



Oil price fluctuation, volatility spillover and the Ghanaian equity market: Implication for portfolio management and hedging effectiveness



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ABSTRACT

This study attempts to contribute to the literature on stock markets and energy prices by examining the dynamic volatility and volatility transmission between oil and Ghanaian stock market returns in a multivariate setting using the recently developed VAR–GARCH, VAR–AGARCH and DCC–GARCH frameworks. In turn, the models' results are used to compute and analyze the optimal weights and hedge ratios for oil-stock portfolio holdings. For comparison purposes and to put the paper more in the perspective of West Africa, the Nigerian stock market is also included in the analysis. Our findings point to the existence of significant volatility spillover and interdependence between oil and the two stock market returns. While spillover effects are stronger for Nigeria, the transmission of volatility is much more apparent from oil to stock than from stock to oil in the case of Ghana. Also, the study demonstrates evidence of short-term predictability in oil and stock price changes through time and reveals that conditional volatility changes more rapidly as result of substantial effects of past volatility rather than past news/shocks for all market returns. Moreover, we show that there is a slightly more effective hedge in the two stock markets under the DCC–GARCH framework (our preferred model) compared to the other two models, although hedging effectiveness is much greater for Ghana. On the whole, our findings for optimal hedge ratios are consistent with other studies and particularly the view that oil assets should be an integral part of a diversified portfolio of stocks and suggest that a better understanding of volatility links is crucial for portfolio management in the presence of oil price risk. Finally, the existence of multivariate asymmetric effects and dynamic conditional correlations as revealed by the VAR–AGARCH and DCC–GARCH models make it clear that the assumptions of symmetric effects and constant conditional correlations are not supported empirically.

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1. Introduction

Following the 1970s oil price shocks and the seminal work of Hamilton (1983) establishing oil price shocks as a factor contributing to recession in the United States, studies on the connections between oil price and the macro-economy have become of significant interest to financial practitioners, market participants and researchers. In particular, much attention has been attracted to the relationships between oil price shocks and stock markets, with the bulk of this literature focusing on developed countries. This interest has been fueled by the potential impacts of oil price changes on stock prices through their effects on corporate cash-flows and earnings, particularly being forced by the context of spectacular oil price fluctuations over the last years. In fact, Lin and Wesseh (2013c) note that fuel prices are subject to fluctuation making

conventional sources of energy risky from a cost perspective. Reflecting on insights from the theory of equity valuation, since corporate cash-flows and discount rate reflect economic conditions such as inflation, interest rates, production costs, income, economic growth, and market confidence, etc., which can be influenced by oil shocks, stock prices may react significantly to patterns in oil price changes (Arouri et al., 2012).

This study is therefore an attempt to add to the scarce literature (see Section 3) on developing countries and emerging markets especially in the context of Africa. To this end, we investigate the connections between oil prices and the stock market of Ghana, a country viewed as one of the economies that are going to be among the strongest growing in Africa. For comparison purposes and to put the paper more in the perspective of West Africa,¹ we also include the Nigerian stock market in

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¹ To the best of our knowledge, there are only three stock markets in West Africa currently. According to some unpublished and unofficial documents, the Ghanaian stock market and Nigerian stock market combined would constitute more than 70% of the total stock market capitalization in West Africa.

the analysis. It is no doubt that most Sub-Saharan African countries suffer serious research vacuum and the literature seems to pay no attention to these countries despite their dependency on oil and considerable growth records. Our analysis is particularly motivated by the lack of related studies for Ghana. Indeed, studies of this nature are crucial for developing policy options in Africa (see [Wesseh and Niu, 2012](#); [Wesseh et al., 2013](#)). The present paper has two major objectives: (1) To examine own conditional volatility for oil price returns and stock market returns and conditional cross series volatility transmission between oil price returns and stock market returns of Ghana and Nigeria, and (2) To use the estimated results to compute the weights of the series in an optimal portfolio of Ghana and Nigeria, and the optimal hedge ratios that minimize overall risk for holding the series in portfolios without affecting the expected returns in the two countries. Indeed, such an analysis is important for building accurate asset pricing models, generating accurate forecasts of the volatility of all markets, and evaluating the oil risk exposure via value-at-risk calculation. In addition, empirical insights from such analysis are equally crucial for hedging strategies and derivatives management (see [Arouri et al., 2012](#); [Ewing et al., 2002](#); [Vo, 2009](#)).

At the empirical stage, we employ more recent and robust econometric techniques that examine shock and volatility. In particular, we apply three multivariate vector autoregressive-generalized autoregressive conditional heteroscedasticity models, VAR-GARCH developed by [Ling and McAleer \(2003\)](#), VAR-AGARCH proposed by [McAleer et al. \(2009\)](#) capable of capturing asymmetric relationships between returns, and the DCC-GARCH model proposed by [Engle \(2002\)](#). The models adopted offer the possibility to explore the conditional volatility dynamics of the series considered as well as the conditional cross effects and volatility spillover between series. They also provide meaningful estimates of the model's parameters with fewer computational complications than several other multivariate GARCH specifications. Furthermore, findings from the model can be used to analyze the diversification and hedging effectiveness across oil asset and markets equity. While a number of authors have applied the VAR-GARCH approach to various economic issues (e.g. [Arouri et al., 2012](#); [Chan et al., 2005](#); [Chang et al., 2011](#); [Hammoudeh et al., 2009, 2010](#)), to our knowledge, this study will be the first to apply the VAR-AGARCH model to emerging stock markets.

