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Understanding Stock Market Fluctuations: Evidence from Sudan

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This paper investigates the responses of the Sudanese stock market to fluctuations in exchange rate, inflation and crude oil price. The paper employs a bi-varaite vector autoregressive-generalized autoregressive conditional heteroscedasticity model recently developed by Ling and McAleer (2003).The dataset is divided into two sub-periods, before and after the secession of South Sudan in July 9, 2011. The empirical results show that the returns on KSE index are significantly affected by their own past values suggesting some evidence of short-term predictability in KSE index changes. In addition, significant effect of a one-period lagged of returns on crude oil price, inflation and exchange rate on KSE returns is provided. Consistent with turbulent macroeconomic environment in Sudan during the past few years, the paper illustrates that KSE has experienced higher levels of fluctuations especially in the post-secession period. The paper concludes that the fluctuations of KSE index are greatly attributed to oil shocks and exchange rate fluctuations. These results are of great interest and have important implications for investors and policymakers. For example, policy-makers can use such results to adjust their actions to prevent contagion risks in the event of market crashes or crises and the macroeconomic fluctuations. The paper recommends that a better management of KSE volatility and appropriate policies to increase its efficiency represent good starting points in order for the market to play a significant role in the national economy.

Keywords: Exchange rate, inflation, oil price, fluctuations, Khartoum stock exchange

1. Introduction

Why do world's economies go through cycles of economic contraction and expansion? To what extent do different types of internal and external shocks play a role in driving fluctuations in aggregate economic

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activity? What are the main transmission mechanisms through which these shocks are propagated between different economies? These kinds of questions are all very critical for a better understanding of how well an overall economy is performing and of course, this involves issues related to decisions of various agents in the economy[2]. Different schools of thought and many economists offer a wide range of theoretical models to address these questions with special attention given to the cyclical behavior of key macroeconomic aggregates[3]. This has led to a plethora of empirical literature examining the impact of both internal and external shocks[4] on aggregate economic activity. For example, one strand of literature reports that external shocks, such as terms of trade shocks, oil price shocks, interest rate fluctuations, stock markets crashes, climate shocks and natural disaster represent main sources for better understanding of the economy performance (see, e.g., Kose and Riezman, 2001; Broda, 2004; Edwards, 2006; Calderon and Levy-Yeyati, 2009; Sosa and Cashin, 2009; Morita, 2013, among others). In contrast, other strand of literature reveals that internal shocks, such as domestic supply shocks, monetary policy shocks, investment-specific technology shocks[5], weak institutions and political instability have larger impact relative to that of external shocks (see, e.g., Hoffmaister and Roldos, 2001; Dejong et al., 2000; Aisen and Veiga, 2006; Fisher, 2006; Hirata et al., 2007; Justiniano and Primiceri, 2008; Klomp and de Haan, 2009; Allegret et al., 2012, among others).

One active branch of literature regarding the fluctuations of world economies has been focusing on understanding the predictability of

[2] For instance, van Dijk (2004) indicated that the consumption and saving decisions of private individuals; investment, production and sales decisions of the industrial sector; and monetary and fiscal policy decisions of the banking and government sector are all based on forecasts of future developments of economic variables which depend, to a large extent, on the state of the business cycle.

[3] According to macroeconomic literature there is always a driving force behind these fluctuations, some sort of shock or disturbance that causes the cycle. The latter may be volatile market expectations about future sales and profits according to Keynesian Business Cycle Theory; fluctuations in monetary growth rate as illustrated by Monetarists Theory; unanticipated fluctuations in aggregate demand according to New Classical Theory; some kind of nominal price/wage rigidities according New Keynesian Theory; and random shocks to total factor productivity that results from technological change according Real Business Cycle Theory.

[4] In this regard, various kinds of shocks have been historically documented and the current macroeconomic fluctuations literature distinguishes between nominal and real shocks, demand and supply shocks, domestic and external shocks, country specific and global shocks, etc.

[5] Technology shocks refer broadly to exogenous "changes in production functions or, more generally, the production possibilities of profit centers" (Hansen and Prescott 1993).

stock market movements based on the behavior of a number of macroeconomic fundamentals. It is worth mentioning at this juncture that the theoretical framework of this link is based on many economic and financial theories, such as quantity theory of money (Fisher, 1928; Friedman, 1956), market efficiency theory (Fama, 1965), capital asset pricing model (Sharpe, 1964), and arbitrage pricing theory (Ross, 1976). For example, according to market efficiency theory, in efficient stock markets, all the relevant information about the changes in macroeconomic fundamentals is fully reflected in the current stock prices and hence, investors would not be earned abnormal profits in such markets. Several empirical studies have investigated this relationship by considering a wide range of macroeconomic fundamentals[6] with greater emphasis given to the impact of fluctuations in economic growth, inflation, industrial production, exchange rate and interest rate (see, Cozier and Rahman, 1988; Levine and Zervos, 1996; Errunza and Hogan, 1998; Hooker, 2004; Chiarella and Gao, 2004, Dritsaki, 2005; Ewing and Thompson, 2007; Leon and Filis, 2008; Rangel, 2011). The general conclusion is that if the overall economy performs well then the stock market is likely to do the same in terms of market returns and volatility. A clear understanding of the robustness and magnitude of this relationship has important implications for policy makers, investors and other stock market participants. For example, policy makers are interested in the main driving forces of stock market fluctuations in their evaluation of the economy; a task that represents a significant part in the process of monetary policy formulation. On the other hand, it allows stock market practitioners to fine tune their investment strategies and risk management.

Although there has been a growing interest in modeling this relationship in developed economies and to some extend in emerging economies, little attention has been given in developing countries[7] whose economies are especially vulnerable to a wide range of fluctuations due to many factors. These include, large external shocks, volatile macroeconomic policies, political instability, poorly developed insurance and financial

[6] Some other factors like macroeconomic mismanagement, political instability, and natural disaster are also considered.

[7] Agénor et al., (2000) provided two reasons to account for this. First, limitations on data quality and frequency could be constraining factors in some cases. Second, developing countries tend to be prone to sudden crises and marked gyrations in macroeconomic variables, often making it difficult to discern any type of "cycle" or economic regularities.

markets, and weak institutions[8], among others. Existing empirical literature has generally agreed on a consensus view that fluctuations in aggregate economic activity in developing countries are quite different from the ones observed in developed countries in the sense that they are generally characterized by low magnitude and higher volatility (see for example, Kose and Riezman, 1999; Agenor et al. 2000; Allegret et al. 2012). There is no doubt that more attention is needed to document the stylized facts regarding macroeconomic fluctuations and the performance of financial institutions in developing countries. This will be useful at least in two aspects. First, to examine whether similar empirical regularities are observed across countries at different levels of income (Agenor et al., 2000). Second, this type of analysis may have important policy implications in the design of stabilization and adjustment programs (Agenor and Montiel, 1996).

Within this context, the current study tries to address the question: How the Sudanese stock market (the Khartoum Stock Exchange, KSE) responds to changes in fundamental economic forces? In particular, the study focuses on the fluctuations of inflation, exchange rate and crude oil price. The remainder of this paper is organized as follows. Section 2 illustrates the motivation and significance of the study. Section 3 discusses the theoretical considerations and provides some empirical literature. Section 4 provides some facts about the stock market in Sudan. Section 5 introduces the empirical framework, while Section 6 describes the data and provides their statistical properties and motivation for empirical framework. Section 7 discusses the empirical results. Finally, Section 8 concludes the paper and provides some recommendations.

2. Motivation and significance

Since its independence from Britain in 1956, Sudan has experienced significant swings in aggregate economic activity resulting from different political, socio-economic and financial turbulences. While it was a relatively good time during 1950s and 1960s, Sudan economy has undergone significant fluctuations during the successive decades. The situation has worsened over the last few years after the secession of the

[8] For example, Kose and Riezman (1999) showed that a highly and unstable domestic macroeconomic environment is one of the primary reasons for the poor growth of African countries.

