EERI

Economics and Econometrics Research Institute

Macroeconomic Development and Stock Market Performance: A Non-Parametric Approach

George Adu, George Marbuah , Justice Tei Mensah, Prince Boakye Frimpong

EERI Research Paper Series No 01/2013

ISSN: 2031-4892

EERI
Economics and Econometrics Research Institute
Avenue de Beaulieu
1160 Brussels
Belgium

Tel: +322 298 8491
Fax: +322 298 8490
www.eeri.eu

Macroeconomic Development and Stock Market Performance

A Non-Parametric Approach

George Adu
Department of Economics, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana Email: gadu.cass@knust.edu.gh

George Marbuah
Department of Economics, Swedish University of Agricultural Sciences, Box 7013, SE-75007, Uppsala, Sweden

Email: George.Marbuah@slu.se

Justice Tei Mensah
Department of Economics, Swedish University of Agricultural Sciences, Box 7013, SE-75007, Uppsala, Sweden

Email: Justice.tei.mensah@slu.se

Prince Boakye Frimpong
Economics Unit, School of Business, Garden City University College, Kenyasi, Kumasi, Ghana
Email: winconsin@yahoo.com

Macroeconomic Forces and Stock Market Performance in Ghana: A Robust Approach

ABSTRACT

This paper applies a local-linear non-parametric kernel regression technique to examine the effect of macroeconomic factors on stock market performance in Ghana. We show that the popular parametric specification in the existing literature suffers from functional misspecification. The evidence suggests that the relationship is non-linear and hence the implied elasticities are non-constant, contrary to findings in the literature. The main finding of the study suggests that stock prices are significantly affected by macroeconomic fundamentals and oil price shocks albeit weakly. This reinforces the need to closely monitor behaviour of macroeconomic indicators while sustaining prudent macroeconomic policy management.

Keywords: *Bandwidth, Ghana stock exchange, local-linear kernel regression, nonparametric*

JEL Classification: *C13, C14, G00, O55*

1. INTRODUCTION

Since the seminal works of Schumpeter (1911) on the role of the financial sector in the macroeconomic development of emerging economies, financial deepening has become a major anchor of economic growth in many countries. Financial deepening, especially the stock market, fuels economic development via increasing liquidity, risk sharing and diversification, efficient allocation of resources to productive investment and, reducing information and transaction costs (Ibrahim, 2011). This suggests that having a well-functioning and efficient stock market is central to the role of financial deepening as a key agent of growth and development in emerging economies. To this end, there is a growing literature on the impact of macroeconomic forces on stock market performance (both the developed and emerging markets). This paper contributes to this strand of the literature using nonparametric kernel regressions.

Studies extant in the literature on the long run relationship between macroeconomic indicators and stock prices (see for instance: Frimpong, 2009; Maysami and Sims, 2002; Hondroyiannis and Papapetrou, 2001; Muradoglu *et al.*, 2001; Maysami and Koh 2000) are mostly based on parametric specification of the functional form prior to estimation. A growing number of these studies investigating the economic variables-stock markets relationship are based on the traditional cointegration test to establish the existence or otherwise of long run relationship between them and parametric ARCH and GARCH models to analyse the implied market volatility. In this paper, we show that the parametric models are prone to misspecification of the functional form which could lead to biased estimates and wrong inferences.

First, applying the nonparametric consistent model specification test (see Hsiao *et al.*, 2007), we show that the imposed explicit parametric functional forms leading to constant elasticity (or constant marginal effects) estimates are mostly wrong. We therefore propose a non-parametric local-linear kernel regression approach to examine the influence of macroeconomic variables on stock markets performance based on the discounted cash flow or Present Value

Model (PVM) (see Frimpong, 2009 for similar framework). The PVM relates stock price to future expected cash flows and future discount rate of these cash flows. The model also postulates that all macroeconomic factors influencing future expected cash flows should have an influence on the stock price (Humpe and Macmillan, 2009).

To the best of our knowledge, this is the first paper that applies nonparametric kernel regressions methods to examine the impact of macroeconomic factors on the performance of the stock market. In addition, we extend the literature by controlling for the effect of oil price shocks on the performance of the capital market in Ghana within the nonparametric framework.