The remainder of the article is organized as follows. [Section 2](#) discusses the significance of oil prices to Ghanaian stock market in particular and economy in general and gives an overview of the Ghanaian stock market. [Section 3](#) presents findings of previous works on the links between oil price and stock markets. [Section 4](#) provides summary statistics of the dataset and its stochastic properties. Our empirical methodology and estimation technique is introduced and discussed in [Section 5](#). [Section 6](#) presents and discusses the obtained results. [Section 7](#) draws the conclusion.

2. Oil prices and the Ghanaian stock market/economy

In this section, the significance of examining oil prices in relation to the Ghanaian stock market is justified. In addition, an overview of the Ghanaian stock market is presented.

2.1. Significance of oil prices

Ghana has over the past years been a net-importer of oil even after discovering and consequently lifting oil in commercial quantities in 2010. Scientific studies have shown that energy consumption makes a significant contribution to the economic growth of Ghana of which oil forms a substantial part (e.g. see [Akinlo, 2008](#)). Thus, petroleum consumption forms a cardinal part of Ghana's energy mix. As evidenced by statistical records from the World Bank database, petroleum consumption as a percentage of total energy consumption over the past few years has been above 50% and in the neighborhood of 70% in the years under focus in this study (see [Fig. 1](#)).

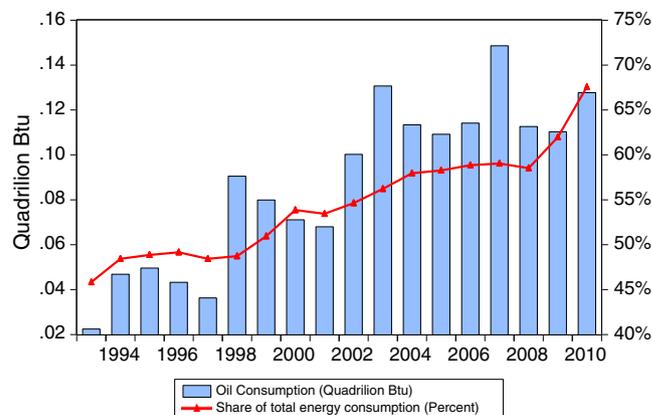


Fig. 1. Oil consumption as a share of total energy consumption in Ghana.

To further demonstrate the importance of oil to the Ghanaian economy and in so far as data could be accessed, the sectoral fuel mix (for 1999 and 2006) and sectoral oil consumption (for 2006) are presented in [Table 1](#) and [Fig. 2](#) respectively. As may be observed, Ghana has been highly oil dependent with the transport and agricultural sectors being the least diversified in terms on energy usage. Thus, the significance of oil as source of energy for productive activities in the Ghanaian economy cannot be underestimated at least for the past few years.

Moreover, manufacturing and mining industries which heavily rely on oil for most of their productive activities form the second largest in terms number of companies listed on the Ghana Stock Exchange and the biggest in terms of market capitalization. The phenomenal role of Ghana stock exchange in the development of the Ghanaian economy can be further justified by the turnover ratio.² The GSE recorded a turnover of 34.8% which was a bit close to the global average of 57.8% in 1994 followed by 25.5%, 21.5%, 16.5% and 29.8 in 1995, 1996, 1997 and 2004 respectively. Thus, in light of the above statistics, the implications of oil price fluctuations on the GSE in particular and the economy of Ghana in general is far reaching and would inevitably warrant a study of this nature.

At this junction, it has to be pointed out that although Ghana recently scrapped costly fuel subsidies to help restore fiscal stability, the country has practiced a subsidy policy on petroleum products during the period spanned in this study. According to [IMF \(2006\)](#), the proportion of financial resources consumed in explicit subsidy payments to oil refineries and distributors to compensate for below-formula prices reached 2.2% of Ghanaian GDP in 2004, equivalent to around 3.2% on an annualized basis. With the subsidy program, it is still a matter of debate that prices of petroleum products in Ghana over the sample period were proportionally lower than international oil prices.³

2.2. Overview of the Ghanaian stock market

The Ghana Stock Exchange was established in July 1989 as a private company limited by guarantee under the Companies Code of 1963. It was given recognition as an authorized Stock Exchange under the Stock Exchange Act of 1971 (Act 384) in October 1990. The Council of the Exchange was inaugurated on November 12, 1990 and trading commenced on its floor the same day. The Exchange changed its status to a public company limited by guarantee in April 1994.

The analysis in this study is based on the GSE-ASI which was the principal index until at the end 2010 in which it was replaced by the GSE-CI. It comprised all listed stocks on the GSE and measured the

² This represents the stock market capitalization as a proportion of GDP.

³ The inability to access data prevents the researchers from showing the disconnections between Ghanaian petroleum prices and the international crude oil prices over the sample period.

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