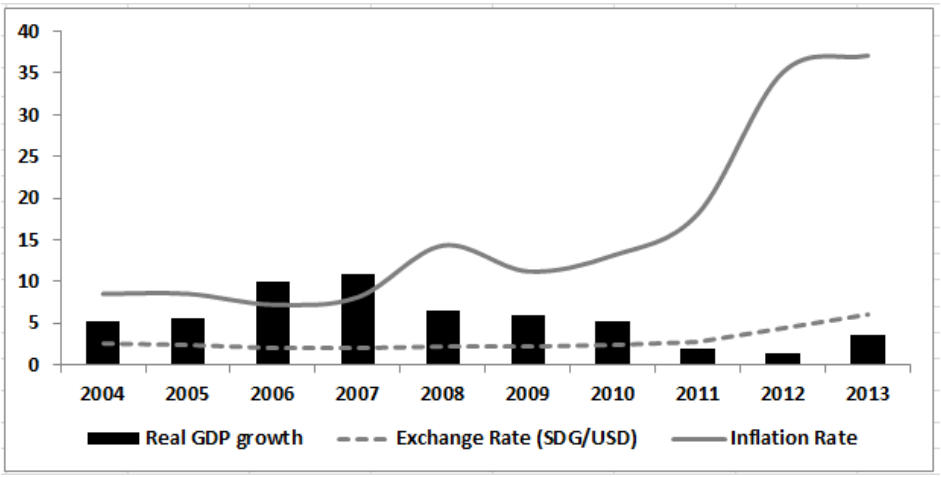
South Sudan in July 9, 2011. All these turbulent events have contributed to creating severe macroeconomic imbalances and deteriorating considerably the economic conditions in Sudan. To adjust to this new economic reality, strong policy responses are required if the economy is to be put onto a sustainable growth path in the future. Although the sources of macroeconomic fluctuations and their potential impacts have still not been tackled in a comprehensive macroeconomic model (to the best of author's knowledge), some interesting studies and considerable empirical literature have emerged to evaluate the overall level of economic activity usually in terms of single driving forces and to suggest some policy options. However, these policy options have not been quite effective in restoring macroeconomic stability; the economy is still experiencing double-digit inflation, unstable exchange rate, large external and internal deficits, and low growth rate (see Figure 1). So, it seems timely for policy makers in Sudan to question what has gone wrong and what has been forgotten in an attempt to put it right in their future policy priorities. It is worth mentioning at this juncture that policy discussions usually assign a relatively minor role to the dynamic behavior of Khartoum stock exchange. Strictly speaking, a wide range of important questions have not been addressed yet, including for example: How does the Sudanese stock market react to the wide range of fluctuations which hit the Sudanese economy during the past few years? Do these fluctuations affect stock returns and volatility? If so, what are the major driving forces behind this volatility? Are the driving forces domestically originated or imported from outside? Therefore, it is timely for the policymakers to have answers to these types of questions which to a large extent involve issues related to macroeconometric modeling.

Consistent with the turbulent macroeconomic environment in Sudan over the past few years, Khartoum stock exchange is also exposed to some degree of fluctuations. For example, based on GARCH methodology [9] Abdalla and Winker (2011) indicate that the KSE experienced an explosive conditional volatility of returns; a result that is unusual for stock market behavior. For the policy makers, to effectively manage such higher volatility they have to first understand the major driving forces behind it. A better understanding of how well KSE is

[9] Over the past few years this methodology has been applied extensively for the Sudanese stock market (see, e.g., (Abdalla, 2011, 2012, 2013, 2014; Abdalla and Winker, 2012).

performing represents a good starting point given the fact that stock market serves as a reliable barometer of the economy's health. Such empirical research may have several practical implications for investors, portfolio managers and policy makers. Considering investors, for example, a clear understanding of the dependencies between these economic forces can help them in explaining the flow of information which significantly affects their investment decisions. For policy makers, this type of analysis may be very useful in assessing the informational efficiency of stock market. It may also provide very useful insight into the way that volatility shocks originated in these variables are transmitted to stock market and therefore they can assess the degree and persistence of these innovations over time to adopt proper policies and forecast the full impact of their decisions. For portfolio hedgers, it is crucial to spell out how markets are linked over time to develop an effective hedging strategy. Finally, the importance of this empirical investigation is enhanced considering the fact that correlations are time-varying.

Figure 1: Selected Macroeconomic Variables for Sudan (2004-2013)



Source: Central Bank of Sudan (Annual Report, various issues)

3. Theoretical considerations and empirical literature

As mentioned in the introductory section, the potential impacts of macroeconomic fundamentals on stock market performance are based on a wide range of economic and financial theories. Of course, discussing these theories is not the objective of this study. Instead, this section briefly outlines some theoretical considerations on the response of stock markets to the movements in the crude oil price, exchange rate, and inflation. This is also accompanied with touching some empirical works.

3.1 On the relationship between crude oil price and stock market

The rationale for the possible oil price impact on stock prices can be explained by at least two transmission channels. First, as the economic theory suggests that the price of a share at any point in time is exactly equal to its discounted future cash flow[10], any factor that could alter the expected discounted cash flows should have a significant effect on these share prices[11]. In this regard, as crude oil along with capital, labor and materials represent key inputs in the production of many goods and services, any oil price increase would result to increased production costs of companies, restraining profits and in greater extend, would cause a decrease in shareholders' value. Hence, any oil price increase should be accompanied by a decrease in the stock prices (See, e.g., Apergis and Miller, 2009; Arouri and Nguyen, 2010; Ciner, 2001; Filis et al., 2011; Nandha and Faff, 2008; Sadorsky, 1999; Sukcharoen et al., 2014). Second, oil price fluctuations may also affect the discount rate used in standard equity valuation models. Rising oil prices are often indicative of inflationary pressures which central banks typically control by raising interest rates, with the subsequent negative effect on share prices via the discount rate (Huang et al., 1996; Miller and Ratti, 2009; Mohanty et al., 2011). Consequently, the impact of increasing oil prices on the stock markets of net oil-importing countries should be negative.

[10] These discounted cash flows reflect economic conditions (inflation, interest rates, production costs, income, economic growth, investor and consumer confidence, and so on) and are then affected by macroeconomic events that may be influenced by oil price changes (Arouri, 2011).

[11] In a pioneering empirical evidence focusing mainly on the standard cash-flow dividend valuation model, Jones and Kaul (1996) show that oil price shocks had a detrimental effect on four developed equity markets (Canada, the UK, Japan and the US) during the post-World War II period.

In contrast, increasing oil prices should have a positive influence on the stock markets of oil-exporting countries in the form of higher income and wealth effects. Additionally, financilisation of oil markets and intensive crude oil trading can also amplify the transmission of oil price shocks to the real economy (see, Creti et al., 2013).

A large body of empirical literature now exists; with the bulk of this literature focusing on developed countries. The results are generally mixed and inconclusive. A number of studies document significant negative impact of oil price fluctuations on stock market returns (see, e.g., Kling, 1985; Jones and Kaul, 1996; Sadorsky, 1999; Ciner, 2001; Wei, 2003; Park and Ratti, 2008; Kilian and Park, 2009; Miller and Ratti, 2009; Chen, 2010; Elder and Serletis, 2010; Masih et al., 2011; Basher et al., 2012). In contrast, some others report positive response of stock markets to oil price shocks (see, e.g., Faff and Brailsford (1999), Sadorsky (2001, 2003), El-Sharif et al. (2005), Zhu et al. (2011), Arouri and Rault (2012), and Li et al. (2012),. One possible explanation for this lack of conclusive results might be that the oil–stock prices link is not stable over time (Aloui et al., 2012; Broadstock et al., 2012; Filis et al., 2011). In this regard, Moya-Martínez et al., (2014) argues that this connection might have experienced dramatic changes in recent years due to factors such as the existence of stock market and/or oil price bubbles, episodes of geopolitical instability, increasing corporate hedging activity or the recent global financial crisis.

3.2 On the relationship between inflation and stock market

Regarding the inflation-stock return relation, many economists thought, until the mid-1970s, that the two variables should be positively related. This idea was loosely based on the Fisher's (1930) hypothesis[12] that nominal asset returns should reflect expected inflation. However, several studies since then have discovered that the real stock return–inflation relation in the post-war U.S. and several European countries is significantly negative. There are also different hypotheses have been proposed to rationalize a negative co-movement between inflation and

[12] The generalized Fisher hypothesis or effect states that equities are a claim against real assets of the company and can serve as a hedge against inflation. When inflation is pronounced, investors would sell financial assets in exchange for physical or real assets such as stocks. If that takes place, the prices of equities should reflect fully the expected inflation, and the relationship between the two variables (inflation and stocks or equities) should be positive.

stock returns. These include, (i) inflation illusion hypothesis by Modigliani and Cohn (1979) which argues that investors undervalued stocks in the 1970s because they used nominal interest rates to discount cash flows and also excluded capital gains that accrued to firms with fixed rate debt liabilities; (ii) Feldstein (1980) real after-tax hypothesis which posits corporate profits vary inversely with inflation as a result of higher effective tax rates due to higher inflation; (iii) Fama (1981) proxy hypothesis that holds that the negative association between stock market returns and inflation rates is not a causal relationship, but a spurious result of the dual effect because inflation acts as a proxy for real economic activity variables in models that relate stock returns to inflation; (iv) the risk premium hypothesis by Devereux and Yetman (2002), and more recently (v) Anari and Kolari (2010) show through simulation that nominal discount rates can have a negative impact on stock values in the short run due to inflation premium included in the discount rate (Alagidede and Panagiotidis, 2010)

Empirically, a large body of empirical literature exists on the movement of stock market prices in response to inflation changes, but conclusions have been widely debated. Several studies document that stock returns and inflation are negatively correlated (Linter, 1975; Bodie, 1976; Jaffe and Mandelker, 1976; Nelson and Schwert, 1977; Fama and Schwert, 1977, Hu and Willett, 2000; Hagmann and Lenz, 2004; Patra and Poshakwale, 2006). On the other hand, some others found a positive relationship[13] (Cagan, 1974; Choudhry, 1998). Explanations of negative (or positive) relation can be found as in Hess and Lee (1999) who showed that the relationship between stock returns and inflation can be either positive or negative, depending on the source of the inflation in the economy. They concluded that the negative stock returns-inflation relationship is due to supply shocks which reflect real output shocks while the positive relationship is due to demand shocks, are mainly due to monetary shocks. However, some empirical investigations provide no significant relationship (see e. g., Hardouvelis, 1988; Pearce and Roley, 1988; Spyrou, 2001; Joyce and Read, 2002; Payne, 2006; Jareno, 2008).

