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THE IMPACT OF OIL PRICE FLUCTUATIONS ON THE SUDANESE STOCK MARKET PERFORMANCE

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Abstract

This paper investigates the impact of crude oil price shocks on the returns and volatility of the Sudanese stock market, Khartoum stock exchange (KSE). A bivaraite VAR-GARCH model is employed for the daily observations of Brent crude oil price and the closing value of the KSE index over the period January 2, 2008 to October 20, 2014. The dataset is divided into two sub-periods, before and after the secession of South Sudan in July 9, 2011. The empirical findings document 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. Regarding the impact of oil price fluctuations on the stock market returns, the results indicate a significant effect of a one-period lagged oil returns for the first sub-period. Additionally, the results show that KSE returns volatility is significantly affected not only by the volatility surprises of the stock market, but also by those originated in crude oil market. The paper concludes that the market has experienced higher volatility in the aftermath of the secession of South Sudan, a result that is completely consistent with the turbulent macroeconomic environment in Sudan over the last few years. These results are of great interest and have important implications for investors, portfolio managers and policymakers. For example, policymakers can use such results to adjust their actions to prevent contagion risks in the event of market crashes or crises. It is left to future empirical research, when appropriate data will be available, to study in more detail the impact of oil price shocks from a sector perspective to shed more light on industry-specific characteristics, dynamics and responses to external shocks.

JEL Classification: E3, Q4

Keywords: Oil price shocks, stock returns, volatility transmission, Khartoum stock exchange

ملخص

تهدف هذه الورقة إلى دراسة أثر الصدمات التي تشهدها أسعار النفط الخام على عوائد وتقلبات سوق الأوراق المالية فى السودان. لذلك الغرض، تم تطبيق نموذج متجه الإنحدار الذاتي ثنائي المتغيرات المعمم والمشروط بعدم تجانس التباين على بيانات يومية لأسعار خام برنت وقيم الإغلاق للمؤشر العام لسوق الخرطوم للأوراق المالية خلال الفترة من 2 يناير 2008 وحتى 20أكتوبر 2014م. وقد تم تقسيم مجموعة بيانات مؤشر السوق إلى فترتين فرعيتين، قبل وبعد إنفصال دولة جنوب السودان فى التاسع من يوليو للعام 2011م. أشارت النتائج التطبيقية إلى أن عوائد مؤشر سوق الخرطوم للأوراق المالية تتأثر معنوياً بعوائد السوق فى الفترات السابقة. النتيجة التي مفادها، إمكانية الحصول على تنبؤات بحركة عوائد السوق على المدى القصير. فيما يتعلق بتاثيرات عوائد اسعار النفط على عوائد السوق، أوضحت النتائج أثراً معنوياً لعوائد أسعار النفط بفترة إبطاء واحدة على عوائد مؤشر سوق الخرطوم للأوراق المالية وذلك خلال الفترة ما قبل إنفصال دولة جنوب السودان. وتشير النتائج أيضاً إلى أن التقلبات التي شهدها سوق الخرطوم خلال فترة الدراسة لا تتأُثر فقط بتقلبات السوق السابقة، ولكن أيضاً بما يحدث من تقلبات فى أسعار النفط الخام. وخلصت الورقة بصورة إجمالية إلى أن التقلبات التي يتعرض لها سوق الخرطوم للأوراق المالية بعد إنفصال دولة جنوب السودان فاقت فى حدتها ما كان يحدث فى السوق خلال فترة الثلاث سنوات التي سبقت الإنفصال. تأتي هذه النتيجة متوافقة تماماً مع البيئة المضطربة للاقتصاد الكلي في السودان خلال السنوات القليلة الماضية. هذه النتائج ذات أهمية كبيرة لصانعي السياسات والمستثمرين ومديري المحافظ الإستثمارية، حيث يمكنهم أخذها فى الإعتبار لتوجيه تصرفاتهم لمنع إنتقال مخاطر العدوى في حالات الأزمات التي يمكن أن يتعرض لها السوق أو مايحدث من تقلبات فى سوق النفط. وقد أقترحت الورقة ضرورة تواصل هذا الإتجاه البحثي فى محاولة التعرف على أثار تقلبات سوق النفط العالمي على القطاعات المختلفة لسوق الخرطوم للاوراق المالية فى مسعى للتعرف على خصائص وديناميكية هذه القطاعات ومدي إستجابتها للصدمات من خارج السوق.

1. Introduction

Understanding how well an overall economy is performing has long been a major preoccupation for both academics and policy makers worldwide. Different schools of thought and many economists offer a wide range of theoretical models to address this issue with special attention given to the cyclical behavior of key macroeconomic aggregates[1]. This has led to a plethora of empirical literature examining the impact of both internal and external shocks[2] 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[3], weak institutions and political instability have larger impact relative to that of external shocks (see, e.g., Hoffmaister and Roldos, 1997, 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).

However, the disruptions in the world energy market have generated a broader consensus among economists that the large fluctuations in oil prices[4] and their higher volatility since the early 1970s have greater impact on the performance of world economies. Generally speaking, this possible impact is expected to be quite differentbetween the national economies of oil-exporting and oil-importing countries. For oil-importing countries higher oil prices may induce increases in industry costs and inflation rates, as well as a reduction of expenditure on non-oil goods (Barsky and Kilian, 2004). On the other hand, they may generate more income for oil-exporting countries due to the low price elasticity of crude oil demand (Bjornland, 2009; Jung and Park, 2011). The pioneering work on the impact of oil on the aggregate economy dates back to 1983 when James Hamilton emphasized that all but one of the U.S. recessions since World War II have been immediately preceded by a dramatic increase in the price of crude petroleum. Unfavorable oil price shocks in 1973 and 1979, in particular, are frequently considered to have been the underlying source of worldwide macroeconomic volatility and stagflation during that period. Since then, the unpredictability and large fluctuations of oil price have bolstered an active line of research into the relationship between oil price movements and macroeconomic fundamentals. Along this line, some researchers have related to the influence of crude oil prices over exchange rate (see, e.g., Krugman, 1980, 1983; Golub, 1983; Ding and

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1According to macroeconomic fluctuations theory, the driving forces of these fluctuations can be: (i) volatile market expectations about future sales and profits according to Keynesian Business Cycle Theory; (ii) fluctuations in monetary growth rate as illustrated by Monetarists Theory; (iii) unanticipated fluctuations in aggregate demand according to New Classical Theory; (iv) some kind of nominal price/wage rigidities according New Keynesian Theory; and (v) random shocks to total factor productivity that results from technological change according Real Business Cycle Theory.

