial data. That is, the research focuses on the importance of volatility in making investment decisions, security valuation, risk management, and monetary policy. This type of study was motivated primarily by the introduction of the autoregressive conditional heteroskedasticity (ARCH) model by Engle (1982), its generalized form, the GARCH model, developed by Bollerslev (1986), and other numerous subextensions of these models[30].

One of the pioneer studies in this area was conducted by Schwert (1989), in which he analyzed the relationships between the U.S. stock market volatility and real and nominal macroeconomic volatility, economic activity, financial leverage, and stock trading activity using monthly data from 1857 to 1987. He concluded that macroeconomic volatility, as measured by changes in real output and inflation, did not help to predict stock and bond return volatility. However, Schwert provided evidence that the volatility of financial assets helped to predict future macroeconomic volatility. This finding supported his claim that the prices of speculative assets should react quickly to new information about economic events.

Kapital (1998) adopted Lee's (1994) GARCH-X model to investigate volatility in the U.S. stock market and the effect of short-run deviations between stock prices and a set of macroeconomic fundamentals such as the money supply, the exchange rate, income, consumer prices, and real oil prices. This study used monthly data from January 1978 to December 1996. Based on his findings, the macroeconomic variables had a significant and positive effect on the

[30] For a list of these models, refer to Bollerslev (2007).

volatility of the U.S. stock market. Also, the GARCH-X model was found to outperform the standard GARCH model in that regard.

Liljeblom and Stenius (1997) analyzed whether changes in stock market volatility attributed to time-varying volatility of a set of macroeconomic variables in Finland's economy. Macroeconomic variables included in the analysis were industrial production, the money supply (M2), the CPI, and a trade variable represented by the export price index divided by the import price index. They examined a 71 year time period from 1920 to 1991. With the exception of the growth of stock market trading volume, the authors concluded that the VAR estimates indicated predictive power in both directions: from stock market volatility to macroeconomic volatility and from macroeconomic volatility to stock market volatility.

Léon (2008) investigated the effects of interest rate volatility on stock market return volatility in the Korean economy using weekly return data from January 31, 1992 to October 16, 1998. Léon estimated two GARCH (1,1) models: one without interest rates, and another one with interest rates in both the conditional mean and variance. Consistent with results for the U.S. market, Léon found that the conditional market returns have a significantly negative relationship with the interest rates. Also, the conditional variance had a positive, but insignificant relationship with the interest rates compared to the findings documented in the U.S. market. Results from Léon's study indicated that interest rates have strong predictive power for stock returns in Korea, but weak predictive power for volatility. Based on these findings, investors in the Korean stock market should adjust their portfolios in response to changes in monetary policy.

Table 3.1 summarized common variables and major results of the studies that were conducted on some of the developed economies. Money supply, interest rate, inflation, industrial production, oil price, and exchange rate are the common variables used in literature. While the

studies show evidence of important relationships of these variables with stock market changes, it is reliable to conclude that there was no consensus of the specific relationship between each variable and the stock markets. In other words the results are sensitive to countries sample period and the methods used.

Table 3.1: Common Macroeconomic Variables and Major Results for Developed Economies

Study	Independent Variable	Method	Major Results	Country
Abdullah (1998)	M1, Consumer Price Index, A long-Term of Interest Rate, Budget Deficits and Surpluses, IP.	Forecast Error Variance Decompositions (FEVD) Analysis	- The results suggested that money growth variability accounted for 22.82% and 19.53% of the variance in interests' rates and stock returns, respectively. The reminder of the variables included in the model was statistically significant in explaining the variance of the UK stock returns.	UK
Abdullah and Hayworth (1993)	M1, Short-Term Interest Rates, Inflation, Budget Deficits, Trade Deficits, IP.	VAR model, Granger Causality Test, and Forecast Error Variance Decomposition (FEVD) Analysis	- This study indicated that the money growth, budget deficits, trade deficits, inflation, both short and long term interest rates are Granger-cause the U.S. stock market returns. - There is evidence that the U.S. stock market returns are positively related to the inflation and money growth, but are negatively related to the budget deficits, trade deficits, and both short and long term interest rates.	U.S.
Chaudhuri, and Smiles (2004)	M3, World Oil Price Index, GDP, Private Personal Consumption Expenditure.	Johansen Cointegration Test, Impulse Response Function (IRF) Analysis, and Forecast Error Variance Decomposition (FEVD) Analysis	- The study showed evidence of a long-run relationship between all tested variables. IRF and VDC analysis revealed weak evidences for the relationship between the Australian real stock price index and all variables in system.	Australia
Darrat (1990)	Money Supply, Interest Rates and its Volatility, Inflation, Exchange Rates, Fiscal Deficits, Real Income	Akaike Final Prediction Error (FPE), and Causality Test	- Results indicated that stock prices in Canada fully incorporated all available information from monetary policy instruments, and the stock returns are Granger-caused by lagged changes in fiscal deficits.	Canada
Darrat and Dickens (1999)	M1, IP.	Causality Tests	- There is strong evidence suggests that the IP, M1, and the S&P 500 were integrated and had causal interrelationships between them.	U.S.

Study	Independent Variable	Method	Major Results	Country
Dhakal et al. (1993)	Money Supply, A Short-Term of Interest Rate, The Price Level, Real Output.	VAR Model	- This study indicated that changes in the money supply have direct significant impacts on share price changes and indirect impacts on share prices via its affect on the interest rate and the inflation rate. - The results suggested that the share prices volatility causes real output fluctuations.	U.S.
Gan et al. (2006)	M1, Short-Term Interest Rate, Long-Term Interest Rates, Inflation Rate, CPI, Exchange Rates, Domestic Retail Oil Price, GDP.	Johansen Cointegration Test, Causality Test, and Forecast Error Variance Decomposition (FEVD) Analysis	- Evidence from the study suggested that a long run relationship exists between New Zealand's stock index and all seven examined macroeconomic variables. - The Granger causality test indicated that the New Zealand stock index was not a leading indicator of New Zealand's economy.	New Zealand
Gjerde and Saettem (1999)	Interest Rates, Inflation, Foreign Exchange Rate, Oil Price, IP, Consumption, the OECD IP	VAR Model	- This study suggested that changes in real interest rate affected both stock returns and inflation, and the stock market responded significantly to the oil price changes. - There was no evidence that real economic activity responded to real stock return shocks. This study argues that this finding may be due to the difference in size and type of the companies listed in the developed stock market compared to companies in the domestic industry.	Norway
Hashemzadeh and Taylor (1988)	M1, US-Treasury bill.	Causality Tests	- A feedback relationship between MI and S&P 500, but the U.S. Treasury bill and MI are not good predictors for the U.S. stock prices.	U.S.
Hondroyiannis and Papapetrou (2001)	IP, Interest Rates, the Exchange Rates, Real Oil Price, S&P 500.	Multivariate Vector Autoregressive VAR Model	- Results from this study suggested that stock returns did not lead changes in real economic activity, and the macroeconomic activity and foreign stock market changes only partially explained stock market movements. - Oil price changes significantly explained stock price movements and had a negative impact on macroeconomic activity.	Greece
Kapital (1998)	Money Supply, Consumer Prices, Real Oil Prices, The Exchange Rate, Real Income.	A GARCH Model, and a GARCH-X Model	- All of the investigated variables except the exchange rates consistently shared short and long run relationships with the stock prices in the Athens stock market. - The GARCH-X model outperforms the standard GARCH model.	U.S.

Study	Independent Variable	Method	Major Results	Country
Kim and Moreno (1994)	Bank Loans.	VAR Model	- This study established three important results. (i), there a positive response of Japanese bank lending to an increase in the stock price (ii) fluctuations in bank lending in Japan contributed significantly to the recent fluctuations in the Nikkei stock price. (iii) the historical relationship between stock prices and bank lending was not steady over all of the period.	Japan
Léon (2008)	Interest Rate Volatility	A GARCH Model	- The conditional market returns have a significant negative relationship with the interest rates. - The conditional variance had a positive, but insignificant relationship with the interest rates compared to the findings documented in the U.S. market. - Interest rates have a strong predictive power for stock returns in Korea, but weak predictive power for volatility.	Korea
Liljeblom and Stenius (1997)	M2, CPI, Trade Variable (measured as the Export Price Index Divided by the Import Price Index), IP.	VAR Model	- With the exception of the growth of the stock market trading volume this study concluded that the predictive power in both directions: from stock market volatility to macroeconomic volatility and from macroeconomic volatility to stock market volatility existed.	Finland
Malliaris and Urrutia (1991)	M1, IP.	Causality Tests	- There is a causal relationship between MI and S&P 500, where MI seems to lead the S&P 500, and the S&P 500 appears to affect the IP.	U.S.
Maysami et al. (2004)	M2, Long-Term of Interest rates, Short-Term of Interest rates, Consumer Price Index, Exchange Rates, Industrial Production,	Johansen Cointegration Test	- This study indicates that the Singapore stock market and property index showed a significant long-run relationship with all macroeconomic variables included in the analysis. - The finance sector index indicated a significant relationship with all macroeconomic variables included in the analysis with the exception of the real economic activity, and money supply. - Also, the hotel index showed no significant relationship with money supply and short-long term interest rates but signified significant relationships with all macroeconomic variables included in the analysis.	Singapore
Mukherjee and Naka (1995)	Money Supply, Long-Term Government Bond Rate, The Call Money Rate, Inflation, Exchange Rate, IP.	Johansen Cointegration Test, and Vector Error Correction Model (VECM)	- Based on the results these variables were integrated with the stock prices for the whole sample period and for an additional two sub-periods examined.	Japan

Study	Independent Variable	Method	Major Results	Country
Patra et al. (2006)	Money Supply, Inflation, Exchange Rate, Trading Volume.	Causality Test, and Vector Error Correction Model (VECM)	- All of the investigated variables except for the exchange rate consistently exhibit both short and long run relationships with stock prices. These findings suggested that the Greek stock market was informationally inefficient during this time period.	Greece
Rahman and Mustafa (2008)	M2, Oil Price.	Causality Test, and Vector Error Correction Model (VECM)	- The results provided support in favor of the three variables being cointegrated. The vector error-correction model shows no causal relationships in the long run although feedback relationships existed in the short run. - The results also indicated that the current volatility of the U.S. stock market was fueled by its past volatility, and negative monetary and oil price shocks initially depressed the U.S. stock market.	U.S.
Ratanapakorn and Sharma (2007)	Money Supply, A Short-Term of Interest Rate, Long-Term Interest Rate, Inflation, Exchange Rate, IP.	Johansen Cointegration Test, Causality Test, and Forecast Error Variance Decomposition (FEVD) Analysis	- The study observed that the stock prices were negatively related to the long-term interest rate, and positively related to the money supply, IP, inflation, the exchange rate, and the short-term interest rate. - Each macroeconomic variable included in the study was Granger caused stock prices in the long run but not in the short run. - Findings suggested that the S&P 500 explained 87% of its variance even after 24 months; therefore S&P 500 is exogenous in relation to the other macroeconomic variables included in this study.	U.S.
Sadorsky (1999)	Interest Rate, Oil Price, Industrial Production.	VAR Model, and Forecast Error Variance Decomposition (FEVD) Analysis	- This study found that positive oil shocks depress real stock returns, while stock returns have a positive impact on interest rates and IP. - This study showed evidence that oil price movements explain a large portion of the forecast error variance in real stock returns, particularly after 1986.	U.S.
Serletis (1993)	Eight Definitions of Money Supply.	Johansen Cointegration Test, Causality	- This study provides evidence that the U.S. stock market satisfied the efficient market hypothesis (EMH) since the S&P 500 did not cointegrate with any of the eight money supplies during the sample period.	U.S.
Thornton (1993)	M0, M5, Real GDP.	Causality Tests	- The results of Granger causality tests suggested that: (i) stock prices tend to lead M5 and real GDP; (ii) there were feedback effects between M0 and M5 volatility and stock price volatility; and (iii) real GDP tends to lead stock price volatility.	UK

Study	Independent Variable	Method	Major Results	Country
Thornton (1998)	M1, Interest Rates, Real Income,	Johansen Cointegration Test, Causality Tests	- The results of the study indicated that: (i) real stock prices have a significant and positive wealth effect on the long-run demand for M1; and (ii) there was a unidirectional Granger-causality effect from interest rates to real stock prices.	Germany

3.3.2: Studies Related to Developing Economies

Ibrahim (1999) studied the dynamic relationships between Malaysian stock prices and seven macroeconomic variables, including the narrow and broad money supplies (M1 & M2), IP, the CPI, domestic credit, foreign reserves, and the exchange rate. Cointegration and Granger causality tests with monthly data from January 1977 to June 1996 were used. The results revealed that the Malaysian stock market is informationally inefficient with respect to consumer prices, official reserves, and the domestic credit aggregates. This study also provided evidence that stock prices are Granger-caused by changes in official reserves and exchange rates in the short run. With respect to M2 and Malaysian stock price were cointegrated, and there was no long-run relationship between stock prices and M1.

Maghayereh (2003) used Johansen's (1990) methodology to analyze the link between the Jordanian capital market index and a set of macroeconomic variables: M1, interest rates, domestic exports, foreign reserves, inflation, and IP. The cointegration test and the vector error correction model indicated that the Jordanian stock price index was cointegrated with all the macroeconomic variables under consideration. Thus, all the variables were significant in predicting changes in stock prices, which suggests that the Jordanian capital market violated the theory of market efficiency from January 1987 to December 2000.

Gunasekarage et al. (2004) examined the relationship between a set of macroeconomic variables and the stock market index in the Sri Lanka. The money supply, the Treasury bill rate as a proxy for the short term interest rate, the CPI as a measure of inflation, and the exchange rate were the macroeconomic variables. The Johansen cointegration approach, IRFs analysis, and FEVD analysis using monthly data from 1985 to 2001 yielded three results. First, the lagged values of the money supply and the Treasury bill rate had a significant influence on the stock market. Second, the All Share Price Index did not have any influence on the money supply, but it did influence the Treasury bill rate. Finally, both VDC and IRF explained only a little of the forecast variance error for the market index, and these effects did not persist for long period.

Ibrahim (2006) evaluated the relationship between bank loans and stock prices in Malaysia using quarterly data from January 1978 to February 1998, using in a VAR framework. The VAR model included four other variables as well, namely interest rates, output, the exchange rate, and the price level. The results revealed that bank loans reacted positively to an increase in stock prices, but the converse is not true. Similarly, bank loans appeared to accommodate an expansion in real output, but had no influence on real economic activity. The impulse response function suggested that bank loans played no significant role in transmitting stock market shocks to the real sector. Ibrahim interpreted these results as an indication that the health of the banking sector may significantly depend on stock market stability. Consequently, stimulating bank loans may be an inefficient way to boost stock market activities and expand real activities.

Muradoglu and Argac (2001) examined the long-run relationship between Turkish stock market returns and three monetary variables, the overnight interest rate, the money supply, and the foreign exchange rate, during the period from 1988 to 1995. The three monetary variables

were found to not be cointegrated with stock prices during the sample period and also during the sub-sample period from 1988 to 1989. However, all three monetary variables were cointegrated with stock prices in the sub-period from 1990 to 1995. These findings suggested that the results of the analysis were sensitive to the examined period.

Using quarterly data, Ahmed (2008) investigated the nature of the long and short run relationships between Indian stock prices and a set of macroeconomic variables over the period March 1995 to March 2007. These variables were the money supply, interest rates, IP, exports, foreign direct investment, exchange rates, the primary stock index of the National Stock Exchange (NSE) in India, and the Bombay Stock Exchange (BSE) index. Johansen's (1990) approach, the causality test of Toda and Yamamoto (1995), FEVD analysis, and IRFs analysis were used. Findings from the study revealed that a long run relationship between stock prices and money supply existed. However, the same relationship did not exist for the interest rate with stock prices. With respect to the short run analysis, the stock market index was discovered to not be affected by money supply movements, but the interest rate was. Therefore, the interest rate appeared to lead stock prices in the short run.

Hasan and Javed (2009) explored the long-term relationship between Pakistan equity prices and monetary variables from June 1998 to June 2008. The monetary variables included the money supply, Treasury bill rate, foreign exchange rates, and the CPI. The Johansen-Juselius (1990) cointegration test provided evidence of a long run relationship between the equity market and the monetary variables. Unidirectional Granger causality was found between the monetary variables and the equity market. Impulse response analysis indicated that the interest rate shock and the exchange rate shocks both have a negative impact on equity returns, whereas the money supply has a positive impact on the equity market. With respect to inflation, Hasan and Javed

found little impact on returns in the equity market. Also, FEVD analysis suggested that interest rate, exchange rate, and money supply shocks were important sources of volatility for equity returns. For example, monetary shocks explained about 4% to 16% of the variation in the Pakistani equity market returns. For that reason they suggested that policymakers be careful in designing monetary policy since it has a direct impact on both cash inflows into the capital market and on capital market stability.

Zafar et al. (2008) investigated the effects of changes in the interest rate proxied by the 90-day T-bill rate on the volatility of Karachi stock returns. Similar to Léon's (2008) approach, Zafar et al. estimated two distinct GARCH (1,1) models; one without interest rates and the other with interest rates to estimate the conditional mean and variance for monthly data for the period from January 2002 to June 2006. For both models, the conditional market returns and variance parameters were very similar to each other. In particular, conditional market returns had a negative significant relationship with interest rates, indicating that it was easy to predict the stock returns by analyzing interest rates. However, the conditional variance had an insignificant negative relationship with interest rates and was a weak predictor for its volatility. These results, in general, demonstrate that when interest rates increase, people tend to deposit their savings in bank accounts rather than investing in the stock market. That is, higher interest rates reduce the profitability of firms, and hence, stock prices go down. Accordingly, Zafar et al. suggested that policymakers should carefully consider these relationships when intervene the stock market and overall investments policy in the economy.

Table 3.2 summarized common variables and major results of the studies that were conducted on some of the developing economies. As can be seen in Table 3.2 the variables used are similar to those variables used in the studies conducted in the developed countries. Also,

while these studies extends our knowledge about relations among stock prices and macroeconomic factors in developing markets, findings show no unique relationship associating these variables and the stock market changes.

Table 3.2: Common Macroeconomic Variables and Major Results for Developing Economies

Study	Method	Variable	Major Results	Country
Ibrahim (1999)	Cointegration Test, and Causality Test	M1, M2, CPI, Exchange Rate, Domestic Credit, Foreign Reserve, IP.	- The results revealed that the Malaysian stock market is informationally inefficient with respect to consumer prices, official reserves, and the domestic credit aggregates. - This study also provided evidence that the stock prices are Granger-caused by changes in the official reserves and exchange rates in the in the short run. - Malaysian stock price were marginally cointegrated with M2, and there was no long-run relationship between the stock prices and M1.	Malaysia
Maghayereh (2003)	Johansen Cointegration Test, and Vector Error Correction Model (VECM)	M1, Interest Rate, Inflation, Domestic Exports, Foreign Reserves, IP.	- There is evidence that the Jordanian stock price index was cointegrated with all of the macroeconomic variables under consideration. These results suggest that the Jordanian capital market violated the theory of market efficiency from January 1987 to December 2000.	Jordan
Gunasekarage et al. (2004)	Johansen Cointegration Test, Impulse Response Function (IRF) Analysis, and Forecast Error Variance Decomposition (FEVD) Analysis	Money Supply, Treasury bills Rate, Consumer Price Index, and The Exchange Rate.	- Lagged values of money supply and the Treasury bill rate had a significant influence on the stock market. - All Share Price Index did not have any influence on money supply, but it did influence the Treasury bill rate.	Sri Lanka
Ibrahim (2006)	VAR model, Impulse Response Function (IRF) Analysis	Bank Loans, Interest Rates, , Exchange Rate, Price Level, Output.	- The results revealed that bank loans reacted positively to the increase in stock prices but the converse is not true. - Bank loans appeared to accommodate expansion in real output but had no influence on real economic activity. - IRFs suggested that the bank loans played no significant role in transmitting stock market shocks to the real sector.	Malaysia

Study	Method	Variable	Major Results	Country
Muradoglu and Argac (2001)	Johansen Cointegration Test	Money Supply, Overnight Interest Rate, Foreign Exchange Rate.	- The three monetary variables were found not be cointegrated with stock prices during the sample period and also during the sub-sample period from 1988 to 1989. - All three other monetary variables were cointegrated with stock prices in the sub-period from 1990 to 1995. These findings suggested that the results of the analysis were sensitive to the examined period.	Turkey
Ahmed (2008)	Johansen Cointegration Test, Causality Test of Toda and Yamamoto(1995), Impulse Response Function (IRF) Analysis, and Forecast Error Variance Decomposition (FEVD) Analysis	Money Supply, Interest Rates, Exchange Rates, Exports, Foreign Direct Investments, IP.	- Findings from the study revealed that a long run relationship between stock prices and money supply existed. - There is no relationship between the interest rate and stock prices. - The interest rate appeared to lead the stock prices in the short run.	India
Hasan and Javed (2009)	Johansen Cointegration Test, Causality Test, Impulse Response Function Analysis, and Forecast Error Variance Decomposition (FEVD) Analysis	Money Supply, Treasury bill rates, Consumer Price Index, Foreign Exchange Rates.	- This study provided evidence for the long run relationship between the equity market and monetary variables. - Unidirectional Granger causality was found between monetary variables and the equity market. - IRFs indicated that the interest rate shock and the exchange rates both have had a negative impact on equity returns, whereas the money supply has had a positive impact on the equity market.	Pakistan
Zafar et al. (2008)	A GARCH Model	90 Days T-bill Rate	- The conditional market returns had a negative significant relationship with interest rates, indicating that it was easy to predict the stock returns by analyzing interest rates. - The conditional variance had an insignificant negative relationship with interest rates and was a weak predictor for its volatility.	Pakistan

3.3.3: Studies of Multiple Countries

Unlike the studies above, other studies have emphasized comparisons of developing economies, of developed economies, or of developing against developed economies. These studies examined how market structure may affect the nature of the short and long run relationships between stock returns and real economic activity. One of the most recent studies in this area of research was by Keung et al. (2006). Their study examined the long and short equilibrium relationships between the major stock index in Singapore, U.S. stock markets, and two macroeconomic variables, the money supply (M1), and the short term interest rate. In their analysis, they used monthly data from 1982 to 2002 and conducted a Johansen-Juselius (1990) cointegration test, fractional cointegration tests, and Granger causality tests. They analyzed the whole sample period and two subperiods to account for the short-run dynamics of the relationship among the represented variables. The results indicated that Singapore's stock prices generally displayed a long-run equilibrium relationship with the interest rate and M1, but similar results did not hold true for the U.S. economy. Also, systematic causal relationships among the underlying variables were revealed, which suggests that the stock market performance might be a good measure of monetary policy adjustment in these two countries.

Within the framework of a standard discounted value model, Humpe and Macmillan (2009) compared U.S. and Japanese stock price behavior with a number of macroeconomic variables over the period January 1965 to June 2005. Based on cointegration analysis, there was evidence of a single cointegration vector between U.S. stock prices, IP, inflation, and the long-term interest rate. The coefficients from the cointegrating vector, normalized on the stock price, suggested that the U.S. stock price was influenced positively, as expected, by IP, and negatively by inflation and the long-term interest rate. The money supply (M1) did not have a significant

influence over the U.S. stock price. With respect to the Japanese stock price, two cointegrating vectors were found. The first vector, which was normalized on the stock price, provided evidence that Japanese stock prices were positively related to IP, but negatively related to the money supply (M1). The second vector, normalized on IP, suggested that IP is negatively related to the interest rate and the rate of inflation. The difference in behavior between the two stock markets may be attributed to Japan's slump after 1990 and its consequent liquidity trap of the late 1990s and early 21st century.

Hammoudeh and Choi (2006) examined the dynamic relationships of three global factors, the price of oil, the S&P 500, and the U.S. T-bill rate, with the Gulf Cooperation Council's (GCC) stock markets. A VECM model as well as IRFs and VDC analyses were used in the study with weekly data from February 15, 1994 to December 28, 2004. Based on the results, the U.S. T-bill rate had a direct influence on some of the GCC markets. The S&P 500 and the Western Texas Intermediate (WTI), or the Brent oil price, did not have such a direct impact, which implies that local factors such as liquidity and profitability may be more important for explaining the behavior of GCC markets than the international factors. In contrast, the impulse response analysis suggested that the S&P 500 shocks had positive impacts on all GCC markets over a 20-week forecast horizon, suggesting that the GCC stock markets rose with the U.S. markets. From the results, there was no definite consensus on the impact of the T-bill rate. Additionally, most of the GCC markets were benefiting from positive oil shocks. The FVDC analysis indicated that the largest portion of total variations in the GCC index returns was attributed to their own domestic or other GCC shocks over the forecast horizon with only two exceptions: the Oman's and Saudi stock markets where the price of oil explained about 30% and 19% of the variations of the market, respectively.

Errunza and Hogan (1998) investigated whether macroeconomic variability can explain time variation in seven European stock markets[31] compared to the U.S. stock market. Macroeconomic variables included IP as a proxy for real activity, and money supply and inflation as proxies for monetary factors. Different techniques including various GARCH models, a VAR model, and ordinary least squares (OLS) two step procedure were used in this study. Along with monthly data from January 1959 to March 1993; Errunza and Hogan found that the time variation in the seven European stock markets was significantly affected by the past variability of monetary and real macroeconomic factors, which contradicts the results commonly documented for the U.S. economy.

Najand and Rahman (1991) used the GARCH model to examine the effect of the volatility of macroeconomic variables on stock return volatility for the U.S., Germany, UK, and Canada. The macroeconomic variables included in the analysis were the actual volatility of real output, the interest rate, inflation, and monetary base. From their empirical analyses of 309 monthly observations between January 1962 and September 1987, Najand and Rahman provided support for existing relationships between the volatility of stock returns and the volatility of macroeconomic variables.

Wenshwo (2002) investigated the impact of currency depreciation on stock returns and its volatility in the five Far East Asian economies of Hong Kong, Singapore, South Korea, Taiwan, and Thailand during the Asian crisis (1997-1999). Based on the GARCH model, this study provided strong evidence indicating that currency depreciation adversely affected stock returns and/or increased market volatility during the Asian crisis. From his finding, Wenshwo suggested that international investors and fund managers planning to invest in Far East markets should evaluate the stability of foreign exchange markets before taking action.

[31] These markets included Italy, UK, France, Germany, Switzerland, Netherlands, and Belgium.

Malik and Hammoudeh (2007) examined the volatility and shock transmission mechanism among U.S. equities, global crude oil market, and the equity markets of Saudi Arabia, Kuwait, and Bahrain. In this study, a multivariate-GARCH model was used to analyze daily data from February 14, 1994 to December 25, 2001. The results indicated that the equity markets of Saudi Arabia, Kuwait, and Bahrain were affected by the world oil market volatility. However, significant volatility spilled over from the Saudi market to the oil market. Additional findings indicated that shocks in the US equity market indirectly affected volatility in the three Gulf stock markets, emphasizing the important link between investments made by Gulf investors in the U.S. and in each of the three Gulf stock markets.

Another comprehensive study conducted by Muradoglu et al. (2000) considered 19 emerging markets from all over the world[32]. The study investigated possible causality relationships between the 19 emerging stock markets returns and other macroeconomic variables; i.e., exchange rates, interest rates, inflation, and IP using monthly data from 1976 to 1997. The results revealed that the relationship between stock returns and the macroeconomic variables mainly depend on the size of the stock markets and their integration with world markets.

Table 3.3 summarized common variables and major results of the studies that were conducted across economies. These studies provide a comparison between the dynamic behaviors of the stock market returns in different economies. As expected, these studies revealed evidences support that the relationship between stock returns and the macroeconomic variables mainly depend on the size of the stock markets and, sample periods and variable used.

[32] These countries included Argentina, Brazil, Chile, Colombia, Greece, India, Indonesia, Jordan, Korea, Malaysia, Mexico, Nigeria, Pakistan, Philippines, Portugal, Thailand, Turkey, Venezuela, and Zimbabwe.

Table 3.3: Common Macroeconomic Variables and Major Results in Multiple Countries Studies

Study	Method	Variable	Major Results	Country	
				Developed	Developing
Keung et al. (2006)	Johansen Cointegration Test, Fractional Cointegration Test, and Causality Test	M1, A Short Term of Interest Rate.	- There is a long-run equilibrium relationship between Singapore's stock prices and interest rate and MI, but similar results did not hold true for the U.S. economy. - Systematic causal relationships among the underlying variables exist, which suggests that the stock market performance might be a good measure for the monetary policy adjustment in these two countries.	Singapore and U.S.	-
Humpe and Macmillan (2009)	Johansen Cointegration Test, Causality Tests, Impulse Response Function (IRF) Analysis, and Forecast Error Variance Decomposition (FEVD) Analysis	Money Supply, Long-Term Interest Rate, Inflation, IP.	- With respect to the U.S. stock market, this study suggests that U.S. stock price was influenced positively by IP and negatively by inflation and the long-term interest rate. - The money supply did not have a significant influence over the U.S. stock price. - With respect to the U.S. stock market, this study provides evidence that Japanese stock prices were positively related to IP but negatively related to the money supply. Also, this study suggested that IP is negatively related to the interest rate and the rate of inflation.	U.S. and Japan	-
Hammoudeh and Choi (2006)	Vector Error Correction Model (VECM), Impulse Response Function Analysis, and Forecast Error Variance Decomposition (FEVD) Analysis	Oil Price, the US T-bill Rate, S&P 500	- This study revealed that the U.S. T-bill rate had a direct influence on some of the GCC markets. The S&P 500, and the Western Texas Intermediate (WTI), and the Brent oil price, did not have such a direct impact. - IRF analysis suggested that the S&P 500 shocks had positive impacts on all GCC markets over a 20-week forecast horizon, while there was no definite consensus on the impact of the T–bill rate. - The VDC' analysis indicated that the oil price explained about 30% and 19% of the variations of Oman's and Saudi stock markets, respectively.	-	Saudi Arabia, Kuwait, Bahrain, Qatar, the United Arab Emirates, and Oman

Study	Method	Variable	Major Results	Country	
				Developed	Developing
Errunza and Hogan (1998)	GARCH Model, VAR Model, and Ordinary Least Squares Method (OLS)	Money Supply, Inflation, IP.	- This study found that the time variation in the seven European stock markets was significantly affected by the past variability of monetary and real macroeconomic factors. This contradicts to those results commonly documented for the U.S. economy.	Italy, UK, France, Germany, Switzerland, Netherlands, and Belgium.	-
Najand and Rahman (1991)	GARCH Model	Monetary Base, Interest Rate, Inflation, Real Output.	- This study provided support for existing relationships between volatility of stock returns and volatility of the tested macroeconomic variables.	U.S., Germany, UK, and Canada	-
Wenshwo (2002)	A GARCH Model	Currency Depreciation	- This study provided strong evidence indicating that currency depreciation adversely affected stock returns and/or increased market volatility during the Asian crisis.	Hong Kong, Singapore, South Korea,	Taiwan, and Thailand
Malik and Hammoudeh (2007)	Multivariate-GARCH Model	US Equity, Global Crude Oil Market.	- Results indicated that the equity markets of Saudi Arabia, Kuwait, and Bahrain received volatility from the oil market. - A significant volatility was spilled over from the Saudi market to the oil market. - Findings indicated that shocks in the U.S. equity market indirectly affected volatility in the three Gulf stock markets, emphasizing the important link between investments made by Gulf investors in the U.S. and in each of the three Gulf stock markets.	Saudi Arabia, Kuwait, and Bahrain	-
Muradoglu et al. (2000)	Causality Test	Interest Rates, Inflation, Exchange Rate, IP.	- The results revealed that the relationship between stock returns and the macroeconomic variables are mainly subject to the size of the stock markets and their integration with world markets.	Greece, and Korea	Argentina, Brazil, Chile, Colombia, , India, Indonesia, Jordan, , Malaysia, Mexico, Nigeria, Pakistan, Philippines, Portugal, Thailand, Turkey, Venezuela, and Zimbabwe.