[13] In theory, there is a case to support the view that since the rate of inflation means an increase in the general level of prices, and since common stocks can be considered as capital goods, then the stock prices should move with the general level of prices. So, when the general inflation rate increases, common stocks should also increase to compensate investors for the decrease in the value of money. In this framework, it is expected that there is a positive relationship between the inflation rate and stock prices (Omran and Pointon, 2001)

3.3 On the relationship between exchange rate and stock market

Theoretical impact of exchange rate movements on the performance of stock market [14] can be explained by the "flow-oriented" approach (Mundell, 1963, 1964; Dornbusch and Fisher, 1980; Gavin, 1989) which assumes that the currency fluctuations affect international competitiveness and the balance of trade position, and consequently the real income and output of an economy, which in turn affects current and future cash flows of companies and their stock prices. According to this approach when exchange rate depreciates, the competitiveness of exports will increase, and the input cost of imports will increase, thus, depreciation will cause positive (negative) effect for export (import) firms and increase (decrease) their stock prices; however, appreciation will cause negative (positive) effect for export (import) firms and decrease (increase) their stock prices. It is very clear that the impact of exchange rate fluctuations on stock market performance would depend on both the degree of openness of domestic economy and the degree of the trade imbalance.

On the empirical front, a number of studies have been conducted to explore the relationship between exchange rates and stock prices. However, the results have been quite mixed regarding the sign and the direction of causality between the two variables (see, e.g., Aggarwal, 1981; Soenen and Hennigar, 1988; Bahmani-Oskooee and Sohrabian, 1992; Roll, 1992; Smith, 1992; Bodnar and Gentry, 1993; Dropsy and Nazarian-Ibrahimi,1994; Choi and Prasad, 1995; Prasad and Rajan, 1995; Ajayi and Mougoue, 1996; Fang and Loo, 1996; Abdalla and Murinde, 1997; Kwon et al., 1997; Malliaropulos, 1998; Kanas, 2000; Nieh and Lee, 2001; Hatemi-J and Irandoust, 2002; Ehrmannet et al., 2011; Katechos, 2011, among others). In contrast, some studies find that there is no significant relationship (see, e.g., Solnik, 1987; Jorion, 1990, 1991; Chow et al., 1997; Yang and Doong, 2004, among others).

[14] It is generally argued that the relationship between exchange rates and stock prices has important implications, especially from the viewpoint of recent large cross-border movement of funds and investments.

4. Some facts about the Stock Market in Sudan

The Sudanese stock market was established in 1995 with technical assistance provided by the Common Market for Eastern and Southern Africa (CoMESA)[15]. Securities traded in the market are ordinary shares and investment units[16]. Furthermore, a substantial number of mutual funds and Government Investment Certificates (GICs)[17] are also traded. Orders are handled through brokers during trading hours and share prices are quoted in Sudanese Pound (SDG). Trading in securities is taking place in two markets, the so called primary and secondary markets[18]. Although the market switched from manual to computer-based trading in January 2012, trading still occurs for only one hour (10:00 am to 11:00 am) and brokers must be physically present at the exchange (IMF, 2014).

As a part of the financial system of Sudan, the market operates on the basis of Islamic *Shariaa* and is supervised and regulated by the Central Bank of Sudan[19]. The key feature of Islamic *Shariaa* practices in Khartoum Stock Exchange is that it is aimed to offer investment portfolios from common stocks of listed companies which ideally satisfy three basic criteria: (i) legitimate field of economic activity; (ii) interest-

[15] Member states are: Burundi, Comoros, Democratic Republic of Congo, Djibouti, Egypt, Eritrea, Ethiopia, Kenya, Libya, Madagascar, Malawi, Mauritius, Rwanda, Seychelles, Sudan, Swaziland, Uganda, Zambia and Zimbabwe.

[16] An investment unit is a proportional accounting share in the total net assets of an open end investment fund (Investment funds are the institutions of collective investment which serve as framework for collection of money funds. Collected money funds are then invested in various assets). The investment unit value is an indicator of how successful a fund is, and the changes of this value depend on the fluctuation of prices of securities and other property that the fund has invested in.

[17] Government investment certificates (GICs) are medium-term securities, based on various contracts financed by the Ministry of Finance of Sudan via the *istisna*, *murabaha* and *ijara* tools. Issuance of these *sukuk* is similar to the conventional securitization, where the Ministry of Finance acts as the originator. GICs are based on a limited *mudarabah*, which means that the raised money is invested solely in the projects stipulated in the original contract.

[18] The Primary Market deals with the trading of new securities. When a company issues securities for the first time (i.e. IPO), they are traded in the Primary Market through the help of issuing houses, dealing /brokerage firms, investment bankers and or underwriters. The acronym IPO stands for Initial Public Offering, which means the first time a company is offering securities to the general public for subscription. Once the securities (shares) of a company are in the hands of the general public, they can be traded in the Secondary Market to enhance liquidity amongst holders of such financial securities. Thus, the Secondary Market facilitates the buying and selling of securities that are already in the hands of the general public (investors).

[19] For more explanations about the ideas of Islamic banking see for example, Venardos (2010).

free dealings in both assets and liabilities, and (iii) the dominance of real assets. Thus, e.g., a company must not be engaged in the production of illegitimate goods like alcoholic drinks; it must not deal with interest rate financing as a means to leverage its capital structure through fixed debt liabilities, or generate interest income from investment securities; and since a company's shares represent equity rights in its assets, the latter should be real assets, not liquid money or receivable debt as they cannot be sold freely at a profit like real goods, real estate and machinery (Hassan and Lewis, 2007).

As consequences of these rules, the composition of assets traded at the KSE differs substantially from other stock markets. In particular, due to the regulations imposed by Islamic *Shariaa*[20] practices a separate class of investment vehicles on the KSE is provided by the so called Government *Musharakah*[21] Certificates (GMCs), which represent an Islamic equivalent to conventional bonds (also known as *Shahama* bonds). *Shahama* bonds offer a way for the government to borrow money in the domestic market instead of printing more banknotes. After one year, holders of GMCs can either liquidate them or extend their duration. These bonds are backed by the stocks of various companies owned by the Ministry of Finance. Consequently, they might be considered as asset-backed securities. The profitability of GMCs depends on the financial results of the companies in the underlying portfolio. It can reach up to 33 per cent per annum. Hence, the profit of GMCs is variable rather than fixed. The government issues these bonds on a quarterly basis and their placement on the market is done usually very fast- in just six days.

Despite its short history KSE has contributed a number of benefits to the investment climate in Sudan, among which, it promoted the auditing profession as one of the listing requirement of any company to submit audited accounts for the latest two years and every year after listing. And, also enhanced awareness in securities investment as manifested in the increasing number of the investment funds in the country (Onour, 2010).

[20] For a detailed discussion of the Islamic Shariaa principles and its practices on stock exchange see for example, El-Gamal (2006) and Ayub (2007).

[21] Musharakah' is a word of Arabic origin which literally means sharing. In the context of business and trade it means a joint enterprise in which all the partners share the profit or loss of the joint venture. It is an ideal alternative to the interest-based financing with far reaching effects on both production and distribution (Usmani, 1998).