Ghana is a small open economy and a net importer of crude oil and related products whose prices are determined on the international commodity market. The economy is often exposed to severe external shocks due to unpredictable and fluctuating oil price trends with often dire impact on the national budget and current account component of the balance of payments. The import bill for oil has shown consistent surges over the last two decades on the current account balance. With an import bill of US$259 million in 1996, the figure more than doubled to US$520 million in 2000. By 2005, Ghana was importing oil to the tune of US$1.13 billion before hitting US$2.24 billion and a corresponding non-oil import bill of US$8.05 billion in 2010.[1]

With a huge oil import bill to shoulder over successive years, past and present Governments have initiated and implemented cross subsidization of crude oil prices by borrowing from the Ghana Commercial Bank to offset the huge oil bills of the Tema Oil Refinery (the only crude oil refinery in Ghana). This has often led to bringing the major public commercial bank to near collapse due to liquidity constraints on its balance sheets which incidentally is supposed to lend to small and medium-sized enterprises and other manufacturing entities. The final effect has often resulted in high interest rates on loans leading to financial crowding-out of the private sector hence affecting activities on the stock market. In addition,

[1] Data are taken from statistical bulletins of the Bank of Ghana and Ghana Statistical Service.

higher domestic prices of goods and services has been the phenomenon in times of higher crude oil prices on the international market due to the "minimal" pass-through effect on both consumers and producers with impact on interest rates and liquidity in the economy. Ghana's discovery of oil in commercial quantities and subsequent production from the last quarter of 2010 makes the sector even more important hence the need to account for its potential impact on various sectors of the economy including the capital market of the financial sector.

Thus, the present paper is important for Ghana as it brings to the fore new evidence on the relationship between stock market behaviour and selected macroeconomic indicators of the Ghanaian economy. As government continues with its efforts aimed at continuing the financial sector reform programme, findings of the paper would bring to the fore and contribute to the empirical literature on the need for prudent monetary and fiscal policies and strategies with concomitant implications for growth and development of the capital market in Ghana.

The analysis revealed that the popular linear parametric specification that dominates the empirical literature on this subject is incorrect. The evidence herein suggests that the relationship between the stock market index (our proxy indicator for market performance) and the set of regressors are nonlinear and hence the elasticities (partial response surfaces) are non-constant, contrary to the findings in the literature. In cases where we found linear relationship, after accounting for oil price shocks, our estimates of the response rates differ markedly from those obtained by Frimpong (2009) who used the same dataset but did not control for oil price effects on the stock market.

The rest of the paper is organized as follows. Section 2 reviews the relevant literature on the impact of macroeconomic factors and stock market performance. The empirical strategy adopted for this paper is outlined in Section 3 alongside data sources and variable descriptions. The results and discussions thereof are presented in Section 4, while Section 5 concludes the paper.

2. LITERATURE REVIEW

Interests in research on the impact of macroeconomic variables on stock market performance were stimulated following the work of Chen *et al*., (1986) and Hamao (1988). The former observes asset prices to be highly responsive to *unanticipated economic* news. They found both inflation, inflationary expectation, spread between long and short term inflation and industrial production to significantly influence asset prices. Oil price shocks however, had no effect on asset pricing. Hamao (1988), replicating the approach of Chen *et al*., (1986) found similar results for the Japanese stock market.

Boyd *et al*., (1996) studying the relationship between inflation and financial market performance found evidence that inflation is negatively correlated with financial market performance. The study further found significant nonlinearities between inflation and financial market performance.

A plethora of literature on the macroeconomic variables-stock performance nexus have been centered on examining the influence on macroeconomic variables on the stock market's composite index than stock market's sector indices. In an attempt to complement the literature in this area, Hamzah *et al.,* (2004) adopted the Singapore Exchange Sector indices − the finance index, the property index, and the hotel index. Findings from the study reveal that Singapore's stock market and the property index form cointegrating relationship with changes in the short and long-term interest rates, industrial production, price levels, exchange rate and money supply. In a similar vein, Pal and Mittal (2011) establishes that the capital markets indices (BSE Sensex and S&P CNX Nifty) in India are dependent on macroeconomic variables.

Auzairy *et al.,* (2011) also interrogated the subject matter in the ASEAN countries of Malaysia, Thailand and Indonesia using both univariate and multivariate regressions and found significant impact of macroeconomic variables on performance of the stock exchange.