3.4: Summary and Remarks

From this comprehensive literature review, several key conclusions can be drawn. First, while existing theories posit a link between macroeconomic variables and stock markets, they do not specify the type or the number of macroeconomic factors that should be included. Thus, the existing empirical studies, reviewed in this chapter, have shown the use of a vast range of macroeconomic and microeconomic variables to examine their influence on stock prices (returns). A summary of these variables is provided in Table 3.1., Table 3.2, and Table 3.3 shown before. Second, while previous studies have significantly improved our understanding of the relationships between financial markets and real economic activity, the findings from the literature are mixed given that they were sensitive to the choice of countries, variable selection, and the time period studied. It is difficult to generalize the results because each market is unique in terms of its own rules, regulations, and type of investors.

Third, the VAR framework, cointegration testes, Granger causality tests, and GARCH models were commonly used to examine the relationships between stock prices and real economic activity. However, there is no definitive guideline for choosing an appropriate model. Finally, it is obvious that there is a shortage of literature concerning emerging stock markets, but it is particularly lacking in regards to the Saudi market. In fact, of the empirical studies reviewed in this study, only two studies included the Saudi market and examined the effect of foreign factors on its dynamic behavior[33]. Therefore, this study, to the best of my knowledge, will be among the first empirical studies to consider the relationships between the Saudi stock market

[33] Studies that examine saudi economy but did not meet the either the object of this dissertation or the criteria for the study to be included in this survey include:

index and a set of macroeconomic variables from 1993 to 2009. The methods to analyze the data will be similar to the methods reviewed in this chapter.

Chapter 4 : Macroeconomic Variable Selection and Validation

4.1: Introduction

As previously mentioned, the EMH and APT are silent about which precise events or economic factors likely influence asset prices. This silence opens the door to investigating a wide range of relevant events both at the microeconomic and macroeconomic levels of a stock market. Discounted cash flows of the expected returns or the present value model (PVM) provides a motivation for the selected variables in the majority of related empirical work, which we discussed in the previous chapter. PVM simply states that the price of a stock is the present discounted value of the expected future dividends received by the owner. The PVM can be expressed as follows (Semmler, 2006, and McMillan, 2010):

$$P_t = \sum_{i=1}^{\infty} \frac{E_t(R_{t+i})}{((1 + k_t)^i} \tag{3.4}$$

This formula indicates that the stock price, P_t, is strongly affected by any possible changes in the expected stream of returns, $E(R_{t+i})$, and by factors associated with the discount rate of future cash flows, k_t. All essential factors that may directly or indirectly affect expected returns and subsequently affect stock prices should be considered. In other words, new related macroeconomic information may be analyzed as long as they impact the expectation of stock prices or returns, the discount rates, k_t, or both.

This study investigates eight macroeconomic variables that all have a significant impact on the general index of the Saudi stock market, specifically the Tadawul All share index (TASI), over the period January 1993 to December 2009. These eight macroeconomic variables include:

the money supply (M1, M2); a short term interest rate, the Saudi Arabia Interbank Offered Rate (Isa3); inflation in the Saudi economy measured by the consumer price index (CPI); bank credit (BC) of local commercial banks for the private sector; world oil price proxied by the UK-Brent crude price oil (BOP); the nominal effective exchange rate of the Saudi Riyal (Ex); and Standard and Poor's 500 stock price index (S&P 500) as a proxy for the influence of international stock markets.

The selection of these variables was based upon the PVM theory, and a previous literature discussed in the Chapter 3. In the following, we will briefly validate the inclusion of each macroeconomic variable utilized in the analysis.

4.2: Tadawul All Shares Index (TASI)

TASI is the only general price index for the Saudi Stock market. TASI is computed based on the calculation that takes into account traded securities or free-floating shares. According to the Saudi capital law, shares owned by the following parties are excluded from TASI calculations: the Saudi Government and its institutions; a foreign partner, if he or she is not permitted to sell without the prior approval of the supervision authority; a founding partner during the restriction period; and owners who hold 10% or more of a company's shares listed on the Saudi stock market (Tadawul website, 2011). At the end of 2010, free-floating shares on the TASI index accounted for 41% of total issued shares (Table 1.5). Thus, the TASI reflects the performance of all listed companies, 146 companies, in the Saudi stock market taking into account the free-floating shares. Thus, TASI expected to provide better insight into the overall performance of the Saudi stock market in response to fundamental changes within the Saudi economy.

4.3: Money Supply (M1 and M2)

The impact of the money supply on the stock prices has been widely discussed in the economic literature. The money supply may affect the present value of cash flows via its effect on the discount rate. Although a strong relationship between the money supply and the stock market prices has been found, the effect of changes in the money supply on stock market prices is still debated, (Hamburger et al., 1972; and Hashemzadeh et al., 1988). Hamburger and Kochin (1972) argue that there is one answer to the questions of how money influences the stock market or how the effects of money should be measured.

Friedman and Schwartz (1963) present a modern quantity theory that suggests that an exogenous shock that increases the money supply changes the equilibrium position of money with respect to other assets included in the portfolio. As a result, asset holders adjust the proportion of their portfolios taking the form of money balances. This adjustment alters the demand for other assets that compete with money balances such as equity shares. An increase in the money supply is expected to generate an excess supply of money balances which leads to an excess demand for shares. In this case, share prices are expected to rise.

Bernanke and Kuttner (2005) clarify that the price of a stock is a function of its monetary value and the perceived risk associated with holding the stock. Therefore, a stock is considered to be attractive if its monetary value is high and/or the perceived risk of the stock is low. Tightening the money supply would raise the real interest rate. An increase in the real interest rate will lead to an increase in the discount rate, which decreases the value of the stock. In addition, tightening the money supply will increase the risk premium necessary to compensate an investor for holding the risky asset. As a result, economic activity would slow down, potentially reducing firms' profits. If this is the case, investors would demand a higher risk premium to bear

more risk. A higher risk premium makes the stock unattractive, which lowers the price of the stock.

Another explanation advocates for indirect channels of relationship between changes in the money supply and share prices via real activity. According to this view, a positive money supply shock would positively affect the aggregate economy, and hence, expected stock returns. That is, higher economic activity implies higher cash flows, which causes stock prices to rise. Also, decreasing the interest rate would cause the discount rate to fall, which would increase the value of the stock. One implication of the above ideas is that investors could earn above normal profits by observing the behavior of the money stock (Sellin, 2001). This result would contradict the EMH since past information may be used to predict future stock prices.

Inclusion of the money supply in our study may contribute to the existing literature in regards to the relationship between changes in the money supply and share prices in an emerging stock market such as the Saudi stock market. In the absence of a unique measure of the money supply in the Saudi economy, this study will use two proxies for the money supply in the Saudi economy. The first proxy (M1) is the narrowest measure of the money supply of Saudi Arabia, and consists of currency outside of banks and demand deposits. The second proxy (M2) is a broad measure of the money supply in the Saudi economy, and consists of the narrow money supply (M1) components, time deposits and savings deposits. Examining these two proxies is expected to give a comprehensive view of the role that the money supply plays in explaining movements in the Saudi stock market.

4.4: Short Term Interest Rate (Isa3)

Economic theory, based on rational expectations, assumes that stock prices are determined in a forward-looking manner such that they are determined by expected future earnings. Monetary policy shocks influence stock prices directly through the discount rate and indirectly through its influence on the degree of uncertainty or risks that an agent may face in the market (Bjornland, Hilde, and Leitemo, 2009). For example, with a negative interest rate shock, i.e., increasing real interest rate, risk and required rate of return of a particular investment increase and profits of a firm tend to decrease, due to increased cost of capital. Ultimately, this may result in a decrease of the stock value.

According to Bernanke (2003), there are two equivalent explanations for why expectations of higher short-term real interest rates should lower stock prices. First, for an investor to value future dividends, they must discount them back to the present time. Since higher interest rates make a given future dividend less valuable in today's dollars, the value of that share or stock will decline. Second, higher real interest rates increase the required return on stocks and reduce what investors are willing to pay for these stocks. In other words, higher real interest rates would make other investments, such as bonds, more attractive to investors.

Investigating the relationship between a short-term interest rate such as Isa3 and stock market prices in the Saudi economy is of particular interest to researchers for at least two reasons. First, the Saudi Monetary Authority works in a unique institutional environment in which charging interest is prohibited by Islamic law. That is, Islamic law does not consider money as an asset, and thus, money is viewed only as a measurement of value. For that reason, SAMA, the central bank in Saudi Arabia, has no direct control over the interest rate (Ramady, 2005). Second, the Saudi currency has been pegged to the U.S. dollar at a fixed exchange rate

since 1986. This restriction makes local monetary policy conditional on the monetary policy of the United States. In such an environment, interest rate based assets are not the primary alternative for the majority of investors in the Saudi economy. Money and capital markets in the Saudi economy are not substitutes but rather are independent.

This study uses a proxy for the local interest rate, Isa3, to account for fundamental changes in the local economy. Most empirical studies related to the Saudi economy use a short or a long term interest rate of the U.S. market as a proxy for the Saudi market due to the Saudi exchange rate policy. Figure 6.3 provides evidence that the local interest rate Isa3 in the Saudi market did not correspond one-to-one to the interest rate in the U.S market during the sample period.

4.5: Inflation (CPI)

The dynamic impact of inflation on equity prices is a matter of considerable debate both theoretically and empirically. This debate is motivated partially by the theory that the stock market provides an effective hedge against inflation, (Bodie, 1976). The argument that the stock market serves as a hedge against inflation is based on the fundamental idea of Irving Fisher (1930), and is known as the Fisher Effect[34]. The Fisher Effect states that in the long run, inflation

[34] Mathematically, the Fisher Hypothesis can be expressed in the following simple identity equation: $i_t^r = i_t^n - \pi_t^e$, where i_t^r is the real interest rate, i_t^e is the nominal rate, and π_t^e is the expected inflation rate at all period *t*. Fisher (1930) believes that the real and monetary sectors of the economy are independent, and claims that the nominal interest rate fully reflects the available information concerning the possible futures values of the rate of inflation. Thus, he hypothesizes that the real return on interest rates is determined by real factors such as the productivity of capital and time preference of savers, hence, the real return on interest rates and the expected inflation rate are independent. One way that the Fisher Effect can be tested is as follows:

$$i_t^n = \alpha + \beta\pi_t^e + \varepsilon_t$$

From this model, the lack of rejection of the null hypothesis $\beta = 1$ would indicate the presence of a full Fisher Effect so that changes in the expected inflation rate would be transmitted one-for one to the nominal interest rate. If the estimate of $\beta < 1$, then the Fisher Effect does not exist and changes in the

and the nominal interest rate should move one-to-one with expected inflation. This implies that higher inflation will increase the nominal stock market return, but the real stock return remains unchanged. Therefore, investors are fully compensated.

Bodie (1976), Jaffe and Mandelker (1976), Nelson (1976), Fama and Schwert (1977), Firth (1979) and Boudhouch and Richardson (1993) extended the original concept of a Fisher Effect to examine the specific interrelationships between rates of return on common stocks and the expected and unexpected rate of inflation. According to Firth (1979), this relationship can be tested using the following model:

$$R_{mt}^{n} = \alpha + \beta E(\pi_{at}^{e}/\emptyset_{t-1}) + \varepsilon_t$$

or (3.5)

$$R_{mt}^{n} = \alpha + \beta_1 E(\pi_{at}^{e}/\emptyset_{t-1}) + \beta_2 E(\pi_{ut}^{e}/\emptyset_{t-1}) + \varepsilon_t$$

where R_{mt}^{n} is the nominal return on the stock market in period *t*, and $E(\pi_{at}^{e}/\emptyset_{t-1})$ is the expected rate of inflation in period *t* based on the information available at time period *t-1*. $E(\pi_{ut}^{e}/\emptyset_{t-1})$ is the unexpected rate of inflation in period t-1 based on the information available at time period t-1; this can be seen as the difference between realized inflation and expected inflation. If $\beta_1 = \beta_2 = 1$, stock prices in nominal terms fully reflect expected inflation, such that investors are fully compensated for expected rates of inflation. In other words, if $\beta_1 = \beta_2 = 1$, the stock market is a hedge against inflation. Firth (1979) and Boudhouch and Richardson (1993), among others, provide support in favor of a positive relationship between inflation and stock market returns.

On the other hand, Fama (1981) and Schwert (1981), among others, support a negative correlation between inflation and stock market prices (returns). One reason for why inflation negatively impacts equity prices is the negative correlation between inflation and expected real

expected inflation rate would be proportionally transmitted to the nominal interest rate.

economic growth so that investors shift their portfolios towards real assets if the expected inflation rate becomes remarkably high (Hatemi-J, 2009).

Given that the empirical evidence on the hypothesis that the stock market is a complete hedge against inflation is mixed, this study includes inflation, by means of the CPI to provide a new insight about the generalized Fisher effect from the perspective of an emerging market such as the Saudi stock market. Therefore, investors may benefit from this study to learn how to allocate their recourses more efficiently to protect the purchasing power of their investments, especially during inflationary periods.

4.6: Bank Credit (BC)

Commercial banks, in the modern economy, create most of the money supply by issuing loans. Therefore, when banks create an excess supply of money, the prices of assets, goods, and services tend to rise. Conversely, when not enough money is created, the prices of assets, goods, and services decrease. Thus, it is reasonable to hypothesize that a strong positive relationship exists between asset prices and bank lending. According to Kim and Ramon (1994), the dynamic relationship between stock prices and bank lending can be observed in two channels. First, changes in the stock price may signal changes in future economic activity, and hence affect the level of loan demand. Second, stock price changes may affect the position of bank's capital and hence the level of loan supply.

Regarding the first channel, public interest and participation in the Saudi stock market have increased significantly during the past few years. In fact, since 1993 stocks and mutual funds, among other financial products, have become common investments. This phenomenon was partially supported by an easy lending policy implemented by commercial banks due to the

enhancement of the credibility of the loan market such as (1) a salary transfer system in which banks can ensure getting their balance from the customers on time according to loan agreements, and (2) establishment of a Saudi credit information system to provide banks with risk profiles of customers.

As for the second channel, the link between commercial banks in the Saudi economy and the stock market is unique, in the sense that banks have a significant position in both the debt and equity markets since the intermediation function of the Saudi stock market was restricted by the law to commercial banks (SAMA, 1997). Accordingly, commercial banks in Saudi Arabia provided regular bank services and played roles similar to brokerage houses in managing mutual funds and portfolios during most of the time period under consideration in this study, 1993-2009. On the other hand, banks are the second largest supplier of credit in the Saudi economy after the government's mutual funds.

The dual role played by these banks enables each bank to use capital gains on stocks to protect itself from adverse shocks to its assets. From my point view, this factor may justify the willingness of these banks to grant more personal loans, especially when Saudi stock prices appreciated from 2002 to 2006. According to the governor of the Saudi Arabian Monetary Agency (SAMA), Saudi banks liquidated a significant part of their net foreign assets between 1997 and 2006 to meet higher domestic credit demand. That is, between 1997 and 2006 the share of domestic credit rose from 39.1 percent to 57.7 percent of total assets or from 24.1 percent to 38.6 percent of GDP (Alsayari, 2007).

In this study, it is vital to include bank credits (BC) since their inclusion will help determine the effect of credit banks' lending behavior on fluctuations of asset prices in the Saudi stock market. Also, examining the historical relationship between bank lending behavior and

stock prices may provide the Saudi authority with reliable knowledge about the role of bank loans in transmitting financial shocks to the real sector through the stock market. In other words, understanding this channel may help authorities to stimulate bank loans as a way to boost real activity in the local economy.

4.7: World Oil Prices (BOP)

Given that stock prices are discounted values of expected future cash flows, stock prices are affected by movements in related macroeconomic variables. Since oil is an essential input cost for final products in a modern economy, it is reasonable to anticipate that oil prices affect stock prices directly via its effects on the expected cash flows and indirectly via its effects on discount rates. That is, changes in the price of oil may directly affect future cash flows via its effects on the cost of final products in the economy, which would cause opposite changes in stock prices.

In regards to the discount rate, changes in the price of oil may affect stock prices via its effects on the expected inflation rate and the expected real interest rate. For instance, a higher price of oil places upward pressure on expected domestic inflation. In this case, a higher expected inflation rate is positively related to the discount rate and is negatively related to stock prices. Also, a higher price of oil could cause the real interest rate to rise. As a result, the rate of return required by investors would increase, which would cause a decrease in stock prices (Huang et al., 1996).

The ultimate effect of the price of oil on the stock market depends not only on what is happening to the price of oil, but also whether the company and country is a net producer or net consumer of oil. Cunado and Garcia (2005) argue that oil price shocks have a different impact on

stock prices depending on (1) whether the economy is considered as a net-importer or net-exporter of oil; (2) the institutional structures of the economy within these groups, and (3) the stage of economic development of the country.

It is often argued that the price of oil must be included in any list of systematic factors that influence stock market prices (Chen, Roll, and Ross, 1986). The rationale for including the world price of oil as a factor influencing stock valuations in the Saudi stock market comes from the critical role that oil revenues play in the Saudi economy. The Saudi economy is a small oil-based economy that possesses nearly 20% of the world's known petroleum reserves and is ranked as the largest exporter of petroleum ("Saudi Arabia facts and figures", http://www.opec.org/opec_web/en/about_us/169.htm). The oil sector in the Saudi economy contributes more than 85% both of the country's exports and government revenues (SAMA, 2010). As a result, oil revenue plays a vital role in all major economic activities in Saudi Arabia, including the stock market.

The effect of the price of oil on stock markets in net-oil importing countries, i.e., U.S. and Australia, is expected to be negative (Huang et al., 1996; Sadorsky, 1999; and Faff and Brailsford, 1999). However, the effect of oil price shocks on the stock market in Saudi Arabia is ambiguous. The price of oil determines the level of government budget revenues, and hence, aggregate demand in the whole economy. In this sense, a high price of oil can positively affect corporate output and earnings and stock prices. Also, the Saudi economy imports almost all manufactured and raw goods except for oil from developed and emerging countries. Therefore, a high price of oil may indirectly harm the Saudi economy and may directly harm the Saudi stock market through its influence on the prices of imported products. In other words, a high price of

oil may feed back to the local economy as imported inflation, which increases future interest rates, causing stock prices to decline.

Needless to say, the total impact of the price of oil shocks on stock market prices is dependent on whether the positive and negative effects offset each other. Thus, this study aims to determine how oil price shocks impact the Saudi stock market and whether fluctuations in the price of oil can explain stock market movements within the Saudi economy. In this study, we use the Brent oil price (BOP). The BOP was preferred over other oil benchmarks, i.e., West Texas Intermediate (WTI) and Dubai-Oman oil prices, mainly because it is used to price two thirds of the crude oil internationally traded[35].

4.8: Exchange Rate (Ex)

There are different theoretical approaches to understanding the relationship between the exchange rate and stock prices. Among these approaches, the two most prominent are the goods market approaches introduced by Dornbusch and Fischer (1980) and the portfolio balance approaches discussed by Frankel (1983).

Dornbusch and Fischer's (1980) approach explains the impact of exchange rate fluctuations on the stock market using the current account or the trade balance. This approach advocates that changes in exchange rates affect international competitiveness of the economy, and thus, changes in its trade balance. A depreciation of the domestic currency makes local firms more competitive, i.e., their export is cheaper in international markets, which increases exports.

[35] Brent, WTI and Dubai-Oman are the main crude oil benchmarks of the current oil pricing system. Nearly all oil traded outside America and the Far East is priced using Brent as a benchmark. WTI is the main benchmark used for pricing oil imports into the U.S. Dubai-Oman is used as a benchmark for Gulf crudes (Saudi Arabia, Iran, Iraq, the UAE, Qatar and Kuwait) sold in the Asia-Pacific market. For more details see Bassam Fattouh (2006).

This increase translates into higher incomes of these companies and higher stock prices. The converse is true for an appreciation in domestic currency.

While it is obvious that the Dornbusch and Fischer approach suggests a negative relationship between stock prices and exchanges rates with the source of causation being attributed to exchange rates, one may argue that the impact of exchange rate fluctuations on the stock market returns, on a macro and micro scale, dependents on importance of international trade to the local economy and whether the companies listed on the stock market are importing or exporting companies.

The portfolio balance approach stresses the role of capital account transactions on determining the relationship between the exchange rate and stock prices (Frankel, 1993). This approach postulates a positive relationship between stock prices and exchange rates, with stock prices being the root cause of the relationship. This conclusion is based on the fact that investors hold domestic and foreign assets, including currencies, in their portfolio. The exchange rate plays a significant role in balancing the demand for assets included in their portfolio. An appreciation of a local stock market would attract capital flows from foreign markets and disposal of foreign assets, causing the local currency to appreciate. The reverse would occur if the local stock market depreciated. In other words, rising (declining) stock prices may lead to an appreciation (depreciation) of the exchange rate of the local currency.

By including the exchange rate in this study, we gain a better understanding of how exchange rates affect stock prices within a small open economy such as the Saudi economy. The World Bank classified the Saudi economy as one of the most open economies in the world with a degree of openness equal to 70%, measured as the ratio of the merchandise trade volume to GDP

(World Development Indicators, 2009). Although there is no standard level of the openness, this may be a sign that the Saudi economy heavily depends on the world economy.

Since 1986, the Saudi authority has adopted a pegged exchange rate regime in which Saudi Riyals are pegged to U.S. Dollars at a fixed rate of 1:3.75. Because of this, the nominal effective exchange rate of the Saudi Riyals (NEER), as defined by the International Monetary Fund (IMF), will be used to examine the impact of the exchange rate of the Saudi Riyals on the stock market, rather than the exchange rate against an individual major currency like the U.S. dollar. In fact, NEER represents the relative value of the Saudi Riyals compared to the other major currencies such as the U.S. dollar, Japanese yen, and Euro.

4.9: Standard and Poor's 500 Index (S&P 500)

Understanding how international financial markets affect each other became critical for portfolio managers and policymakers after the stock market crash in October 1987 that affected global markets. While policymakers want to diminish the negative effects of international crises on the local economy, portfolio managers are interested in taking advantage of international diversification. The benefit of international diversification, however, is limited when equity markets are cointegrated because of the presence of common factors which limit the amount of independent variation (Wong et al., 2004).

This study aims to examine whether the international market contributed to movements of the Saudi stock market during the sample time period, 1993-2009. To accomplish this goal, we include the Standard and Poor's (S&P 500) price index as a proxy for international stock market effects. The S&P 500 is one of the most popular benchmark indexes used to capture the overall U.S. stock market. It is also regarded as the leading indicator reflecting the risk/return

associate international investments worldwide (Standard & Poor's 500 Index, http://www.investopedia.com/terms/s/sp500.asp). Additionally, given that the Saudi Riyal has been pegged to the U.S. dollar at a fixed exchange rate, we argue that the U.S. stock market is the optimal alternative market for Saudi investors to take advantage of the exchange rate policy mentioned above, as it reduces exchange rate risks usually associated with foreign investments using something other than the U.S. dollar due to the exchange rate peg arrangements between the Saudi Riyal and U.S. dollars.

Chapter 5 : Econometric Methodology

This chapter presents the econometric methods that we will use in this dissertation. The first section will give a brief background on the empirical methods of VAR models, such as the Johansen-Juselius (1990) test, causality tests, impulse response functions (IRFs), and forecast error variance decompositions (FEVD). We employ these methods to answer the first four research questions mentioned in the first chapter. The second section provides some background on autoregressive conditional heteroskedasticity modeling with the standard GARCH model suggested by Bollerslev (1986), its GARCH-X model extension suggested by Lee (1994), and two other versions of the GARCH-X model, known as the GARCH-S, and GARCH-G models. These four models will be used to answer the final research question proposed in Chapter 1.

5.1. Analysis Using VAR Models

5.1.1. Johansen-Juselius (1990) Cointegration Test

Many economic time series data, such as consumption and income, stock prices and dividends share theoretical long-run relationships. It is also widely accepted that these time series data evolve over time such that their mean and variance are not constant (Nelson and Plosser, 1982). Relying on such non-stationary time series data may lead macroeconomists to wrongly conclude that two variables are related when in reality they are not. This phenomenon is well known in the literature as spurious regression (Stock and Watson, 2006). That is, if Y_t and X_t are non-stationary time series data ($Y, X \sim I(1)$), then a "spurious" relationship between these two variables may exist unless the linear combination of the two variables, i.e., $\hat{\mu}_t = Y_t - \hat{\beta} X_t$, is stationary or $\hat{\mu}_t \sim I(0)$.The typical method to analyze a non-stationary process is to either de-

trend or difference the data depending on the type of trend. While these methods may provide stationary variables for the regression, they can cause a loss of significant long run information and omitted variables bias (Maddala, 2001). Granger's Representation Theorem (GRT) introduced an effective method to analyze non-stationary processes without losing valuable long run information as with differencing or de-trending techniques. This method is well known in literature by the cointegration. The idea of the cointegration test is simple. Suppose Y_t and X_t are integrated of order one, or $Y_t \sim I(1)$ and $X_t \sim I(1)$. Then Y_t and X_t are said to be cointegrated if and only if $\hat{\mu}_t$ obtained from the long run relationship regression is integrated of order zero or $\hat{\mu}_t \sim I(0)$. Therefore, if the cointegration condition is met, then Y_t and X_t move together in the long run such that they cannot drift arbitrarily far apart from each other as time goes on (Maddala, 2001). In this context, the GRT says that the short term disequilibrium relationship between two cointegrated time series can be expressed in the error correction form which may be seen as a force pushing the residual errors back towards the equilibrium (Maddala, 2001).

Two typical methods are available in literature to examine the long run relationships among variables, and both follow the idea of the GRT. One is the Engle and Granger (1987)[36] cointegration test and the other is the Johansen-Juselius (1990) cointegration test. The first is

[36] According to Engle and Granger (1987) test, if we have two time series Y_t, and X_t where $Y_t \sim I(1), and\ X_t \sim I(1)$, then Y_t and X_t are said to be cointegrated and have long-run relationships, if and only if their linear combination, $\hat{u}_t$, is stationary. Engle-Granger (1987) consists of two steps proceeded as follows: (i) estimate the long-run relationships i.e. $Y_t = \alpha + \beta X_t + \mu_t$ Where β is the cointegration parameter; and (ii) test whether the estimated residuals $\hat{u}_t$ obtained in the first step are stationary or $\hat{u}_t \sim I(0)$. The test of the estimated residuals $\hat{u}_t$ can be conducted using different methodologies such as augmented Dickey Fuller ADF test, Dickey and Fuller (1979, 1981), and/or Phillips-Perron test PP (1988) where the null hypothesis in the two tests is to test for non-stationarity or equivalently no cointegration. If the null hypothesis of non-stationarity is rejected, then the time series are cointegrated of order $CI\sim$ (1,1), (Engle and Granger, 1987). If the null hypothesis cannot be rejected then the results of the OLS regression are misleading or "spurious". It should be noted, however, that because the residuals obtained from the first step are estimated and are not the actual ones, the critical values provided by Dickey Fuller (1981) are no longer valid, instead the critical suggested by Engle and Yoo (1987) are the convenient critical values. For more details, see Enders (2004).

suitable for bivariate analysis[37], while the second is convenient to use when there are more than two variables. Since this study aims to investigate the long and short run relationships among more than two variables, we restrict our discussion below to the Johansen-Juselius (1990) cointegration test.