When it comes to look at the market size, it is very important to point out that it is relatively small even compared to many stock markets in the Arab region; the number of listed companies is few and most stocks are infrequently traded, market capitalization and traded value are very low (See Table 1 and Figure 2). Banks, communications and certificates sectors dominate the trading activity of the market in terms of trading volume and number of shares (see Tables 2 and 3). The market is currently listing 59 companies with a total market capitalization of SDG 11,758.06 (2,243.90 $US million) million (Arab Monetary Fund, 2014). Although, the amount of capitalisation is very small, but it shows considerable increase, especially during the past few years (see Figure 3). The overall performance of the market is measured by the KSE index, which is a market capitalization-weighted index. In September 2003, the KSE index was established and listed in the Arab Monetary Fund database. At the end of the first month the index closed at 961.74 points.

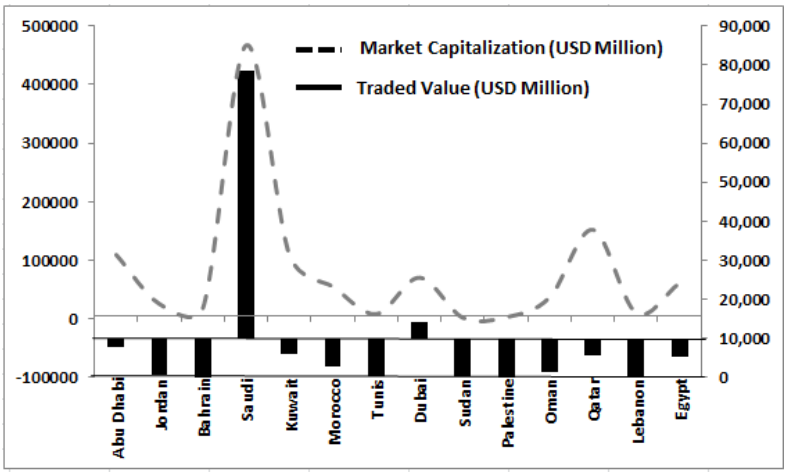
Table 1: Trading activity in selected Arab stock markets, End-2013

	Number of Shares Traded (In Million)	Daily average shares traded (Million)	Daily Average Value Traded (Million $U.S.)	Relative Market Capitalization (% of Total)	Stocks Traded Turnover Ratio (%)	Number of Listed Companies
Abu Dhabi Securities Market	17,044.68	304.369	131.0	9.68	7.05	66
Amman Stock Exchange	526.55	9.079	12.9	2.28	2.9	240
Bahrain Bourse	440.20	7.590	2.2	1.63	0.7	47
Saudi Stock exchange	10,993.02	180.213	1,287.4	41.28	16.8	163
Kuwait Stock Exchange	17,507.68	265.268	90.7	9.57	5.5	210
Casablanca Stock Exchange	94.15	1.569	44.5	4.89	4.8	75
Algeria Stock Exchange	0.034	0.0014	11.0	0.01	0.21	2
Tunis Stock Exchange	54.43	0.878	3.5	0.76	2.5	65
Dubai Financial Market	40,746.10	690.612	240.0	6.24	20	55
Damascus Securities Exchange	2.24	0.064	0.1	0.09	0.29	22
Khartoum Stock Exchange	**32.87**	**0.522**	**3.1**	**0.20**	**8.6**	**59**
Palestine Stock Exchange	91.58	1.607	2.5	0.29	4.4	49
Muscat Securities Market	1,735.10	29.408	26.4	3.25	4.2	131
Qatar Exchange	591.88	10.205	98.1	13.48	3.7	42
Beirut Stock Exchange	20.40	0.352	2.8	0.93	1.5	28
Egyptian Exchange	10,270.00	168.361	89.7	5.43	8.9	212

Source: Arab Monetary Fund.

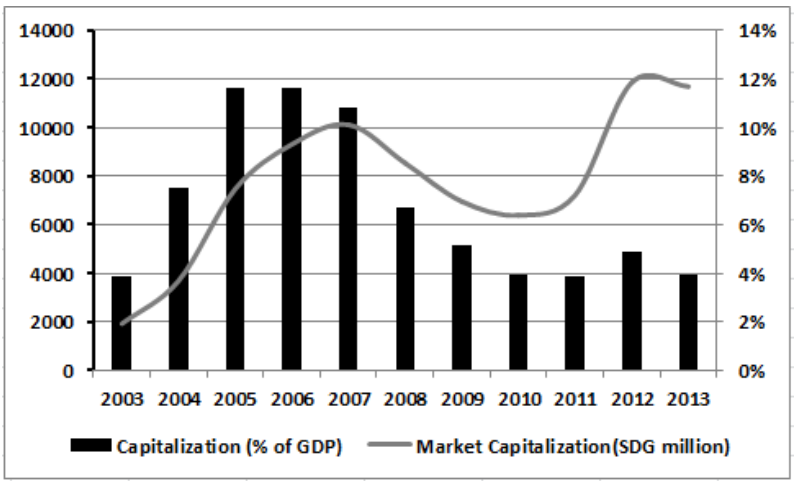
Despite its rapid growth in terms of market capitalization, KSE is characterized as highly concentrated market as only few companies constitute significant contribution of both capitalization and traded value around 90% of the total market capitalization. And, also can be regarded as an illiquid market as the shares of only few companies are tradable.

Figure 2: Trading Activity in Selected Arab Stock Markets, End-2013



Source: Arab Monetary Fund

Figure 3: Market Capitalization for the KSE (2003-2013)



Source: Central Bank of Sudan (Annual report, various issues)

Table 2: No. of Shares (million) by Sectors (2002 –2013)

Years	Banks	Insurance	Commerce	Industry	Agriculture	Communication	Services	Funds	Certificates	Others
2002	1926.566	0.0067	2130.592	0.0164	0	0	0	0	0	3.0553
2003	8950.99	0.0004	790.228	0.0544	0	0	0	0	0	4.1844
2004	1506.397	0.0074	650.9387	21.6722	0	0	0	0.0308	0.1021	6.9789
2005	848.351	0.0021	848.0048	21.501	0	0	0	0.8458	0.3081	12.6575
2006	7146.345	0.0018	316.0161	28.0363	0	0	0	1.4334	1.4724	74.4771
2007	9283.037	8.0397	22.6046	2.056	0.0435	88.5736	1.9954	2.7172	2.0165	0.475
2008	195.7864	0.078	0.9087	1.0072	0.0679	78.1495	5.5248	4.9769	2.4211	0.0873
2009	85.0252	0.1689	1.48	39.3634	0	36.583	2.0034	4.2289	3.4177	0.089
2010	144.346	0.13389	0.2135	2.88556	0.00705	12.49552	1.36723	1.79111	4.0589	5.09979
2011	64.42859	1.39631	0.10922	13.6168	0.00008	21.84176	0.21574	7.33345	3.89207	4.90361
2012	165.1817	0.0942	0.0627	0.1313	0	5.8242	1.2666	5.7936	5.1166	0.0199
2013	12.5216	1.7148	0.066	0.0308	0	43.8405	5.7097	1.4473	6.9833	16.974
Period Average (%)	**84.90**	**0.03**	**13.33**	**0.36**	**0.0003%**	**0.80**	**0.05**	**0.09**	**0.08**	**0.36**

Source: Central Bank of Sudan (Annual reports, various issues) and own calculation

Table 3: Volume Trading (SDG million) by Sectors (2002 –2013)

Years	Banks	Insurance	Commerce	Industry	Agriculture	Communication	Services	Funds	Certificates	Others
2002	13.594	0.023	9.123	0.005	0	0	0	10.754	108.853	106.703
2003	39.7	0.001	1.946	0.016	0	0	0	7.414	62.663	132.364
2004	7.805	0.004	39.29	38.958	0	0	0	2.767	113.702	245.197
2005	11.095	0.008	18.309	48.2	0	0	0	47.116	194.408	897.697
2006	91.4	0	22.3	57	0	0	0	120.2	799.9	977.3
2007	139.7	1.9	22	4	0.1	432.2	0.8	130.3	1068.5	0.1
2008	135.8	1.8	6.2	0.8	0.1	320.1	7.6	123.5	1283.2	0.04
2009	81.5	0.1	15.1	25.4	0	122.5	0.9	164.8	1836.3	0
2010	145.94	0.07	0.5	2	0.01	23.23	0.93	81.4	2157.93	10.31
2011	114.728	35.473	0.216	8.746	0.001	32.148	0.299	302.481	2059.139	9.394
2012	41.2	0.1	0.4	0.2	0	9.2	0.6	308.1	2713.7	0.03
2013	9.9	1.6	0.5	0.01	0	95.9	23.6	71.7	3679.7	2.4
Period Average (%)	**3.77**	**0.19**	**0.62**	**0.84**	**0.001**	**4.68**	**0.16**	**6.20**	**72.76**	**10.78**

Source: Central Bank of Sudan (Annual reports, various issues) and own calculation

5. Empirical Framework

For modelling the responses of the Sudanese stock market to the fluctuations in crude oil prices,, inflation, and exchange rate, a VAR(1)-GARCH(1,1) model [22] proposed by Ling and McAleer (2003) is employed. In this model, there are two distinct equations, the first one for the conditional mean and the second one for the conditional variance. The interest is mainly in the second equation as it provides estimates of volatility transmission.