Even though several empirical works document significant impact of macroeconomic variables (exchange rate, interest rate, and oil price) on stock market performance, the direction of impact has been mixed. Ibrahim and Hassanuddeen (2003) and Somoye *et al.,* (2009) found exchange rate to be negatively related to stock market returns in Malaysia and Nigeria respectively. Also Somoye *et al.,* (2009) finds that as a result of inflationary or discounted factor effect, interest rates are negatively related to stock market returns. Bilson *et al.,* (2001), however, finds a contrary conclusion. Studies on the Ghana Stock Exchange have also produced mixed results. Contrary to the earlier findings of Osei (2006) of a positive nexus between interest rates and stock prices, Kyereboah and Agyire-Tettey (2008) and Frimpong (2009) found otherwise. Frimpong (2009) further found exchange rate to have positive impact on stock prices whiles consumer price index, money supply, impacted negatively on stock prices in Ghana. Similar to the work of Frimpong (2009), Adjasi (2009) examines the influence of macroeconomic uncertainty on stock prices in Ghana. Adjasi (2009) finds significant positive volatility spillovers from cocoa prices and interest rate to the stock prices on the GSE whilst higher volatility in gold and oil prices, and money supply were found to reduce stock price volatility in Ghana. Quartey and Gaddah (2008) also finds economic forces (real income, gross domestic savings, domestic credit to the private sector, and exchange rate) to predict the long run development of the capital market in Ghana.

Evidence in terms of causality between macroeconomic forces and stock market performance varies across countries and the choice of indicators. For instance, Adjasi (2007) examining stock market returns and exchange rate dynamics in selected African countries, finds no significant causality between exchange rate movements and stock market returns for Ghana, Nigeria, Kenya, and South Africa. However, there were evidence of one-way causality from exchange rate to stock market returns in Egypt as against a reverse causality from in Kenya and Mauritius. Adjasi (2007) also finds a unidirectional causality from inflation to stock returns in Ghana and bidirectional causality between inflation and stock returns in Kenya. There was however no significant test results for Nigeria and Tunisia. On the other hand, Adam and Tweneboah (2008) finds a significant one way causality of interest rate and inflation on stock prices, whereas, other variables like FDI, oil prices, and exchange rate exert weak causality effects on stock prices in Ghana.

Empirical evidence from some Asian economies also show varying conclusion. Azman-Saini et al (2008) examining the causality between stock prices and exchange rate in the Pre-and Post-crises Malaysia reveal a bi-directional causality for the pre-crisis period and a one-way causality running from exchange rates to stock prices in the post-crises era. On the other hand Rahman and Uddin (2009) using the Toda and Yomantoto granger causality test finds no so there is no way causal relationship between stock prices and exchange rates among three Asian economies considered.

Interestingly, the majority of studies on macroeconomic variables and stock market returns exist for high income economies with fully fledged stock exchanges (Hamzah *et al.*, 2004; Ibrahim and Hassanuddeen, 2003; Ibrahim, 1999; Boyd *et al.*, 1996; Mukherjee and Naka, 1995; Hamao, 1988). Notwithstanding, few studies have been conducted in emerging markets (Muradoglu *et al.*, 2001; Vuyyuri, 2005; Hussainey and Ngoc, 2009; Pal and Mittal, 2011) especially in Africa (Osei, 2006; Kyereboah and Agyire-Tettey, 2008; Somoye *et al.,* 2009; Frimpong, 2009; Adjasi, 2009; Quartey and Gaddah, 2008).

This paper contributes to the literature on emerging countries but from a different perspective. Whereas previous studies investigated the nexus using variants of parametric approaches, this paper adopts a non-parametric approach.

3. THE MODEL AND EMPIRICAL STRATEGY

We draw on theory and existing empirical studies in selecting the macroeconomic variables related to stock prices for the present paper. Following Hamao (1988), Chen *et al.*, (1986) and Humpe and Macmillan (2009), we select our macroeconomic variables by formulating the following simple PVM:

$$P_t = \frac{E_t(d_{t+1})}{1+E_t r} + \frac{E_t(P_{t+1})}{1+E_t r} \tag{1}$$

where $E_t(\cdot)$ denotes the expectations operator conditional on all information available at time t, P_t is the real price of the stock at time t, $E_t(d_{t+1})$ is the expected annual (real) dividend per share at the end of the first year, $E_t(P_{t+1})$ is the expected (real) price of the share at the end of the first year and $E_t r$ is the expected (constant) market determined (real) discount rate or cost of capital.