The Johansen-Juselius (1990) cointegration test (henceforth the JJ approach) is a statistical method for testing for cointegration. The JJ approach is based on a VAR model of order p to examine the long run relationships that may exist among representative variables. For that reason, the JJ approach overcomes some drawbacks associated with the two-step Engle-Granger (1987) method. The JJ approach does not require the choice of dependent and independent variables. All variables entering the VAR models are treated as endogenous variables. Also, the JJ approach is a one step calculation; free from carrying forward any bias introduced in the first step as in the case of the two-step Engle-Granger methodology (1987). Finally, if multiple cointegrating vectors exist, the use of the Engle-Granger method may simply produce a complex linear combination of all distinct cointegrating vectors. The JJ approach can be expressed mathematically in the following general form:

$$Y_t = \mu + A_1 Y_{t-1} + A_2 Y_{t-2} + A_3 Y_{t-3} + \cdots + A_p Y_{t-p} + \varepsilon_t \qquad (5.1)$$

where Y_t is a vector containing n variables, all of which are integrated of order one and the subscript t denotes the time period. μ is an $(nx1)$ vector of constants, A_p is an $(n \times n)$ matrix of coefficients where ρ is the maximum lag included in the model, and ε_t is an $(n\,x1)$ vector of error terms. This can be written in the form of the error correction model assuming cointegration of order p. Enders (2004) shows how to rewrite equation (5.1) as:

[37] While the Engle and Granger (1987) method is valid with multiple variables, it cannot detect multiple cointegrating relations. Also, researchers should be careful with the choice of dependent variable, as he/she might choose a variable that does not enter the relationship.

$$\Delta Y_t = \mu + (A_1 - I)\, Y_{t-1} + A_2 Y_{t-2} + A_3 Y_{t-3} + \cdots + A_p Y_{t-p} + \varepsilon_t, \quad (5.2)$$

or in a final broad form as:

$$\Delta Y_t = \mu + \Gamma_1 \Delta Y_{t-1} + \cdots + \Gamma_{p-1} \Delta Y_{t-p+1} + \Pi\, Y_{t-p} + \varepsilon_t, \quad (5.3)$$

where $\Gamma_i = (A_1 + A_2 + \cdots + A_{p-1} - I)$ represents the dynamics of the model in the short run. In equation 5.3, $\Pi = (A_1 + A_2 + \cdots + A_p - I)$ represents the long run relationship among the variables included in the vector Y_t, and I is the identity vector. The key idea of the JJ approach is to determine the rank of the matrix Π, which represents the number of independent cointegration vectors. In other words, how many error correction terms belong in the model.

The rank of the matrix Π is found by determining the number of eigenvalues Π that are significantly different from zero. In this regard, the JJ approach distinguishes between three cases depending on the values of the rank of Π (r). The first case is when $r = 0$. This implies that the variables included in the model are not cointegrated. In other words, there is no linear combination of the variables exist in the vector Y_t. The second case, when $r = n$, where n the number of variables is in the system, indicates that the vector process Y_t is stationary, and there is no stochastic trend in the series under consideration. In other words, Π is of full rank, which implies that the initial assumption that all variables included in the Y_t vector are $I{\sim}(1)$ is no longer valid (Johansen and Juselius (1990). Unlike the above two extreme cases, the typical case is to find r greater than zero but less than n, which implies that a stationary number of linear combinations exist among the vector process Y_t, (Enders, 2004). The JJ approach suggests two likelihood ratio statistics to examine the rank of matrix Π. These are the trace and maximum eigenvalues tests commonly given by the following formulas:

$$\lambda_{\text{trace}}(\text{r}) = -\text{T} \sum_{\text{i=r+1}}^{\text{n}} \ln\left(1 - \hat{\lambda}_{\text{i}}\right) \tag{5.4}$$

and

$$\lambda_{max}(r, r+1) = -T \ ln(1 - \hat{\lambda}_{r+1}) \tag{5.5}$$

where T is the sample size and $\hat{\lambda}_i$ is the eigenvalues, or characteristic roots, which have been obtained from the matrix Π. For the trace test (equation 5.4), the null hypothesis is that the number of cointegrating vectors is less than or equal to r, and the alternative hypothesis is that Π is of the full rank, $r = n$ cointegrating vectors. However, in the maximum eigenvalue test (equation 5.5), the null hypothesis, $r = 1$, is tested against the alternative of $r > 1$.

It should be noted that both tests are distributed asymptotically x^2 with degrees of freedom $p - r$, and they can be evaluated using the critical values that are reported in Johansen and Juselius (1990). The results drawn from λ_{trace} and λ_{max} might be inconsistent and that is one of the significant drawbacks of the two tests. The JJ approach is potentially sensitive to the lag length and to the type of deterministic components included in the VAR system. Thus, it is important to determine the appropriate lag length and deterministic components. Otherwise, hypothesis testing may be misleading (Enders, 2004).

The lag length of the VAR model used in the Johansen test is selected using a sequential log likelihood ratio (LR) test as in Lütkepohl (2005)[38]. Johansen (1995a) suggests five different structures of the deterministic trends to use: (i) the series included in the system have no deterministic trends, and the cointegrating relationship has no intercept and no trend; (ii) the series included in the system have no deterministic trends, and the cointegrating relationship has

[38] Other selection criteria usually used in the literature to complement LR test are: the final prediction error (FPE), Akaike Information Criterion (AIC), Schwarz information criterion (SIC), and Hannan-Quinn information criterion (HQ).

an intercept and no trend; (iii) the series included in the system have linear trends, and the cointegrating relationship has only an intercept; (iv) the series included in the system have linear trends and the cointegrating relationship has only deterministic trends; and (v) the series included in the system have quadratic trends, while the cointegrating relationship has a linear deterministic trend.

5.1.2. Causality Tests

The previous discussion of the JJ approach explained how to specify the nature of the relationship among the variables of interest in the long run and to determine whether the variables involved in the model are cointegrated. However, in either case, is essential to consider the relationship among the variables of interest in the short run. Accordingly, the analysis will proceed to investigate the short run linkages among the variables by performing causality tests. Causality tests can be conducted in two different ways depending on the results of the long run analysis. The Granger test (Granger (1969)) is suitable for analyzing the short-run relationship if no cointegration exists among the variables. On the other hand, when the variables of interest are cointegrated, the standard Granger test is misspecified and the error correction strategy suggested by Engle and Granger (1987) should be used (Enders, 2004). The following two sections will provide a brief discussion of these two techniques.

5.1.2.1. The Granger Test

The Granger test examines whether including lags of one variable have predictive power for another variable. This test implies that X causes Y if Y can be better forecast by including

past values of X in the model rather than using only Y's past values[39]. It should be noted that the concept of causality in the Granger test does not mean that changes in one variable cause changes in another variable, as the term is used in the context of policy discussions. The Granger test only tests whether predictability exist among the variables of interest. For instance, the Granger causality test can be used to determine if shocks to the money supply lead movements in stock market prices, or vice versa.

The Granger test based on a VAR model in differences is appropriate when the long-run analysis indicates there is no long-run relationship between variables that are integrated of the same order, *i.e.,* X and $Y \sim I(1)$. As in Enders (2004),[40] the Granger test begins with the estimation of a VAR model in differences:

$$\Delta X_t = \delta_i + \sum_{i=1}^{p} a_i \, \Delta X_{t-i} \; + \sum_{j=1}^{p} \beta_j \, \Delta Y_{t-j} + u_{1t} \tag{5.6}$$

$$\Delta Y_t = \gamma_i + \sum_{i=1}^{p} c_i \, \Delta Y_{t-i} \; + \sum_{j=1}^{p} d_j \, \Delta X_{t-j} + u_{2t} \tag{5.7}$$

where ΔX_t and ΔY_t are the first difference of the time series under investigation, δ_i and γ_i are constants, and u_{1t} and u_{2t} are white noise error terms. Furthermore, the subscripts t and p denote time periods and the number of lags used in the model. Based on the OLS coefficient

[39] By "better forecast" we mean that if the variance of the optimal linear predictor of Y_{t+j} based on the past information of X_{t+i} has a smaller variance than the optimal linear predictor of Y_{t+j} based only on lagged values of *Y*. Thus, *X* is Granger cause *Y* if and only if $\sigma^2_{(Yt:\, Yt-j\,,Xt-i)} < \sigma^2_{(yt:\, yt-j)}$, with *j* and *i* = *1, 2, 3, ...n* and σ^2 representing the variance of the forecast error.

[40] The Granger causality test can be also witten in a more general VAR framwork in a case where we have more than two variables. In this case the causailty test can be implemented as: $\Delta Z_t = \mu + \Gamma_1 \Delta Z_{t-1} + \cdots + \Gamma_p \Delta Z_{t-p} + \varepsilon_t$, where ΔZ_t is the matrix of all variables included in the model in their first differnces, u is a vector of constants, Γ_i is consists of coefficients corsponeding to all variables included in the system up to the lag p and ε_t is a matrix of white noise error terms.

estimates, four different null hypotheses can be tested to determine the direction of the relationship between X and Y.

If $\sum_{j=1}^{n} \beta_j$ and $\sum_{j=1}^{n} d_j = 0$, it can be concluded that X and Y do not help to predict one another. If a feedback relationship exists between the two variables X and Y, which we call bi-directional Granger causality, $\sum_{j=1}^{n} \beta_j$ and $\sum_{j=1}^{n} d_j$ are both significantly different from zero. In the case where $\sum_{j=1}^{n} \beta_j = 0$ but $\sum_{j=1}^{n} d_j \neq 0$, unidirectional Granger causality exists from X to Y, but not vice versa. In other words, changes in X can help to predict future values of Y, but Y cannot help to predict future values of X. Finally, the converse relationship is true when $\sum_{j=1}^{n} \beta_j \neq 0$ and $\sum_{j=1}^{n} d_j = 0$, where changes in Y can help to predict future values of X but not the other way around. These four null hypotheses can be tested using an F-test given by the following formula as in Brandt and Williams (2006):

$$\mathrm{F_{Calculated}} = \left[\frac{(\mathrm{RSS_R} - \mathrm{RSS_{UR}})/\mathrm{p}}{(\mathrm{RSS_{UR}}/\mathrm{n} - \mathrm{k} - 1)}\right] \tag{5.8}$$

where, p is the number of lagged terms, k is the number of parameters estimated in the unrestricted model, n is the number of observations, and RSS_R and RSS_{UR} are residual sum of squares of the restricted and unrestricted models, respectively. The restricted model occurs when the above model's parameters are restricted by the null hypotheses conditions mentioned above. It should be noted also that the null hypotheses will be rejected if the F-statistic is greater than the critical value for a chosen level of significance (Brandt and Williams, 2006).

5.1.2.2. The Error Correction Model

Engle and Granger (1987) argue that the Granger test is misspecified and may lead to spurious causality among the variables if they are cointegrated. In other words, the Granger test

is valid only when there is no long-run equilibrium relationship among the examined variables. To overcome this drawback of the Granger test, Engle and Granger suggest including error terms in equations 5.6 and 5.7. These error terms capture the long run and short run relationships among variables that are cointegrated in their levels. More precisely, in a two variable setting where X and Y are integrated of order one or $I\sim(1)$, the error correction model (ECM) can be formulated as:

$$\Delta X_t = \delta_i + \sum_{i=1}^{p} a_i \, \Delta X_{t-i} \; + \sum_{i=1}^{p} \beta_i \, \Delta Y_{t-i} + \gamma_1 \hat{\varepsilon}_{1t-1} + v_{1t} \tag{5.9}$$

and

$$\Delta Y_t = \lambda_i + \sum_{i=1}^{p} d_i \, \Delta X_{t-i} + \sum_{i=1}^{p} c_i \, \Delta \, Y_{t-i} \; + \gamma_2 \hat{\varepsilon}_{2t-1} + v_{2t} \tag{5.10}$$

where $\hat{\varepsilon}_{1t-1}$ and $\hat{\varepsilon}_{2t-1}$ are the error correction terms obtained from the long run model lagged once, which can be interpreted as the deviation of X and Y from their long run equilibrium values, respectively[41]. Including the error correction terms represents the short-run dynamics necessary to reach the long run equilibrium and opens a channel to detect Granger causality (Granger,1988). γ_i capture the long run causal relationships among the variables in the system, and it is expected to be negative and most likely have an absolute value of less than one. When the $\gamma_i's$ are not statistically significant, the system of equations suggests that the variables of the system are independent in the context of prediction. When γ_1 is statistically significant, while γ_2 is not, the system suggests a unidirectional causality from $Y \; to \; X$, meaning that Y drives X toward long run equilibrium but not the other way around. However, the opposite implication

[41] For example, if Y_{t-1} and X_{t-1} are above their long run values as predicted by the long run model then the disequilibrium error is positive and hence this period Y_t and X_t falls (ΔX_t and ΔY_t will be negative) in order to move Y back to their long run equilibrium values.

will be observed when γ_2 significant and γ_{i} is not. Indeed, if both coefficients $\gamma_1$and γ_2 are significant, then this suggests feedback causal relationships in the system or bidirectional Granger causality relationships. β_j measures the short run impact of changes in X on Y, d_j measures the short run impact of changes in Y on X, and v_{it} is the standard error term.

5.1.3. Impulse Response Functions

The impulse response function (IRF) is one of the essential tools for interpreting VAR model results. The IRF allows researchers to examine the current and future behavior of a variable that following a shock to another variable within the system. The IRF is a useful tool for determining the magnitude, direction, and the length of time that the variables in the system are affected by a shock to another variable. To estimate IRFs, some practical issues need to be considered. The VAR model needs to be transformed into the vector moving average (VMA) representation[42]. Enders (2010) advocates that this transformation is an essential feature of Sims's (1980) methodology since it allows for tracing out the effects of various shocks on variables contained in the VAR system. In the case of a VAR model with two variables included, the form of the IRFs can be written as shown in Enders (2004):

$$\begin{bmatrix} Y_t \\ z_t \end{bmatrix} = \begin{bmatrix} \bar{Y} \\ \bar{Z} \end{bmatrix} + \sum_{i=0}^{\infty} \frac{A^i}{1 - b_{12}b_{21}} \begin{bmatrix} 1 & -b_{12} \\ -b_{21} & 1 \end{bmatrix} \begin{bmatrix} \varepsilon_{Y_{t-i}} \\ \varepsilon_{Z_{t-i}} \end{bmatrix}$$

$$\begin{bmatrix} Y_t \\ z_t \end{bmatrix} = \begin{bmatrix} \bar{Y} \\ \bar{Z} \end{bmatrix} + \sum_{i=0}^{\infty} \begin{bmatrix} \theta_{11}^i & \theta_{12}^i \\ \theta_{21}^i & \theta_{22}^i \end{bmatrix}^i \begin{bmatrix} \varepsilon_{Y_{t-i}} \\ \varepsilon_{Z_{t-i}} \end{bmatrix}, \quad \text{and} \tag{5.11}$$

$$X_t = \mu + \sum_{i=0}^{\infty} \theta_i \varepsilon_{t-i}$$

[42] This feature is based on the Wold theorem that suggests that every stationary (vector) finite order autoregressive time series model can be written as infinite lagged moving average time series model, for more details see for example and Brandt and Williams (2006) and Lütkepohl (2005).

where θ_i is the IRFs of disturbances. Therefore, the IRF is found by reading off the coefficients in the moving average representation of the process. If the innovations ε_{t-i} are contemporaneously uncorrelated, the interpretation of the impulse response is straightforward. For example, the i^{th} innovation of ε_t is simply a shock to the i^{th} endogenous variable in the system Enders (2004).

However, the residuals generated by the VAR models are usually contemporaneously correlated. This is because in a VAR model only lagged endogenous variables are admitted on the right-hand side of each equation (in addition to a constant term), and hence all the contemporaneous shocks which impact on X_t are forced to feed through the residuals, u_{it} (Kuszczak and Murray, 1986). While this may not cause a problem in the estimation of the VAR model, the impulse responses and variance decompositions derived from the initial estimates of the VAR model could be affected such that any adjustment to the order in which the variables are entered in the system could produce different results (Kuszczak and Murray, 1986). Thus, there is a need to impose some restrictions when estimating the VAR model to identify the IRFs. In this regard, a common approach is the Cholesky decomposition, which was originally applied by Sims (1980). The Cholesky decomposition overcomes the problem of contemporaneous relationships among the innovations error terms within the estimated VAR model by identifying the structural shocks such that the covariance matrix of the estimated residuals is lower triangular. In fact, the Cholesky decomposition suggests that there is no contemporaneous pass-through from Y_t to the other variable, z_t. More formally, in the VAR, the matrix error structure becomes left triangular, $\begin{bmatrix} e_{1t} \\ e_{2t} \end{bmatrix} = \begin{bmatrix} 1 & -b_{12} \\ 0 & 1 \end{bmatrix} \begin{bmatrix} \varepsilon_{Y_t} \\ \varepsilon_{Z_t} \end{bmatrix}$. In practice, this means that the Cholesky decomposition attributes all the effect to the variable that comes first to the target variable in the VAR system.

5.1.4. Forecast Error Variance Decompositions

For any variable, short run variations are due to its own shocks, but over time other shocks contribute to these changes as well. Forecast error variance decomposition (FEVD) is a method available to examine this interesting phenomenon. In fact, while the IRFs analyze the dynamic behavior of the target variables due to unanticipated shocks within a VAR model, variance decompositions determine the relative importance of each innovation to the variables in the system. That is, variance decompositions can be considered similar to R^2 values associated with the dependent variables in different horizons of shocks. Enders (2010) show how to write FEVD to conditionally calculate n-period forecast error X_{t+n} considering the VMA representation of VAR presented in equation 5.11 as:

$$X_{t+n} - E_t X_{t+n} = \mu + \sum_{i=0}^{\mathrm{n-1}} \theta_i \varepsilon_{t+\mathrm{n}-i} \tag{5.12}$$

Considering $\mathrm{Y_t}$, the first element of the $\mathrm{X_{t+n}}$ matrix in equation 5.11, the variance of the n-step-ahead forecast error can be calculated as :

$$\begin{aligned} \mathrm{Y_{t+n}} - \mathrm{E_t Y_{t+n}} = {} & \theta_{11}(0)\varepsilon_{\mathrm{Yt+n}} + \theta_{11}(1)\varepsilon_{\mathrm{Yt+n-1}} + \cdots + \theta_{11}(\mathrm{n}-1)\varepsilon_{\mathrm{Yt+1}} \\ & + \theta_{12}(0)\varepsilon_{\mathrm{Zt+n}} + \theta_{12}(1)\varepsilon_{\mathrm{Zt+n-1}} + \cdots + \theta_{12}(\mathrm{n}-1)\varepsilon_{\mathrm{Zt+1}} \end{aligned} \tag{5.13}$$

or

$$\begin{aligned} \sigma_y(n)^2 = {} & \sigma_y^2[\theta_{11}(0)^2 + \theta_{11}(1)^2 + \cdots + \theta_{11}(n-1)^2] \\ & + \sigma_z^2[\theta_{12}(0)^2 + \theta_{12}(1)^2 + \cdots + \theta_{12}(n-1)^2] \end{aligned}$$

where $\sigma_y(n)^2$ and $\sigma_z(n)^2$ denote the n-step-ahead forecast error variance of Y_{t+n} and Z_{t+n}, respectively. The first part of equation 5.13 shows the proportion of variance due to the variables own shock, Y_t, while the second part of equation 5.13 shows the proportion of variance due to the other variables shock, z_t. Theoretically, the first part decreases over time while the second part

of the variance increases. However, it is typical for a variable to explain almost all of its forecast error variance at a short horizon and smaller proportions at longer horizons (Enders, 2010). From this stand point FEVD is useful to assess the Granger causal relationships among variables when the variance decomposition results imply that one variable explains a high portion of the forecast error variance of another variable. That is, when a shock ε_z explains none of the forecast error variance of the sequence Y_t at all forecast horizons, i.e., $\partial\sigma_y^2/\sigma_z^2 \approx 0$, we may say that Y_t evolves indecently of the Z_t shocks, ε_z. Also, when a shock to the Z_t sequence, ε_z, explains the entire forecast error variance of the sequence the Y_t at all forecast horizons, i.e., $\partial\sigma_y^2/\sigma_z^2 \approx 100\%$, may say that Y_t sequence is totally endogenous (Enders, 2010).

5.2. Analysis Using GARCH Models

It is well known that financial time series data, including stock market returns, often exhibit the phenomenon of volatility clustering, meaning that a period of high volatility tends to be followed by periods of high volatility, and periods of low volatility tend to be followed by periods of low volatility. Stock returns also exhibit leptokurtosis, meaning that the distribution of the financial data has heavy tailed, non-normal distributions. In addition, data on stock market returns is expected to show a so called "leverage effect" or asymmetric volatility. This means that the effect of bad news on stock market volatility is greater than the effect induced by good news. Cont (2001) shows how these stylized financial facts invalidate many of the common statistical approaches used to study financial data sets.

While VAR models are commonly used to investigate the interrelationship between stock market behavior and key macroeconomic variables, these models by nature do not account for the stylized facts that characterize financial time series in general and stock market returns in

particular (Rydberg, 2000). For that reason, we are motivated to go further and employ GARCH models to account for these stylized facts in order to answer the final research question raised of this study. Therefore, the following sections review of the theory forming the basis for models and how to estimate and evaluate them.

5.2.1. The Theory of GARCH Models

Given the three stylized facts that characterize financial time series, i.e., volatility clustering, leptokurtosis, and a leverage effect, the assumption of homoscedasticity is often not met. Therefore, ordinary least square models are not adequate to analyze data that exhibit variances that change through time (Rachev et al., 2007). Engle (1982) developed a new method called the autoregressive conditional heteroskedasticity (ARCH) model. The ARCH model is designed to account for a time-varying variance that usually is associated with high frequency financial and economic data. Toward this goal, Engle (1982) suggested that the conditional variance equation needs to be modeled as a linear function of the past q squared innovations as,

$$h_t^2 = \omega + \sum_{i=1}^{q} \alpha_i \, \varepsilon_{t-i}^2 \tag{5.14}$$

where ω and α_i are non-negative parameters to ensure that the conditional variance is positive, and ε_t^2 is the square error obtained from the mean equation. However, empirical work has shown evidence that the ARCH(p) model fits financial time series well only with a large number of lags (Fan and Yao, 2003). This weakness led to extensions of the ARCH model in a number of directions, driven by either economic or statistical considerations (Fan and Yao, 2003).

Bollerslev (1986) developed a fundamental extension to the ARCH(p) model known in the literature as generalized autoregressive conditional heteroskedasticity, or the GARCH model. This extension was an attempt to overcome the need for a large number of lags usually required

by the ARCH(q) process to correctly model the high persistence of variance associated with financial and economic data. Bollerslev (1986) achieved this objective using a technique that allows the conditional variance to be modeled as an ARMA process such that the conditional variance is determined by the innovations and its own lags (Fan and Yao, 2003). In practice, the GARCH(q, p) model jointly estimates two equations, which will be elaborated in the following two subsections.

5.2.1.1. The Conditional Mean Equation

Estimating the mean equation (equation 5.15) is the first step in the GARCH (q, p) model. We construct the fitted squared errors, $\hat{\varepsilon}_t^2$, which will serve as the dependent variable of the second equation. The conditional mean equation can be anything, but in practice, the typical form of the mean equation adapted in the literature is the ARMA(p, q) process (Alexander, 2007, Rachev et al., 2007):

$$R_t = \mu + \sum_{i=1}^{p} \alpha_i R_{t-i} + \sum_{j=1}^{q} \gamma_j \varepsilon_{t-j} + \varepsilon_t \tag{5.15}$$

In our study, R_t represents the daily return of a market index and is calculated as $R_t = log(P_t) - log(P_{t-1})$. R_{t-i} and ε_{t-j} are the autoregressive and moving average components, respectively, and q and p are the orders of the processes. Depending on the values of p and q, we can distinguish four different forms of the mean equation. First, when p and q are equal to zero, we have a random walk model. This model implies that stock prices cannot be predicted using their past values. Second, when p and q are greater than zero the mean equation is an ARMA(q, p) process. Third, the mean equation is a pure autoregressive process, $AR(p)$, when $p > 0$ and $q = 0$, and a pure moving average process, $MA(q)$, when $p = 0$ and $q > 0$.

The Box-Jenkins procedure,[43] the Schwarz Information Criterion (SIC), or the Akaike Information Criterions (AIC), can be used to determine a parsimonious model for the data. At this stage, a simple model is always preferred. Alexander (2007) reports that when a larg number of parameters are included in the model, they may affect convergence of the conditional mean so it is difficult to maximize the likelihood function. However, if the stock market has long memory or if a relationship between risk and return exists, we have to go beyond the random walk model, to account for the time variation inherent in financial and economic data (Alexander, 2007).

5.2.1.2. The Conditional Variance Equation:

The conditional variance equation[44] is the fundamental contribution of the GARCH(q,p) model, and can be written in the following form:

$$\varepsilon_t|\Omega_{t-1}\sim N(0,h_t^2),$$

$$h_t^2=\omega+\sum_{i=1}^{p}\alpha_i\varepsilon_{i-1}^2+\sum_{j=1}^{q}\beta_j h_{t-j}^2, \tag{5.16}$$

$$\omega>0\ ,\ \alpha_i,\ \beta_j\geq 0\ \rightarrow\ \ h_t^2\geq 0,\ i=1,\dots p,\text{and}\ j=1,\dots.q$$

where Ω_{t-1} is the set of all information available at time t-1. The conditional variance of the GARCH model defined in equation 5.16 is a function of three terms. The first term is the mean of yesterday's forecast, ω. The second term is the lag of the squared residuals obtained from the mean equation, ε_{i-1}^2, or the ARCH terms. The ARCH terms represent the news (information) about volatility from the previous period that has a weighted impact, which declines gradually, while never reaching zero, on the current conditional volatility. The third term is the GARCH

[43] For more details on the Box-Jenkins procedure, see Box and Reinsel, (1994).
[44] Since h_t is the one-period ahead forecast variance based on past information, it is called the conditional variance.

term, h_{t-j}^2, measuring the impact of last period's forecast variance. It is important to note that these three parameters (ω, α_i's, and β_j's) are restricted to be non-negative to ensure positive values for the conditional variance or $h_t^2 \geq 0$.

The size of the parameters α_i and β_j determines the short-run dynamics of the volatility of the data, and the sum of the estimated α_i and β_j determines the persistence of volatility to a particular shock. A large positive value of α_i indicates strong volatility clustering is present in the time series of interest. A large value of β_j indicates that the impact of the shocks to the conditional variance lasts for a long time before dying out, so volatility is persistent (Alexander, 2007). The GARCH(q,p) model is covariance stationary if and only if $\alpha_i + \beta_j < 1$ (Nelson, 1990)[45]. In this case, the unconditional variance of the errors is $h_t^2 = \frac{\omega}{1-\sum_{i=1}^{n}(\alpha_i+\beta_j)}$, where n is equal to the lag order of q and p. One advantage of the GARCH(q,p) model over the ARCH (p) process is that good news corresponds to negative shocks $(\varepsilon_{i-1}^2 < 0)$ since it reduces the conditional volatility, while bad news corresponds to positive shocks $(\varepsilon_{i-1}^2 > 0)$ since it increases conditional volatility. Thus, in Bollerslev's GARCH model, the sign of the shock is irrelevant. The magnitude of the positive or negative shocks is the only factor that matters for conditional volatility.

Although practical applications of the GARCH(q,p) model frequently show that the GARCH$(1,1)$ is sufficient to describe the data (Fan and Yao, 2003), substantial disadvantages of the GARCH(q,p) model exist. These disadvantages contribute considerably to the failure of the

[45] It should be noted that there are two special cases: one when $\alpha_i + \beta_j > 1$, and another when $\alpha_i + \beta_j = 1$. The first case implies that the GARCH model is non-stationary; the volatility will eventually explode to infinity as time goes to infinity. The second case is a restricted version of the standard GARCH model which is well known in the literature as the Integrated Generalized Autoregressive Conditional Heteroskedasticity or IGARCH model, (Alexander, 2007; and Rachev et al. 2007).

GARCH(q, p) model to account for asymmetric aspects of volatility[46]. More precisely, it has been recognized empirically that bad news (bad information) has a larger effect on volatility than good news, which contradicts the nature of the GARCH(q, p) model (Black, 1976; Pagan and Schwert, 1990; Bollerslev, Chou, and Kroner, 1992; and Engle and Ng, 1993). This phenomenon is due to the fact that investors act differently depending on whether a share moves up or down. In fact, market declines forecast higher volatility than comparable market increases (Gourieroux and Jasiak, 2002).

Consequently, a large number of extensions to the standard GARCH model have been suggested either to overcome the asymmetries problem and/or to account for different local or international shocks that may affect the behavior of specific stock markets. The Exponential GARCH model (EGARCH) suggested by Nelson (1991), the Glosten-Jagannathan-Runkle GARCH model (GJR-GARCH) proposed by Glosten, Jagannathan, and Runkle (1993), and the periodic GARCH model (PGARCH) presented by Ding, Granger, and Engle (1993) are commonly used in academic and professional settings to account for the asymmetric phenomenon that characterizes financial data (Alberg et al., 2008, and Hagerud, 1997).

Some other extensions to the standard GARCH model advocate adding an explanatory variable in the GARCH conditional mean equation, conditional variance equation, or both. The GARCH-M model introduced by Engle, Lilien and Robins (1987) is an example of the first extension. This extension seeks to examine the risk-return tradeoffs suggested in finance theory by adding the variance of the return as an independent variable to the conditional mean equation. For example a higher perceived risk should be correlated with a higher return on average. The

[46] Though the standard GARCH model suggested by Bollerslev (1986) and the idea of the GARCH-X model extend by the Lee, (1994), do not account for asymmetric effects, they are enough to fulfill this dissertation goals.

second type of extension to the standard GARCH model is the GARCH-X model suggested by Lee (1994).

For this study, the GARCH-X model is of interest as it examines the impact of the short-run deviation on the long run equilibrium within cointegrated series. Lee (1994) extends the standard GARCH model by adding error correction terms obtained from the cointegration model to the conditional variance equation. According to Lee, the GARCH-X model is useful for examining how the short-run disequilibrium affects uncertainty in predicting cointegrated series. According to Lee, examining the behavior of the variance over time as a function of the disequilibrium is reasonable when one expects increased volatility due to shocks to the system. Mathematically the GARCH-X model can be expressed as follows (Lee, 1994):

$$\varepsilon_t | \Omega_{t-1} \sim N(0, h_t^2),$$

$$h_t^2 = \omega + \sum_{i=1}^{p} \alpha_i \varepsilon_{i-1}^2 + \sum_{j=1}^{q} \beta_j h_{t-j}^2 + \lambda_n Z_{t-1}^2, \qquad (5.17)$$

$$\omega > 0\ ,\ \alpha_i\ ,\ \beta_j\ ,\ \lambda_n \geq 0\ \rightarrow\ \ h_t^2 \geq 0,\ i = 1, \ldots p, \text{and}\ j = 1, \ldots . q.$$

The new feature of this model over the standard one (equation 5.17) is the addition of the lagged squared error correction terms obtained from the long-run cointegration model, Z_{t-1}^2. These terms account for the short-run deviation of the conditional variance. The parameter λ_n measures the effect of short-run deviations from the long-run relationship of the cointegrated variables. A large positive value of the parameter λ_n indicates that the deviation of stock market returns from the group of macroeconomic variables gets larger over time. The implication of this is that the stock market becomes more volatile and harder to predict.