2In 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.

3Technology shocks refer broadly to exogenous “changes in production functions or, more generally, the production possibilities of profit centers” (Hansen and Prescott 1993).

4Since 2000, crude oil prices have been rising rapidly. In February 2008, the price of both WTI crude oil and Brent crude oil surpassed $100/barrel, and the price hit a historic high of $145/barrel in July 2008.

Vo, 2012; Reboredo, 2012; Turhan et al., 2013)), over economic growth (see, e.g., Mork, 1989; Eika and Magnussen, 2000; Ferderer, 1996; Lardic and Mignon, 2008; Kilian, 2009; Prasad et al., 2007; Kilian and Vigfusson, 2012), over industrial production (see, e.g., Herrera et al., 2011; Tiwari, 2012), over trade balance (see, e.g., Hassan and Zaman, 2012) over interest rate and unemployment (see, e.g., Dogrul, 2010) or over inflation rates (see, e.g., LeBlanc and Chinn, 2004; Chen, 2009; Cunado and Perez, 2005). There is also a growing body of literature on"Dutch disease" suggesting that high oil prices are associated with high inflation, real exchange rate appreciation, loss of competitiveness, and decline in manufacturing output and employment in oil-exporting countries (see, e.g., Bruno and Sachs, 1982; Fardmanesh, 1991; Benkhodja, 2014). As reported in surveys by Chaudhuri and Daniel, (1998), Brown and Yücel (2002), Jones et al, (2004), Kilian (2008), and Kilian and Park (2009), literature finds such consequences as rising oil prices, slower GDP growth and possible economic recessions, higher unemployment rates, higher price levels, trade deficits, exchange rate fluctuations, higher uncertainty and low values for stocks and bonds.

From standpoints of theoretical debate, oil price shocks affect the performance of the world economies through different transmission mechanisms[5]. First, a classical supply-side shock effect focusing on the direct impact on output due to the change in marginal production costs caused by oil-price shock (see, e.g., Brown and Yücel, 2002; Abel and Bernanke, 2001). Second, a transmission through the 'wealth effect channel' indicating an increase in oil prices leads to an income transfer from oil-importing countries to oil-exporting countries and thus reduces disposable income of oil consumers (see, e.g., Dohner, 1981). Third, transmission through real balance effect emphasizing an increase in oil prices would lead to increase in money demand. If monetary authorities fail to increase money supply to meet this growing money demand, there would be a rise in interest rate and a retard in economic growth (see, e.g., Mork, 1994). Fourth, oil price shocks may have a pass-through effect into inflation. When the observed inflation is caused by oil price-increased cost shocks, a contractionary monetary policy can deteriorate the long term output by increased interest rate and decreased investment (see, e.g., Fuhrer, 1995; Hooker, 2002). Fifth, an oil price shock can affect unemployment through a change in the production structure. When oil prices increases, firms try to adopt production methods that are less oil-intensive. This change leads to a labor reallocations among sectors and can affect unemployment in the long-run (see, e.g., Loungani, 1986). Finally, oil price uncertainty might reduce investment expenditures (see, e.g., Hamilton, 1988; Bernanke, 1983). It is argued that increasing uncertainty may also cause to recessions during oil crisis periods (see, e.g., Pindyck and Rotemberg, 1983). Firms chose to postpone investment expenditures when they face increased uncertainty about future oil prices.

Since the stock market serves as a reliable barometer of how well the economy is performing, it is not surprisingly to expect some degree of interdependence between oil prices fluctuations and the behavior of stock prices. Given the heterogeneity across energy-producing and consuming countries, the possible reaction of stock markets to oil price shocks can be determined to a large extent by the relative significance of positive and negative impacts on these countries. The rationale for the possible oil price

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5For an extensive review on the oil price shocks and macroeconomy and a discussion on various transmission channels of oil price shocks, see among others, Jones et. al. (2004) and Cologni and Manera (2008, 2009).

impact on stock prices can be theoretically 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[6], any factor that could alter the expected discounted cash flows should have a significant effect on these share prices[7]. 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. 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).

It is widely accepted that a better understanding of the co-movements between these quantities has important implications for investors, portfolio managers and policymakers. It offers insights into building accurate asset pricing models and accurate forecasts of the return and volatility of both markets. Without any doubt this will help, for example, portfolio managers and policymakers to adjust their actions to prevent contagion risks in the event of market crashes or crises. Accordingly, 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.

6These 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).

7In 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.

From econometric point of view, a variety of methodologies have been applied to investigate this relationship including the traditional time-series models[8] such as the vector autoregression (VAR) approach (e.g., Sadorsky, 1999; Papapetrou, 2001; Park and Ratti, 2008), a cointegration vector error-correction models (e.g., Miller and Ratti, 2009). On the other hand, some previous studies has commonly used the multivariate GARCH models to evaluate time-varying dependence structures between the two markets (e.g., a bivariate EGARCH model applied by Bharn and Nikolovann, 2010, a univariate regime-switching EGARCH model by Aloui and Jammazi, 2009, a multivariate CCCGARCH model by Cifarelli and Paladino, 2010, a symmetric DCC-GARCH model by Choi and Hammoudeh, 2010, and a trivariate BEKK-GARCH model as used by Malik and Hammoudeh, 2007). The main feature of such models is that they are based on tight restrictions and linear correlations to guarantee a well-defined covariance matrix that contains a serious deficiency, namely, that it is a variant under non-linear strictly increasing transformations[9].

The main objective of this paper is to investigate the response of stock markets returns and volatility to crude oil price shocks in Sudanese stock market. The remainder of this paper is organized as follows. Section 2 illustrates the motivation of the study. Section 3 provides some facts about the stock market in Sudan. Section 4 introduces the empirical framework, while Section 5 describes the data and provides their statistical properties and motivation for empirical framework. Section 6 discusses the empirical results. Finally, Section 7 concludes the paper.