The conditional mean equation can be expressed as follows:

$$\begin{cases} R_t = \mu + \Pi R_{t-1} + \varepsilon_t \\ \varepsilon_t = H_t^{1/2}\eta_t \end{cases} \quad (1)$$

where

$R_t = \left(r_t^s, r_t^{\mathrm{F}}\right)'$ where r_t^s are the returns on the general market index and r_t^{F} represents the returns of (oil price, inflation, and exchange rate). So when the interest is to look at the impact of oil price fluctuations on stock market performance, this vector can be written as follows: $R_t = (r_t^s, r_t^o)'$. For the impact of exchange rate fluctuations it can be $R_t = (r_t^s, r_t^{ex})'$. Finally $R_t = \left(r_t^s, r_t^{inf}\right)'$ is used when examining the impact of inflation fluctuations. For explaining the rest of this methodology, F is used to indicate that one of the three variables (oil price, inflation, and exchange rate) is used.

[22] This model has two major advantages. First, it has an analysis advantage since it has relatively less excessive in parameters and allows the modeler to focus more on the estimation of meaningful and interpretable parameters. Second, it permits a multivariate analysis of conditional volatility of the series under investigation as well as of conditional cross effects and volatility spillovers between the series. This model has previously been used to study the dynamic properties of different financial and economic phenomena, such as international tourism demand and volatility (Chan et al., 2005), dynamic relationship between stock market returns and exchange rate fluctuations (Abdalla, 2013; Boubaker and Jaghoubi, 2011), conditional correlations in volatility of rubber spot and futures returns (Chang et al. 2011), Shock and Volatility transmissions between bank stock returns (Chaibi and Ulici, 2014), return and volatility transmission between gold and stock sectors (Kumar, 2014). It appears to provide meaningful and interpretable coefficients.

$\mu = (\mu_t^s, \mu_t^{\mathrm{F}})'$ is the vector of constant terms.
Π is a (2×2) matrix of coefficients allowing for cross-sectional dependency of conditional mean between stock market and (oil price, inflation, and exchange rate) of the following form:

$$\Pi = \begin{pmatrix} \Pi_{11} & \Pi_{12} \\ \Pi_{21} & \Pi_{22} \end{pmatrix}$$

$\varepsilon_t = (\varepsilon_t^s, \varepsilon_t^{\mathrm{F}})'$ is the vector representing the error terms of the conditional mean equations.

$\eta_t = (\eta_t^s, \eta_t^{\mathrm{F}})'$ is a sequence of independently and identically distributed $(i.i.d)$ random errors;

$H_t = \begin{pmatrix} h_t^s & h_t^{s\mathrm{F}} \\ h_t^{s\mathrm{F}} & h_t^{\mathrm{F}} \end{pmatrix}$ is the matrix of conditional variances of stock and returns of (oil price, inflation, and exchange rate) with h_t^s and h_t^{F} being the conditional variances of r_t^s and r_t^{F} respectively. Their time series dynamics are modelled as follows:

$$h_t^s = C_s^2 + \beta_{s1}^2 h_{t-1}^s + \alpha_{s1}^2 (\varepsilon_{t-1}^s)^2 + \beta_{s2}^2 h_{t-1}^{\mathrm{F}} + \alpha_{s2}^2 (\varepsilon_{t-1}^{\mathrm{F}})^2 \quad (2)$$

$$h_t^{\mathrm{F}} = C_{\mathrm{F}}^2 + \beta_{\mathrm{F}1}^2 h_{t-1}^{\mathrm{F}} + \alpha_{\mathrm{F}1}^2 (\varepsilon_{t-1}^{\mathrm{F}})^2 + \beta_{\mathrm{F}2}^2 h_{t-1}^s + \alpha_{\mathrm{F}2}^2 (\varepsilon_{t-1}^s)^2 \quad (3)$$

According to Eqs. 2 and 3, negative and positive shocks of equal magnitude have identical effects on conditional variances. The equations also show how volatility is transmitted over time. The cross values of error terms, $(\varepsilon_{t-1}^{\mathrm{F}})^2$ and $(\varepsilon_{t-1}^s)^2$, represent the return innovations in the (oil price, inflation, and exchange rate) and to the corresponding stock price at time $(t-1)$, and thus capture the impact of direct effects of shock transmission. The transfer of risk is accounted for by the lagged conditional volatilities, h_{t-1}^{F} and h_{t-1}^s. To guarantee stationarity, the roots of the equation $|I_2 - AL - BL| = 0$ must be outside the unit circle where the expressions $(I_2 - AL)$ and BL satisfy some other identifiability conditions as proposed by Jeantheau (1998). L is a lag polynomial, I_2 is a (2×2) identity matrix, and A and B are defined as:

$$A = \begin{pmatrix} \alpha_{s1}^2 & \alpha_{s2}^2 \\ \alpha_{F2}^2 & \alpha_{F1}^2 \end{pmatrix} \text{ and } B = \begin{pmatrix} \beta_{s1}^2 & \beta_{s2}^2 \\ \beta_{F2}^2 & \beta_{F1}^2 \end{pmatrix}$$

The conditional covariance between returns of each of the three variables (oil price, inflation, and exchange rate) and stock market in the bivariate VAR(1)-GARCH(1,1) is modeled as:

$$h_t^{sF} = \rho * \sqrt{h_t^s} * \sqrt{h_t^F} \quad (4)$$

where ρ is the constant conditional correlation (CCC) coefficient.

Overall, the proposed empirical model simultaneously allows capturing both return and volatility spillover effects between (oil price, inflation, and exchange rate) and stock market. Note that the CCC assumption can be viewed as restrictive given that correlation coefficient is likely to vary over time according to changes in economic and market conditions. The quasi-maximum likelihood estimation (QMLE) method of Bollerslev and Wooldridge (1992) is used to estimate the empirical model in order to take into account the fact that normality condition is often rejected for majority of macroeconomic and financial series.

6. Data and preliminary analysis

6.1 The data used for the Analysis

The data used in the analysis of this study consist of daily observations on crude oil price and the closing value of the KSE index. Monthly data on KSE index, exchange rate, inflation rate are also used. Crude oil prices expressed in USD per barrel for Brent spot prices to represent the international crude oil market given that they are serving as pricing benchmark for two thirds of the world's internationally traded crude oil supplies (see Aloui et al., 2013; Maghyereh, 2004). To look at the impact of the secession of South Sudan on July 9, 2011, the paper uses a sub-period analysis by splitting the whole sample period into two sub-periods (before and after the secession). Table 4 provides the description and sources of the variables.

Table 4. Variables included, their frequency, period and sources

Variable	Frequency	period	Source
KSE index	Daily	2/8/2008-20/10/2014	KSE database
KSE index	Monthly	9/2003-10/2014	KSE database
Exchange rate	Monthly	9/2003-10/2014	Central Bank of Sudan
Inflation rate	Monthly	9/2003-10/2014	Central Bank of Sudan
Crude oil prices	Daily	2/8/2008-20/10/2014	the US Energy Information Administration

Daily (monthly) returns on the variables are computed as percentage by taking the difference in logarithm of two successive values as follows:

$$r_t^{\mathrm{F}} = log\left(\frac{P_t^{\mathrm{F}}}{P_{t-1}^{\mathrm{F}}}\right) * 100 \quad (5)$$

$$r_t^{s} = log\left(\frac{P_t^{s}}{P_{t-1}^{s}}\right) * 100 \quad (6)$$

Equ. 5 is used for calculating the returns of oil prices, exchange rate and inflation. P_t^s and $r_t^s in$ Equ. 6 denote daily (monthly) closing values of the KSE index and their returns respectively.

6.2 Descriptive Statistics of KSE index and crude oil prices

To specify the distributional properties of the variables and their returns during the sample period, some descriptive statistics are reported in Tables 5 and 6. It is very clear that returns on oil prices and KSE index have very small means (very close to zero). In view of the value of standard deviation (an indication of unconditional variance in the return series) regarding the mean value, the results show that oil prices, inflation, and exchange rate are characterized by higher volatility and risky nature in comparison with KSE returns. The results also indicate that all series do not conform to normal distribution but display positive skewness (the distribution has a long right tail), in addition to that, a highly leptokurtic distribution is also observed for all returns series. The Jarque-Bera (JB) statistic confirms that the returns distribution is non-normal at a p-value of almost 1% in all cases (except for inflation variable in post-secession period). As for comparing the behavior of the KSE index before and after the secession of South Sudan, Table 5 indicates that the average value of the KSE index in post-secession

period is greater and with higher volatility. This feature is also true for the returns series (Table 6) but with less volatility. ARCH-LM test results provide strong evidence for rejecting the null hypothesis of no ARCH effects indicating that the variance of the residuals series of returns on the variables under investigation is non-constant. The presence of ARCH effects is a justification to use the GARCH methodology.