In this study, we will estimate four different GARCH models. The first model is the standard GARCH model (equation 5.16) which will be treated as the benchmark model. Second,

we will examine the GARCH-X model in its original version (equation 5.17). Third, we will examine two extended versions of the GARCH-X model (equation 5.18 and 5.19). The first extended version (equation 5.18) will examine the impact of each individual macroeconomic variable included in the analysis on the stock market return's volatility, denoted as the GARCH-S model where S represents ΔX_{t-1}. In particular, the GARCH-S model will be altered by replacing the Z_{t-1}^2 term by the first difference of each individual macroeconomic variable under investigation, ΔX_{t-1}. The second extended version (equation 5.19) will examine the impact of all macroeconomic variables on the stock market return's volatility denoted, as the GARCH-G model, where G represents $\sum_{n=1}^{k} \Delta X_{nt-1}$ and k represents the number of macroeconomic variables in the system. This task will be accomplished by replacing the Z_{t-1}^2 term with the first difference of all macroeconomic variables ΔX_{nt-1}. More specifically, these two extensions can be expressed mathematically in the following equations:

$$h_t^2 = \omega + \sum_{i=1}^{p} \alpha_i \varepsilon_{i-1}^2 + \sum_{j=1}^{q} \beta_j h_{t-j}^2 + \lambda_n \Delta X_{nt-1} \tag{5.18}$$

$$h_t^2 = \omega + \sum_{i=1}^{p} \alpha_i \varepsilon_{i-1}^2 + \sum_{j=1}^{q} \beta_j h_{t-\mathrm{j}}^2 + \sum_{n=1}^{k} \lambda_n \Delta X_{nt-1} \tag{5.19}$$

The λ_n parameter in equation 5.18 is expected to account for the previous impact of the explanatory variables on the movements of the stock market returns. The λ_n parameter in equation 5.19 is expected to represent the impact of changes of each explanatory variable on the movements of the stock market returns, along with other impacts. k represents the number of explanatory variables. Thus, we will have eleven models in total including the GARCH model and original GARCH-X models.

5.2.2. Estimation of the GARCH-Family Models

The method of quasi maximum likelihood as in Bollerslev and Wooldridge (1992) is used to estimate the parameters of the GARCH models with the EViews software package (version 6). This method requires an assumption about the conditional distribution of the error terms. There are three assumptions commonly employed in empirical work that adopts the GARCH model: the normal distribution, student's t-distribution, and the generalized error distribution (GED). In the presence of GARCH effects, as in our study, the more appropriate distribution of the data is the one that is able to match the kurtosis and skewness in the data, (Taylor, 1986). Following Mandelbrot (1963) and Fama (1965) who, among others, suggested that stock returns are normally distributed, this study estimates a GARCH(1,1) model assuming a normal distribution. Accordingly, the log-likelihood function of the estimated GARCH (1,1) models can be written as:

$$l_t = -\frac{1}{2}\left(log(2\pi) + log(h_t^2) + \frac{\hat{\varepsilon}_t^2}{h_t^2}\right) \tag{5.20}$$

where $\hat{\varepsilon}_t^2$ is the estimated error terms obtained from the mean equation, and h_t^2 is the conditional variance equation of order 1.

5.2.3. Evaluation of Estimated GARCH models

The robustness of the GARCH models can be evaluated using a number of in-sample and out-sample diagnostics. Consistent with the goal of this dissertation, we will use some in-sample diagnostics to assess the performance of the estimated GARCH models. These diagnostics include the Ljung-Box (1978) test statistics, $Q(p)$and $Q^2(p)$. These tests examine the null hypothesis of no autocorrelation and homoscedasticity in the estimated residuals, and squared

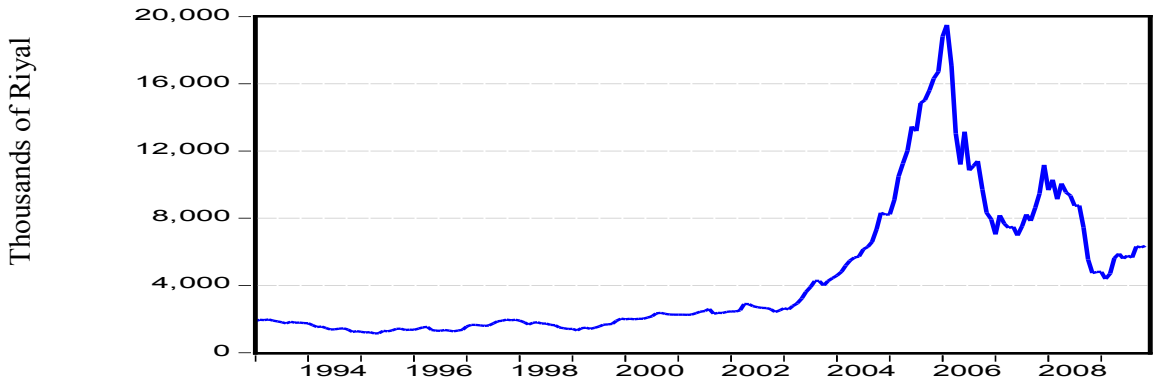
standardized residuals, or $\varepsilon_t/\sqrt{h_t}$, up to a specific lag, respectively. Also, Engle's (1982) LM statistic will be used to test the null hypothesis of no remaining ARCH effects up to a specific order. In fact, if the GARCH model is specified correctly, then the estimated standardized residuals should behave like white noise, i.e., they should not display serial correlation, conditional heteroskedasticity, or any other type of nonlinear dependence. Furthermore, since GARCH models can be treated as ARMA models for squared residuals, traditional model selection criteria, such as the AIC, the SIC, and maximized log-likelihood value will be used to assess which model is most appropriate. Also, we applied the mean square error (MSE) calculated as $\mathrm{MES} = \frac{1}{\mathrm{T}}\sum_{\mathrm{i}=1}^{\mathrm{T}}(\sigma_{\mathrm{i}}^2 - \widehat{\sigma}_{\mathrm{i}}^2)^2$ and graph them against the estimated squared error to compare the performance of the estimated GARCH models in accounting for the impact of macroeconomic variables power of the competing models. A similar strategy was used by Engle and Ng (1993), Hsieh (1989), Des and Tonuri (1995), Song et al. (1998), Chong et al. (1999), Poshakwale and Murinde (2001), Li and Li (2005), and Frimpon and Eric (2006).

Chapter 6 : Empirical Results of the VAR Model

6.1. Data Definitions

The data are monthly frequency running from January 1993 to December 2009, making 204 observations in total. This time period was chosen to capture the effect of fundamental changes made to regulate, liberalize, and implement advanced technology for the operation of the Saudi stock market. The set of macroeconomic variables includes the Tadawul All Share Index (TASI), the money supply (M1 and M2), inflation (CPI), the three-month Saudi Arabia Interbank Offered Rate (Isa3) as a proxy for the short term interest rate[47], bank claims on the private sector or bank credit (BC), the nominal effective exchange rate of the Saudi Riyal (Ex), the Brent oil price (BOP), and the Standard and Poor's price index (S&P 500) as a proxy for foreign financial markets.. Figures 6.1 to 6.7 show the evolution of these variables during the sample period, which we defied in Table 1.1.

Figure 6.1: End-Month Closing Values of the TASI



[47] A large body of empirical studies related to the Saudi economy has used a short or long term interest rate of the U.S. market as proxy for the Saudi market because Saudi Riyals pegged to U.S. dollars. However, this study uses a proxy for the local interest rate, the Saudi Arabia Interbank Offered Rate (Isa3), to capture any fundamental changes within the local economy. Figure 6.3 provides evidence that the Saudi market did not correspond one-to-one to the U.S. market in setting the interest rate during the sample period.

Figure 6.2: End–Month Money Supply M1 and M2

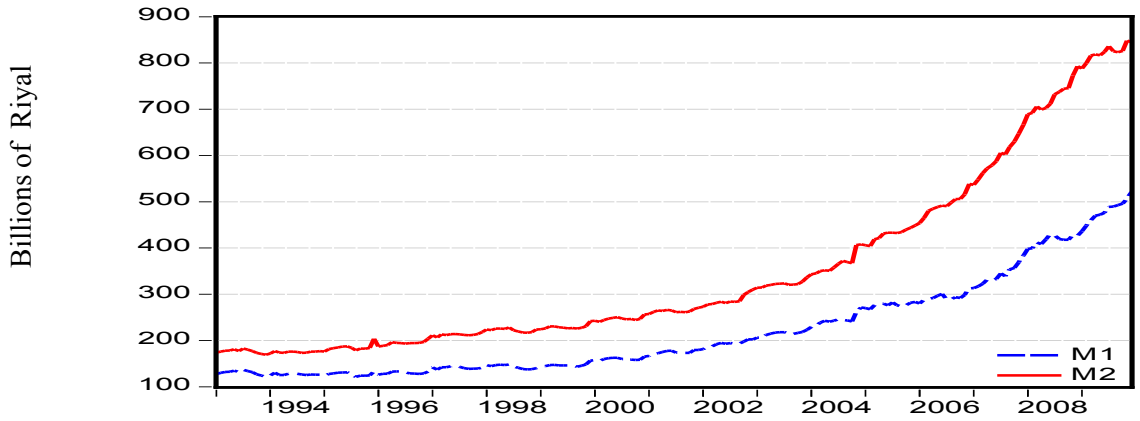


Figure 6.3: The Saudi 3-Month Interbank Interest Rate (Isa3) and the US Treasury Bill Rate

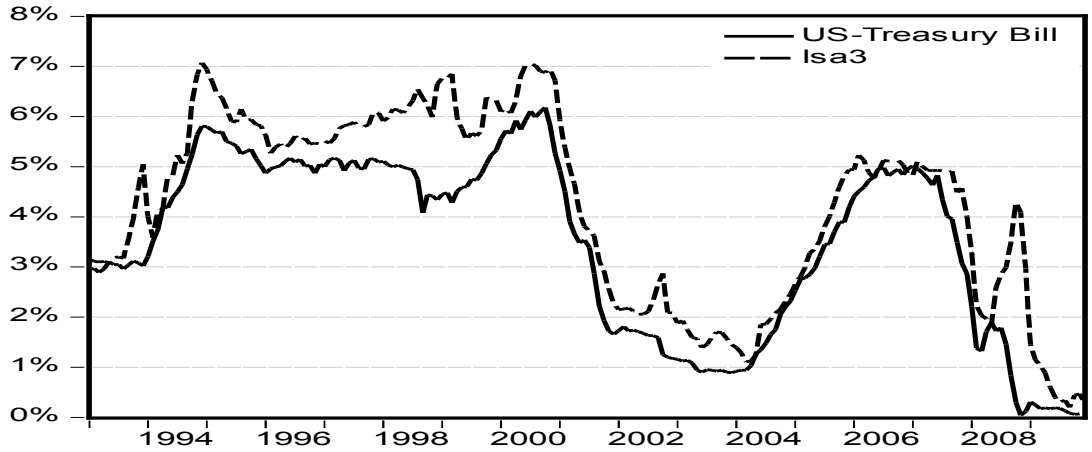


Figure 6.4: Total Bank Credits in Saudi Arabia, Billion Riyals

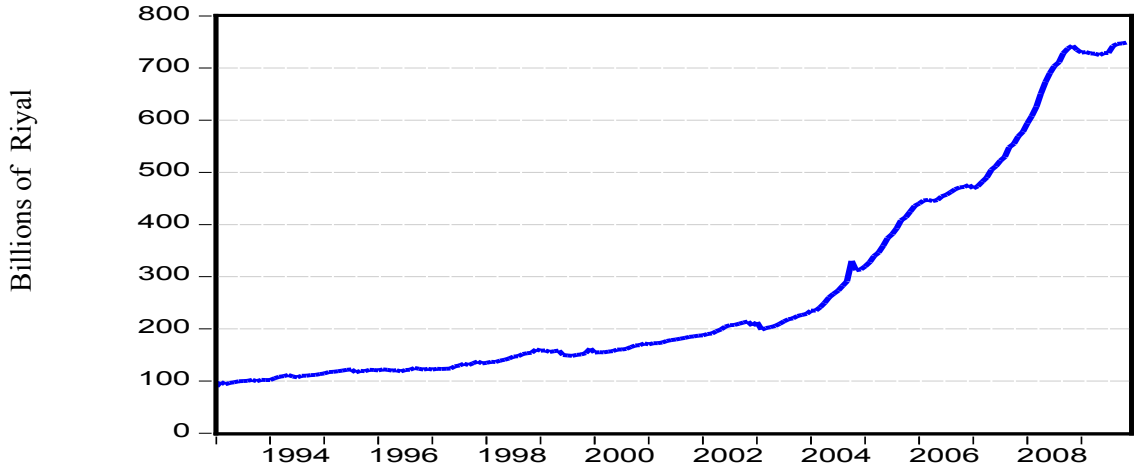


Figure 6.5: Nominal Effective Exchange Rate Index of the Saudi Riyal

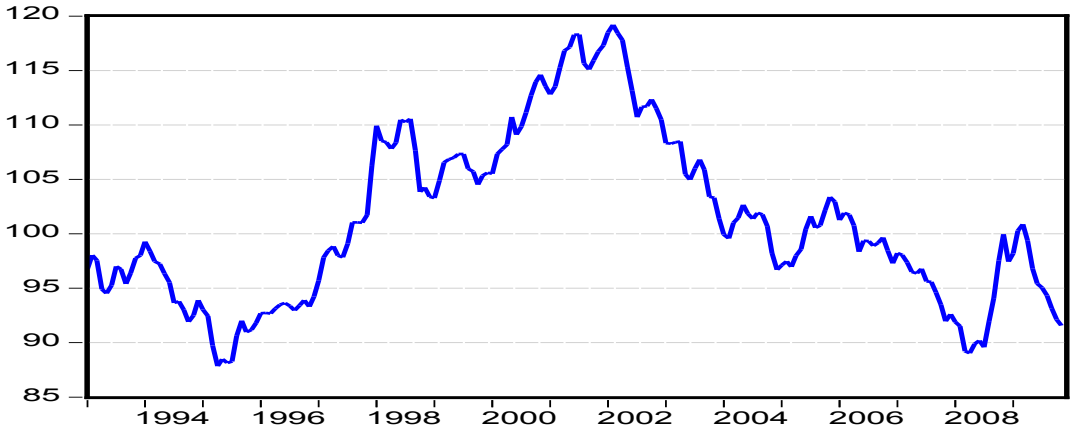


Figure 6.6: End-Month Brent Oil Prices

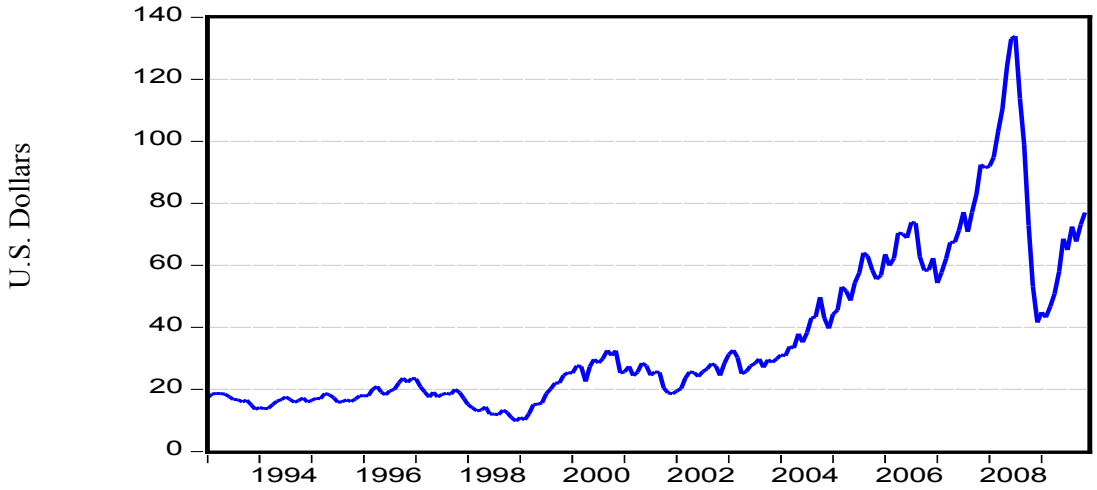
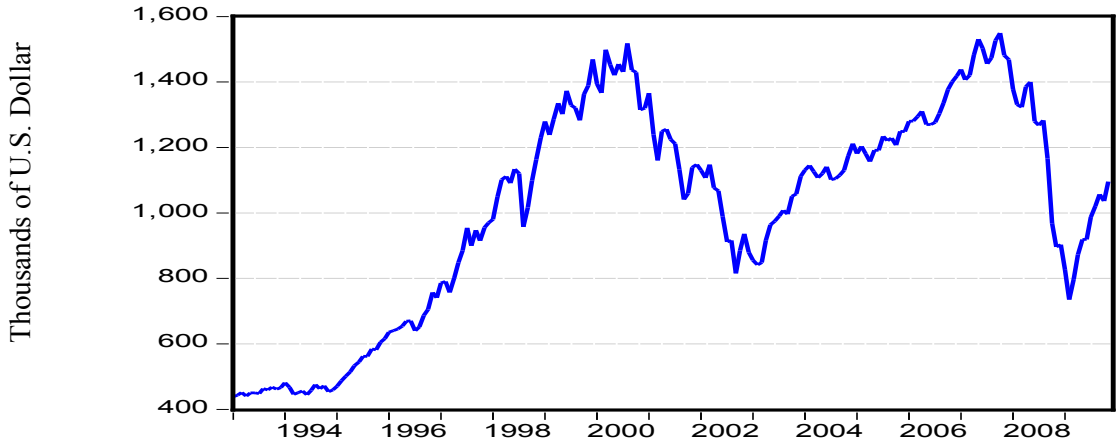


Figure 6.7: End-Month Closing Values of the S&P 500, Thousand Dollars



6.2. Descriptive Statistics

Panel (a) in Table 6.1 summarizes the basic statistical features of the data under consideration including the mean, the minimum and maximum values, standard deviation, kurtosis, skewness, and the Jarque-Bera test for the data in their levels. Also, Panel (b) reports the mean of the data in first differences. These descriptive statistics provide a historical background for the behavior of our data. For instance, the standard deviations indicate that TASI, Isa3, BC, and BOP are more volatile compared to the money supply (M1 and M2), the U.S. stock market (S&P 500), (panel (a) in Table 6.1). Furthermore, the standard deviations indicates that the exchange rate (Ex) and inflation (CPI) are less volatile compared to the rest of the macroeconomic variables during the same time, which perhaps due to the fixed exchange rate to the U.S. dollar that has been effectively adopted for the Saudi Riyals since 1986 and the inflation rate has been quite low within a range of 1% - 5% from 1993 to until 2006 (SAMA, 2010).

Table 6.1: Statistical Features of the Macroeconomic Variables

Panel (a): Statistical Features of the Data in Level

	TASI	M1	M2	ISA3	CPI	BC	EX	BOP	SP500
Mean	8.064	26.019	26.451	4.216	4.627	26.118	4.614	3.386	6.862
Maximum	9.880	26.980	27.470	7.0700	4.8300	27.340	4.780	4.900	7.350
Minimum	7.040	25.520	25.860	0.2000	4.5500	25.210	4.480	2.280	6.080
Range	2.84	1.46	1.61	6.87	0.28	2.13	0.3	2.62	1.27
Std. Dev.	0.789	0.427	0.488	1.891	0.064	0.642	0.076	0.621	0.375
Skewness	0.600	0.665	0.679	-0.394	1.833	0.621	0.370	0.516	-0.851
Kurtosis	2.001	2.170	2.215	1.924	5.566	2.027	2.235	2.222	2.481
Jarque-Bera	20.705	20.890	20.908	15.133	170.240	21.155	9.644	14.187	26.910
Probability	0.0000	0.0000	0.0000	0.0005	0.0000	0.0000	0.0080	0.0008	0.0000
Observations	204	204	204	204	204	204	204	204	204

Panel (b): Mean of the Data in their First Differences

TASI	M1	M2	Isa3	CPI	BC	Ex	BOP	S&P500
0.006	0.007	0.008	-0.014	0.001	0.010	0.000	0.007	0.005

P-values associated with the Jarque-Bera statistics, a test for departures from normality, show that the sample skewness and kurtosis are significantly different from zero and three respectively (panel (a) in Table 6.1). Given that the kurtosis of macroeconomic variables are all less than three, the distributions of these series exhibit non-normality (Stock and Watson, 2006). Also, positive values of the skewness tests for TASI, M1 and M2, CPI, BC, Ex, and BOP suggest that these variables have long right tails, while negative values of the skewness tests for Isa3 and S&P 500 suggest that these two variables have long left tails (Stock and Watson, 2006). On the other hand, TASI grew at less than 1%, on average, each month during the whole period. This is comparable to the growth rate of all other variables included in the analysis with the exception of the short term interest rate (Isa3), which had an average monthly growth rate of -1.4% (Panel (b) in Table 6.1).

Table 6.2: Correlation Matrix of the Macroeconomic Variables

	TASI	M1	M2	Isa3	CPI	BC	Ex.	BOP	S&P500
TASI	1								
M1	0.864	1							
M2	0.852	0.996	1						
Isa3	-0.455	-0.597	-0.539	1					
CPI	0.410	0.757	0.778	-0.341	1				
BC	0.872	0.988	0.994	-0.495	0.757	1			
Ex	-0.125	-0.175	-0.165	-0.002	-0.377	-0.171	1		
BOP	0.899	0.916	0.913	-0.440	0.616	0.918	-0.259	1	
S&P500	0.569	0.535	0.572	-0.038	0.268	0.584	0.417	0.542	1

Although we cannot comment on causation, the results reported in Table 6.2 reveal information on the strength of the relationships connecting the nine macroeconomic variables. In particular, Table 6.2 shows a strong positive relationship between TASI and M1, M2, BC, BOP, and the S&P 500 index. Table 6.2 suggests a positive relationship between TASI and the inflation rate. On the other hand, a negative relationship exists between TASI and Isa3, and TASI and Ex. These results support the inclusion of these macroeconomic variables in our analysis[48].

[48] In October 2001, Saudi stock market authority established new trading system to handle the daily

6.3. Long-Run Analysis

As mentioned before, the long-run analysis is conducted using the Johansen-Juselius (1990) cointegration test. Typically, the Johansen-Juselius cointegration test consists of three general steps. First, examine whether all variables in the model are integrated of the same order, which can be established by unit root tests. Second, determine the optimal lag length for the VAR model to verify that the estimated residuals are not autocorrelated. Third, estimate the VAR model to construct the cointegration vectors in order to determine the order of cointegration that is necessary to establish the trace and the max-eigenvalue statistics tests (Enders, 2004, 2010). The following subsections present the results for each step.

6.3.1. Unit Root Test Results

Determining the order of integration for each variable included in the system is the first step to understanding the long-run relationships among these variables. To this end, two different unit root tests are employed to establish that all (if any) variables are integrated of the same order. The following two tests are widely used in literature: the augmented Dickey-Fuller (1979) (ADF) unit root test, and Phillips-Perron (1988) (PP) unit root test[49]. For the ADF test, we

transactions named as Tadawul All Share Index (TASI) to replace the old system called ESIS. This modification may cause structural changes in the stock market. Chow Test is one way to test whether the process has a structural break. Under the null hypothesis there is no structural break, i.e. the parameters of the TASI in October, 2000 are equal to those of the remaining months of the whole sample. Since the p-value is 0.61, we cannot reject the null hypothesis of no structural break, i.e. the regression parameters do not differ significantly in October, 2001 as compared to the other months of the sample period. Also, Eviews gives a warring massage if there is a problem with multicollinearity. My estimates did not yield such a warring.

[49] The PP unit root test differs from the ADF unit root test mainly in how it treats the serial correlation and heteroskedasticity in the error terms. While the ADF test corrects for higher order serial correlation by adding lagged differenced terms on the right-hand side of the model, the PP test makes a correction to the t-statistic of the coefficient from the AR(p) regression to account for the serial correlation in ε_t. Therefore, serial correlation does not affect the asymptotic distribution of the test statistic. For more

estimated the most general ADF model, which includes both a drift and linear time trend, as follows:

$$\Delta LY_t = \alpha_0 + \alpha_1 t + \gamma Y_{t-1} + \sum_{i=1}^{p} \beta_i \Delta Y_{t-i} + \varepsilon_t$$

where LY is the natural logarithm of the variables in question. α_i, and γ are constant terms while t,and Δ are the time trend and the first difference operator, respectively. ε_i is the white noise residual and p is the lagged values of ΔLY to control for higher-order correlation assuming that the series follows an AP(p). For the PP unit root, we estimated the following model:

$$\Delta \mathrm{LY_t} = \alpha_0 + \alpha_1 \mathrm{t} + \gamma \mathrm{Y_{t-1}} + \varepsilon_\mathrm{t}$$

where the variables and parameters are the same as defined in the ADF unit root test. The null hypothesis for the ADF unit root test and for the PP unit root test is that $\gamma = 0$, which implies that the series has a unit root, the time series is non-stationary, against the alternative hypothesis of stationarity. Since these ADF test and PP test do not have a normal distribution even if the sample size is large, we examined the null hypothesis using the critical values reported in Enders (2010). Second, the upper limit of the lag-length is determined based on the Bartlett criteria: ($p_{max} = int(12(\frac{T}{100})^{0.25})$ where T is the sample size (Hayashi, 2000). This step suggests that 14 lags is the upper limit of the lag-length of all estimated models. Finally, the optimal lag-length is chosen to minimize SIC by $SIC = T\ ln|\hat{\Sigma}| + n\ ln(T)$ where T is the number of observations, $\hat{\Sigma}$ is the estimated sum of squared residuals, and n is the number of estimated parameters. The optimal lag length varies across the series (Tables 6.3 and 6.4).

Panel (a) in Table 6.3 reports the results of the ADF test on the model including the intercept and trend components. It is clear that the null hypothesis of non-stationarity cannot be

details, see Phillips and Perron (1988).

rejected for any of the series in their levels since ADF statistics for all variables are not less than the critical values at any significance level, i.e., 1%, 5%, and 10%. Therefore, we conclude that all series are non-stationary in levels. Applying the same test to their first differences shows that the null hypothesis of a unit root is rejected in all cases even at a 1% significance level. On the basis of these results all variables are treated as integrated of order one.

Table 6.3: ADF Unit Root Test for the Log Value of All Variables

	Data in Levels		Data in First-differences	
	T-statistics	Optimal Lag	T-statistics	Optimal Lag
◆Panel (a): Model with intercept & trend				
TASI	-1.79	1	-11.40	0
M1	-1.19	1	-15.17	0
M2	-1.22	1	-16.60	0
Isa3	-2.35	1	-9.16	0
CPI	1.38	1	-13.94	0
BC	-1.20	2	-8.358	1
Ex	-1.33	1	-11.09	0
BOP	-2.97	1	-11.93	0
S&P 500	-1.22	0	-12.60	0
◆Panel (b): Model with intercept only				
TASI	-0.711	1	-11.43	0
M1	2.58	0	-14.45	0
M2	2.96	1	-15.82	0
Isa3	-1.30	1	-9.05	0
CPI	2.80	0	-6.31	2
BC	1.39	0	-8.12	1
Ex	-1.37	1	-11.07	0
BOP	-0.91	1	-11.94	0
S&P 500	-2.10	0	-12.46	0
◆Panel (c): the τ Critical Values*				
	Model with intercept & trend		Model with intercept only	
1 %	-3.99		-3.46	
5 %	-3.43		-2.88	
10 %	-3.13		-2.57	

*. The critical values are taken from Enders (2010).

The conclusions from the ADF test are confirmed by the results of the PP unit root test (Panel (a) in Table 6.4). ADF and PP unit root tests with only an intercept were also performed (Panels (b) in Table 6.3 and 6.4, respectively). The results from these two tests provide additional support for treating all the individual series as non-stationary in their levels but stationary in their first differences. Consequently, all the individual series are treated as integrated of order one. Descriptive statistics

Table 6.4: The PP Unit Root Test for the Log Value of All Variables

	Data in Levels		Data in First-differences	
	T-statistics	Optimal Lag	T-statistics	Optimal Lag
◆Panel (a): Model with intercept & trend				
TASI	-0.711	1	-11.43	0
M1	2.58	0	-14.45	0
M2	2.96	1	-15.82	0
Isa3	-1.30	1	-9.05	0
CPI	2.80	0	-6.31	2
BC	1.39	0	-8.12	1
Ex	-1.37	1	-11.07	0
BOP	-0.91	1	-11.94	0
S&P 500	-2.10	0	-12.46	0
◆Panel (b): Model with intercept only				
TASI	-0.83	7	-11.81	6
M1	3.10	6	-14.45	2
M2	3.39	7	-15.81	3
Isa3	-1.03	5	-8.96	4
CPI	2.46	2	-13.98	8
BC	1.183	6	-16.55	8
Ex	-1.26	4	-11.12	1
BOP	-0.94	4	-11.94	2
S&P 500	-2.06	6	-12.59	6
◆Panel (c): the τ Critical Values*				
	Model with intercept & trend		Model with intercept only	
1 %	-3.99		-3.46	
5 %	-3.43		-2.88	
10 %	-3.13		-2.57	

*. Critical values are taken from Enders (2010).

6.3.2. Selection of Optimal Lag lengths

The second step for establishing the presence of a long-run relationship among the variables is to determine the optimal lag length for the VAR system. Lag-length misspecification for the VAR model often generates autocorrelated errors, (Lütkepohl, 2005). To perform the second step, five different criteria including the sequential modified likelihood ratio (LR) test statistic, the final prediction error criteria (FPE), the Akaike information criterion (AIC), the Schwarz information criterion (SIC), and the Hannan-Quinn information criterion (HQ) are used to determine the lag lengths used in the VAR. These criteria are widely used in the literature (Lütkepohl, 2005, and Enders, 2010). Table 6.5 reports the results for each criteria with a maximum of 12 lags. We precede our analysis using three lags suggested by the sequential modified (LR) test. Using three lags produces no autocorrelation in the VAR model for up to 12

months (Panel (b) Table 6.6). Precisely, the p-values associated with the Lagrange multiplier (LM) tests strongly indicate the absence of serial correlation in the estimated residuals generated from the VAR(3) models up to $p = 12$. Furthermore, the estimated residuals of the VAR(3) models are behaving like "white noise" (Figure 6.8). This provides visual evidence to support the adequacy of the VAR(3) model to explore the long relationship among the macroeconomic variables. These results may support the adequacy of the VAR(3) model for a cointegration test (Panel (a) in Table 6.6).