By noting that $E_t P_{t+i} = \dfrac{E_t(d_{t+i+1})}{1+E_t r} + \dfrac{E_t(P_{t+i+1})}{1+E_t r}$ (2)

for $i = 1,..., N-1,$ by substituting equation (2) into equation (1) and repeatedly substituting for the expected future price term we get:

$$P_t = \sum_{i=1}^{N} \frac{E_t(d_{t+i})}{(1+E_t r)^i} + \frac{E_t(P_N)}{(1+E_t r)^N} \tag{3}$$

As $T \rightarrow \infty$, (3) becomes: $P_t = \sum_{i=1}^{\infty} \dfrac{E_t(d_{t+i})}{(1+E_t r)^i}$ (4)

From equation (4) the share price depends on the expected stream of dividend payments and the market discount rate. Hence, any macroeconomic variable that may be thought to influence expected future dividends and/or the discount rate could have a strong influence on aggregate stock prices (Chen *et al.*, (1986) and Humpe and Macmillan (2009)).

We therefore hypothesize that a country's stock index is influenced by growth in real output, interest rate, expected inflation rate, and risk premium (Frimpong, 2009). Thus following Chen *et al.*, (1986), Humpe and Macmillan (2009), Fama (1981) and other empirical studies, we posit that exchange rate, nominal interest rate, inflation rate and money supply will affect stock prices based on equation (4) and should therefore implicitly influence the Ghana Stock Exchange.

Based on Mukherjee and Naka (1995), we hypothesize a positive relation between the exchange rate and stock prices. A depreciation of the Singapore dollar will lead to an increase in demand for Ghana's exports and increase cash flows to the domestic economy, assuming that the demand for exports is sufficiently elastic. Conversely, expected appreciation of the Ghana Cedi will attract investments to the Ghanaian market. The rise in demand will push up the stock market level, suggesting stock market returns will be positively correlated to the changes in the exchange rates (Maysami *et al.*, 2004). In the case of the "Stock-Oriented" (Frankel, 1983) model, the exchange rate equates demand and supply for bonds and stocks. Therefore, expectations of relative currency movements have a significant impact on price movements of financially held assets. Depreciation of the domestic currency makes foreign investment more attractive to domestic investors with a depressing effect on stock market returns (Adjasi, 2009).

Several studies have established a negative relationship between inflation and stock prices. We also hypothesize that based on equation (4), an increase in the rate of inflation is likely to lead to economic tightening policies, which in turn increases the nominal risk-free rate and hence raises the discount rate in the valuation model explained above. The effect of a higher discount rate would not necessarily be neutralized by an increase in cash flows resulting from inflation, primarily because cash flows do not generally grow at the same rate as inflation (Fama and Schwert (1977); Chen *et al.*, (1986); Maysami *et al.*, 2004, Frimpong, 2009)).

The interest rate directly changes the discount rate in the valuation model and thus, influences current and future values of corporate cash flows. This will negatively affect stock prices in the following way. If substantial amount of stocks are purchased with borrowed money, an increase in interest rates would make stock transactions more costly. Investors will require a higher rate of return before investing. This will reduce demand and lead to stock price depreciation (Frimpong, 2009).

The effect of money supply on stock prices is an empirical issue. An increase in money supply would lead to inflation, and may increase the discount rate and reduce stock prices (Fama, 1981). However, the negative effects might be countered by the economic stimulus provided by money growth, which may increase future cash flows and stock prices (Mukherjee and Naka, 1995).

Oil and commodity prices are also hypothesized to capture the possible effects of external supply side shocks. An increase in oil prices will increase energy and production costs, reduce expected future cash flows and have a negative impact on stock market returns (Anderson and Subbaraman, 1996; Adjasi, 2009).

On the basis of the theoretical and empirical literature reviewed above, we posit the following specified model akin to Frimpong (2009) which takes a general form as follows:

$$GSE_t = f(EXR_t, INFL_t, INTR_t, M2+_t) + \varepsilon_t, \quad (5)$$

where *GSE* is the Ghana Stock Exchange (*GSE*) All-share index (serving as a proxy for stock market performance); *EXR* is the exchange rate (i.e. the Ghanaian currency Cedi[2] (GH¢) to the US dollar (US$) rate); *INFL* is the rate of inflation (average monthly inflation rate); *INTR* is the interest rate (proxied by the interest equivalent of the 91-day treasury bill rate) and *M2+* (broad money supply including foreign currency deposits) is the measure of money supply and ε_t is the stochastic error term. Frimpong (2009) estimated the parametric form of the model in equation (5) using standard time series econometric procedure. We argue here that the constant elasticity model estimated by Frimpong (2009) and similar studies may be incorrect if the assumed parametric functional form is wrong. We therefore propose a nonparametric regression approach

[2] Cedi (¢) is Ghana's official unit of currency generally denoted as GH¢. On 3rd July 2007, the Ghanaian cedi (GHC) was redenominated. The new Ghana cedi (GHS) is equal to 10,000 old Ghanaian Cedis (1 GHS = 10,000 GHC). The old currency remained in circulation alongside the new until December 2007. One Ghana cedi is divided into one hundred Ghana pesewas (Gp).

to answer the same research question as in Frimpong (2009). As a further extension of Frimpong (2009), we augment the model in equation (5) to take account of oil price shocks on the performance of the Ghana stock exchange using monthly data spanning the period 1990:11-2009:08 obtained from the Ghana Stock Exchange, Bank of Ghana and International Financial Statistics of the IMF.