2. Motivation

Notwithstanding the fact that the nexus of crude oil prices and stock market movements is commonly regarded as an important input for many key financial and economic applications, empirical literature mostly concentrates on industrialized countries and to some extent on emerging countries, leaving most of the developing economies outside the analysis. To the best of author's knowledge, the potential impact of oil price fluctuations has still not been tackled for the Sudanese stock market. There are several convincing reasons justifying the need for such empirical research. First, Sudan is a country that has been experiencing significant swings in aggregate economic activity since its independence from Britain in 1956 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 and the situation has worsened in more recent years after the secession of the South Sudan[10] in July 9, 2011 which has contributed to the creation of severe macroeconomic imbalances and deteriorated considerably the economic conditions in Sudan[11]. Consequently, it may be worthwhile to note at this juncture that

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8Although these models have some advantages, they assume that asset returns follow normal or Student t-distributions and thus neglect certain stylized facts. In particular, the assumption of normality is at odds with previous empirical research, which shows that crude oil and stock returns are skewed, leptokurtic, and fat-tailed (see e.g., Cuñado and Pérez de Gracia (2003), Basher and Sadorsky (2006), Narayan and Narayan (2010), Chang et al. (2012), Aloui et al. (2013).

9As noted by Embrechts et al., (1999), the use of linear correlation to depict the financial market dependence structure has many disadvantages.

10In the aftermath of the South Sudan's secession, the Sudan economy has lost some three-quarters of its oil production, half of its fiscal revenues, and about two-thirds of its international payment capacity. It has also driven the trade balance from substantial surplus to a large deficit.

11In fact, even after the secession of Southern Sudan, Sudan still endures political instability and conflicts along with the resulting economic disruption.There are currently several crises happening in Sudan, including those in *Darfur*, *Abyei*, South Kordofan and Blue Nile and Eastern Sudan; as well as with South Sudan.

these turbulent events have posed considerable challenges to policy makers in the central bank and other national policy institutions. Subjecting the economy to these types of events means that a thorough understanding and evaluating of the impacts of different internal and external shocks on the performance of economy is of utmost importance if the economy is to be put onto a sustainable growth path in the future. Of course, looking at what is going on the Sudanese stock market represent one of the good starting points.

Second, consistent with the turbulent macroeconomic environment in Sudan, some interesting studies and considerable empirical literature have emerged during the last few years to evaluate the overall level of economic activity. This is usually in terms of single driving forces, but leaving the dynamic behavior of Khartoum stock exchange out of this analysis. 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.

Third, some interesting results exist on measuring the efficiency and volatility of Khartoum stock exchange based on the market data. For example, Arabi (2014) and Onour (2010) show that the market is inefficient. Additionally, Abdalla and Winker (2011) indicated that the conditional volatility of returns on KSE index can be considered as an explosive process; 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.

Motivated by the gab in the literature and given the fact that crude oil prices have swung wildly during the past few years, this paper aims to contribute to the understanding of the dynamic relationship between oil prices and stock returns and conditional volatility.

3. 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)[12]. Securities traded in the market are ordinary shares and investment units[13]. Furthermore, a substantial number of mutual funds and Government Investment Certificates (GICs)[14] 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

12Member 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.

13An 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.

14Government 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.

markets, the so called primary and secondary markets[15]. 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[16]. 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-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*[17] practices a separate class of investment vehicles on the KSE is provided by the so called Government *Musharakah*[18] 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).

15The 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).

16For more explanations about the ideas of Islamic banking see for example, Venardos (2010).

17For a detailed discussion of the Islamic Shariaa principles and its practices on stock exchange see for example, El-Gamal (2006) and Ayub (2007).

18Musharakah' 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 the 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 Table1and Fig. 1 and 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.

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.

4. Empirical Framework

In the empirical finance literature, the generalized autoregressive conditional heteroscedasticity (GARCH) model of Bollerslev (1986) is one of the most widely used specifications on modeling and forecasting volatility of commodities prices. Empirical works indicated that the use of such types of models has centered on the evaluation of their forecasting performance (Morana, 2001; Fong and See, 2002; Agnolucci, 2009; Cheong, 2009; Kang et al., 2009; Sadorsky, 2006) and their application to Value-at-Risk (VaR) estimations (Aloui and Mabrouk, 2010; Giot and Laurent, 2003; Sadeghi and Shavvalpour, 2006). However, as far the major concern is about volatility transmissions among multiple financial variables, it is commonly accepted that multivariate GARCH specifications such as BEKK (full parameterization) model of Engle and Kroner (1995), CCC-GARCH model of Bollerslev (1990) or DCC- GARCH model of Engle (2002) with dynamic covariances and conditional correlations are more relevant than univariate settings. The superiority of these models and their ability to effectively capture the stylized facts of the commodity-price volatility has been extensively confirmed in the literature (see, e.g. Malik, 2007; Agnolucci, 2009; Kang et al., 2009; Arouri et al., 2011, among others.

Given the facts that the above mentioned models do not have a VAR attached (see Hammoudeh et al., 2009) and they are also excessive in parameters, many of which lack empirical explanations and often encounter convergence problems during estimation processes especially when additional exogenous variables are introduced to the conditional mean and variance equations, the current study uses the multivariate VAR(k)–GARCH(p,q) model proposed by Ling and McAleer (2003) as an interesting alternative. 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[19] of the series under investigation as well

[19] Kraft and Engle (1983), Engle et al. 1984), and Bollerslev et al. (1988) were thefirst to discuss multiple equation models with a multivariate ARCH structure.

as of conditional cross effects and volatility spillovers between the series. Specifically, the paper applies the VAR(1)-GARCH(1,1) specification. 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.

In this model, the conditional mean equation can be as follows:

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

where

$R_t = (r_t^s, r_t^o)'$ is the vector of returns on the general market index and oil price respectively.

$\mu = (\mu_t^s, \mu_t^o)'$ 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 prices of the following form:

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

$\varepsilon_t = (\varepsilon_t^s, \varepsilon_t^o)'$ is the vector representing the error terms of the conditional mean equations for stock and oil returns respectively.