Figures 4-6 display the KSE index, crude oil prices, inflation, exchange rate and their returns. To some extent, there seems to be some comovements between the KSE index and the three variables during most of the time, except for some relatively short sub-period (end of 2011 up to the beginning of 2012) where there was no significant change in the index returns. For all returns series, there is evidence for volatility clustering a phenomenon indicating that large changes tend to be followed by large changes, and small changes tend to follow small changes. This characteristic suggests the possibility of return and volatility spillover effects between the two markets and makes GARCH types models to be the preferred methodology for modeling such time series (Francq and Zakoian, 2010).

Table 5: Summary statistics for crude oil prices, exchange rate, inflation and KSE index

Measures	Oil Prices	KSE Index		Inflation Rate		Exchange Rate	
		Before	After	Before	After	Before	After
Mean	95.79	2586.14	2673.09	10.4621	35.3103	2.3175	4.3576
Std. dev.	22.39	168.81	300.64	4.4406	9.8817	0.2191	1.1757
Maximum	143.95	3077.12	3423.37	21.800	47.900	2.7816	5.6958
Minimum	33.37	2353.20	2365.02	1.7000	18.900	2.0051	2.6789
Skewness	-0.79	0.24	0.77	0.1399	-0.5062	0.0752	-0.3368
Excess Kurtosis	2.86	2.38	2.47	2.4518	1.7165	1.8107	1.7159
Jarque-Bera	185.25[a]	23.75 [a]	91.88 [a]	1.4992	4.3427	5.6881[a]	3.4028
No. of Observations	1770	934	827	95	39	95	39

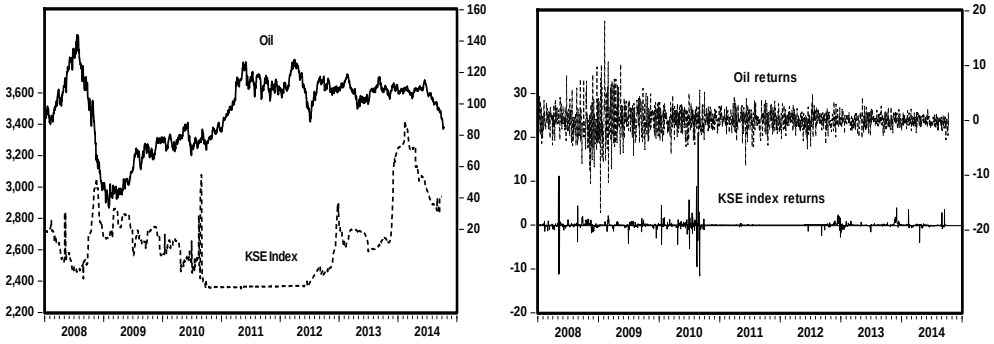
Note: [a] denotes statistical significance at the 1% significance level.

Table 6: Summary statistics for returns on crude oil prices, exchange rate, inflation and KSE index

Measures	Oil Prices	KSE Index		Inflation Rate		Exchange Rate	
		Before	After	Before	After	Before	After
Mean	-0.0052	-0.0148	0.0263	1.7808	2.0533	0.0266	1.9205
Std. dev.	2.1535	1.3585	0.4222	40.6697	11.956	1.5518	6.9098
Maximum	18.1297	21.1228	3.3937	189.712	31.536	6.4437	37.314
Minimum	-16.8320	-11.6074	-3.9978	-151.634	-31.408	-5.5912	-0.299
Skewness	0.0947	2.8156	1.7141	0.6002	0.0599	0.7655	4.0779
Excess Kurtosis	11.0428	97.4340	42.407	9.4970	4.0247	7.3963	19.787
Jarque-Bera	4770.65 [a]	347912 [a]	53851.8 [a]	170.972[a]	1.7297	84.879[a]	566.01[a]
ARCH(30)	416.14	316.83		32.172		44.204	
No. of Observations	1770	934	827	95	39	95	39

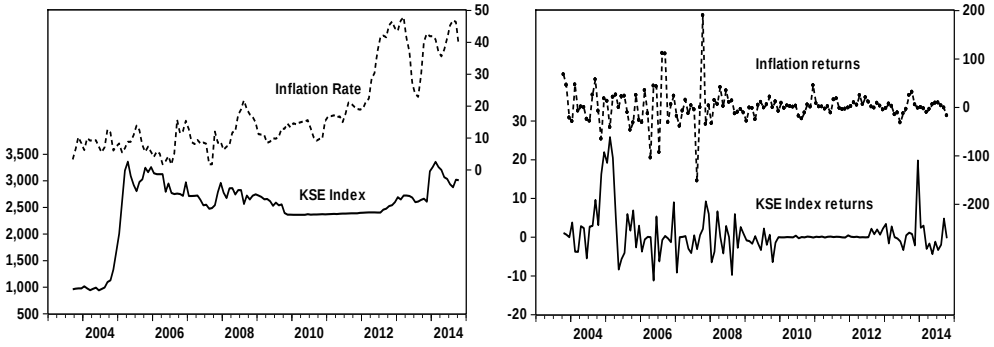
Note: ARCH(30) refers to the empirical Engle (1982) test for conditional heteroscedasticity up to order 30
* [a] denotes statistical significance at the 1% significance level.

Figure 4: Crude oil price and KSE index (January 2, 2008 – October 20, 2014)



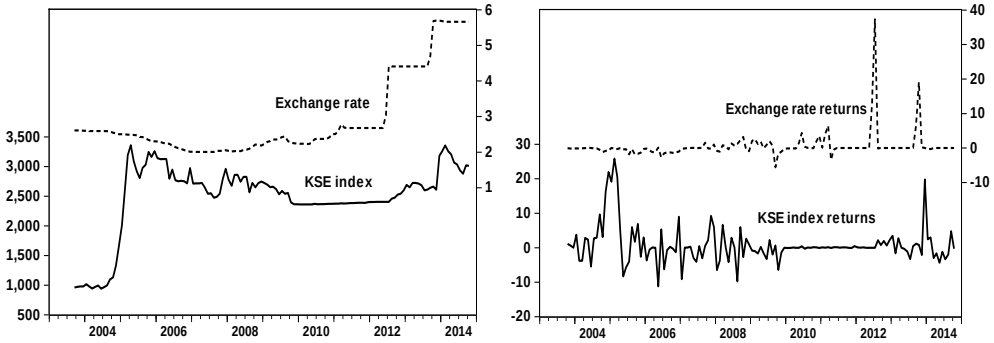
Source: Khartoum stock exchange and the US Energy Information Administration (EIA) database

Figure 5: Inflation rate and KSE index (September 2003 – October 2014)



Source: Khartoum stock exchange and the Central Bureau of Statistics (Sudan)

Figure 6: Exchange rate and KSE index (September 2003 – October 2014)



Source: Khartoum stock exchange and the Central Bank of Sudan

7. Empirical Results

Given the results of ARCH-LM test in the previous section, it is now possible to proceed with modeling the responses of the Sudanese stock market to fluctuations in crude oil prices, inflation, and exchange rate by employing a VAR(1)-GARCH(1,1) model. The proposed model is estimated using maximum likelihood method under the assumption of multivariate normal distributed error terms. The log likelihood function is maximized using Marquardt's numerical iterative algorithm to search for optimal parameters. Beside the estimation output of the VAR(1)-GARCH(1,1) model, diagnostics test results are also provided to see

whether there still ARCH effects left in the estimated model[23]. The results of returns and volatility spillovers are presented in Tables 7-9.

When considering crude oil price fluctuations, the empirical findings in Table 7 document that KSE index returns is significantly affected by its own past returns suggesting some evidence of short-term predictability in KSE index changes. This finding is consistent with some existing literature in this regard (see, e.g., Arouri and Nguyenk 2010; Arouri et al., 2012; Elder and Serletis, 2008; Shambora and Rossiter, 2007). But when inflation and exchange rate are considered, the significant of short term predictability is not confirmed (see Tables 8-9).