A potential threat to estimating the model specified in equation (5) using a single equation technique is possible reverse causality. While the world price of crude oil and broad money supply could safely be assumed to be exogenous, same cannot be assumed for the interest rate, inflation and the exchange rate. There is possibility of reverse causality from the stock market index to these macro variables, thus creating endogeniety problem. However, the review of the literature does not support this reverse causality. Since existence of endogenous regressors could lead to wrong inference, we first test for existence of reverse causality between the stock index and the suspected variables using Granger Causality test. The results of this test are reported in Tables A2 and A3 of the appendix of the paper. The results of the pre-estimation test flatly rejected the hypothesis of Granger causality running from the stock market index on the one hand to inflation, interest rate and exchange rate on the other hand. This suggests that there is weak evidence of reverse causality and the model in (5) can be estimated nonparametrically without fear of endogenity.

One major setback of parametric methods is the model specification which has raised much concern in the nonparametric methods literature. Incorrect specified parametric model may lead to wrong inference. To justify the use of nonparametric approach, we apply Hsiao *et al.*, (2007) consistent model specification test to the parametric functional form used by Frimpong (2009). Having established that the assumed constant partial elasticity functional form is wrong, we estimate equation (5) using the local linear kernel estimator.[3] The local linear estimator possesses

[3] See Li and Racine, (2004; 2007) for detailed description of the local linear estimator.

the following advantages over other popular kernel methods such as the local constant estimator. First the traditional local constant kernel estimator is known to suffer from boundary bias, while the local linear estimator is known to be among the best boundary-correction methods so far. As noted by Li and Racine (2004, 2007), when the underlying relationship is somewhat linear, the resulting nonparametric estimator can have a convergence rate that is arbitrarily close to the parametric rate. Also, this estimator takes into account all possible nonlinearities and interactions among the variables in our model that the parametric model may not capture.

To estimate the market performance model in equation (5) using the local linear kernel estimator, we follow three steps. First, the optimal bandwidth is estimated using the Hurvich, *et al.*, (1998) Akaike Information Criterion (AIC) method for bandwidth selection, which is based on minimizing a modified AIC. Second, we estimate the nonparametric regression using the local linear estimator. This estimator, unlike the local constant estimator does not suffer from boundary bias and hence very good in applied settings as this. These first two steps are crucial to the methodology we apply here hence we describe them in detail from equations (6) to (11). The nonparametric regression model in terms of the general specification in equation (5) is

$$GSE_t = F(X_t) + \varepsilon_t, \qquad t = 1,...,T, \tag{6}$$

where X_t is a vector of q consisting of some sub set of the following regressors: *EXR, INFL, INTR, M2+* and *OILP*. The derivative of $F(X_t)$: $\beta(X) = \nabla F(X) \equiv \partial F(X)/\partial X$, where $\nabla F(X)$ is a $q \times 1$, and q is the number of regressors in the model.

Define $\Phi(X) = [F(X), \beta(X)']'$, so that $\Phi(X)$ is a $(q+1)\times 1$ vector –valued function whose first component is $F(X)$ and whose remaining q components are the first derivatives of $F(X)$. Taking a Taylor series of expansion $F(X_t)$ at X_i for some i, we get

$$F(X_t) = F(X_i) + (X_t - X_i)'\beta(X_i) + R_{it}, \tag{7}$$

where $R_{it} = F(X_t) - F(X_i) - (X_t - X_i)'\beta(X_i)$. Substituting equation (7) into (6), we rewrite equation (6) as

$$\begin{aligned} GSE_t &= F(X_i) + (X_t - X_i)'\beta(X_i) + R_{it} + \varepsilon_t \\ &= [1, (X_t - X_i)']\Phi(X_i) + R_{it} + \varepsilon_t \end{aligned} \tag{8}$$