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

$H_t = \begin{pmatrix} h_t^s & h_t^{so} \\ h_t^{so} & h_t^o \end{pmatrix}$ is the matrix of conditional variances of stock and oil returns with h_t^s and h_t^o being the conditional variances of r_t^s and r_t^o respectively. Their time series dynamics are modelled as follows:

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

$$h_t^o = C_o^2 + \beta_{o1}^2 h_{t-1}^o + \alpha_{o1}^2(\varepsilon_{t-1}^o)^2 + \beta_{o2}^2 h_{t-1}^s + \alpha_{o2}^2(\varepsilon_{t-1}^s)^2 \tag{3}$$

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 and across the two markets under investigation. The cross values of error terms, $(\varepsilon_{t-1}^o)^2$ and $(\varepsilon_{t-1}^s)^2$, represent the return innovations in the oil market and to the corresponding stock rate at time $(t-1)$, and thus capture the impact of direct effects of shock transmission. The transfer of risk between the two markets is accounted for by the lagged conditional volatilities, h_{t-1}^o 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:

$A = \begin{pmatrix} \alpha_{s1}^2 & \alpha_{s2}^2 \\ \alpha_{o2}^2 & \alpha_{o1}^2 \end{pmatrix}$ and $B = \begin{pmatrix} \beta_{s1}^2 & \beta_{s2}^2 \\ \beta_{o2}^2 & \beta_{o1}^2 \end{pmatrix}$

The conditional covariance between oil returns and stock market returns in the bivariate VAR(1)-GARCH(1,1) is modeled as:

$$h_t^{eo} = \rho * \sqrt{h_t^e} * \sqrt{h_t^o} \qquad (4)$$

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

Overall, the proposed empirical model simultaneously allows to capture both return and volatility spillover effects between the crude oil 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.

5. Data and Preliminary Analysis

5.1 The data used for the analysis

The data set used in this study consists of daily observations on crude oil price and the closing value of the KSE index. Both series span from January 2, 2008 to October 20, 2014. Daily frequency is used because it affords an opportunity to capture the intensity of the dynamics of the relationship between the two variables. 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 Alloui 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 (January 2, 2008-July 30, 2011 and August 1, 2011- October 20, 2014). Data on crude oil prices are extracted from the US Energy Information Administration (EIA) database. While the data for the KSE index prices are obtained from the KSE database.

Daily returns on the two variables are computed by taking the difference in logarithm of two successive prices. Daily returns, in percentage, for the two series are computed as follows:

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

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

Here, P_t^o and r_t^o are the daily crude oil prices and their returns respectively. P_t^s and r_t^s denote daily closing values of the KSE index and their returns respectively.

5.2 Descriptive Statistics of KSE index and crude oil prices

To specify the distributional properties of the daily observations of oil prices, and KSE index along with their returns during the sample period, some descriptive statistics are reported in Tables 4 and 5.

Both returns series have small means (very close to zero). For each one, the standard deviation is much greater than the mean in absolute value, indicating that the mean is not significantly different from zero. Additionally, in view of the value of standard deviation (an indication of unconditional variance in the return series) regarding the mean value it is very clear that oil market is characterized by higher volatility and risky nature in comparison with stock returns. The results also indicate that both 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 distribution of daily returns is non-normal at a p-value of almost 1%. As for comparing the behavior of the KSE index before and after the secession of South Sudan, Table 4 indicates that the average value of the KSE index in the aftermath of the secession is greater than before the secession and with higher volatility. This feature is also true for the returns series (Table 5) but with less volatility. The unconditional correlation between the two markets is very weak especially in the post secession period.

Figs. 4 and 5 display the KSE index, crude oil prices and their returns. Fig. 4 shows that the KSE index experienced large fluctuations in two periods (left panel). The first one: after the recent global financial crisis and the other one occurred in the aftermath of the secession of South Sudan. This feature is also applied for the returns on the KSE index (right panel). In the same way, Fig. 5 shows that the higher fluctuations in oil market during the period after the South Sudan secession is accompanied with higher fluctuation in the Sudanese stock market. To some extent, there is a comovement between the two series 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 both return 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).

5.3 Testing for heteroscedasticity

As the main interest of this paper is to investigate volatility transmission between oil market and Khartoum stock exchange, it is very important to start by testing for the presence of ARCH effects. For this purpose, the paper applies the Lagrange Multiplier (LM) test proposed by Engle (1982) to the residuals of simple time series models of the returns. In summary, the test procedure is performed by first obtaining the residuals e_t from the ordinary least squares regression of the conditional mean equation which might be an autoregressive (AR) process, moving average (MA) process or a combination of AR and MA processes, i.e. an ARMA process. For example, in the ARMA (1,1) process the conditional mean equation will be:

$$r_t = \emptyset_1 r_{t-1} + \varepsilon_t + \theta_1 \varepsilon_{t-1} \quad (7)$$

After obtaining the residuals e_t, the next step consists in regressing the squared residuals on a constant and q lags[20] as in the following equation:

$$e_t^2 = \beta_0 + \beta_1 e_{t-1}^2 + \beta_2 e_{t-2}^2 + \cdots + \beta_q e_{t-q}^2 + v_t \quad (8)$$

20 The appropriate number of lags can either be determined by the span of the data (i.e. 4 for quarterly data) or by an information criteria.

The null hypothesis that there is no autoregressive conditional heteroscedasticity (ARCH) up to order q can be formulated as:

$H_0 : \beta_1 = \beta_2 = \cdots = \beta_q = 0$, against the alternative: $H_1 : \beta_i > 0$, for at least one i = 1, 2, …, q.

The test statistic for the joint significance of the q-lagged squared residuals is given by the number of observations times the R-squared (TR^2) of the regression (8). TR^2 is evaluated against the $\chi^2(q)$ distribution. This represents an asymptotically locally most powerful test (Rachev et al., 2007). In this paper, ARMA (1,1) model for the conditional mean in returns of oil prices and KSE index is employed as an initial regression. Then, the null hypothesis that there are no ARCH effects in the residual series is tested up to lag 30 corresponding to one trading month. The results of this examination are summarized in Table 6.

From Table 6, it is very clear that for all lags included, the 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 oil prices and KSE index is non-constant. The presence of ARCH effects in the two series is a justification to use the GARCH methodology.

6. Empirical Results

It is now possible to proceed with modeling the response of the Sudanese stock market to oil price fluctuations 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[21]. The results of returns and volatility spillovers are presented in Tables 7.

The empirical findings 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).