Table 6.5: Optimal Lag Lengths of the VAR Model

Lag	Log-Likelihood	LR	FPE	AIC	SIC	HQ
0	1008.48	n.a.	2.43e-16	-10.41	-10.26	-10.35
1	3652.07	5011.81	6.22e-28*	-37.10*	-35.58*	-36.49*
2	3723.43	128.59	6.91e-28	-37.00	-34.10	-35.83
3	3797.20	126.03*	7.55e-28	-36.93	-32.65	-35.20
4	3839.68	68.59	1.16e-27	-36.53	-30.88	-34.24
5	3906.80	102.09	1.39e-27	-36.38	-29.36	-33.54
6	3966.13	84.66	1.86e-27	-36.16	-27.76	-32.76
7	4040.52	99.19	2.18e-27	-36.09	-26.32	-32.13
8	4105.13	80.09	2.92e-27	-35.92	-24.77	-31.40
9	4184.64	91.10	3.50e-27	-35.90	-23.38	-30.83
10	4256.05	75.13	4.80e-27	-35.80	-21.91	-30.17
11	4315.50	56.97	7.93e-27	-35.58	-20.31	-29.39
12	4427.81	97.10	8.17e-27	-35.90	-19.26	-29.16

* Indicates optimal lag order selected according to the associated criterion.

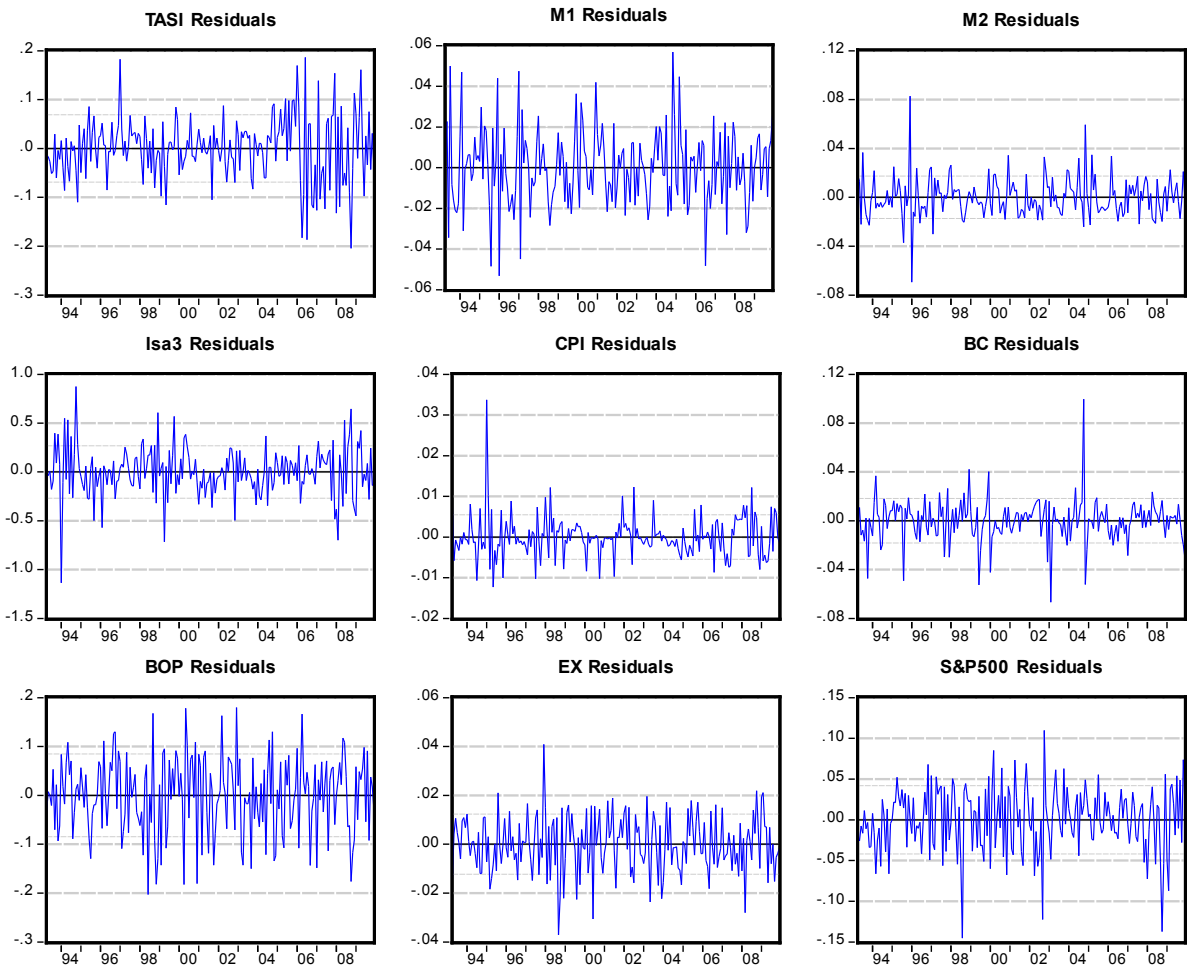
We also estimated the VAR with one lag as suggested by the rest of criteria, i.e., FPE, AIC, SIC, and HQ up to $p = 12$ and we found that the null hypothesis of no serial correlation in the estimated residuals generated from the VAR(1) model cannot be rejected based on the LM tests (Panel (a) in Table 6.6).

Table 6.6: Residual Serial Correlation LM Tests for the VAR

Lags	Panel (a): One Lag		Panel (b): Three Lags	
	LM-Stat	P-values*	LM-Stat	P-values*
1	139.22	0.00	75.41	0.65
2	112.93	0.01	88.63	0.26
3	66.81	0.87	67.95	0.85
4	107.86	0.02	101.64	0.06
5	67.73	0.85	65.64	0.89
6	81.23	0.47	91.56	0.20
7	96.99	0.11	67.79	0.85
8	89.37	0.25	81.54	0.46
9	71.67	0.76	55.17	0.99
10	99.56	0.08	95.20	0.13
11	105.23	0.04	97.02	0.11
12	90.45	0.22	83.15	0.41

*P-values based on χ^2 asymptotic (large sample) distribution with 81 degree of freedom (df).

Figure 6.8: The Estimated Residuals of the VAR(3) models



6.3.3. Results of the Johansen-Juselius Cointegration Test

The final step for the Johansen-Juselius cointegration test is to determine the number of cointegration vectors. The cointegration test is sensitive to the presence of deterministic trends (Johansen, 1991, 1995). Johansen (1991, 1995) suggests five possible deterministic trends to be analyzed. These are: (1) no deterministic trends in the VAR and the cointegrating relationship has no intercept and no trend; (2) no deterministic trends in the VAR and the cointegrating relationship has an intercept and no trend; (3) linear trend in the VAR and the cointegrating relationship only has an intercept; (4) linear trend in the VAR and the cointegrating relationship only has a deterministic trend; and (5) a quadratic trend in the VAR and the cointegrating relationship has a linear deterministic trend.

Following the rough guide in the EViews 6 User's Guide II, and since we believe that all of the data series have stochastic trends, the analysis proceeds to examine the long run and short run relationships between TASI and the rest of the macroeconomic variables in the system assuming a linear trend in the VAR and the cointegrating relationship only has an intercept. Panels (a) and (b) in Table 6.7 present detailed results of cointegration tests for model three including the trace test and the max-eigenvalue test at the 5% significance level. From Table 6.7, the max-eigenvalue tests support one cointegrating vector at the 5% significance level, while trace tests suggest five cointegrating vectors at the 5% significance level. However, the analysis allows for one cointegrating vector at the 5% significance level based on the maximum eigenvalue statistic test following the recommendation of both Enders (2004) and Banerjee et al. (1993) who prefer the max-eigenvalue test.

The major implications derived from these two tests are: (1) the macroeconomic variables in the system share a long run relationship. Hence each variable in the system tends to adjust proportionally to remove short run deviations from the long run equilibrium. (2) there is at least one direction of causality among the variables in the system as expected by the Granger representation theorem.

Table 6.7: Johansen-Juselius Cointegration Test Assuming the System Has Linear Trends and the Cointegrating Relationship Has Only an Intercept

Panel (a): Unrestricted Cointegration Rank based on Trace Statistic Test

Hypothesized no. of CE(s)		Eigenvalue	Trace Statistic	0.05 Critical Value	P-values.**
Null	Alternative				
$r = 0$	$r \geq 1$	0.254	225.35*	197.37	0.001
$r \leq 1$	$r \geq 2$	0.163	166.82*	159.53	0.019
$r \leq 2$	$r \geq 3$	0.157	131.31*	125.62	0.022
$r \leq 3$	$r \geq 4$	0.121	097.13*	95.75	0.040
$r \leq 4$	$r \geq 5$	0.112	071.30*	69.82	0.038
$r \leq 5$	$r \geq 6$	0.103	47.49	47.86	0.054
$r \leq 6$	$r \geq 7$	0.063	25.65	29.80	0.140
$r \leq 7$	$r \geq 8$	0.052	12.55	15.49	0.132
$r \leq 8$	$r \geq 9$	0.020	1.94	3.84	0.164

Panel (b) Unrestricted Cointegration Rank Test based on Maximum Eigenvalue Test

Hypothesized no. of CE(s)		Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	P-values.**
Null	Alternative				
$r = 0$	$r = 1$	0.254	58.53*	58.43	0.059
$r = 1$	$r = 2$	0.163	35.50	52.36	0.768
$r = 2$	$r = 3$	0.157	34.18	46.23	0.513
$r = 3$	$r = 4$	0.121	25.83	40.08	0.714
$r = 4$	$r = 5$	0.112	23.81	33.88	0.470
$r = 5$	$r = 6$	0.103	21.84	27.58	0.229
$r = 6$	$r = 7$	0.063	13.10	21.13	0.443
$r = 7$	$r = 8$	0.052	10.61	14.26	0.175
$r = 8$	$r = 9$	0.001	1.940	3.84	0.164

Notes: CE(s) the null hypothesis that there is no cointegration(s). r indicates the number of cointegrating relationships.
* Indicates rejection of the null hypothesis at the 5% level. ** MacKinnon-Haug-Michelis (1999) p-values.

Finding a long run relationship between TASI and a set of macroeconomic variables in the Saudi economy is consistent with a large body of empirical studies including Gan et al. (2006), Gunasekarage et al. (2004), Hasan and Javed (2009), Humpe and Macmillan (2009), Ibrahim (1999); Keung et al. (2006), Maysami et al. (2004), Mukherjee and Naka (1995), Patra

et al. (2006); Thornton (1998) and Keung et al. (2006) for the stock market in Singapore, but contradicts the results of Muradoglu and Argac (2001) for the Turkish stock market, and Rahman and Mustafa (2008), Serletis (1993), and Keung et al. (2006) for the U.S. stock market.

Given that there is at least one cointegration vector among the variables in the system, the analysis normalizes the cointegrating vector on (TASI)[50]. Equation 6.1 presents these findings, which indicate, in general, that all variables included in the system are statistically significantly contributing to the long run relationships between TASI and the rest of macroeconomic variables in the system with only one exception, which is the exchange rate.

$$\begin{array}{l} TASI = 87.38 - \underset{\substack{(3.33)\\[-4.07]}}{13.56}\, M1 + \underset{\substack{(3.30)\\[2.38]}}{7.60}\, M2 - \underset{\substack{(0.07)\\[-2.71]}}{0.19}\, Isa3 - \underset{\substack{(2.08)\\[-4.30]}}{8.95}\, CPI + \underset{\substack{(0.99)\\[4.42]}}{4.38}\, BC + \underset{\substack{(0.28)\\[3.71]}}{1.04}\, BOP \\ \qquad + \underset{\substack{(1.31)\\[0.63]}}{0.83}\, Ex - \underset{\substack{(0.36)\\[-2.83]}}{1.02}\, S\&P\ 500 \end{array} \qquad (6.1)$$

Note: Standard Errors in parentheses and t-statistics in square brackets.

That is, the normalized cointegrating vector given in Equation 6.1, suggest the following results. First, there is a significant negative long run relationship between M1 and TASI and a significant positive relationship for M2. This result is not surprising, since the existing theoretical and empirical studies show no consensus regarding the relationship between the money supply and stock market prices (returns) (Hamburger et al., 1972; and Hashemzadeh et al., 1988). For example, while finding of a positive relationship between M2 and TASI is consistent with the modern portfolio monetary models, the negative relationship found between M1 and TASI is consistent with Bernanke and Kuttner (2005). It should be noted that the omitting M1 or M2 from the model did not affect either the nature of the long run relationships

[50] In the presence of more than cointegration vector Johansen and Juselius (1990) suggested that the first eigenvector is the most useful to use in examining the long run relationship between variables in the system (Mukherjee and Naka, 1995).

between the system variables and the TASI or on the sign of the estimated coefficients. Therefore, these findings are perhaps an indication that the relationships between the money supply and TASI in the Saudi economy are an empirical question.

Consistent with Bernanke (2003) but in contrast with the argument that assets associated with fixed interest rate are not the primary alternative for the majority of investors in Saudi Arabia, the cointegration tests revealed a significant negative relationship between Isa3 and TASI. One possible explanation for this negative relationship is that investors would not consider the Saudi stock market when the interest rate is high; hence the money and capital markets in the Saudi economy are substitutes in the long run. This finding is consistent with the results of Hammoudeh and Choi (2006) for the GCC markets, including the Saudi stock market, and other empirical studies such as Abdullah and Hayworth (1993), Maghayereh (2003), Gan et al. (2006), Gjerde and Saettem (1999), Gunasekarage et al. (2004), Hondroyiannis and Papapetrou (2001), Ratanapakorn and Sharma (2007), Sadorsky (1999), Zafar et al. (2008), Humpe and Macmillan (2009) for the U.S. stock market, and Léon (2008), and Mukherjee and Naka (1995) for the long term interest rate in Japan.

Equation 6.1 also indicates a statistically significantly negative relationship between TASI and the CPI inflation rate. This result is in line with Fama (1981) and Schwert (1981), who both found a negative correlation between inflation and stock prices. One possible implication of this result is that the Saudi stock market is not an effective hedge against inflation; hence investments probably would shift from a risky stock market to real assets when the inflation rate is very high. This result is consistent with the previous empirical studies of Maghayereh (2003), Mukherjee and Naka (1995), and Gjerde and Saettem (1999).

As expected, Equation 6.1 presents a positive relationship between TASI and BC. This result is consistent with Kim and Ramon's (1994) rationalization of the relationship between asset prices and bank lending. This result also indicates that increasing bank lending in Saudi Arabia would increase stock market prices. Given that commercial banks are the second lenders in the local economy, this result may be of interest to the Saudi Authority as an indicator of how financial shocks transmit to real activity through the stock market. The findings of our analysis are in contrast with Ibrahim (2006) who finds that bank loans reacted positively to an increase in the Malaysian stock market but not the converse. Kim and Moreno (1994) suggest that the historical relationship between Japanese stock prices and bank lending was weak and not steady until the 1980s and became more significant after the middle of the 1980s.

In conjunction with the fact that Saudi Arabia is an oil-based economy; Equation 6.1 suggests a positive long run relationship between the price of oil and TASI. This finding is consistent with the result of the Gjerde and Saettem (1999) for the stock market in Norway, which is strongly dependent on oil, similar to the Saudi economy. In contrast, Hondroyiannis and Papapetrou (2001), and Sadorsky (1999) both find that a positive the price of oil shock depresses real stock market returns in Greece and the U.S., which are both net oil importing countries. These mixed results support the notion that oil price shocks have a different impact on stock prices depending on (1) whether the economy is a net importer or net exporter of oil; (2) the institutional structure of the economy within these groups, and (3) the stage of economic development of the country (Cunado and Garcia, 2005).

In line with the portfolio balance approach (Frankel, 1993); Equation 6.1 shows a positive long run relationship (although statistically insignificant) between the exchange rate (Ex) and TASI. The insignificance of this relationship is not surprising since foreign investors in

the Saudi stock market were limited during the sample, i.e., 4% as of 2010, and because the Saudi economy is an import dominant country (Ratanapakorn and Sharma, 2007). Gunasekarage et al. (2004) find similar results for the stock market in Sri Lanka, and Ratanapakorn and Sharma (2007), and Maysami et al. (2004) find a positive correlation for the stock market in the U.S. and Singapore, respectively.

International stock market shocks, proxied by the S&P 500, seem to negatively affect the Saudi stock market. This finding is consistent with the argument that the U.S. stock market is ideal for Saudi investors to benefit from the Saudi Riyal being pegged to the U.S. dollar at a fixed exchange rate, which reduces the exchange rate risk associated with foreign investment. This finding is similar to Malik and Hammoudeh (2007), who found a link between the variance of the U.S. stock market and the Saudi stock market, along with other GCC stock markets.

Table 6.8: Johansen-Juselius (1990) Cointegration Test Assuming the System has Linear Trends and the Cointegrating Relationship Has Only an Intercept

Panel (a): Unrestricted Cointegration Rank based on Trace Statistic Test

Hypothesized no. of CE(s)		Eigenvalue	Trace Statistic	0.05 Critical Value	P-values.**
Null	Alternative				
$r = 0$	$r \geq 1$	0.239	179.10*	159.53	0.003
$r \leq 1$	$r \geq 2$	0.158	124.49	125.62	0.058
$r \leq 2$	$r \geq 3$	0.114	90.02	95.75	0.116
$r \leq 3$	$r \geq 4$	0.099	65.75	69.82	0.101
$r \leq 4$	$r \geq 5$	0.094	44.93	47.86	0.092
$r \leq 5$	$r \geq 6$	0.076	25.26	29.80	0.153
$r \leq 6$	$r \geq 7$	0.036	9.35	15.49	0.334
$r \leq 7$	$r \geq 8$	0.001	1.97	3.84	0.160

Panel (b) Unrestricted Cointegration Rank Test based on Maximum Eigenvalue Test

Hypothesized no. of CE(s)		Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	P-values.**
Null	Alternative				
$r = 0$	$r = 1$	0.239	54.61*	52.36	0.029
$r = 1$	$r = 2$	0.158	34.48	46.23	0.4946
$r = 2$	$r = 3$	0.114	24.27	40.08	0.811
$r = 3$	$r = 4$	0.099	20.82	33.88	0.698
$r = 4$	$r = 5$	0.094	19.67	27.58	0.364
$r = 5$	$r = 6$	0.076	15.91	21.13	0.230
$r = 6$	$r = 7$	0.036	7.37	14.26	0.446
$r = 7$	$r = 8$	0.001	1.97	3.84	0.160

Notes: CE(s) represents cointegration equation(s). r indicates the number of cointegrating relationships.
* Indicates rejection of the null hypothesis of no cointegration at the 5% level. ** MacKinnon-Haug-Michelis (1999) p-values.

Given that the exchange rate (Ex) does not contribute to the long relationship, based on the t-statistics associated with the exchange rate, the cointegration test is reestimated excluding the exchange rate (Ex) (Equation 6.1). The trace and max-eigenvalue statistic tests both suggest that there should be one cointegrating vector at the 5% level as can be seen in Table 6.8. Based on the t-statistics, all variables in the system contribute significantly to the long run equilibrium relationship with the TASI, and also continue to maintain their signs (Equation 6.2).

$$\begin{aligned} TASI = 87.38 &- \underset{\substack{(3.57)\\[3.69]}}{13.17}\, M1 + \underset{\substack{(3.43)\\[-1.93]}}{6.61}\, M2 - \underset{\substack{(0.07)\\[2.86]}}{0.20}\, Isa3 - \underset{\substack{(2.08)\\[3.47]}}{7.21}\, CPI + \underset{\substack{(1.09)\\[-4.19]}}{4.44}\, BC + \underset{\substack{(0.27)\\[-4.67]}}{1.26}\, BOP \\ &- \underset{\substack{(0.28)\\[2.54]}}{1.02}\, S\&P\ 500 \end{aligned} \qquad (6.2)$$

Note: Standard Errors in parentheses and t-statistics in square brackets.

6.4. Short-Run Analysis

Having established that eight of the nine macroeconomic variables in the analysis are cointegrated, the fundamental question that needs to be asked is: what is the nature of the dynamic relationship between these variables in the short run? This question can be answered using three complementary methods: causality tests, impulse response analysis, and forecast error variance decompositions. The following three sub sections present the results for these three methodologies.

6.4.1. Causality Tests

Given that TASI, M1, M2, Isa3, CPI, BC, BOP, and S&P 500 are cointegrated, the short run analysis for these variables is performed using a vector error correction model as developed by Engle and Granger (1987). Granger (1988) states that using a VECM rather than a VAR in

differences will not result in any loss in long run information, as is the case for the Granger (1969) causality test. However, the Granger causality test is used to examine the short run dynamic relationship between exchange rate (Ex) and TASI, since these variables are not cointegrated. The following two sections present the results of both the VECM and Granger causality tests.

6.4.1.1. VECM Causality Tests

In this section, a VECM is estimated to investigate the short and long run dynamic adjustment of a system of cointegrated variables. The estimation equation is:

$$\Delta X_t = \delta + \sum_{i=1}^{p} \Gamma \Delta X_{t-i} \; + \; \Pi X_{t-i} + v_t \tag{6.3}$$

where ΔX_t is an nx1 vector of variables and δ is an (nx1) vector of constants. Π is the error-correction mechanism, which has two components: Π=αβ′ where α is an (nx1) column vector representing the speed of the short run adjustment to the long-run equilibrium, and β′ is a (1xn) cointegrating vector with the matrix of long run coefficients. Γ is an (nxn) matrix representing the coefficients of the short run dynamics. Finally, v_t is an (nx1) vector of white noise error terms, and p is the order of the autoregression. Interestingly, Equation 6.3 has two channels of causation. The first channel is through the lagged exogenous variables' coefficients. The second channel of causation is through the error correction term. The ECT captures adjustment of the system towards its long run equilibrium.

Since the VECM technique is a more general case of the standard VAR model, the analysis proceeds to determine the lag length, p, for the dynamic terms, i.e., the lagged variables in first difference form, the number of cointegrating vectors, and the structural cointegrating

vector of the VECM. The optimal lag is $p = 12$ based on the sequential modified LR test statistic (LR) (Table 6.9).

Table 6.9: Optimal Lag Lengths of the VECM

Lag	Log-Likelihood	LR
0	2898.992	NA
1	2976.967	148.4852
2	3037.942	110.9218
3	3078.154	69.72975
4	3119.838	68.73404
5	3157.113	58.29119
6	3201.745	65.99834
7	3244.318	59.33052
8	3292.569	63.13797
9	3327.782	43.07960
10	3387.798	68.31591
11	3451.054	66.62038
12	3540.647	86.73377*
13	3602.736	54.82330
14	3680.571	62.10267
15	3770.469	64.07583

* Indicates optimal lag order selected according to the associated criterion.

Table 6.10: Residual Serial Correlation LM Tests for the VECM

Lags	LM-Stat	P-values*
1	51.47	0.87
2	52.35	0.85
3	54.46	0.80
4	56.03	0.75
5	56.45	0.74
6	76.91	0.13
7	78.27	0.11
8	80.14	0.08
9	50.34	0.89
10	73.66	0.19
11	78.98	0.10
12	60.08	0.62
13	44.82	0.97

*P-values based on χ^2 asymptotic (large sample) distribution with 81 degree of freedom (df).

The LM test reported in Table 6.10 indicates that the estimated VECM with $p = 12$ consistently produces residuals that are free from serial correlation as can be seen in Table 6.10. Also, the same structure for the cointegrating vector is maintained as used for the Johansen-Juselius cointegration test in section 6.3.3. That is, it is assumed that the system of VECM has linear trends, and the cointegrating relationship has only an intercept given that we believe that

most of our data have stochastic trend. Finally, following the previous results of the max-eigenvalue test, there is one cointegrating vector among the variables in the VECM model.

Table 6.11 presents the results of the short and long run causality tests for the VECM. The first row in Table 6.11 presents the short run and long run relationship between TASI and the rest of the system's independent variables. The first column indicates the short run contribution of TASI as an independent variable to other models in the system. The results of the long and short run causality tests are different. The p-values reported in the first row indicate significant unidirectional short run causal effects associated with M1, M2, and inflation CPI to the Saudi stock market returns. That is, money growth, defined by M1 and M2, and CPI predict the Saudi stock market returns in the short run, but the converse is not true. One possible conclusion from this result is that the Saudi stock market is an inefficient stock market with respect to M1, M2, and the CPI since Saudi stock market returns can be predicted using available information about these three variables in the short run during this time period. These results are to some extent consistent with the empirical evidence revealed by the studies of Abdullah and Hayworth (1993), Darrat and Dickens (1999), Ahmed (2008), Hasan and Javed (2009), Hashemzadeh and Taylor (1988), Ibrahim (1999), Keung et al. (2006), Malliaris and Urrutia (1991), Patra et al. (2006), and Thornton (1998).

However, the rest of the macroeconomic variables, i.e., Isa3, BC, BOP, and S&P 500, appear to not have a significant relationship with the Saudi stock market returns in the short-run based on the p-values (first row in Table 6.11). In other words, all information available on changes of the Isa3, BC, BOP, and S&P 500 are already incorporated in the Saudi stock market prices. This result may be seen as empirical evidence that the Saudi stock market meets the

efficient-market hypothesis (EMH) with respect to these macroeconomic indicators in the short run.

Table 6.11: Multivariate VECM Causality Tests

Dependent Variable	Independent Variables								ECT
	ΔTASI	ΔM1	ΔM2	ΔIsa3	ΔCPI	ΔBC	ΔBOP	Δ*S&P* 500	
ΔTASI	-	**0.00***	**0.00***	**0.06**	**0.02***	**0.75**	**0.09**	**0.07**	**-0.170*** **[-2.84]**
ΔM1	**0.49**	-	0.61	0.99	0.31	0.57	0.96	1.00	-0.042 [-2.24]
ΔM2	**0.95**	0.46	-	0.97	0.24	0.19	0.74	1.00	-0.029 [-1.73]
ΔIsa3	**0.01***	0.13	0.09	-	0.00	0.69	0.00	0.00	0.915 [4.21]
ΔCPI	**0.77**	0.79	0.93	0.47	-	0.78	0.79	0.87	-0.004 [-0.71]
ΔBC	**0.10**	0.37	0.18	0.32	0.26	-	0.11	0.03	0.069 [4.06]
ΔBOP	**0.03***	0.59	0.54	0.81	0.21	0.59	-	0.46	-0.136 [-1.59]
Δ*S&P* 500	**0.26**	0.25	0.21	0.06	0.14	0.22	0.10	-	-0.013 [-0.32]

- The table contains both t-statistics associated with the error-correction term (ECT), and the p-values that associated with the χ^2-statistic, which represents test the joint significance of the lagged values of the independent variables.
* Indicates 5% level of significance.

Nonetheless, the t-statistic associated with the coefficient on the lagged error-correction term, or the speed of adjustment, indicates a significant long-run causal effect, with an expected negative sign (Table 6.11). This is what we expect given the results of the Johansen-Juselius' cointegration test. Furthermore, the ECT demonstrates that the Saudi stock market converges to its equilibrium within almost half a year after being shocked; adjusting by about 17% each month. This result is in line with the empirical evidence for the U.S and Japanese stock markets (Humpe and Macmillan, 2009; Ratanapakorn and Sharma, 2007) and Ibrahim (1999) for the Malaysian stock market.

The p-values reported in the first column in Table 6.11 indicate that the Saudi stock market is a leading indicator for two macroeconomic variables, i.e., the short term interest rate

(Isa3) and the price of oil (BOP). The correlation of the TASI with the future price of oil perhaps reflects the fact that Saudi Arabia is a net oil exporting country and is consistent with Malik and Hammoudeh (2007), who suggest that the Saudi market contributes significantly to changes in the oil market.

The Saudi stock market is not a leading indicator for the rest of the macroeconomic variables in the system, i.e., M1, M2, CPI, BC, and S&P 500, based on the p-values in the first column in Table 6.11. In the literature there is no consensus about how real economic activity reacts to stock market shocks. These findings are in line one way or another with Hashemzadeh and Taylor (1988). Keung et al. (2006), Ratanapakorn and Sharma (2007) for the U.S. stock market, Liljeblom and Stenius (1997), Patra et al. (2006), Thornton (1998), but Gan et al. (2006), Gjerde and Saettem (1999), Gunasekarage et al. (2004) find empirical evidences that the stock market is not a leading indicator of real economic activities in New Zealand, Norway, and Sri Lanka, respectively.

6.4.1.2. Granger Causality Tests

This section presents Granger causality test results for the exchange rate and TASI. If the variables are not cointegrated, as we concluded earlier, the Granger causality test is appropriate to examine the short run dynamic relationships between these two variables. Table 6.12 shows that the Saudi stock market returns are independent from changes in the Saudi exchange rate. While the reported results of the Granger causality test (1969) are based on a $VAR(12)$ model, which was choose arbitrarily since we work with monthly data. Also, the Granger causality test was performed using different lags up to a maximum of 11 lags, and the results remained the same. Therefore, TASI and exchange rate do not Granger-cause one another in the short run during this sample time period. The absence of a relationship between the Saudi stock market and the

exchange rate in the short run is consistent with the result of the long run analysis, supporting the claim that the amount of foreign investment is small and pegging the Saudi Riyal to the U.S. dollars makes exchange rate changes irrelevant to the stock market.

Table 6.12: Pairwise Granger Causality Tests between TASI and the Exchange Rate

Null Hypothesis	Obs.	F-Statistic	P-values	Implication
ΔEX does not Granger Cause ΔTASI	191	1.196	0.290	No causality
ΔTASI does not Granger Cause **ΔEX**		1.228	0.268	No causality

This result, however, may be taken as an indicator that the Saudi stock market already incorporates the effect of short run exchange rate changes when the conditions of the efficient market hypothesis are met.