A leave-one-out local linear kernel estimator of $\Phi(X_i)$ is obtained by a weighted regression of GSE_t on $[1,(X_t - X_i)']$ given by

$$\hat{\Phi}_{-i}(X_i) = \begin{pmatrix} \hat{F}_{-i}(X_i) \\ \hat{\beta}_{-i}(X_i) \end{pmatrix}$$

$$= \left[\sum_{t \neq i} W_{h,it} \begin{pmatrix} 1, & (X_t - X_i)' \\ X_t - X_i, & (X_t - X_i)(X_t - X_i)' \end{pmatrix} \right]^{-1} \sum_{j \neq i} W_{h,it} \begin{pmatrix} 1 \\ X_t - X_i \end{pmatrix} GSE_t, \qquad (9)$$

where $W_{h,it} = \Pi_{j=1}^{q} h_j^{-1} w[(X_{tj} - X_{ij})/h_j]$ is the product Kernel function and $h_j = h_j(T)$ is the bandwidth or smoothing parameter associate with the *j*th component of X.

Define a $(q+1)\times 1$ vector e_1 whose first element is one with the remaining elements being zero. The leave-one-out kernel estimator of $F(X_i)$ is given by $\hat{F}_{-i}(X_i) = e_1'\hat{\Phi}_{-i}(X_i)$ and we choose $h_1,...,h_q$ to minimize the least-squares cross-validation given by

$$CV(h_1,...,h_q) = \sum_{i=1}^{T} [GSE_i - \hat{F}_{-i}(X_i)]^2 \qquad (10)$$

We use $\hat{h} = (\hat{h}_1,...,\hat{h}_q)$ to denote the cross-validation choices of $h_1,...,h_q$ that minimize the expression in (9). Substituting the estimated optimal bandwidth parameters into equation (9), we then estimate $\Phi(X_i)$ by

$$\hat{\Phi}(X_i) = \begin{pmatrix} \hat{F}(X_i) \\ \hat{\beta}(X_i) \end{pmatrix}$$

$$= \left[\sum_{t \neq i} W_{\hat{h},it} \begin{pmatrix} 1, & (X_t - X_i)' \\ X_t - X_i, & (X_t - X_i)(X_t - X_i)' \end{pmatrix} \right]^{-1} \sum_{j \neq i} W_{\hat{h},it} \begin{pmatrix} 1 \\ X_t - X_i \end{pmatrix} GSE_t, \qquad (11)$$

where $W_{h,it} = \Pi_{j=1}^{q} \hat{h}_j^{-1} w[(X_{tj} - X_{ij})/\hat{h}_j]$, and we estimate $F(X_t)$ by $\hat{F}(X_t) = e_1'\hat{\Phi}(X_t)$.

As a final step, we plot the partial regression and partial gradient or partial response surfaces that measure how the dependent variable (log of *GSE*) and its response surface change in response to changes in one of the regressors, holding all other variables constant at their medians or modes. Thus a partial regression and partial gradient that measure how the outcome variable and its response surface change in response to changes in a covariate when all other covariates are held constant at their respective medians/modes. All the figures are plotted within 95% confidence band by bootstrapping.

4. EMPIRICAL RESULTS AND DISCUSSION

In this section, we present and discuss the key results of our estimations, starting with the functional specification test. Since we use the same data (though extended) and model as Frimpong (2009), we will compare the findings here with his constant elasticity estimates. The results of our estimations are presented in Tables 1 to 3 and Figures 1 to 4.

Each table has two panels (A&B) which reports the results for the models with and without the oil price shock. Table 1 presents the results of nonparametric consistent model specification test which tests the null hypothesis of correct parametric functional form. The results of the tests for both the model without oil price as in Frimpong (2009) and our augmented model with oil price shock rejects the null hypothesis of correct parametric specification at 0.1% percent error level. The implication of this is that the constant elasticity estimates of Frimpong (2009) are wrong at least for one of the regressors in the model.

(Insert Table 1 about here)

Since the hypothesis of the correct parametric model is rejected, we proceed with the nonparametric estimations of both the model without and with oil price shocks. The nonparametric estimation begins with estimation of the optimal bandwidths and the corresponding scale factors for each of the independent variables. The results of our bandwidths estimations are reported in Table 2. In the first model without the oil price shock, all the estimated bandwidths are lower than 0.5. Similarly, the scale factors all less than one except that of inflation that has a value of about 1.21. The implication for the rather low values of the bandwidths and scale factors is that the relationship between the Ghana Stock Market Index and its covariates is nonlinear, which supports our rejection of the linear parametric estimations. This finding will become more transparent when we start our analysis on Figures 1 and 2.