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,In contrast, the autoregressive term of oil is insignificantly different from zero during the post secession period.

As for shock dependence and volatility persistent (ARCH and GARCH coefficients), the results of Table 7 indicate that they are statistically significant in all cases. 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

21If the variance equation of GARCH model is correctly specified, there should be no ARCH effect left in the residuals.

can be considered as an explosive process especially after the secession of South Sudan. This result is completely consistent with the turbulent macroeconomic environment in Sudan over the last few years.The results also indicate that the two markets are sensitive to past own volatility given that the GARCH terms appear to be significant for all cases. This finding typically suggests that past values of the conditional volatility can be employed to forecast future volatility. Additionally, the results suggest that the current conditional volatility of KSE index returns depends on past shocks affecting return dynamics since ARCH-terms are highly significant for all sub-periods. This suggests that the conditional variance of stock market does not only depend on its immediate past values and innovations but also on those of the oil market 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). On the other hand, the GARCH-terms, which capture the impact of past volatility on current volatility, are substantially large for oil market indicating gradual fluctuations over time, but not the case for the KSE index returns.

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 $(\varepsilon_{t-1}^{o})^2$. Apparently, a shock originating from the oil market leads to increase stock returns volatility. In addition, there is strong evidence to suggest that past volatility of the oil market is transmitted to stock market because the coefficients associated with h_{t-1}^{o} are statistically significant.

Some diagnostics tests such as the Ljung–Box (LB) test for autocorrelation and ARCH LM test for ARCH effects are reported in the last part of Table 7 to validate the estimates of the VAR-GARCH model. LB statistic suggests that the null hypothesis of no autocorrelation cannot be rejected for all cases; thus, the residuals are free of autocorrelation. The ARCH-LM test suggests that the null hypothesis of no ARCH effects cannot be rejected, implying that the residuals do not suffer from the ARCH effects which means that VAR(1)-GARCH(1,1) has effectively captured the ARCH effects.

Estimated conditional volatility graphs (as conditional standard deviation) for the two markets are provided in Figs. 6-8. The most striking feature from Fig. 6 is that although the crude oil market experienced higher volatility by the end of 2008 as a result of the recent global financial crisis, KSE experienced such type of volatility after almost two years. In contrast, the market started to experience another episode of volatility in only few months after the secession of South Sudan. Generally speaking, the Figs. 6-8 depict higher volatility in KSE index after the secession of South Sudan confirming the results of the conditional mean and variance equations of Table 7.

To sum up, the findings of this paper lend support to volatility spillover between crude oil and stock markets exits in empirical finance literature. This result is consistent with some empirical literature worldwide (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).The estimated VAR(1)-GARCH(1,1) model seems to be more appropriate in dealing with returns and volatility spillover impacts between the two markets. Generally, the paper tells that the Sudanese stock market has become more volatile in the aftermath of the secession of South Sudan.

The justification of why Khartoum stock market has experienced higher volatility after the secession can be based mainly on the changing nature of the Sudanese economy during the past few years. In fact, since the late 1999, the economy has become increasingly dependent on oil for exports and revenues. The advent of oil in 1999-2011 represented a positive oil shock that has enabled Sudan to gain self-sufficiency in oil to satisfy domestic demand and therefore, significantly changes the position of Sudan's economy. With the increased oil production, high oil prices, and the significant inflows of foreign direct investment, the economy of Sudan boomed for nearly a decade. Over this period, oil wealth led to many remarkable improvements of various sectors of the Sudan's economy. This includes: stabilized the exchange rate, sound economic growth, for example, the size of its economy, measured by gross domestic product, has grown fivefold- from $10 billion in 1999 to $53 billion in 2008. per capita income has increased from $334 to $532 in constant dollar terms over the same period, in contrast to being range-bound between $200-300 since the 1960s (The World Bank, 2010). The Sudanese economy has also become more integrated with rest of the world- its trade to GDP ratio has increased from 25 per cent in 2000 to 44 percent in 2008, and the country has emerged as one of the highest recipients of foreign direct investment in Africa (the World Bank, 2010).This sound macroeconomy environment had let to some extend to improve the performance of the Khartoum stock exchange.

However, by the end of 2011 the situation has completely changed after the secession of south Sudan on July 9, 2011. This secession represented a negative oil shock that led to a broad-based slowdown in the aggregate economic activity. As a result of this permanent shock, Sudan lost almost 75 percent of its oil production, nearly 55 percent of its fiscal revenues, and about two-thirds of its foreign exchange earnings. Accompanied with a weak policy response, this shock led to chronic economic problems such as increases in foreign debts, the depletion of foreign exchange reserves, national currency depreciation, high double digits inflation, and internal and external disequilibria.

Within this turbulent macroeconomic environment, it is not surprisingly to expect that the Sudanese stock market, as a reliable barometer of the overall economy performance, will show negative responses to this significant oil shock. Of course, higher stock market volatility represents one aspect of these potential responses. It is also worth mentioning at this juncture that oil price shocks tend to affect consumer and investor confidence and the demand for financial products which will definitely have important effects on the dynamics of the overall stock market performance.

7. Concluding Remarks and Implications

Over the last few decades the unprecedented and high fluctuations in crude the oil prices have bolstered an active line of research relating oil price movements to a wide range of macroeconomic aggregates for both oil-importing and oil-exporting countries. One active area of empirical research has been focusing on the impact of oil on the stock market performance given the fact that a clear understanding of the co-movements between these quantities has important implications for investors, portfolio managers and policymakers. It offers insights into building accurate asset pricing models and accurate forecasts of the return and volatility of both markets. Motivated by this importance, this paper has investigated the dynamic relationship between crude oil price fluctuations and the performance of the Sudanese stock market measured by the KSE general index over the period January 2, 2008 to October 20, 2014. The paper employs a bivaraiteVAR-GARCH model recently developed by Ling and McAleer (2003) to simultaneously estimate the conditional mean and conditional variance of returns on crude oil prices and the closing values of the KSE index. Based on the secession of South Sudan in July 9, 2011, the paper uses a sub-period analysis by splitting the whole sample period into two sub-periods (January 2, 2008-July 30, 2001 and August 1, 2011- October 20, 2014).