6.5. Dynamic Analysis

Despite the importance of conducting causality tests, a causality test, by definition, does not determine the strength of the relationships between the variables nor does it describe the relationship between these variables over time. For that reason, the response of Saudi stock market returns is examined to shocks to the some macroeconomic shocks represented by (1) the growth of the money supply (M1and M2), (2) changes in the short term interest rate, (3) inflation, (4) claims on the private sector or bank credits, (5) changes in the price of oil, (6) the U.S. stock market return, and (7) changes exchange rate. Impulse response functions and forecast error variance decompositions are used to estimate the responses.

6.5.1. Impulse Response Function Analysis

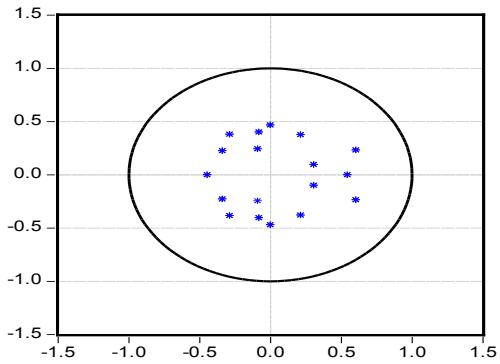
Impulse response functions track the response of a variable over time after a shock to the VAR system. The persistence of a shock indicates how quickly the system returns to equilibrium.

In order to examine to what extent innovations in each of the eight macroeconomic variables can explain the movements in the TASI we estimate the IRFs. This will allow us to determine the magnitude, direction, and length of time that the TASI is affected by a shock of a variable in the system, holding all other variables constant. The impulse response functions are identified using a Cholesky decomposition with TASI ordered first, i.e., it is contemporaneously affected by all other variable shocks, followed by Isa3, CPI, Ex, M2, M1, S&P 500, BC, and finally BOP. That is, shocks to BOP will affect all of the other variables contemporaneously but is not affected by them contemporaneously. The rationale for this ordering is: (1) the Saudi economy is a small, open, oil-based economy in which oil revenue is the most stimulatory factor to almost all local economic sectors; (2) commercial banks in Saudi Arabia have significant positions in both the debt and the equity market since they play roles similar to the role of brokerage houses in managing mutual funds and portfolios as well as being are the second largest supplier of credit in the Saudi economy after the government's mutual funds during most of the time period 1993-2009; (3) the Saudi monetary policy is not fully independent of the U.S. monetary policy. For instance, the Saudi monetary authority chose to peg the local currency to the U.S. dollar at a fixed rate back in 1986, and the local investors were exchange rate risk free when investing in the U.S. stock market; (4) the Islamic financial model works on the basis of risk sharing[51]. As a result, investors must share the risk of making any investment and divide any profits or losses between them, accordingly. In Islamic countries like Saudi Arabia in which people consider Islam as a way of life, it is reasonable to argue that the interest rate is exogenous; (5) the Saudi economy experienced constant low levels of inflation within a range of 1% - 5% from 1993 to 2006 (SAMA, 2010); and (6) during the sample period, Saudi Arabia's central bank, SAMA,

[51] Taking or giving fixed interest on loaned money is explicitly prohibited according to Islamic law (Holy Quran, Surat Al-Baqarah, verse 275-280).

released information about the money supply at least three months late. Thus, it is highly plausible that practitioners in the stock market did not have access to current, relevant information to help predict the dynamic behavior of Saudi stock market returns.

Figure 6.9: Inverse Roots of the Autoregressive Characteristic Polynomial of the Estimated VAR (2) Model



In order to draw conclusions from the IRFs and FEVDs, the VAR model must be stable. The stability of our estimated VAR model is not difficult to check, since the data is integrated of order zero. Figure 6.9 indicates that the VAR model with two lags satisfies the stability condition, since there are no roots lying outside the unit circle in each model. This is also confirmed by showing that the IRFs declined to zero within a short time period of the system being shocked, i.e., nine months, one could suggests that the estimated VAR model is stable. It is worth mentioning that the two lags were determined by the LR at a 5% significance level (Table 6.13).

Figure 6.10 displays the estimated impulse response functions with 95% confidence bands represented by dotted lines. That is, all panels in Figure 6.10 show the response of TASI to a transitory shock associated with each macroeconomic variable in the VAR system. The confidence bands in the IRFs are obtained from Monte Carlo simulations with 1,000 repetitions.

Table 6.13: The Optimal Lag Lengths of the VAR in the First Difference (Maximum 12 lags)

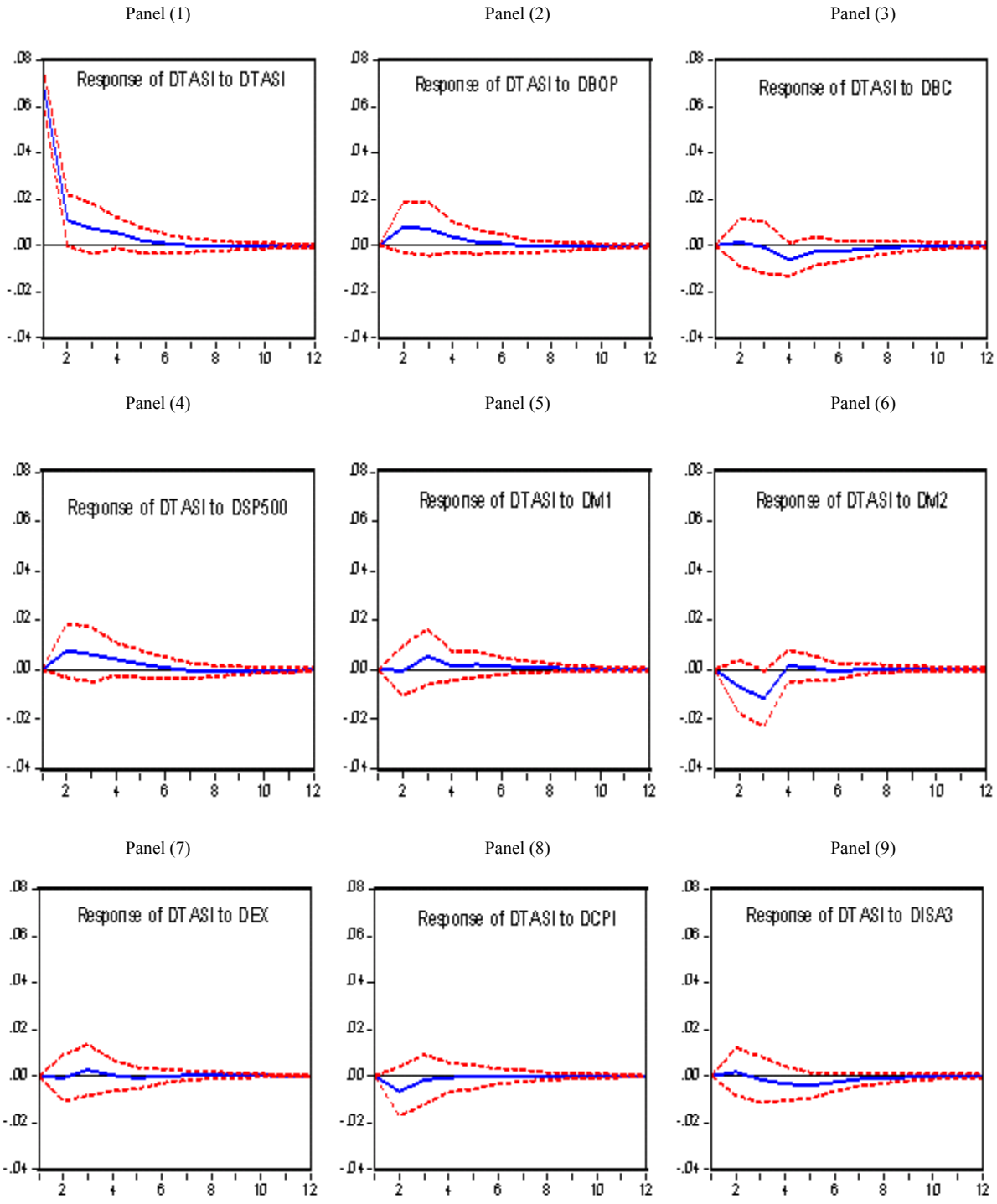
Lags	Log-Likelihood	LR
0	3509.26	NA
1	3597.17	166.60
2	3674.93	140.06*
3	3720.03	76.98
4	3773.50	86.22
5	3822.68	74.66
6	3879.54	80.99
7	3936.60	75.87
8	4000.21	78.60
9	4048.84	55.51
10	4128.17	83.06
11	4220.62	88.09
12	4335.47	98.62

* Indicates optimal lag order selected according to the associated criterion.

Based on all panels in Figure 6.10, the IRFs indicate that there is no statistically significant short run relationship between the Saudi stock market returns and the eight macroeconomic variables. This implies that the IRFs indicate that there are no contemporaneous effects of the macroeconomic variable shocks on the Saudi stock market. These findings are consistent with the EMH and suggest that the Saudi stock market is weakly informationally efficient since stock prices incorporate all of the current and projected changes in macroeconomic variables in the system. However, the short-run response of Saudi stock market returns to its own shock is statistically significant but less persistent since it dies out after one month.

Table 6.14 indicates low correlation, i.e., $\rho \leq 0.2$, associated with the estimated residuals of the variables in the system. This may be taken as additional evidence for the absence of a contemporaneous effect of either variable on the other. Another application of the low cross-correlation of the estimated residuals of the reduced form VAR is that the ordering of the variable in the system does not matter (Enders, 2010).

Figure 6.10: Impulse Response Functions of the TASI to Cholesky One S.D. Innovations



NOTE:

- For each plot, the x-Axis is the number of months (Lags), and the y-Axis represents the percent changes.
- The impulse response function is statistically significant when both standard error bands (dashed-lines) are above or below zero on the y-Axis.

Table 6.14: Correlation Matrix of the Estimated Reduced Form VAR Residuals

	DTASI	DM1	DM2	DIsa3	DCPI	DBC	DEx.	DBOP	DS&P500
DTASI	1								
DM1	0.097	1							
DM2	0.072	0.799	1						
DIsa3	-0.140	-0.181	-0.145	1					
DCPI	-0.058	-0.031	-0.016	-0.074	1				
DBC	0.093	-0.044	-0.072	0.063	0.041	1			
DEx	0.051	-0.107	-0.099	-0.009	-0.069	-0.064	1		
DBOP	0.132	0.002	-0.033	-0.055	0.027	0.080	-0.173	1	
DS&P500	0.205	0.168	0.142	-0.152	-0.131	-0.007	-0.249	0.005	1

6.5.2. Forecast Error Variance Decompositions

FEVDs indicate the relative importance of each structural shock to the variables in the system. In this study, FEVDs determine the percentage of variation in the forecast error of the Saudi stock market returns that is due to its own shocks versus shocks to other macroeconomic variables in the system. That is, we aim to estimate the variance of the n-step-ahead forecast error to determine the relative importance of the macroeconomic shocks in the system. The estimation equation is:

$$\begin{aligned}\sigma_y(n)^2 = \sigma_y^2[\theta_{11}(0)^2 + \theta_{11}(1)^2 + \cdots + \theta_{11}(n-1)^2] \\ +\sigma_z^2[\theta_{12}(0)^2 + \theta_{12}(1)^2 + \cdots + \theta_{12}(n-1)^2]\end{aligned} \quad 6.4$$

where $\sigma_y(n)^2$ and $\sigma_x(n)^2$ denote the n-step-ahead forecast error variance of $Y_{t+n}$and Z_{t+n}, respectively. As discussed in chapter 5, the first part of the equation shows the proportion of variance due to the own variable shock, Y_t, while the second part of the equation 5.13 shows the proportion of variance due to the other variables shocks, z_t.

Table 6.15: Variance Decomposition

Months	S.E.	ΔTASI	ΔBOP	ΔSP500	ΔBC	ΔM1	ΔM2	ΔEx	ΔCPI	ΔIsa3
1	0.070557	100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.075800	90.11	2.21	1.96	0.71	0.51	3.3	0.13	0.8	0.27
8	0.076246	89.14	2.23	2.04	0.99	0.63	3.29	0.14	0.8	0.74
12	0.076258	89.12	2.24	2.05	0.99	0.63	3.29	0.14	0.8	0.74
16	0.076258	89.12	2.24	2.05	0.99	0.63	3.29	0.14	0.8	0.74
20	0.076258	89.12	2.24	2.05	0.99	0.63	3.29	0.14	0.8	0.74
24	0.076258	89.12	2.24	2.05	0.99	0.63	3.29	0.14	0.8	0.74

Cholesky Ordering: TASI, ISA3 CPI EX M2 M1 S&P500 BC BOP.

Table 6.15 reports the FEVDs for the Saudi stock market return over a two year period using the same identification restrictions (ordering of the variables) that were used for the IRF analysis. In the first month, as expected, there is no contribution of other variables in the system to the variance of the forecast error of Saudi stock market returns. The results show that TASI shocks are the main driver of TASI, i.e., 89%, which implies that the Saudi stock market can be predicted by its previous behavior. Four months ahead, the strongest influence on Saudi stock market returns variation is the money supply M2, (3.3%), followed by the price of oil (2.2%) and the U.S. stock market, (1.96%). The rest of the variables, i.e., M1, CPI, BC, Isa3, and Ex, contribute only about 2.4% of the variation in Saudi stock market returns after four months. The magnitude of the contribution of the variables in the system did not change dramatically over 24 months which implies that these variables do not have a significant effect on the Saudi stock market. This may be due to the fact that speculative trading continues to dominate the Saudi stock market. This rationale may be supported by two important arguments. First, historically, there have been no fundamental changes in the Saudi economy associated with or preceding the big changes in the Saudi stock market. Second, the shortage of free-floating shares available for trading due to large government holdings, family-owned businesses and other management

groups, was also a weakness (Niblock and Malik, 2007). In fact, until 2009 the free-floating shares in the Saudi stock market were less than 41% of the issued shares.

This conclusion is consistent, in general, with the IRF analysis that revealed insignificant evidence for the relationship between the Saudi stock market and all of the macroeconomic variables in the system during the sample time period. It is also comparable to the evidence provided for the Saudi stock market by Hammoudeh and Choi (2006). In particular, Hammoudeh and Choi (2006) find that the largest portion of the total variation in the Saudi stock market may be attributed to its own shocks and only 19% of the variation is attributed to oil price changes. Sadorsky (1999) found that oil price movements explained a large portion of the forecast error variance in real U.S stock market returns, particularly after 1986.

Table 6.16: Variance Decomposition of the Macroeconomic Variables in the System

Months	ΔBOP	ΔSP500	ΔBC	ΔM1	ΔM2	ΔEX	ΔCPI	ΔIsa3
1	1.73	4.19	0.87	0.95	0.51	0.26	0.34	1.97
4	5.88	3.97	2.82	1.30	0.56	0.51	3.52	2.67
8	5.84	4.02	2.84	1.43	0.64	0.51	3.53	2.77
12	5.84	4.02	2.84	1.43	0.64	0.52	3.53	2.77
16	5.84	4.02	2.84	1.43	0.64	0.52	3.53	2.77
20	5.84	4.02	2.84	1.43	0.64	0.52	3.53	2.77
24	5.84	4.02	2.84	1.43	0.64	0.52	3.53	2.77

Cholesky Ordering: TASI, ISA3 CPI EX M2 M1 S&P500 BC BOP.

Table 6.16 presents the effect of the Saudi stock market shocks on variations of other variables in the system. It is obvious from Table 6.16 that the FEVDs associated with each variable in the system reveal weak evidence for the importance of Saudi stock market shocks for explaining the variation in each macroeconomic variable in the system. In other words, FEVDs indicate that a shock to the Saudi stock market explains only 2.84%, 3.53%, 2.77% 1.43%, 0.64%, and 0.52%, of the variance of BC, CPI, Isa3, M1, M2, and the Exchange rate

respectively, after 4 months, and remains the same throughout the horizons. This indicates that the Saudi stock market had little effect on real economic activity in the Saudi economy during the sample time period. One possible implication is that the Saudi stock market seems to not act as a mediator between lenders and borrowers, which is the primary condition for the stock market to boost savings and allocate economic resources efficiently in the society. Another conclusion is that the Saudi stock market returns in Saudi Arabia is a poor predictor of the variability associated with the system's variables.

On the other hand, a shock to the Saudi stock market explain 6%, and 4%, of the variance of the price of oil (BOP), and the U.S. stock market respectively, after 4 months, and remains the same throughout the horizons. This may indicate the importance of the Saudi economy to these two markets.

Chapter 7 : Empirical Results of the GARCH-Family Models

This chapter is devoted to examining whether the volatility of the macroeconomic variables included in this study, as defined in Table 6.1, have any influence on Saudi stock market volatility. In other words, this chapter serves to answer question number five of the research questions. In the first section, we present descriptive statistics for Saudi stock market returns. The second section estimates Bollerslev's GARCH(p, q) model with no exogenous variables and checks weather it provides an adequate model for the volatility of Saudi stock returns. Third, we will explore the impact of macroeconomic variables on the volatility of the Saudi stock market return by examining three different sets of the GARCH models, as detailed in the chapter 5. These models are the AR(1)-GARCH-X(1,1) model, the AR(1)-GARCH-S(1,1) model, and the AR(1)-GARCH-G(1,1) model, all of which incorporate the macroeconomic variables in the variance equation in different ways[52].

7.1. Descriptive Statistics

A stationarity test was carried out on the Saudi stock return series in the previous chapter using the ADF test and PP test. We found that TASI is not stationary in levels, but was stationary after first differencing. Given that, we proceed to examine other statistical properties of TASI that are essential for the GARCH family of models. Table 7.1 contains basic descriptive statistics for monthly stock returns of the Saudi stock market and the S&P 500 for comparison purposes. As can be seen from table 7.1, the sample mean of the Saudi stock market return is 0.0058,

[52] Details of these steps and models were discussed in chapter 5.

which is slightly higher than the mean return of the S&P 500, 0.0046, over the same period[53]. The unconditional standard deviation shows that Saudi stock market returns were relatively volatile during the sample period, i.e., 7% relative to the U.S. stock market returns represented by the S&P 500, i.e., 4%. The kurtosis coefficient of 4.97 implies that this series strongly departs from normality. As expected, the Jarque-Bera normality test strongly rejects the null hypothesis of normality for Saudi stock market returns as seen in table 7.1.

Table 7.1: Descriptive Statistics for Saudi Stock Market Returns

Markets	Mean	Max.	Min.	Std. Dev.	Skewness	Kurtosis	Jarque-Bera	P-Value	Obs.
TASI	0.0058	0.1800	-0.3000	0.0724	-0.7054	4.9736	49.7787	0.0000	203
S&P500	0.0046	0.0900	-0.1800	0.0443	-0.9816	4.8892	62.7850	0.0000	203

Note: The standard value for normal distribution is equal to 3, the normal distribution skewness value is equal to zero. Jarque-Bera used to test the hypothesis of H_0: is the Saudi stock market returns~ normal; JB~x_2^2.
Source: calculated by the author.

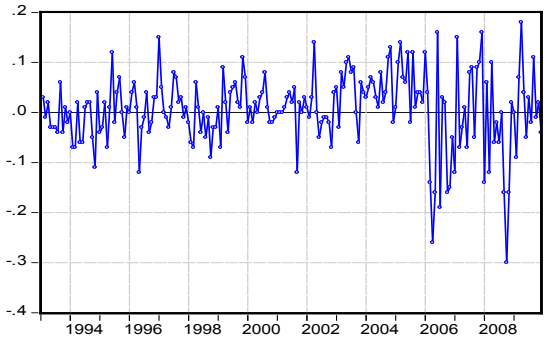
The departure from normality for Saudi stock market returns is visually supported by looking at the histogram coupled with the normal distribution plot in figure 7.1. It is obvious from figure 7.1 panel (b) that the Saudi stock market return is not normally distributed and is heavy-tailed to the left, consistent with the previous result. This suggests that Saudi stock market returns exhibit leptokurtosis, a well known stylized fact in the finance literature. Also, the series has asymmetric tails skewed to the left, i.e., -0.71, which implies, from the market point of view, that investors in this market are likely to earn negative returns. The results for the U.S. stock market can be seen in Table 7.1.

Another stylized fact about the Saudi stock market return is volatility clustering. It is noticeable from figure 7.1 panel (a) that period of high (low) volatility in Saudi stock market returns are followed by periods of high (low) volatility. This becomes obvious when we look at

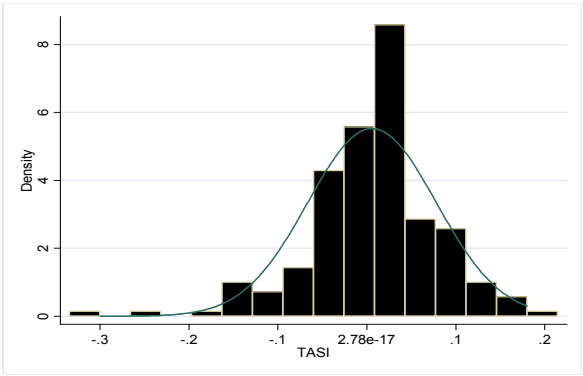
[53] Calculated by the author based on data obtained from Yahoo; Finance<www.yahoo.com>.

the absolute and squared return of the Saudi stock market plotted in Figure 7.2 panel (a) and panel (b) respectively, where these two figures show significant evidence of a long permanent positive autocorrelation. One theoretical explanation for clustered volatility is that at the beginning of each period new information leads to higher volatility associated with large returns (Kirchler and Huber, 2007). Kirchler and Huber (2007) attributed this phenomenon to heterogeneity of expectations. In the path of each period, returns tend to decline as traders learn from their trading strategies. Consequently, the market moves towards a partial equilibrium until new fundamental information is arrived to the market caused a new start for the next period with the same the same patterns (Kirchler and Huber, 2007).

Figure 7.1: Saudi Stock Market Return and Its Distribution Over the Whole Sample

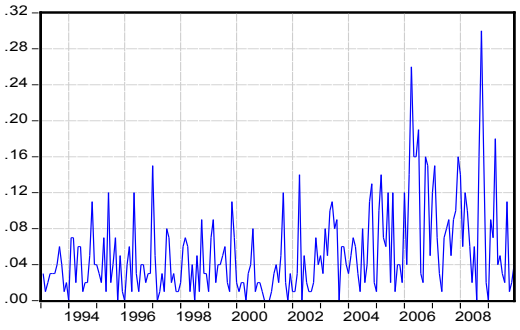


Panel (a): ΔTASI

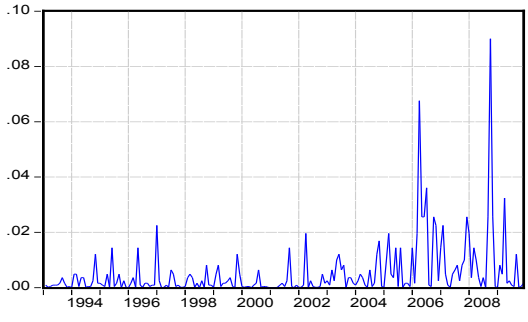


Panel (b): Histogram and the normal distribution of ΔTASI

Figure 7.2: Absolute and Squared Values of the Saudi stock Market Return



Panel (a): Absolute Values of Stock Market Return ΔTASI



Panel (b): Squared Stock Market Return $\Delta TASI^2$

This result is confirmed by the fact that Ljung-Box Q-statistics associated with the ACF coefficients of the raw, absolute, and squared values of Saudi stock market returns reject the null hypothesis of no autocorrelation up to 36 months (Table 7.2). This may be taken as evidence for the presence of volatility clustering, which can be interpreted as a sign of long-range dependence in Saudi stock market returns during the sample period.

Table 7.2: Ljung-Box Q-Statistics for Saudi Stock Market Returns

Lag	Raw Stock Market Return		Absolute Stock Market Return		Squared Stock Market Return	
	Q-Test	P-Value	Q-Test	P-Value	Q-Test	P-Value
1	8.98	0.00	29.59	0.00	25.56	0.00
4	18.64	0.00	37.88	0.00	36.49	0.00
8	26.94	0.00	55.90	0.00	67.40	0.00
12	30.86	0.00	71.13	0.00	92.25	0.00
16	34.50	0.01	77.74	0.00	116.92	0.00
20	35.49	0.02	96.08	0.00	147.76	0.00
24	42.00	0.01	111.61	0.00	173.18	0.00
28	43.17	0.03	121.12	0.00	181.68	0.00
32	50.98	0.02	154.43	0.00	198.11	0.00
36	58.25	0.01	159.86	0.00	211.39	0.00

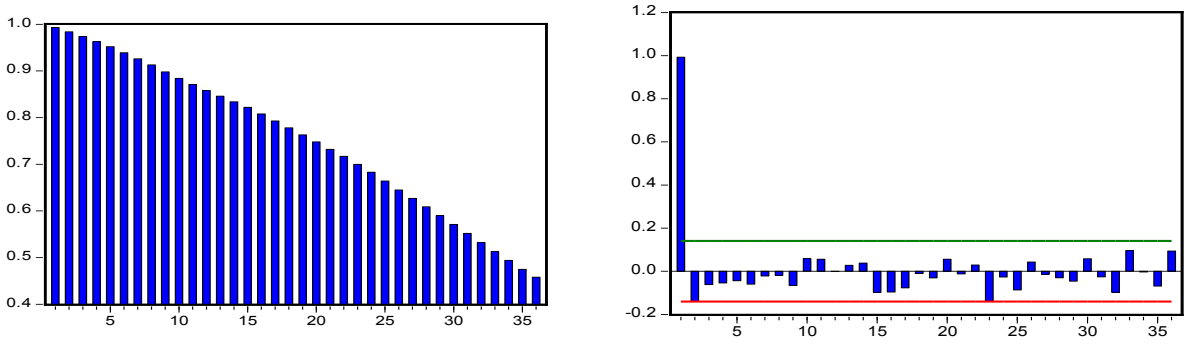
This basic analysis of Saudi market returns is consistent with the the pioneering works of Mandelbrot (1963) and Fama (1965) who, among others, suggest that stock returns are not normally distributed. It also suggests that stock market returns exhibit leptokurtosis, skewness and volatility clustering which are the popular stylized facts that often characterize financial time series (Rydberg, 2000). Consequently, it is legitimate to use GARCH models to answer research question number five as discussed in the next sections.

7.2. Modeling the Conditional Mean Equation

The first step in estimating a GARCH model, as explained in chapter 5, is to determine the dynamics of the conditional mean. This step is significant to avoid generating autocorrelation

in the squared residuals of the dependent variable of the variance equation. That is, using the right model of the mean equation may help to ensure convergence in estimating the GARCH model; since more parameters in the GARCH model may make the likelihood function flat, which in turn makes the likelihood function difficult to maximize (Alexander, 2007). Accordingly, we attempt to find an adequate model for the conditional mean equation based on three steps: identification, estimation, and diagnostic checking. For identification, the autocorrelation function (ACF) and partial autocorrelation function (PACF) may give hints about the nature of the dynamic behavior of the process and which ARMA specification of the Saudi stock market returns should be adopted.

Figure 7.3: Correlogram of Saudi Stock Market Returns



Panel (a): ACF

Panel (b): PACF

Since the ACF plotted in Figure 7.3 panel (a) dies off somewhat geometrically with increasing lag this may be taken as a sign that the series TASI follows a first-order autoregressive process. This conclusion is supported by the fact that the PACF is zero after one lag and falls significantly within the boundaries of two standard errors ($\mp 2/\sqrt{T}$). Though the ACF and PACF give us an important hint about the appropriate lags to be included in an ARMA model, some argue that ACF and PACF are both informative in determining the order of an ARMA model (Tsay, 2010). Thus, the ACF and the PACF were taken as a starting point for the analysis and we proceed toward choosing the optimal model based on Schwarz's information

criteria (SIC), given that the SIC will always select a more parsimonious, i.e., lower order, model compared to the AIC (Enders, 2010). This comes from that fact that the penalty for adding more regressors is greater with the SIC than with the AIC (Enders, 2010). Accordingly, we estimate several combinations of ARMA (p, q) models up to 5 lags.

Table 7.3: SIC for the Mean Equation for Saudi Stock Market Returns

		MA					
	Lag $[p, q]$	0	1	2	3	4	5
AR	0	-2.393	-2.404	-2.387	-2.363	-2.348	-2.324
	1	-2.407*	-2.398	-2.373	-2.347	-2.325	-2.299
	2	-2.383	-2.369	-2.342	-2.323	-2.303	-2.277
	3	-2.356	-2.339	-2.319	-2.334	-2.320	-2.297
	4	-2.336	-2.311	-2.285	-2.315	-2.286	-2.258
	5	-2.305	-2.280	-2.397	-2.243	-2.260	-2.235

* indicate the optimal lag.

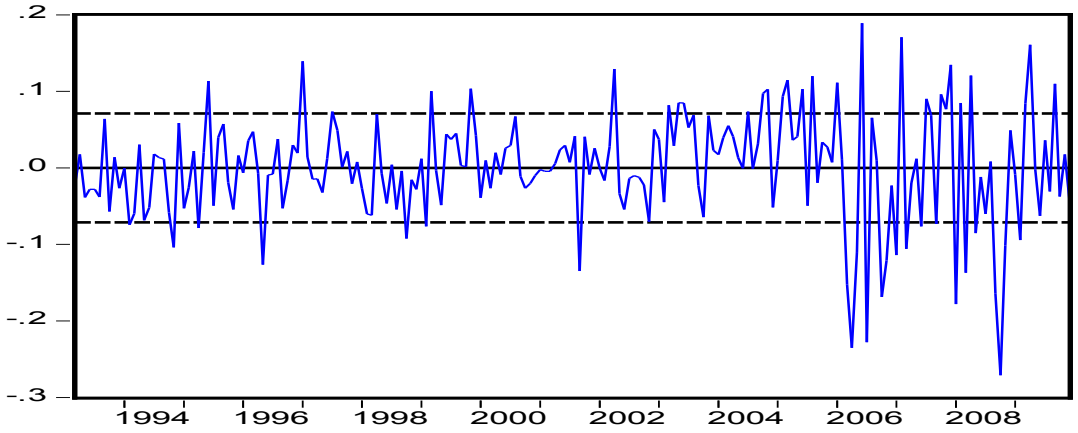
Table 7.3 reports the SIC values associated with all of the estimated models. The SIC suggests that an ARMA model of order (1,0) is the adequate model. This is consistent with the ACF and PACF analysis mentioned above. It is also supported by the facts. First, the estimated ARMA(1,0) model produces residuals that are free from serial correlation up to 12th order as indicated by, the Breusch-Godfrey[54] test reported in table 7.4. That is the Breusch-Godfrey test does not reject the null hypothesis of no serial correlation in the estimated residuals of the two optimal candidate ARMA(p, q) models up to 12 months. Second, the ARCH-LM test shown in the table 7.4 presents strong evidence that the estimated residuals of the candidate ARMA(1,0) model is exhibit autoregressive conditional heteroskedasticity (ARCH-effect) rather homoscedasticity.