(Insert Table 2 about here)

The interesting finding here is that when we take account of the oil price shock, the bandwidths for the exchange rate and inflation becomes rather very large, while those for the remaining variables still stay below 0.5. The implication of this is that, the relationship between the Stock Market Index on the one hand and inflation and exchange rate on the other hand becomes linear after accounting for oil price shock. This means that inflation and exchange rate picked the effect of oil price shocks in the model without this variable. These together cast some doubts on the constant elasticity estimates obtained in Frimpong (2009) and other studies that use similar parametric forms.

Having estimated the optimal bandwidths, we use the information therein to estimate the local-linear kernel regression for the two alternative specifications. The results of the kernel regression estimations are presented in Table 3. Both models performed well in terms of their R-squared and residual standard errors. In the case of the model without controlling for oil price shocks, the estimated R-squared is 0.998 while the residual standard error is only 0.0058. Interestingly, the model that controls for the oil price shock has the same R-squared value as the model without, though with a lower residual standard error of 0.0048, which is lower. This further supports the relevance of the oil price in predicting the movements in the market index. The rather high R-squared values coupled with the relatively low residual standard errors for the nonparametric regressions are good indication that our model really fits the data well. The estimated relationships are presented as plots of partial regression relationships (figures 1 and 3) and partial gradients (figures 2 and 4).

(Insert Table 3 about here)

(Insert Figure 1 about here)

We now consider the 'partial regression' and 'partial gradient' or partial response surfaces that measure how the dependent variable (*log(GSE)*) and its response surface change in response to changes in an explanatory variable, holding all other variables constant at their medians/modes. All figures contain 95% variability bands using bootstrapping in 500 replications. The estimates of the local-linear kernel estimator for the stock market performance model are presented in Figures 1 and 2 (for the case without controlling for oil price) and Figures 3 and 4 when we allow for oil price shock.

(Insert Figure 2 about here)

The plots in Figures 1 and 2 reveal that there is negative nonlinear relationship between *logGSE* and *logEXR*. Remember that the exchange rate is measured in terms of Cedi per dollar and hence increase in the exchange rate implies depreciation of the cedi. Therefore, the estimated negative relationship between the stock market index and the exchange rate suggested that currency depreciation has negative repercussion on stock market performance. The reason is not farfetched: a depreciation of the domestic currency makes foreign investment more attractive to domestic investors. Figure 2 indicates that the relationship between the *logGSE* and *logEXR* is nonlinear, with the estimated response surface varying within the interval -4 to 2. This suggest that the constant elasticity of about 0.91 in Frimpong (2009) is quite misleading, though this value falls within our rage. The non-constancy of this elasticity is obvious from Figure 2.

The partial regression plots in Figure and the plots of partial gradients in Figure 2 show that there is a positive nonlinear relationship between the stock market index and the interest rate. In particular, the partial response surface shows a declining elasticity as the interest rate increases. Specifically, the partial response rate has a starting value of about 2.8 and declines to a low of nearly zero as the interest rate increases. Frimpong (2009) estimated this elasticity to be about -0.036 (though not statistically significant).

The plots in Figures 1 and 2 also show that there is nonlinear positive relationship between the stock market index and the rate of inflation. However, this relationship appears to be very weak and can be seen from Figure 1. The partial response rate is in the range of 0.1 and 0.4. Frimpong (2009) estimated this coefficient to be about -0.897. This clearly falls outside of our response surface. This is due to the wrong parametric form imposed on the process generating the *GSE* series. We also found money growth to have positive, although weak, relationship with the stock market index. The partial response surface of this variable ranges from about 0 to 3.5 while Frimpong (2009) estimated the constant long run elasticity of this variable at -1.753, falling completely outside our estimated response surface.

We now consider the extended model that controls for the effect of oil price shocks on stock market performance. The estimates of the local-linear kernel estimator for the market performance model with oil price shocks are presented in Figures 3 and 4. As before, Figures 3 and 4 present the plots of partial regression surfaces and partial response surface plots respectively.

From Figures 3 and 4, we observed that there is a negative linear relationship between the log of the exchange rate and the log of the Stock Market Index. The partial response rate is now constant at -0.41. Thus, by controlling for oil price shocks, the relationships change from nonlinear to linear. The plots in Figures 3 and 4 also show that there is a negative and almost linear relationship between the interest rate and the stock market index. Also, by controlling for oil price shock, the relationship between inflation turned from nonlinear to linear. However, the relationship appears to be very weak with the estimated response rate of about 0.01. The relationship between money supply and the market index is now very difficult to describe. It appears that the relationship becomes negative after some threshold level and turns back to positive after a certain threshold value. It is, however, clear that the relationship is nonlinear and the elasticity non-constant, contrary to the findings by Frimpong (2009).