Empirical results of the conditional mean equations document that there is evidence of short-term predictability in the KSE index returns and also reveal that crude oil prices has a significant impact on KSE index movements only for the period before the secession of South Sudan. Additionally, the paper also investigates volatility transmission between the two markets. Based on the conditional variance equations, empirical findings indicate that the conditional volatility of the returns on KSE index is affected not only by its own volatility, but also by innovations in the oil market over the period of study.

As for the impact of the secession of South Sudan and its serious repercussions, the empirical results show that Khartoum stock exchange has experienced higher volatility in the aftermath of the secession, a result that is completely consistent with the turbulent macroeconomic environment in Sudan over the last few years.

The empirical results regarding interdependence between crude oil and stock market have some important implications for investors, portfolio managers and policymakers. It offers insights into building accurate asset pricing models and accurate forecasts of the return and volatility of both markets. Without any doubt this will help, for example, portfolio managers and policymakers to adjust their actions to prevent contagion risks in the event of market crashes or crises. The results of the paper also represent a good starting point for the policy makers in their attempt to curb higher volatility in the Sudanese stock market. This is simply because higher levels of volatility cannot be reduced without a clear determination of the major driving forces behind this volatility.

Lastly, for a better understanding of the higher volatility in the Sudanese stock market, there are several possible extensions of this article. Within the context of the nexus of oil price-stock return, it is left to future empirical research, when appropriate data will be available, to study in more detail the impact of crude oil price fluctuations from a sector perspective to shed more light on industry-specific characteristics. For example, one line of possible research can address the issue of volatility spillover between the general market index to sectoral indices from one side, and between crude oil shocks and the market sectors from the other side. This is simply because different sectors (industries) may respond differently to crude oil shocks.

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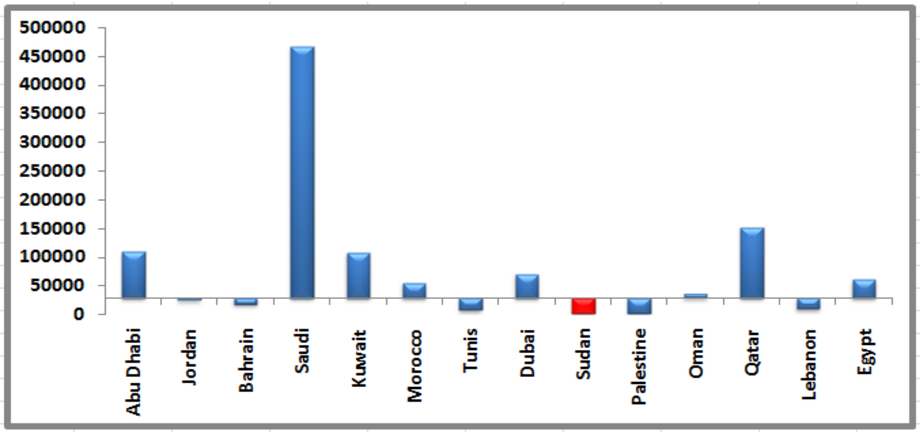
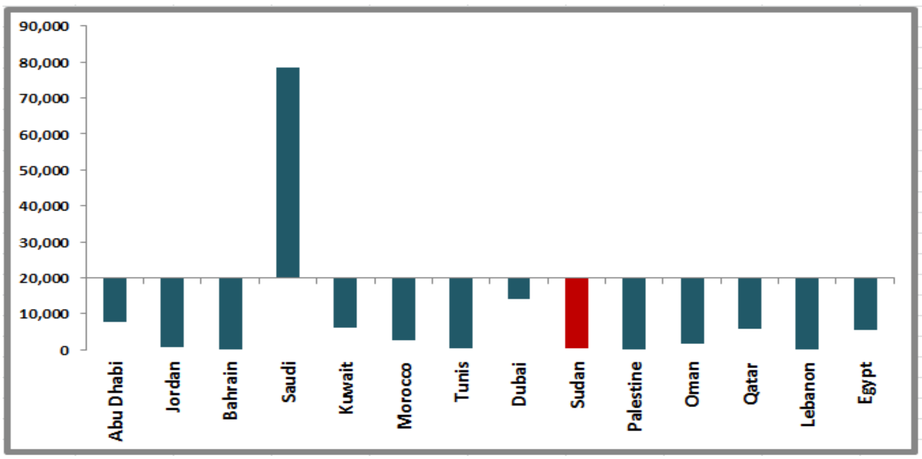
Figure 1: Markets Capitalization in Selected Arab Markets (Million $U.S.), End-2013



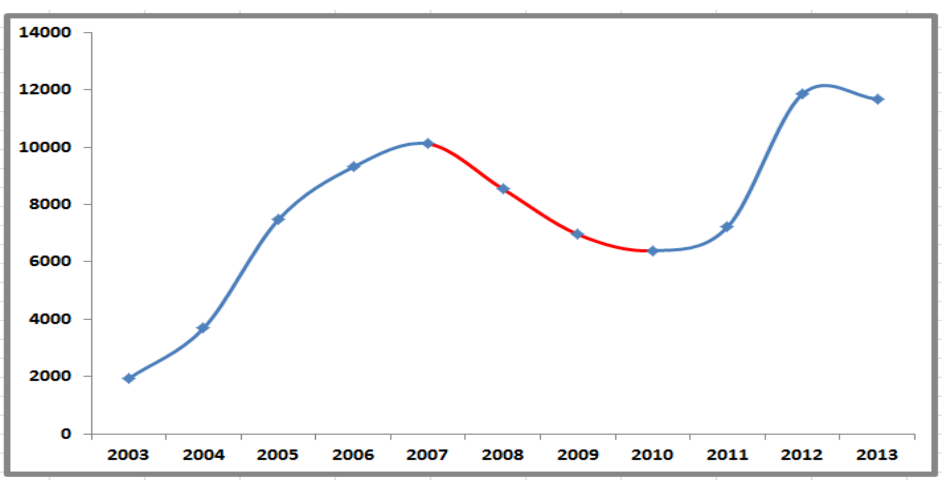
Source: Arab Monetary Fund.