[54] Alternative popular test is the Q-test. However, LM test is more appropriate to use here, for more interesting justifications please see Maddala (2001).

Table 7.4: Serial Correlation LM and Heteroskedasticity Tests for the Estimated Residuals of the ARMA (1,0) Model

Lags	Breusch-Godfrey Test F-Test [P-values]	ARCH-LM Test Chi-Square Test[P-values]
1	1.373 [0.243]	23.60 [0.000]
4	1.044 [0.386]	36.08 [0.000]
8	1.430 [0.186]	41.08 [0.000]
12	1.253 [0.250]	42.63 [0.000]

Figure 7.4: Estimated Residuals of the ARMA (1,0) model



Further, the estimated residuals of the ARMA(1,0) model behaves like "white noise" around zero as can be seen in figure 7.4. Therefore, the ARMA (1,0) model satisfies the primary statistical diagnostics to conduct the impact of a set of macroeconomic variable volatility on the conditional variance of the Saudi stock returns. Thus, the remaining analysis will use this specification for the mean equation. Table 7.5 shows the results for the estimated model from which the P-value associated with the AR(1) coefficient is statistically significant. This result implies that stock market return has a relatively short memory (one month), which may be reasonable since the stock market should react to information faster than other markets like goods markets (Davis and Kutan, 2003).

Table 7.5: Estimated Optimal ARMA (1,0) Models

Variable	Coefficient [P-value]	
C	0.006 [0.381]	
AR[1]	0.209 [0.003]	
R-squared	0.044	
Adjusted R-squared	0.039	
S.E. of regression	0.071	
Sum squared residual	1.011	
Log likelihood	248.37	
F-statistic [P-value]	9.135	[0.0028]
Akaike info criterion (AIC)	-2.439	
Schwarz criterion (SIC)	-2.407	
Durbin-Watson stat	2.032	

7.3. Estimated Results of the AR(1)-GARCH (1,1) Model

Following Bollerslev (1987) and Engle (1993), among others, who argue that the standard GARCH(1,1) specification is a parsimonious representation for modeling the conditional variance of many high-frequency times series, the AR(1)-GARCH(1,1) process is used as the benchmark model for modeling the conditional volatility of Saudi stock returns[55]. Panels (a), (b), (c), and (d) in Table 7.6 report the results of the joint estimation of the mean and variance equations of the AR(1)-GARCH(1,1) model for the Saudi stock market and different diagnostic fits of the model. A quick glance over these results leads to several conclusions.

The mean equation of the estimated AR(1)-GARCH(1,1) model shows that the coefficient on the AR(1) term, θ_1 , is significant, signifying that the previous period returns play a vital role in determining the current stock market return (Panel (a) in Table 7.6). The constant μ is close to zero, consistent with unconditional mean shown in table 7.1 (although insignificant).

[55] Engle (2001) argues that higher-order models are often useful when a long span of data is used, like several decades of daily data or a year of hourly data which is not our case. Higher order GARCH model up to 3rd order were estimated but we found no significant improvement over the standard GARCH (1,1) model.

The variance equation suggests several conclusions, (i) All the key parameters in the variance equation (ω, α_1, and β_1) have the expected positive signs, and α_1 and β_1 are highly significant (Panel (b) in Table 7.6). The latter results indicate that the sufficient conditions for a non-negative conditional variance are met. Therefore, the standard AR(1)-GARCH(1,1) model seems to capture volatility clustering in our data quite well. (ii) The sum of the ARCH and GARCH coefficients is less than one, i.e., $\alpha_1 + \beta_1 = 0.976$, which implies that the unconditional variance of ε_t or $h_t^2 = \frac{\omega}{1-(\alpha_1+\beta_1)} < 1$ is stationary. Since the sum of $\alpha_1 + \beta_1$ is nearly close to one, the time-varying volatility of the Saudi stock market returns is highly persistent. In other words, a shock to the Saudi stock market volatility will last a long time. (iii) α_1 is lower than β_1, which implies that the volatility of the stock market is affected by past volatility more than by related news from the previous period.

Table 7.6: Estimates of the AR (1)-GARCH (1,1) Model

Panel (a)			Panel (b)			Panel (c)		
Mean Equation			Variance Equation			AIC	SIC	Log Likelihood
μ	0.006	[0.242]	ω	0.0001	[0.270]	-2.629	- 2.547	270.54
θ_1	**0.239**	**[0.000]**	α_1	**0.080**	**[0.032]**			
			β_1	**0.896**	**[0.000]**			
			$\alpha_1 + \beta_1$	**0.976 <1**				

Panel (d): Residual Diagnostic Fits

The Ljung-Box Q-Statistics			ARCH-LM Test			Jarque-Bera	Skewness	Kurtosis
Order	Q-test	Q^2-test	Order	F-statistic	Obs.*R-squared			
2	0.28 [0.598]	2.10 [0.148]	1	1.48 [0.224]	1.49 [0.222]	2.750 [0.253]	-0.23	3.34
10	11.28 [0.257]	8.27 [0.507]	3	0.78 [0.5058]	2.36 [0.501]			
20	13.79 [0.796]	14.30 [0.766]	6	0.60 [0.726]	3.69 [0.718]			
36	26.24 [0.857]	30.50 [0.685]	12	0.76 [0.691]	9.30 [0.677]			

Note:
P-values are in square brackets. For the parameters, p-values are associated with z-statistics and for diagnostic fitting, p-values are associated with the χ2-statistic.

Panel (d) in Table 7.6 contains the diagnostic tests on the residuals generated from the AR(1)-GARCH(1,1) model. The Ljung-Box Q-statistics suggest no serial correlation on the

standardized residuals obtained from the model up to 36th order at the 5% significance level. Also, the Q^2-statistic test cannot effectively reject the null hypothesis of no autocorrelation of the squared standardized residuals obtained from the AR(1)-GARCH(1,1) model up to 36 lags at the 5% significance level. Not rejecting the null hypothesis of both Q and Q^2 statistic tests provides evidence that the mean and variance equations of the Saudi stock returns are correctly specified (Enders, 2010). These results are also confirmed by the fact that the estimated standard AR(1)-GARCH(1,1) model successfully produced residuals that are free from ARCH effects based on the ARCH-LM test up to order 12 either by the F-statistic or by Chi-squared tests. The Jarque-Bera statistic also cannot reject the hypothesis of normality since Kurtosis statistics value of 3.34 is lower than those for the original data at 4.97 (Panel (d) in Table 7.1). These findings support the adequacy of the standard GARCH(1,1) model as a benchmark to describe the dynamic behavior of the Saudi stock market with the volatility of the macroeconomic variables in the system during the sample time period, which will be considered in the following section.

7.4. Impact of Macroeconomic Volatility

Given that the estimated AR(1)-GARCH(1,1) model is appropriate to describe the conditional volatility of Saudi stock market returns, this model is used to explore the impact of macroeconomic variable volatility on the volatility of Saudi stock market returns. In particular, three sets of the GARCH models, as detailed chapter 5, are estimated. These are the AR(1)-GARCH-X(1,1) model, the AR(1)-GARCH-S(1,1) model, and the AR(1)-GARCH-G(1,1) model, each of which incorporates macroeconomic variables in the variance equation in a different way. The results of these three models will be presented in the following three sections.

7.4.1. AR(1)-GARCH-X(1,1) Model Results

Based on The Johansen-Juselius (1990) cointegration test, we have concluded that there is a long run relationship between Saudi stock market returns and the macroeconomic variables (Section 3.3). Thus, the analysis proceeds to estimate an AR(1)-GARCH(1,1)-X model as suggested by Lee (1994). As explained above, the AR(1)-GARCH (1,1)-X model links the volatility of stock market returns to the deviation from equilibrium, represented by the magnitude of the error correction terms of the cointegrating relationships. This task is accomplished by adding the lagged square of the error correction term as an independent variable into the variance equation. Specifically, we estimate the following model,

$$\begin{gathered} R_t = \mu + \theta_1 R_{t-1} + \varepsilon_t \\ \varepsilon_t | \Omega_{t-1} \sim N(0, h_t^2) \\ h_t^2 = \omega + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 h_{t-1}^2 + \lambda_{ECT} Z_{t-1}^2 \end{gathered} \tag{7.1}$$

$$\omega > 0\ ,\ \alpha_i\ ,\ \beta_j\ ,\ \lambda_n \geq 0\ \rightarrow\ h_t^2 \geq 0,\ i = 1, \ldots p, \text{and } j = 1, \ldots . q.$$

where the λ_{ECT} parameter is the new feature of Lee's (1994) model over the standard GARCH model to account for the deviation from the cointegrating relationship on the conditional volatility of the Saudi stock market returns. The parameter λ_n measures the effect of short-run deviations from the long-run relationship of the cointegrated variables on the conditional variance of the Saudi stock returns. A large positive value of the parameter λ_n indicates that the deviation of stock market returns from the group of macroeconomic variables gets larger over time. The implication of this is that the stock market becomes more volatile and harder to predict. $\mathrm{Z}_{\mathrm{t}-1}^2$is the lagged square of the ECT obtained from the long run relationship (Equation 6.1).

Table 7.7: Impact of Economic Factors on Saudi Stock Market

Panel (a)			Panel (b)			Panel (c)		
The Mean Equation			The Variance Equation			Diagnostic Fitting		
μ	0.009	[0.007]	ω	2.98E-05	[0.671]	Q-test [2]	1.392	[0.238]
θ_1	0.182	[0.000]	α_1	-0.161	[0.007]	Q-test [6]	6.829	[0.234]
..	..		β_1	0.644	[0.000]	Q^2-test [2]	2.569	[0.109]
..	..		λ_{ECT}	0.547	[0.001]	Q^2-test [6]	3.338	[0.648]
..	..		$\alpha_1 + \beta_1$	0.483		ARCH Test [1]	2.037	[0.154]
..	..		..	..		ARCH Test [12]	11.101	[0.520]
..	..		..	..		Jarque-Bera	8.102	[0.017]
..	..		..	..		Kurtosis	2.016	
..	..		..	..		Skewness	0.0103	
..	..		..	..		AIC	-3.030	
..	..		..	..		SIC	-2.931	
..	..		..	..		Log Likelihood	310.47	

P-values are in square brackets. For the parameters, p-values are associated with z-statistics and for diagnostic fitting, p-values are associated with the χ2-statistic.

Panels (a), (b) and (c) in Table 7.7 present the estimated results of the AR(1)-GARCH(1,1)-X model. The mean equation of the GARCH-X model implies that the previous returns positively and significantly affect the current stock market returns in the Saudi economy since the p-value on θ_1 is zero (Panel (a) in Table 7.7). Also, consistent with the unconditional mean, the constant term in the mean equation μ is close to zero and statistically significant based on the p-value, i.e., , 0.007, which is comparable to the sample mean of the Saudi stock market return. This is consistent with stock market returns behaving randomly.

The estimated parameters in the variance equation of the AR(1)-GARCH(1,1)-X model, i.e., ω, β_1 and λ_{EC}, satisfy the conditions such that all parameters are positive and statistically significant with the exception of ω. The AR(1)-GARCH(1,1)-X model did not find a positive sign for the ARCH parameter α_1, and it is statistically significant[56]. The sum of the ARCH and GARCH coefficients are less than one, which satisfies the stability condition for of the GARCH model. The ARCH effect, α_1, is less than the GARCH effect, β_1, which implies that

[56] Nelson and Cao (1992) and He and Terasvirta (1999) showed that Bollerslev's (1986) non-negativity conditions are too restrictive so negative estimates may be obtained.

the volatility of stock market returns is affected by past volatility more than by related news from the previous period. Also, a large GARCH coefficient $\beta_1 = 0.664$ indicates that shocks to the conditional variance take a long time to die out, so volatility is persistent (Panel (b) in Table 7.7).

In terms of the adequacy of the estimated AR(1)-GARCH(1,1)-X model, the Ljung-Box Q-statistics suggest no serial correlation of the standardized residuals obtained from the AR(1)-GARCH(1,1)-X model up to order 6. Also, the Q^2 test cannot reject the null hypothesis of no autocorrelation of the standardized residuals squared obtained from the model up to 36^{th} order. Not rejecting the null hypothesis for both the Q and Q^2 tests is evidence that the mean equation and variance equation for Saudi stock returns is correctly specified. These results are also confirmed by the fact that the estimated standard AR(1)-GARCH(1,1)-X model successfully produced residuals that are free of ARCH effects, according to the ARCH-LM test using either the F-statistic or Chi-squared statistic up to order 12. The Jarque-Bera statistic also rejects the hypothesis of normality with a kurtosis statistic of 2.016. This may indicate the importance of considering other than the normal distribution in investigating the stock market returns (Panel (c) in Table 7.7).

The coefficient λ_{ECT} is positive and statistically significant. This indicates a direct relationship between the volatility of Saudi stock market returns and short-run deviations of the macroeconomic variables from the equilibrium relationship. This result is consistent with the study of Malik and Hammoudeh (2007) who find, based on a multivariate-GARCH model, that the equity markets of Saudi Arabia, Kuwait, and Bahrain reflected volatility from the oil market, and the U.S. equity market indirectly affected volatility in the three Gulf stock markets. This result is also consistent with the study of Najand and Rahman (1991), which provides evidence, using a GARCH model, for a relationship between the volatility of stock market returns and the

volatility of macroeconomic variables in the U.S., Germany, UK, and Canada. Kapital (1998) also finds a significant and positive effect of a set of macroeconomic variables on the volatility of the U.S. stock market using a GARCH-X model. The same results are also suggested by Léon (2008) using weekly data from the Korean stock market, for seven European stock markets, i.e., Italy, UK, France, Germany, Switzerland, Netherlands, and Belgium (Errunza and Hogan, 1998). Wenshwo (2002) found evidence that currency depreciation increased the volatility of stock returns in five Far East Asian economies, (South Korea, Hong Kong, Singapore, Taiwan, and Thailand) during the Asian financial crisis (1997-1999).

7.4.2. AR(1)-GARCH-S(1,1) Model Results

In this section, eight AR(1)-GARCH-S(1,1) models are estimated to account for the impact of each macroeconomic variable on the volatility of Saudi stock market returns. Each of the eight models takes the following form,

$$\begin{gathered} R_t = \mu + \theta_1 R_{t-1} + \varepsilon_t \\ \varepsilon_t | \Omega_{t-1} \sim N(0, h_t^2) \\ h_t^2 = \omega + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 h_{t-1}^2 + \lambda_n \Delta X_{nt} \\ \omega > 0\ ,\ \alpha_1,\ \beta_1 \geq 0\ \rightarrow\ h_t^2 \geq 0\ , \text{and, } n = 1, \dots 8. \end{gathered} \tag{7.2}$$

where the λ_n parameter is expected to account for the impact of change of each macroeconomic variable in the analysis on the volatility of the Saudi stock market returns in turn, $i.e.,\ \Delta X_{it} = \Delta M1_t,\ \Delta M2_t, \Delta Isa3_t,\ \Delta BC_t,\ \Delta CPI_t,\ \Delta BOP_t,\ \Delta EX_t,$ and $\Delta S\&P\ 500_t$. Table 7.9 presents the results for the eight models, which can be classified into two important components; the statistical performance of the estimated AR(1)-GARCH-S(1,1) models and the economic interpretation of their outcomes.

From Panel (a), (b), and (c) in Table 7.8, it is obvious that the estimated AR(1)-GARCH(1,1) models with one exogenous macroeconomic variable being included in the second equation produces positive and significant α_1 and β_1 parameters in almost all of the models. The insignificance of the coefficient α_1 associated with models 3, 4, and 5, and the non-positive sign of ω for model 5, are the only exceptions. The sum of the ARCH and GARCH coefficients are less than one, $i.e., \alpha_i + \beta_j < 1$, except for model 7. More specifically, including changes in the exchange rate in the variance equation causes high persistence $(\alpha_1 + \beta_1 > 1)$ which implies that the unconditional variance is infinite or non stationary.

In terms of diagnostic fit, the estimated AR(1)-GARCH(1,1) models satisfied all conditions of the GARCH theory based on the Ljung-Box Q and Q^2 statistics, ARCH-LM Test, Jarque-Bera, skewness, and kurtosis values all at the 5% level of significance. That is, the performance of the eight estimated models as seen in panel (c) in Table 7.8, capture all linear and nonlinear dependence associated with the economic variables as required by the GARCH theory.

With regard to the impact of economic news, the λ_n associated with each macroeconomic variable of the eight estimated models suggests the following conclusions (Panel (b) in Table 7.8). First, the growth of the narrow money supply ($\Delta M1$), changes in the short term interest rate (ΔIsa3), the inflation rate (ΔCPI), changes in the world oil price (ΔBOP), and changes in U.S. stock returns ($\Delta S\&P500$), all had no significant impact on the volatility of the Saudi stock market returns over the sample period.

Table 7.8: Impact of Macroeconomic Variables on the Volatility of the Saudi Stock Market

Panel (a) :The Mean Equations

Coefficients	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
μ	0.0053 [0.323]	0.006 [0.210]	0.006 [0.261]	0.008 [0.155]	0.007 [0.181]	0.006 [0.288]	0.0002 [0.973]	0.007 [0.201]
θ_1	0.232 [0.000]	0.216 [0.004]	0.237 [0.000]	0.235 [.001]	0.215 [0.001]	0.238 [0.000]	0.193 [0.004]	0.240 [0.000]

Panel (b) :The Variance Equations

ω	0.0001 [0.255]	0.001 [0.002]	0.0001 [0.283]	0.0004 [0.240]	-2.83E-06 [0.944]	0.0001 [0.227]	1.68E-05 [0.201]	0.0001 [0.291]
α_1	0.0819 [0.033]	0.250 [0.002]	0.074 [0.073]	0.0856 [.061]	0.024 [0.270]	0.079 [0.032]	-0.016 [0.000]	0.080 [0.039]
β_1	0.8807 [0.000]	0.449 [0.000]	0.903 [0.000]	0.818 [0.000]	0.953 [0.000]	0.894 [0.000]	1.026 [0.000]	0.901 [0.000]
$\alpha_1 + \beta_1$	0.963	0.699	0.978	0.904	0.977	0.973	1.01	0.981
$\lambda_{\Delta M1}$	0.0091 [0.373]	-	-	..	..	..	..	..
$\lambda_{\Delta M2}$	..	0.055 [0.001]	-	..	..	..	..	..
$\lambda_{\Delta Isa3}$	..	..	7.52E-05 [0.783]	..	..	..	..	..
$\lambda_{\Delta CPI}$	..	..	..	0.078 [0.317]	..	..	..	..
$\lambda_{\Delta BC}$	..	..	..	..	0.014 [0.029]	..	..	..
$\lambda_{\Delta BOP}$	..	..	..	..	..	0.0011 [0.609]	..	..
$\lambda_{\Delta Ex}$	..	..	..	..	..	..	-0.016 [0.000]	..
$\lambda_{\Delta S\&P500}$	..	..	..	..	..	..	..	-0.002 [0.285]

Panel (c) :Diagnostic Fitting

Q-test (2)	[0.551]	[0.442]	[0.587]	[0.566]	[0.478]	[0.569]	[0.584]	[0.630]
Q-test (10)	[0.256]	[0.188]	[0.255]	[0.232]	[0.322]	[0.266]	[0.168]	[0.299]
Q-test (36)	[0.845]	[0.722]	[0.857]	[0.820]	[0.872]	[0.851]	[0.718]	[0.864]
Q^2-test (2)	[0.138]	[0.166]	[0.149]	[0.116]	[0.283]	[0.128]	[0.162]	[0.181]
Q^2-test (10)	[0.590]	[0.431]	[0.481]	[0.530]	[0.537]	[0.521]	[0.263]	[0.573]
Q^2-test (36)	[0.734]	[0.710]	[0.688]	[0.693]	[0.780]	[0.709]	[0.666]	[0.704]
ARCH-LM Test (1)	[0.201]	[0.659]	[0.220]	[0.191]	[0.477]	[0.200]	[0.308]	[0.263]
ARCH-LM Test (3)	[0.486]	0.6585	[0.497]	[0.430]	[0.750]	[0.472]	[0.559]	[0.565]
ARCH-LM Test (12)	[0.718]	[0.620]	[0.653]	[0770]	[0.620]	[0.686]	[0.433]	[0.716]
Kurtosis	3.581	3.158	3.374	3.503	3.203	3.299	3.143	3.232
Jarque-Bera	[0.167]	[0.475]	[0.212]	[0.129]	[0.538]	[0.227]	[0.453]	[0.489]
Skewness	-0.294	-0.195	-0.239	-0.241	-0.163	-0.256	-0.205	-0.171
AIC	-2.623	-2.610	-2.620	-2.626	-2.652	-2.621	-2.673	-2.624
SIC	-2.525	-2.512	-2.521	-2.528	-2.554	-2.522	-2.575	-2.526
Log Likelihood	270.97	269.64	270.58	271.24	273.87	270.68	275.99	271.07

P-values are in square brackets. For the parameters, p-values are associated with z-statistics and for diagnostic fitting, p-values are associated with the χ2-statistic.

The implication of these results is that the change of each these five macroeconomic variables, i.e., $\Delta M1, \Delta Isa3, \Delta CPI, \Delta BOP$, $\Delta S\&P500$, does not explain the volatility of the Saudi stock market. In other words, adding these variables to the benchmark AR(1)-GARCH(1,1) model does not provide further significant knowledge about the behavior of Saudi stock market volatility.

Second, there is a significantly positive relationship between the volatility of Saudi stock market returns and the growth of the broad money supply ($\Delta M2$). This result indicates that with an increase in the broad money supply ($M2$) of 1%, the volatility of the Saudi stock market returns is expected to increase by 6%. Also, including the growth of the broad money supply ($\Delta M2$) in the model depresses the estimated coefficient of volatility persistence, i.e., $(\alpha_1 + \beta_1)$, from 0.976 to 0.699, which indicates the importance of considering news about $\Delta M2$ in explaining the dynamic behavior of Saudi stock market returns. Third, there is a significantly positive relationship between the volatility of Saudi stock market returns and changes in bank credit (ΔBC). An increase in the volatility of the bank credits (ΔBC) of 1% is expected to increase the volatility of the Saudi stock market returns by 1.4%.

Finally, there is a significantly negative relationship between changes in the exchange rate and the volatility of the Saudi stock market returns during the sample time period. This result is in line with Dornbusch and Fischer's (1980) approach, which advocates a negative relationship between stock prices and exchanges rates, with the source of causation being attributed to exchange rates. This result might also be taken as evidence for the importance of international trade to the local economy and for the companies listed on the stock market in particular. However, the accuracy of the variance equation specification for the relationships

between changes of the exchange rate and the volatility of the Saudi stock market returns should be caution since the volatility persistency is greater than one , i.e., $\alpha_1 + \beta_1 > 1$.

7.4.3. AR(1)-GARCH-G(1,1) Model Results

In this section, an AR(1)-GARCH-G(1,1) model is estimated to account for the impact of all macroeconomic variables as a group on the volatility of Saudi stock market returns. Thus, all macroeconomic variables are included in the variance equation so the AR(1)-GARCH-G(1,1) model is of the following form:

$$\begin{gathered} R_t = \mu + \theta_1 R_{t-1} + \varepsilon_t \\ \varepsilon_t | \Omega_{t-1} \sim N(0, h_t^2) \\ h_t^2 = \omega + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 h_{t-1}^2 + \sum_{n=1}^{8} \lambda_n \Delta X_{nt-1} \\ \omega > 0 \ , \ \alpha_1, \ \beta_1 \geq 0 \ \rightarrow \ h_t^2 \geq 0 \text{ and, } n = 1, \dots 8. \end{gathered} \tag{7.3}$$

where the λ_n parameter accounts for the impact of changes of each explanatory variable mentioned above on the conditional volatility of Saudi stock market returns at one time.

Panels (a), (b) and (c) in Table 7.9 present the estimation results. Panel (a) in Table 7.9 indicates that the AR(1) coefficient, θ_1 , is statistically significant, which implies that previous returns affect the current stock market returns positively. However, the variance equation demonstrates the following points. (i) All of the key parameters in the variance equation (ω, α_1, and β_1) have the expected positive sign, which implies that the sufficient conditions for a non-negative conditional variance are met. They are statistically significant, with the exception of β_1 (Panel (b) in Table 7.9). This should not affect the performance of this model in capturing volatility clustering, given that α_1 is statistically significant. (ii) The sum of the ARCH and

GARCH coefficients is less than one, i.e., $\alpha_1 + \beta_1 = 0.332$, which implies that the unconditional variance of ε_t or $h_t^2 = \frac{\omega}{1-(\alpha_1+\beta_1)} < 1$ is stationary. Since the sum of $\alpha_1 + \beta_1$ is small, the time-varying volatility of the Saudi stock market returns is not highly persistent. (iii) α_1 is greater than β_1, which implies that previous news affects the volatility of stock market returns more than the past volatility of the stock market return itself.

Table 7.9: Impact of Economic Factors on the Saudi Stock Market Returns

Panel (a)		Panel (b)		Panel (c)	
The Mean Equation		The Variance Equation		Diagnostic Fitting	
μ	0.007 [0.120]	ω	0.003 [0.026]	Q-test [1]	0.035 [0.851]
θ_1	0.211 [0.002]	α_1	0.198 [0.031]	Q^2-test [1]	0.646 [0.422]
..	..	β_1	0.134 [0.547]	ARCH Test [1]	0.655 [0.418]
		$\alpha_1 + \beta_1$	0.332	Jarque-Bera	1.070 [0.586]
..	..	$\lambda_{\Delta M1}$	0.001 [0.970]	AIC	-2.551
..	..	$\lambda_{\Delta M2}$	0.055 [0.178]	SIC	-2.338
..	..	$\lambda_{\Delta Isa3}$	0.002 [0.361]	Log Likelihood	270.64
..	..	$\lambda_{\Delta CPI}$	0.184 [0.043]		
..	..	$\lambda_{\Delta BC}$	0.007 [0.850]		
..	..	$\lambda_{\Delta BOP}$	0.005 [0.422]		
..	..	$\lambda_{\Delta Ex}$	-0.007 [0.789]	..	..
..	..	$\lambda_{\Delta S\&P500}$	-0.007 [0.387]	..	..

P-values are in square brackets. For the parameters, p-values are associated with z-statistics and for diagnostic fitting, p-values are associated with the χ2-statistic.

Panel (c) in Table 7.9 contains diagnostic tests on the residuals generated from the AR(1)-GARCH-G(1,1) model. The Ljung-Box Q-statistics suggest no serial correlation of the standardized residuals obtained from the model up to one lag at the 5% significance level. Also, the Q^2 statistics test cannot effectively reject the null hypothesis of no autocorrelation of the squared standardized residuals obtained from the AR(1)-GARCH-G(1,1) model up to one lag at the 5% significance level. Rejecting the null hypothesis of both Q and Q^2 tests provides evidence that the mean and variance equations of the Saudi stock returns were correctly specified. These results are also confirmed by the fact that the estimated standard AR(1)-GARCH-G(1,1) model

successfully produced residuals that are free from ARCH effects based on the ARCH-LM test. The Jarque-Bera statistic also cannot reject the hypothesis of normality based on the p-value.

On the other hand, the AR(1)-GARCH-G(1,1) model produces insignificant results in accounting for the impacts of macroeconomic variables on the volatility of Saudi stock market returns. As can be seen in Panel (b) in Table 7.9, the λ_n coefficients associated with the macroeconomic variables are statistically insignificant based on the p-values at the 5% level of significance. The only exception is the impact of the inflation rate. In fact, the AR(1)-GARCH-G(1,1) model suggests that the inflation rate has a significant and positive impact on the volatility of Saudi stock market returns. For instance, a 1% change in inflation will affect stock market volatility by 18.4%. One explanation for the poor performance of the AR(1)-GARCH-G(1,1) model may be the relatively large amount of noise included in the variance equation.

7.4.4. Summary and Remarks

From the estimated results reported in the tables 7.6, table 7.7, table 7.8, and table 7.9 we have shown that all of the estimated GARCH models seem adequate in modeling the volatility of Saudi stock market returns. In particular, Ljung-Box Q and Q^2 suggested that all of the estimated GARCH models produced residuals and squared residuals that are free from serial correlation up to 36 lags, respectively. These results indicate that Saudi stock market returns do not suffer from autocorrelation and its squared residuals show no independence. Also, an ARCH test supports that these models succeed in removing conditional heteroskedasticity up to 12 lags.

This section provides further robustness checks across the competing GARCH models. First, table (7.10) ranks AR(1)-GARCH-X(1.1) as the most adequate model in the sense that it succeed to produce the lowest values of AIC, SIC, and generates the highest value of the log-

likelihood compared with all of the estimated models. Second, the AR(1)-GARCH(1.1) with a single variable of the money supply (M2) and changes in bank credits (BC) rank as the second and third best models to describe the dynamics of Saudi stock market returns based on the same statistical criteria. Other estimated GARCH models ranked different depending on the statistical criteria used.