Table 7: Estimation results of VAR(1)-GARCH(1,1) model for oil price and stock market returns

Variables	Before Secession	After Secession	Full Sample Period
Conditional mean equation			
Constant	-0.1173***	-0.0005*	-0.0085***
Return(-1)	0.2132***	0.4412***	0.8343***
Oil(-1)	0.0033*	0.0004	-0.0017***
Conditional variance equation			
Constant	0.0499***	0.0008**	0.00012***
$(\varepsilon_{t-1}^{s})^2$	2.7693***	13.0857***	3.66881***
$(\varepsilon_{t-1}^{o})^2$	0.04726***	0.03713***	0.04525***
h_{t-1}^{s}	0.4286***	0.01603***	0.63243***
h_{t-1}^{o}	0.9481***	0.95261***	0.95362***
Diagnostics			
ARCH(30)	9.1875	4.0775	15.231
$LB^2(12)$	10.028	3.8519	24.633

Note: ARCH(30) and $LB^2(12)$ refer to the empirical statistics of the Engle (1982) test for conditional heteroscedasticity up to order 30 and the Ljung-Box test for autocorrelation of order 12 applied to the standardized residuals.
*, **, and *** indicate the rejection of the null hypothesis of associated statistical tests at the 10%, 5%, and 1% levels respectively.

[23] If the variance equation of GARCH model is correctly specified, there should be no ARCH effect left in the residuals.

Regarding the returns spillover effects in the conditional mean equations, Table 7 indicates that a one-period lagged oil returns, oil (-1) parameter, significantly affects the current value of returns on the KSE index for the first sub-period and for the full sample period, In contrast, the autoregressive term of oil is insignificantly different from zero during the post secession period. When inflation and exchange rate are considered, the results show that their lagged values are statistically significant specially, in the post secession period.

Table 8: Estimation results of VAR(1)-GARCH(1,1) model for inflation and stock market returns

Variables	Before Secession	After Secession	Full Sample Period
Conditional mean equation			
Constant	0.0612	0.5288***	0.1385**
Return(-1)	0.1406	-0.1218	0.1733
INF(-1)	0.0058	0.1013***	0.0122***
Conditional variance equation			
Constant	-0.0096	0.3759	-0.0007
$(\varepsilon_{t-1}^{s})^2$	0.4149***	2.6545**	1.3618***
$\left(\varepsilon_{t-1}^{inf}\right)^2$	0.2143***	0.2542*	0.1994***
h_{t-1}^{s}	0.6825***	-0.0518	0.5089***
h_{t-1}^{inf}	0.8085***	0.3919**	0.8145***
Diagnostics			
ARCH(5)	43.253	0.3134**	15.315
$LB^2(12)$	55.356	0.5756*	14.415

Note: ARCH(5) and LB2(12) refer to the empirical statistics of the Engle (1982) test for conditional heteroscedasticity up to order 5 and the Ljung-Box test for autocorrelation of order 12 applied to the standardized residuals.
*, **, and *** indicate the rejection of the null hypothesis of associated statistical tests at the 10%, 5%, and 1% levels respectively.

Table 9: Estimation results of VAR(1)-GARCH(1,1) model for exchange rate and stock market returns

Variables	Before Secession	After Secession	Full Sample Period
Conditional mean equation			
Constant	0.0419	0.2209*	0.02424
Return(-1)	-0.0052	-0.0267	-0.0041
EXR(-1)	0.0179	0.0892***	0.1329***
Conditional variance equation			
Constant	-0.0143***	-0.0297	0.0612
$(\varepsilon_{t-1}^{s})^2$	0.3813***	2.0628**	0.5936***
$(\varepsilon_{t-1}^{ex})^2$	-0.0727**	1.1513**	0.6822***
h_{t-1}^{s}	0.7071***	0.4518**	0.6685***
h_{t-1}^{ex}	1.1206***	1.2168***	1.1624***
Diagnostics			
ARCH(5)	25.768	0.4765*	11.324
$LB^2(12)$	50.825	0.7596**	10.608

Note: ARCH(5) and LB2(12) refer to the empirical statistics of the Engle (1982) test for conditional heteroscedasticity up to order 5 and the Ljung-Box test for autocorrelation of order 12 applied to the standardized residuals.
*, **, and *** indicate the rejection of the null hypothesis of associated statistical tests at the 10%, 5%, and 1% levels respectively.

When it comes to the shock dependence and volatility persistent (ARCH and GARCH coefficients[24]), the results of Table 7 indicate that they are statistically significant in all cases when oil price returns are considered. These coefficients are significant for most cases when the focus is on the impact of inflation and exchange rate (see Tables 8 and 9). In empirical finance literature, it is stylized fact that volatility persistent is attained when the sum of ARCH and GARCH coefficients is less than one. For example, the summation of these coefficients is 0.99, 0.98 and 0.99 for the crude oil returns for three periods respectively. On the other hand, the results show that the sum of these coefficients is more than one for returns on KSE in all cases, indicating that volatility can be considered as an explosive process especially after the secession of South Sudan. These results are completely consistent with the turbulent

[24] In Table 7 for example, ARCH coeffiencts are $(\varepsilon_{t-1}^{s})^2$ and $(\varepsilon_{t-1}^{o})^2$. While GARCH terms are h_{t-1}^{s} and h_{t-1}^{o}.

macroeconomic environment in Sudan over the last few years. Additionally, the results suggest that the current conditional volatility of KSE index returns depends on past shocks affecting return dynamics since ARCH-terms are significant for all sub-periods. This suggests that the conditional variance of stock market does not only depends on its immediate past values and innovations but also on those of the oil market, inflation, and exchange rate fluctuations as previously hypothesized. A closer inspection of the above coefficients reveals that in general, conditional volatility is changing very rapidly as the ARCH-terms measuring the impact of past shocks on conditional volatility are large in size (especially after the secession).

The empirical findings regarding the volatility transmission between oil and stock market the results indicate that the conditional volatility of returns on KSE index is affected by innovations in the oil market as indicated by the significance of the coefficient of $(\varepsilon_{t-1}^{o})^2$. It is also affected by what is going on inflation and exchange rate, given the statistical significance of the terms $\left(\varepsilon_{t-1}^{inf}\right)^2$ and $(\varepsilon_{t-1}^{ex})^2$respectivelly. Apparently, a shock originating from the oil market, inflation, or exchange rate leads to increase stock returns volatility. In addition, there is strong evidence to suggest that past volatility of the oil market, inflation and exchange rate is transmitted to stock market because the coefficients associated with h_{t-1}^{o}, h_{t-1}^{inf}, h_{t-1}^{ex} are statistically significant.

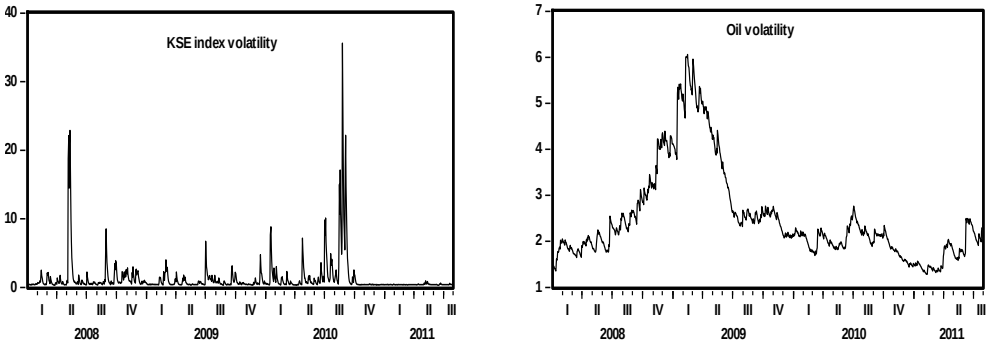
Some diagnostics tests such as the Ljung–Box (LB) test for autocorrelation and ARCH LM test for ARCH effects are reported to validate the estimates of the VAR-GARCH model. LB statistic suggests that the null hypothesis of no autocorrelation cannot be rejected for most cases; thus, the residuals are free of autocorrelation (except for inflation and exchange rate in post secession period[25]). The ARCH-LM test suggests that the null hypothesis of no ARCH effects cannot be rejected for most cases, implying that the residuals do not suffer from the ARCH effects which means that VAR(1)-GARCH(1,1) has effectively captured

[25] This result can be justified by the low number of observations.

the ARCH effects (except for inflation and exchange rate in post secession period.