Figure 2: Value Traded in Selected Arab Markets (Million $U.S.), End-2013



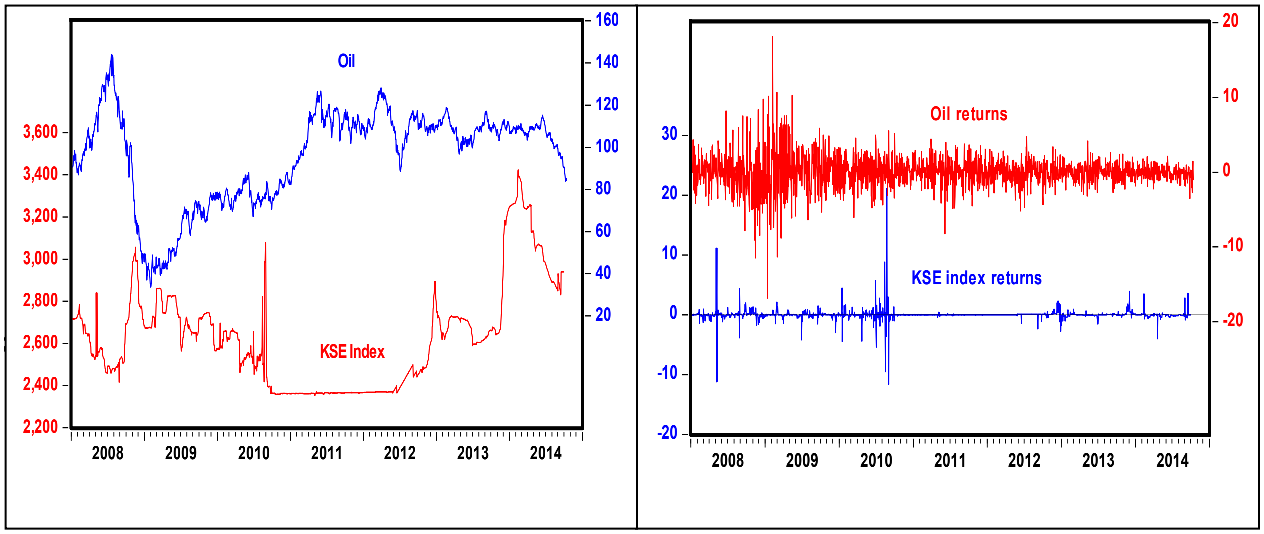
Source: Arab Monetary Fund.