Table 7.10: Rank of Estimated GARCH Models

Estimated Models	AIC	SIC	Log Likelihood
AR(1)-GARCH (1,1)	4	4	5
AR(1)-GARCH-X (1,1)	1	1	1
AR(1)-GARCH-S (1,1)			
-M2	5	5	6
-BC	3	3	3
-Ex	2	2	2
AR(1)-GARCH-G (1,1)	6	6	4

We also evaluate the estimated GARCH models by looking at their power to capture the volatility of the Saudi stock market during the sample time period. This assignment has been done by computing the predicted volatility from the significant competing GARCH models and graphing them against the squared residuals generated by each model. The optimal model is the one succeeded in reducing the estimated mean squared error. Panels from 1 to 6 in figure 7.5 show the the predicted volatility against the squared residuals generated by each the competing GARCH models. Based on these figures one can conclude that including macroeconomic variables in the GARCH model is, in general, important to explain and model the volatility of the Saudi stock market returns during the sample time period. From figure 7.5, it is obvious that the estimated GARCH models with macroeconomic variables fit the volatility of the Saudi stock market returns well, i.e., panels 2, 3, and 6 in the figure 7.5, compared to the benchmark

GARCH model in which no macroeconomic variables are being considered in the estimation, i.e., panel 1.

As to the question of how the macroeconomic variables should enter that model, the AR(1)-GARCH-X(1.1) model is considered the best in the sense it produces the lowest squared residuals compared to the other estimated GARCH models (Table 7.11). The AR(1)-GARCH-X(1,1) model form the volatility of the Saudi stock market returns by taking into account the long relationships between the volatility of the stock market returns and the cointegrated macroeconomic variables under consideration. That is, the AR(1)-GARCH-X(1,1) model suggests to including the error correction terms generated from the long run model to account for the short run deviations of the real economic activity.

Table 7.11: MSE Rank of Estimated GARCH Models

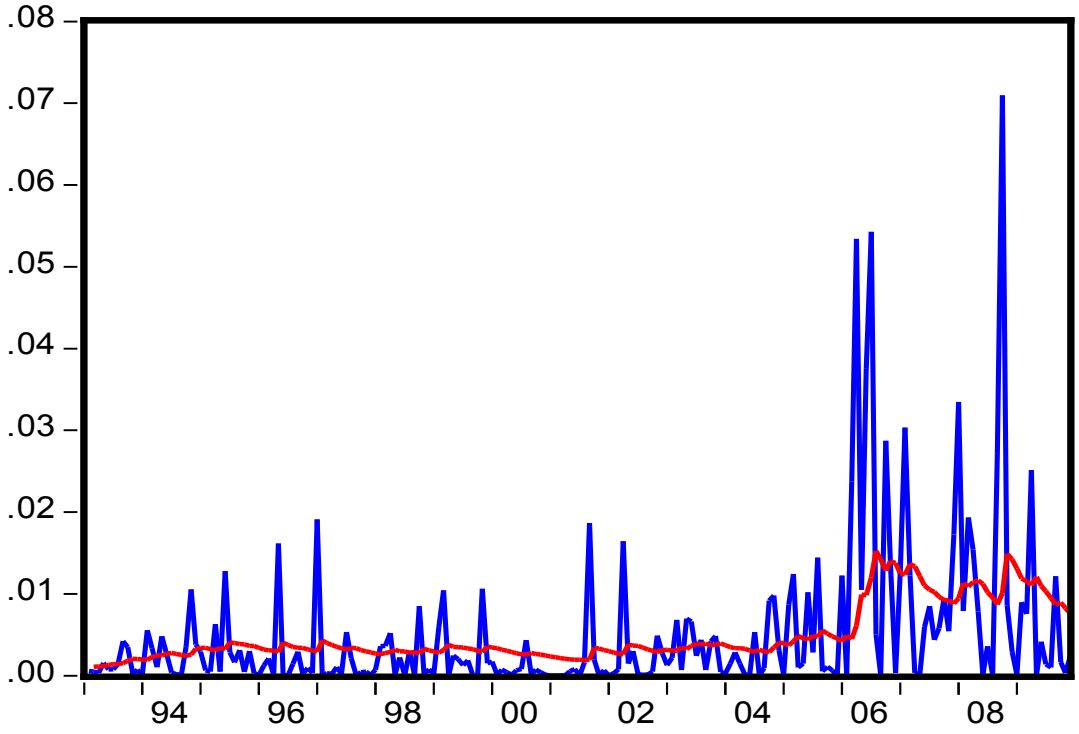
Estimated Models	MSE	Rank
AR(1)-GARCH (1,1)	0.005237	4
AR(1)-GARCH-X (1,1)	0.005105	1
AR(1)-GARCH-S (1,1)		
-M2	0.005236	3
-BC	0.005238	5
-Ex	0.005266	6
AR(1)-GARCH-G (1,1)	0.005224	2

This result may be taken as evidence for Lee's (1994) results where he extended the standard GARCH model to account for the short-run disequilibrium effect of uncertainty within the cointegrated series by adding error correction terms obtained from the cointegration model to the conditional variance equation. According to Lee, the GARCH-X model is useful for examining how the short-run disequilibrium affects uncertainty in predicting cointegrated series. According to Lee, examining the behavior of the variance over time as a function of the disequilibrium is reasonable when one expects increased volatility due to shocks to the system

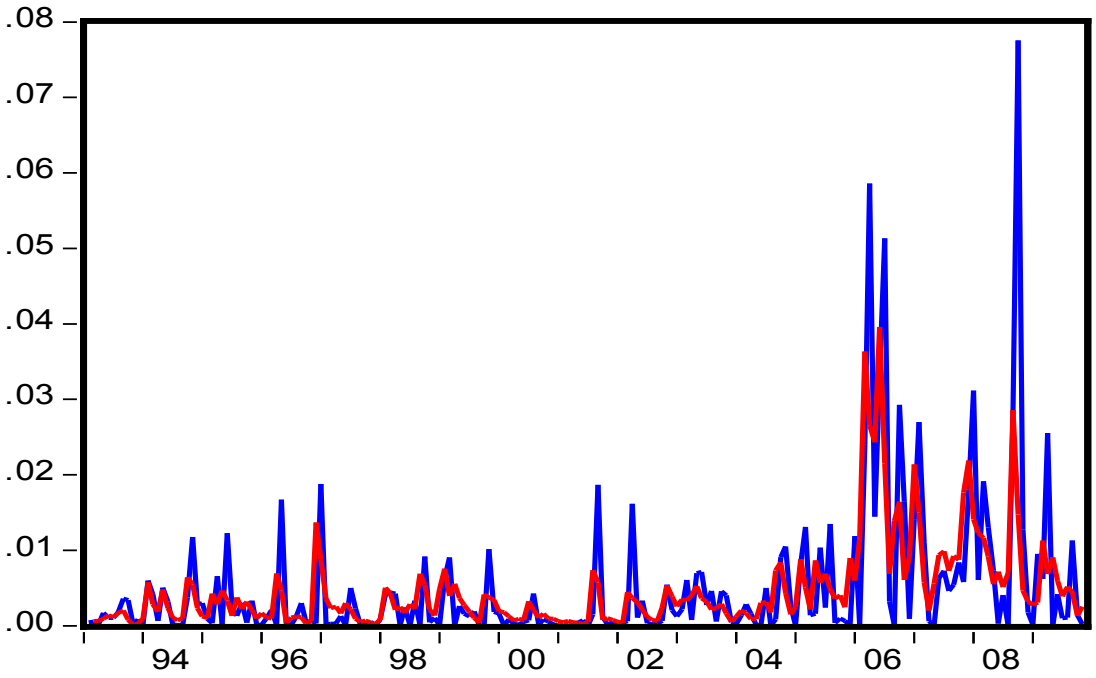
which may be the case for Saudi stock market returns. Also, this finding is consistent with the findings of Najand and Rahman (1991) who used the GARCH model to examine the effect of the volatility of macroeconomic variables on stock return volatility for the U.S., Germany, UK, and Canada.

On the other hand, the results of AR(1)-GARCH-S(1,1) with a single macrocosmic variable, i.e., the money supply (M2), bank credits (BC) and exchange rate (Ex), AR(1)-GARC(1,1) and AR(1)-GARCH-G(1,1) model where all macroeconomic variables being included, are ambiguous in demonstrating the impact of macroeconomic variables on the volatility in the Saudi stock market.

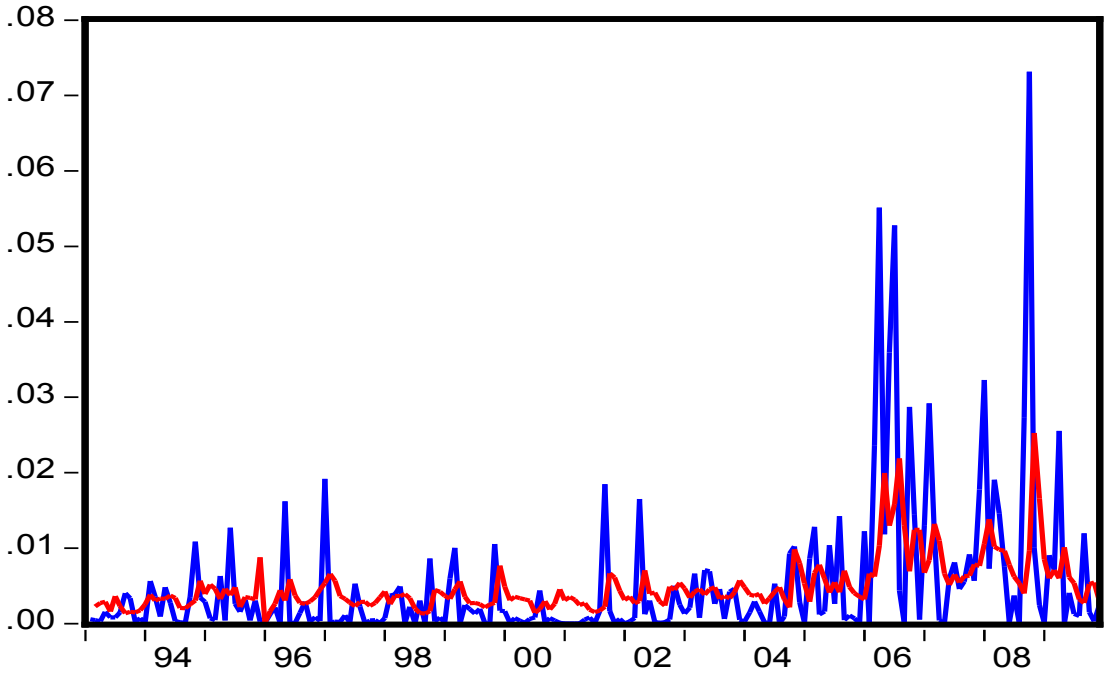
Figure 7.5: Compression of Estimated GARCH volatility (Red line) and Estimated Squared Residuals (Blue line)



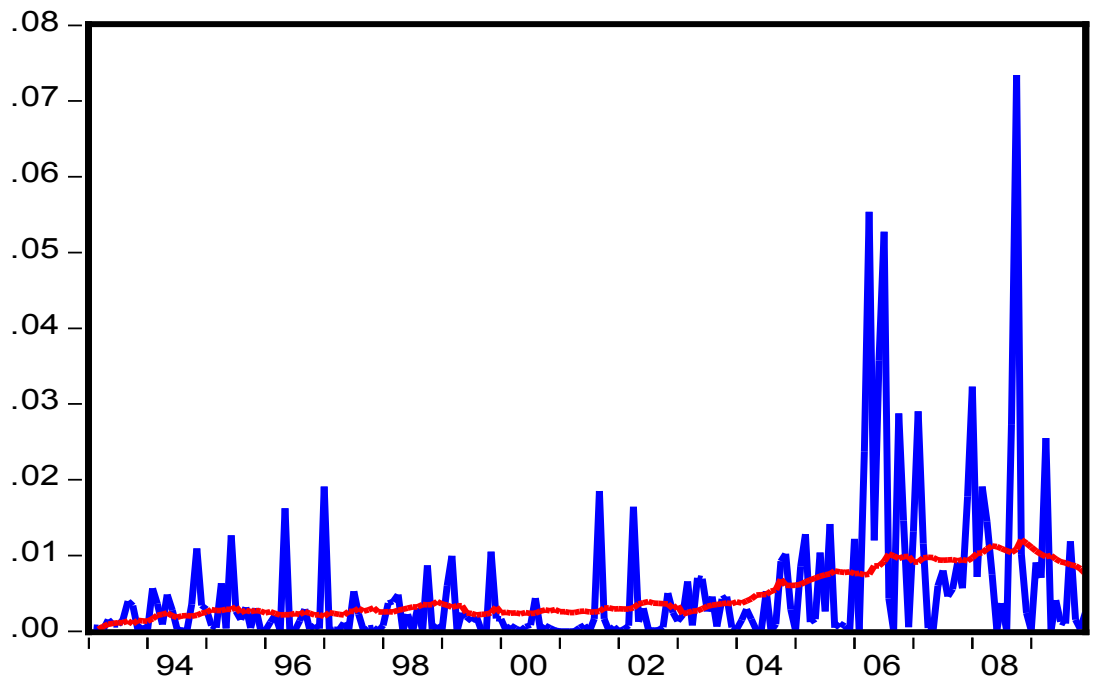
Panel (1): AR(1)-GARCH Model



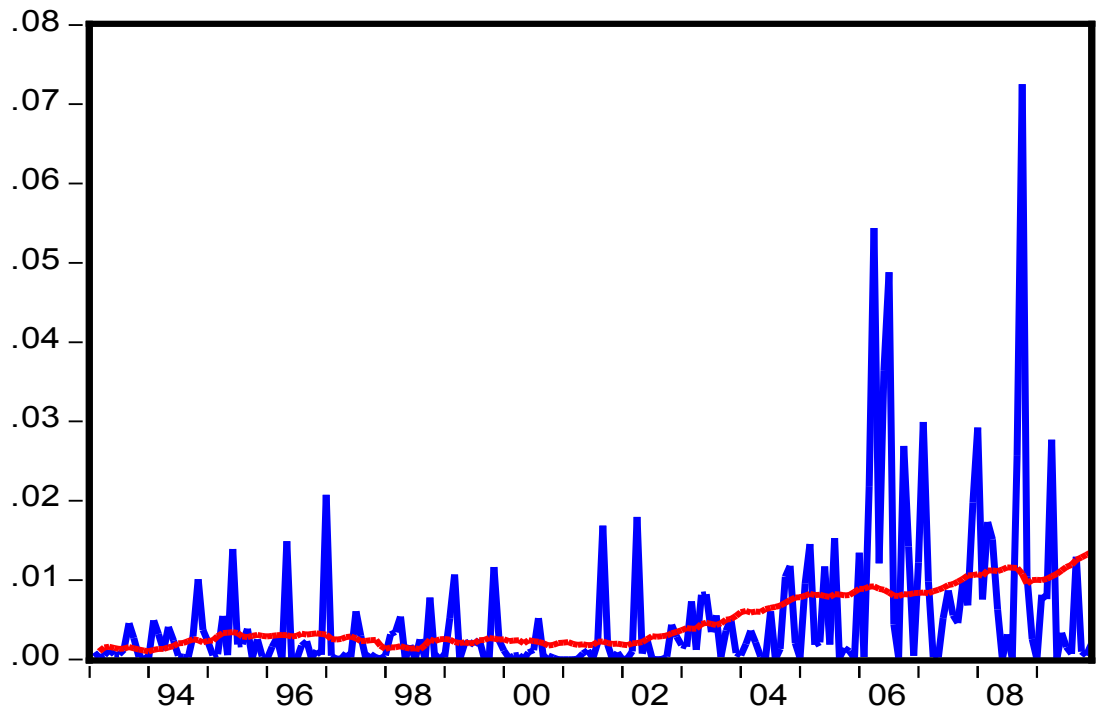
Panel (2): AR(1)-GARCH-X Model



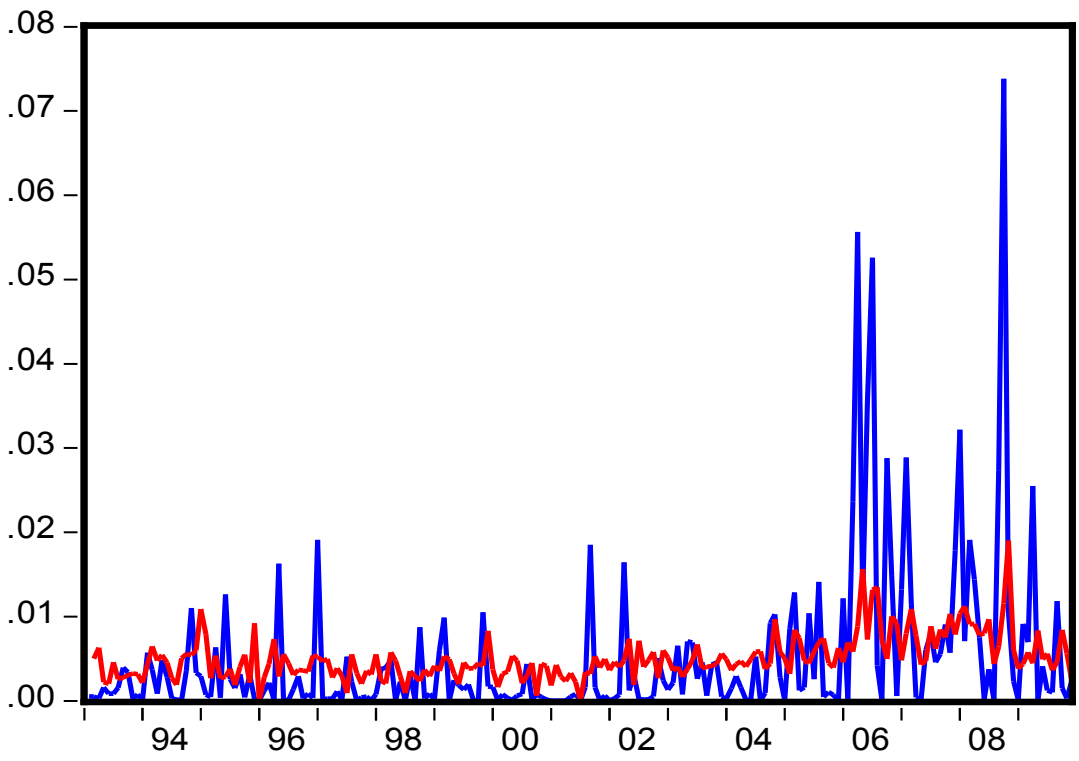
Panel (3): AR(1)-GARCH-S Model (S=M2)



Panel (4): AR(1)-GARCH-S Model (S=BC)



Panel (5): AR(1)-GARCH-S Model(S=Ex)



Panel (6): AR(1)-GARCH-G Model (G=All Variables)

The prediction of stock market returns may become difficult as the volatility of a macroeconomic variable increases in the short run. In another words, the more volatile the macroeconomic variables is, the more difficult it is to predict the stock market returns in the Saudi economy. Investors in the Saudi stock market should look at the systematic risks revealed by the money supply (M1 and M2), short term interest rates, inflation, bank credits, the price of oil, exchange rates, and the U.S. stock market (S&P 500) when structuring portfolios and diversification strategies. Financial regulators and policymakers may need to take these macroeconomic variables into account when formulating economic and financial policies.

Chapter 8 : Conclusion and Implications

The objective of this dissertation was to observe whether a set of macroeconomic factors contribute to the long and short run behavior of the Saudi stock market. In particular, we examined the long and short run dynamic relationships between TASI and eight macroeconomic variables over the period from January 1993 to December 2009. These macroeconomic variables are: two different figures of the money supply (M1, M2); a proxy for short term interest rates on the Saudi Riyal; the Consumer Price Index; bank credit; UK Brent crude oil; exchange rate; and the Standard & Poor's stock price index 500.

Existing financial and economic literature such as the efficient market hypothesis (EMH) and the asset pricing theory, i.e., the arbitrage price theory (APT) both imply a relationship between the stock market and economic activity. However, these theories have been silent about determining which precise events or economic factors are likely to influence asset prices. Accordingly, the macroeconomic variables included in this analysis were selected based upon the PVM theory which advocates that the price of a stock is the present discount value of the expected future dividend received by the owner. This implies that all essential factors that may directly or indirectly affect the expected returns and subsequently affect the stock prices may be analyzed. These variables were also commonly used in literature to examine the theoretical links between the stock market and economic activity. Furthermore, these variables are consistently available at a monthly frequency for the Saudi economy.

A wide range of VAR models including the Johansen and Juselius multivariate cointegration test, Granger causality tests and Engel-Granger causality tests, impulse response functions, and forecast error variance decomposition analysis were used to examine the long and

short run relationships between the macroeconomic variables and the Saudi stock market. The GARCH (p, q) model, Lee's (1994) GARCH-X(p, q) model, and two other versions of the GARCH-X model suggested in this study denoted as the GARCH-S model, and the GARCH-G model were used to investigate the impact of the volatility of these nine macroeconomic variables on the Saudi stock market return volatility. The GARCH model was of particular interest since VAR models by nature do not account for the stylized facts that characterize financial time series, in general, and stock market returns, in particular, i.e., volatility clustering, leptokurtosis, and leverage effect (Rydberg, 2000).

For the long run analysis, the Johansen-Juselius cointegration test suggested that macroeconomic variables in the system share a long run relationship with only one exception, which is the exchange rate. This result indicates that each variable in the system tends to adjust proportionally to bring in the system back to its long run equilibrium. Normalizing the cointegrating vector on the Saudi general stock market index suggested the following results.

1. There was a significant negative long run relationship between M1 and TASI and a significant positive relationship for M2. This result was not surprising, since the existing theoretical and empirical studies showed no consensus regarding the relationship between money supply and the stock market prices (returns). Thus, it can be concluded that these findings may be considered as an indication that the money supply's relationship with TASI is an empirical question.

2. There was a significant negative relationship between Isa3 and TASI. This finding was in contrast with the analysis' argument that based-interest rate assets are not the primary alternative for the majority of investors in the Saudi Arabia. One possible explanation for this negative relationship is that investors would not consider the Saudi stock market when the interest rate is high; hence the money and capital markets in the Saudi economy are substitutable in the long run.

3. There was a significant negative relationship between TASI and the inflation rate defined by the CPI. One possible implication of this result is that the Saudi stock market is not an effective hedge against inflation; hence investments probably would shift to the real assets from a risky stock market when the inflation rate is very high.

4. There was a significant positive relationship between TASI and Bank Credits (BC) in Saudi Arabia. This result also indicated that increasing bank's lending in Saudi Arabia would increase stock market prices. Given that the commercial banks are the second lenders in the local economy; this result maybe of the Saudi Authority's interest to consider how the financial shocks, i.e., increases bank loans, transmits to the real activity via the stock market.

5. In conjunction with the fact that Saudi Arabia is an oil-based economy; this analysis suggested a significant positive long run relationship between the price of oil (BOP) and TASI. The existing empirical studies showed no consensus regarding this relationship which perhaps support the notion that the price of oil shocks have a different impact on the stock prices depending on (1) whether the economy is considered as a net-importer or net-exporter of oil; (2) the institutional structures of the economy within these groups, and (3) the economic development stage of the country (Cunado and Garcia, 2005).

6. The international stock market shocks proxied by the S&P 500 appeared to negatively affect the Saudi stock market during the sample time period, 1993-2009. This finding supported the analysis's argument that the U.S. stock market is ideal for Saudi investors to get advantage from the fact that the Saudi Riyal is pegged to the U.S. dollar at a fixed exchange rate which reduces the exchange rate risks that is usually associated with foreign investments.

7. Johansen-Juselius (1990) cointegration test suggested a positive (although statistically insignificant) long relationship between the exchange rate (Ex) and TASI. This result implied that an appreciation of the Saudi Riyals may attract more foreign investments to invest in the Saudi stock market in the long run. The insignificance of this relationship was not surprising since foreign investors in the Saudi stock market are limited during the sample time period, i.e., 4% as of 2010 and perhaps because the Saudi economy is an import dominant country, hence appreciation of local currency positively could affect companies' profits by lowering their import costs.

Since the exchange rate did not contribute to the long relationship, based on t-statistics, the cointegration test was re-estimated with exclusion of the exchange rate. The trace and max-eigenvalue statistic tests both suggested that there was one cointegrating vector at the 5% level. Also, the t-statistics suggested that all other variables in the system contributed significantly to the long run equilibrium relationship with the TASI and also continued to maintain their coefficient's signs (Table 6.12 and Equation 6.2).

For the short run analysis, the VECM and the Granger causality tests were used. The former method was used to detect causal relationships among the cointegrated variables, i.e., TASI, M1, M2, Isa3, CPI, BC, BOP, and S&P 500, while the Granger causality method was used to test for a causal relationship between the exchange rate and TASI since these two variables were not-cointegrated in the long run analysis.

The findings of the causality tests were mixed. While the VECM indicated significant unidirectional short run causal effects associated with the money supply (M1 and M2) and inflation to Saudi stock market returns, the rest of the macroeconomic variables appear to not have a significant relationship with Saudi stock market returns in the short run. These results suggest that the Saudi stock market violated the efficient market hypothesis (EMH) with respect to M1, M2, and the CPI since the Saudi stock market returns can be predicted using available information about these three variables in the short run, but showed evidence for the efficient market hypothesis with respect to the other macroeconomic variables. On the other hand, the VECM supported the previous results obtained from the Johansen-Juselius cointegration test. The VECM found a significant long run causal effect, based on t-statistics associated with the coefficient of the lagged error-correction term, and with the expected negative sign. Furthermore,

the Saudi stock market converged to its equilibrium within almost half a year after being shocked.

A Granger causality test showed that there is no causal relationship between Saudi stock market returns and changes in the Saudi exchange rate in the short run. This result was consistent with the result of the long run analysis which can be explained by the fact that the amount of foreign investment is small and the Saudi Riyal is pegged to the U.S. dollar, which perhaps made exchange rate changes irrelevant to the stock market. Also, this result may be taken as an indicator that Saudi stock market prices already incorporated short run exchange rate changes, consistent with the efficient market hypothesis.

The IRF analysis showed evidence that there were no significant short run relationships between the Saudi stock market returns and all eight macroeconomic variables. The findings were consistent with the EMH since shocks to macroeconomic variables showed no significant effect on stock prices in the Saudi stock market. However, the short run response of the Saudi stock market to its own shocks was statistically significant and died out after one month.

The FEVD analysis suggested that the Saudi stock market return was largely independent of the macroeconomic variables. In fact, the results of the FEVD showed that after four months, 90% of the variation in the forecast error of the Saudi stock market returns was attributable to its own shocks, and only 10% to shocks to other variables in the system. In The strongest influence on Saudi stock market returns variation was the price of oil, 2.2%, followed by the U.S. stock market, 2%. The rest of the variables contributed less than 4% of the variation in the Saudi stock market returns after four months. The magnitude of the contributions of all variables in the system did not change dramatically over 24 months which showed that these variables did not

have a significant effect on the Saudi stock market. The FEVD conclusion was consistent, in general, with the IRF analysis.

On the other hand, findings of the FEVD revealed weak evidence for the importance of the Saudi stock market shocks in explaining the variation in each macroeconomic variable in the system. In fact, a sudden shock to the Saudi stock market explained only 1.4%, 0.6%, 2.8%, 3.5%, 2.8%, 5.8%, 0.5%, and 4%, of the variance of M1, M2, Isa3, CPI, BC, BOP, Ex, and S&P 500, respectively, after 24 months. One possible implication is that the Saudi stock market did not act as a mediator between lenders and borrowers, which is the primary condition for the stock market to boost savings and allocate economic resources efficiently. Another implication is that Saudi stock market returns in Saudi Arabia are a poor predictor of the variability associated with the system's variables.

With respect to the impact of the volatility of macroeconomic variables on Saudi stock market return volatility, we first found that a GARCH(1,1) model was adequate to model the volatility of the Saudi stock returns with the conditional mean equation being modeled as an AR(1) process. That is, GARCH(1,1) model succeeded in capturing the autocorrelation in the volatility of Saudi stock market returns. Second, we examined the impact of all macroeconomic variables under consideration on the volatility of the Saudi stock market return by examining three different sets of GARCH models. These three models were the AR(1)-GARCH-X(1,1) model, the AR(1)-GARCH-S(1,1) model, and the AR(1)-GARCH-G(1,1) model, all of which incorporated the macroeconomic variables into the variance equation in different ways.

The AR(1)-GARCH (1,1)-X model accounted for the volatility of stock market returns to deviations from equilibrium by implementing the error correction terms that were formulated by

the long run model. The estimated results of the AR(1)-GARCH (1, 1)-X model indicated the following results.

1. Saudi stock market returns behaved randomly and the previous returns positively affected the current stock market returns in the Saudi economy.
2. Volatility of Saudi stock market returns was affected by past volatility more than by related news from the previous period. Also, shocks to the conditional variance took a long time to die out, so the volatility was highly persistent.
3. There was a direct relationship between the volatility of the Saudi stock market returns and the short run deviations of the macroeconomic variables in the system. This result was in the line with the study of Malik and Hammoudeh (2007) who found, based on a multivariate-GARCH model, that the equity markets of Saudi Arabia, Kuwait, and Bahrain received volatility from the oil market and that the U.S. equity market indirectly affected volatility in the three Gulf stock markets.

Some implications of these findings are: (i) the prediction of stock market returns may become difficult as the volatility of macroeconomic variables increases in the short run. In other words, the more volatile the macroeconomic variables are, the more difficult it is to predict stock market returns in the Saudi economy, (ii) investors in the Saudi stock market should look at the systematic risks revealed by the money supply (M1, and M2), short term interest rates, inflation, bank credits, the price of oil, exchange rates, and the U.S. stock market when structuring portfolios and diversification strategies; and (iii) financial regulators and policymakers may need to take these macroeconomic variables into account when formulating economic and financial policies.

This study also suggests some future research to enhance our understanding about the dynamic relationship between real economic activity and the behavior of the stock market in oil-based developing countries. One future research topic is to conduct the same study for the GCC countries, which are the major world energy suppliers. Such a study could compare the behavior

of the Saudi stock market against the rest of the GCC countries in responding to shocks to real economic activity. This comparison is of great interest for policymakers since these countries are state members of the GCC and are working forward into unifying their economies and harmonizing their financial markets. This study is also of interest since GCC stock markets are very promising markets for international portfolio diversification.

Another possible extension of this study is to consider the impact of other macroeconomic variables such as GDP or IP and the Saudi government's spending, which were not included in the analysis because monthly data for these variables are not currently available. In fact, inclusion of these variables would be a significant addition to account for the impact of real activity and the effect of the public sector, given that the Saudi government owns all of the oil revenues, on the Saudi stock market behavior.

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