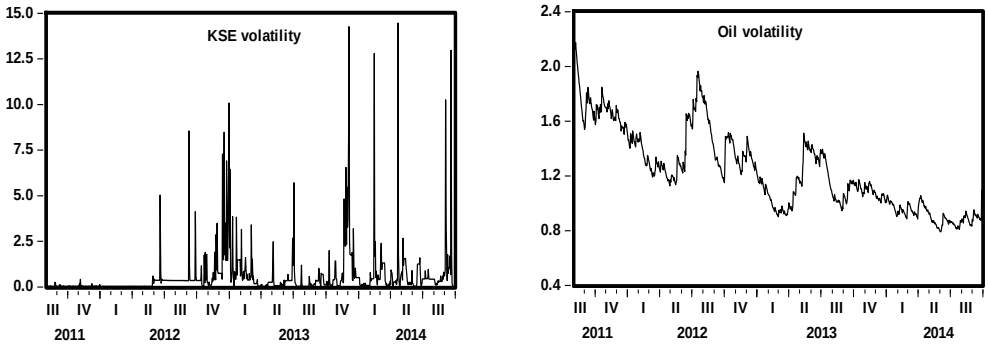
Estimated conditional volatility graphs (as conditional standard deviation) for the returns on KSE index accompanied with volatility of returns on crude oil price, exchange rate and inflation rate are provided in Figures. 7-12. It is obvious that KSE index returns experienced higher levels of volatility in post-secession period confirming the results of the conditional mean and variance equations of Tables 7-9.

Figure 7: Volatility of Crude oil prices and KSE index
(Before the Secession of South Sudan)



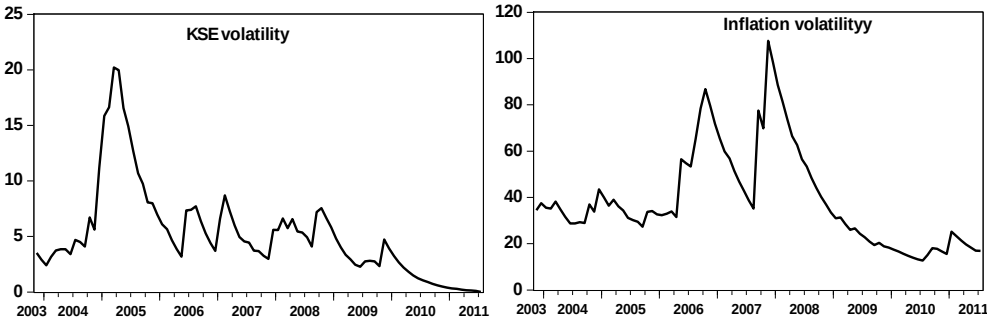
Source: Khartoum stock exchange and the US Energy Information Administration (EIA) database

Figure 8: Volatility of Crude oil prices and KSE index
(After the Secession of South Sudan)



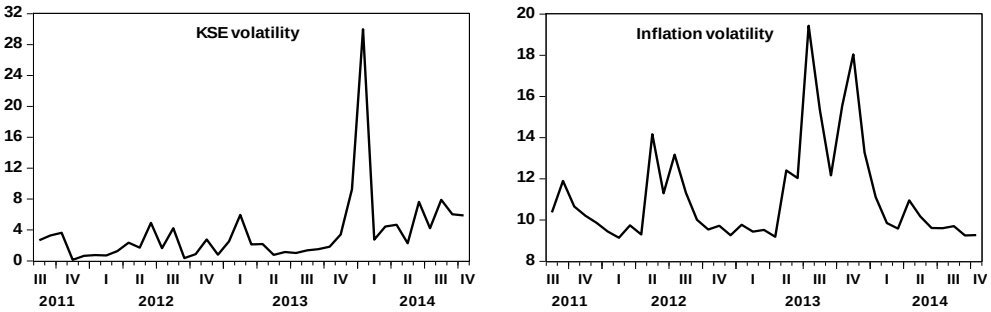
Source: Khartoum stock exchange and the US Energy Information Administration (EIA) database

Figure 9: Volatility of inflation and KSE index
(Before the Secession of South Sudan)



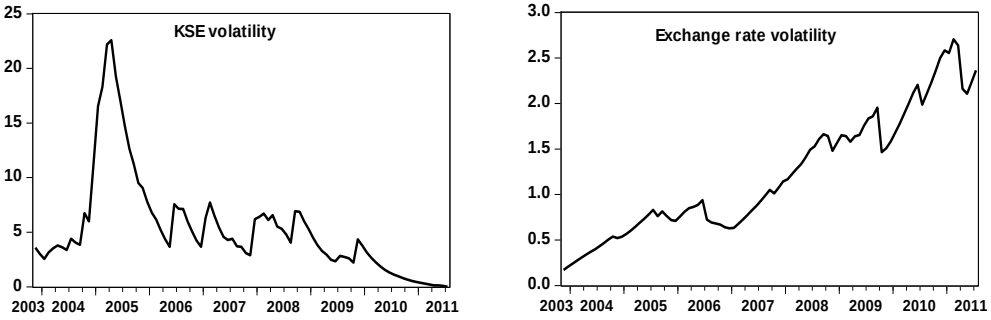
Source: Khartoum stock exchange and the Central Bureau of Statistics (Sudan)

Figure 10: Volatility of inflation and KSE index
(After the Secession of South Sudan)



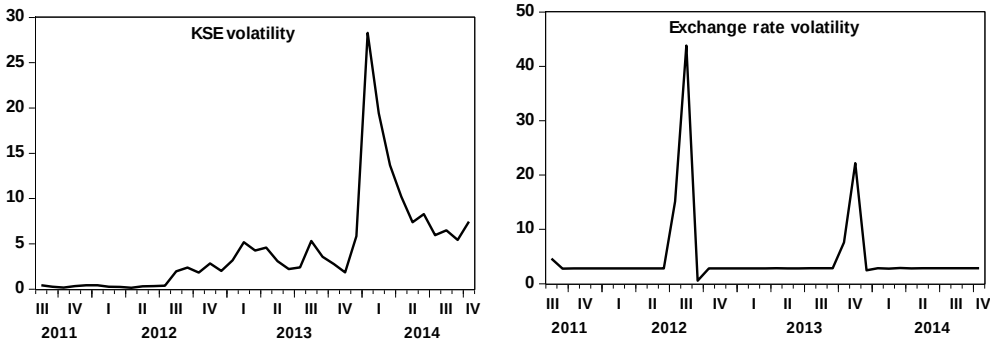
Source: Khartoum stock exchange and the Central Bureau of Statistics (Sudan)

Figure 11: Volatility of exchange rate and KSE index
(Before the Secession of South Sudan)



Source: Khartoum stock exchange and the Central Bank of Sudan

Figure 12: Volatility of exchange rate and KSE index
(After the Secession of South Sudan)



Source: Khartoum stock exchange and the Central Bank of Sudan

8. Conclusion and policy recommendations

To sum up, this paper provides evidences that the Sudanese stock market has experienced higher levels of fluctuations consistent with the turbulent macroeconomic environment in Sudan during the past few years, especially after the secession of South Sudan in 2011. It shows that these fluctuations are greatly explained by oil shocks and exchange rate fluctuations. Little evidence is found for inflation rate movements. It is worth mentioning at this juncture that although a wide range of policy options have been suggested over the past few years the Sudanese economy is still experiencing a lot of macroeconomic difficulties (double-digit inflation, unstable exchange rate, large external and internal deficits, and low growth rate). So, it seems timely for policy makers to question what has gone wrong and what has been forgotten in an attempt to put it right in their future policy priorities. Within this context, it is recommended that forward-looking macroeconomic policies should put greater emphasis on domestic resource mobilization by enhancing the performance of financial institutions. Curbing KSE volatility and increasing its efficiency represent good starting points in order for the market to play a significant role in the national economy. To that end, the paper presents the following recommendations: (i) Policy-makers in the Central Bank of Sudan are required to enhance monetary policy transparency to ensure symmetric information between monetary policymakers and other economic agents, (ii) Market regulators can introduce some margin regulations to discourage investors from excessive speculation by making future trading more

costly, (iii) Regulators should adopt circuit breakers (such as trading halts and daily price limit) to temporarily suspend trading activity if price movements exceed certain thresholds. This provides time for traders to re-evaluate market conditions in times of panic selling and to bolster their liquidity and credit, (iv) Public awareness about KSE activities should be strengthened through regular and intensive educational and promotional campaigns programs. These may include: embarking on vigorous campaigns through digital press, newspapers, radio programs, TV campaigns, social networking sites to reach out to as wide a target audience as possible; creating a dedicated website to provide general information about market activities, this also could include a guide for questions that potential investors should ask themselves before taking investment decisions; hosting forums and workshops on themes pertinent to the market performance where business community can learn about the requirements, anticipated benefits and costs of listings on the market; expanding the geographic coverage of the educational programs to include not only the public and business community in the Khartoum city but also to the general public in other states of the country. (v) To attract significant portion of the potentially large amount of financial wealth exists outside the Sudanese financial system, the geographic coverage of educational programs should be expanded to include the general public not only in the Khartoum state but also in other states of the country, and (vi) Policy makers should put greater emphasis on enhancing information disclosure and transparency by developing a new disclosure regime and transparency standards which lead to timely, consistent, complete and accurate information about KSE activities.

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