Figure 3: KSE Market Capitalization (SDG millions), 2003-2013

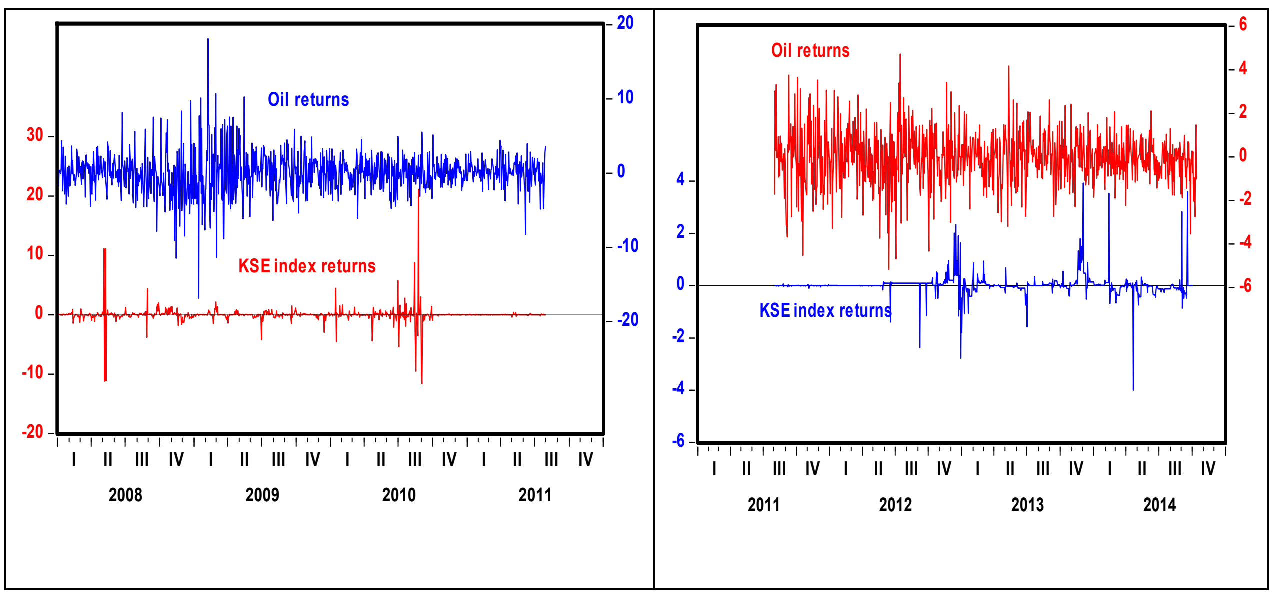


Source: Khartoum Stock Exchange

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

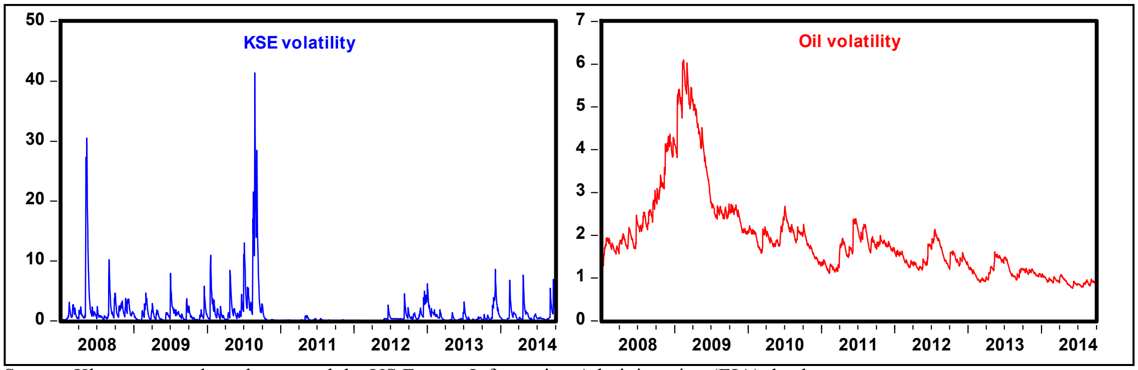


Before the Secession of South Sudan	Before the Secession of South Sudan



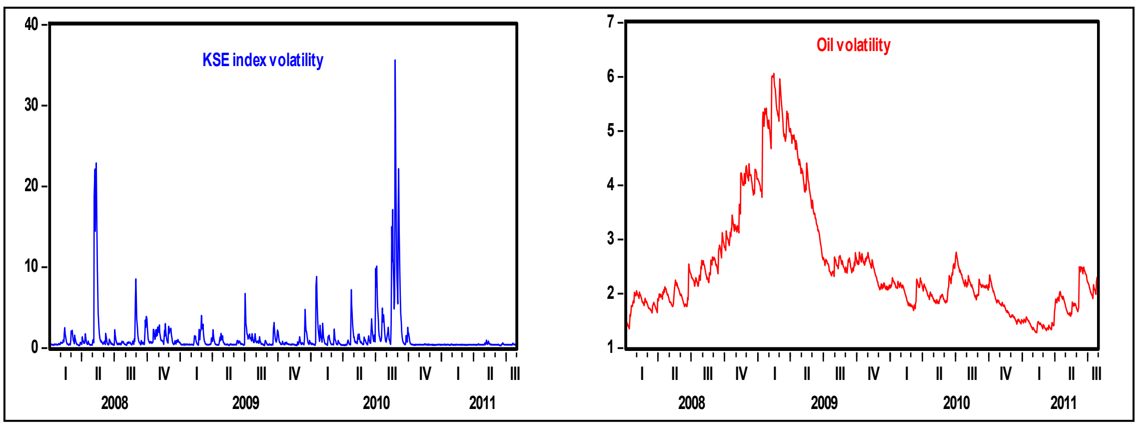
Source: Khartoum stock exchange and the US Energy Information Administration (EIA) database

Figure 6: Volatility of Crude oil prices and KSE index (January 2, 2008 – October 20, 2014)



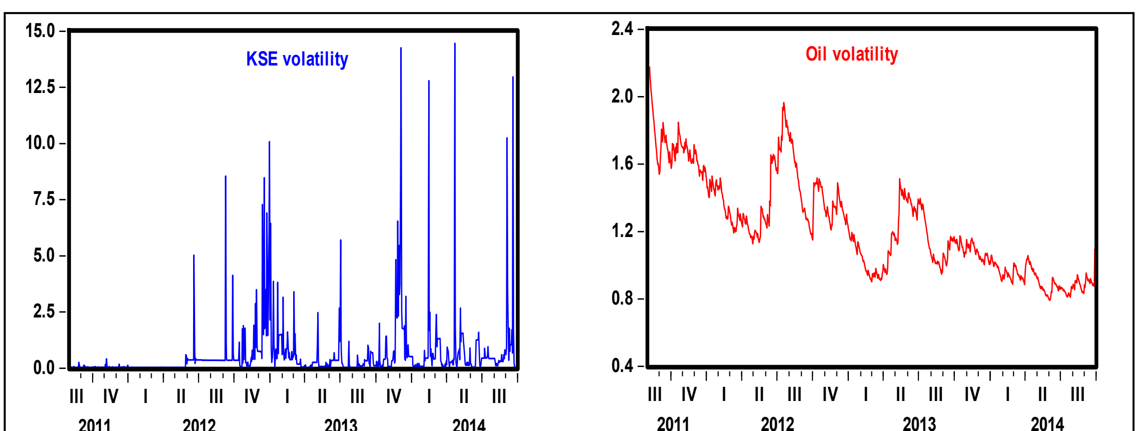
Source: Khartoum stock exchange and the US Energy Information Administration (EIA) database

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

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.

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 (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 (various issues) and own calculation

Table 4: Summary Statistics For Crude Oil Prices and KSE Index (2/1/2008-20/10/2014)

Measures	Crude Oil Prices	KSE Index		
		Before Secession	After Secession	Full Sample Period
Mean	95.79	2586.14	2673.09	2626.97
Std. dev.	22.39	168.81	300.64	243.74
Maximum	143.95	3077.12	3423.37	3423.37
Minimum	33.37	2353.20	2365.02	2353.20
Skewness	-0.79	0.24	0.77	1.01
Excess Kurtosis	2.86	2.38	2.47	3.66
Jarque-Bera	185.25[a]	23.75[a]	91.88[a]	328.41[a]
Correlation with Oil		-0.56	-0.26	-0.17
No. of Observations	1770	934	827	1761

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

Table 5: Summary Statistics For Returns On Crude Oil Prices and KSE Index (2/1/2008-20/10/2014)

Measures	Oil Returns	Returns on KSE Index		
		Before Secession	After Secession	Full Sample Period
Mean	-0.0052	-0.0148	0.0263	0.0045
Std. dev.	2.1535	1.3585	0.4222	1.0305
Maximum	18.1297	21.1228	3.3937	21.1228
Minimum	-16.8320	-11.6074	-3.9978	-11.6074
Skewness	0.0947	2.8156	1.7141	3.4259
Excess Kurtosis	11.0428	97.4340	42.407	156.1724
Jarque-Bera	4770.65[a]	347912[a]	53851.8[a]	1723974[a]
Correlation with Oil		0.0327	-0.0039	0.0281
No. of Observations	1769	933	826	1760

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

Table 6: ARCH-LM Test for Residuals of Returns on the KSE Market

Lags	Crude oil returns		KSE index returns	
	ARCH-LM test statistic	Prob.	ARCH-LM test statistic	Prob.
1	48.459	0.0000	51.623	0.0000
5	128.42	0.0000	86.264	0.0000
10	163.41	0.0000	310.04	0.0000
15	300.96	0.0000	316.58	0.0000
20	403.14	0.0000	317.43	0.0000
30	416.53	0.0000	316.83	0.0000

Note: H_0: There are no ARCH effects in the residual series.

Table 7: Estimation Results of VAR(1)-GARCH(1,1) Model for Oil 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(5)	1.7500	0.6657	0.4472
ARCH(15)	9.3172	3.6067	1.2522
ARCH(30)	9.1875	4.0775	15.231
$LB^2(12)$	10.028	3.8519	24.633

Note: ARCH(5, 15, and 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.