(Insert Figure 3 about here)

The plots in Figures 3 and 4 also show that there is no definite relationship between the Stock Market Index and crude oil price. Though the relationship is nonlinear, the relationship appears to be rather weak with the response surface hovering around zero.

(Insert Figure 4 about here)

5. CONCLUSION

This paper applied nonparametric kernel regressions techniques to examine the impact of macroeconomic shocks on stock market performance. We develop a theoretical model of the Ghanaian bourse in relation to selected macroeconomic variables within the nonparametric framework which was found to yield robust estimates implying that investors, fund managers, monetary and fiscal authorities can make valid inferences from our results for purposes of further analysis and policy decision-making thus improving the informational efficiency of the Ghana Stock Exchange.

The analysis revealed that the popular linear parametric specification that dominates the empirical literature on this subject is incorrect. The evidence herein suggests that the relationship between the dependent variable and the set of regressors are nonlinear and hence the elasticities (partial response surfaces) are non-constant, contrary to the findings in the literature. In cases where we found linear relationship, after accounting for oil price shocks, our estimates of the response rates differ markedly from those obtained by Frimpong (2009) who used the same dataset as we do here but did not control for oil price effects on the stock market. Specifically, our findings show that currency depreciation has a significant deleterious impact on the Exchange and positive relationship with the short-term interest rate. Money supply and inflation also show a positive link with the GSE albeit weakly. Controlling for oil price shock, the relationships either assume linear, nonlinear or a mix of linear and nonlinear link with the stock index. Albeit with a positive shock effect on the stock market oil price shows a rather weak relationship given a response surface close to zero.

We conclude based on our findings that macroeconomic variables significantly affect the growth of the Ghana Stock Exchange with implication for policy-making. It is therefore imperative for policy-makers, investment and financial analysts, and investors (domestic and foreign) to further deepen interest in the stock market while paying attention to macroeconomic variables such as money supply growth, interest rates, inflation, exchange rate and crude oil price movements on the international commodity market. Thus, sound macroeconomics through prudent monetary, exchange rate and fiscal policy management of the economy would boost activities on the stock market given stabilization in exchange rates, low inflation rates and short-term interest rates. The recent gains on the macroeconomic front in Ghana with sustained single-digit inflation rate for more than a year coupled with falling short-term interest rates (91-day treasury bill) and relative stability of the Cedi to the major trading currencies (US Dollar, British Pound Sterling and Euro) among others have increased interest activities and investment interest on the Ghana Stock Exchange. Recent listing of oil giant, Tullow Oil plc, on the Ghana Stock Exchange attests to the growing investor confidence on the bourse. Furthermore, Kosmos Energy's decision to raise US$50 million through floatation of shares on the Ghana Stock Exchange is highly commendable. This would invariably raise the profile of the Ghanaian bourse by diversifying listed equities which have been dominated by local companies since the inception of the Exchange. These recent activities on the capital market demonstrate the extent to which prudent macroeconomic management could bolster growth and development of an emerging stock market like the Ghana Stock Exchange with improvement in the necessary regulatory framework.

Finally, given the adverse effects of oil price shocks on the Ghanaian economy, including that of the capital market, it is imperative managers of the economy devise innovative policy strategies to insulate the economy from oil price fluctuations on the international commodity market. We urge policy-makers to consider periodic hedging of the oil price on the international market as a means of reducing impact of the unpredictable fluctuating oil price trends. Gains from oil price hedging could improve general performance of the economy and enhance liquidity on the Stock Exchange, all things being equal.

References

Adam, A.M. & G. Tweneboah. 2008. Do macroeconomic variables play any role in the stock market movement in Ghana?, MPRA Paper No. 9301

Adjasi, C. K. D. 2009. Macroeconomic uncertainty and conditional stock-price volatility in frontier African markets: Evidence from Ghana. *The Journal of Risk Finance*, 10(4), 333-349.

Adjasi C.K., 2007. Links between stock market development and key Economic growth variables: the case of selected African Countries. PhD Dissertation University of Stellenbosch

Anderson, M., & R. Subbaraman, 1996. Share prices and investment. Reserve Bank of Australia, Discussion Paper 9610.

Auzairy, N. A., R., Ahmad, & C. S. F. Ho, 2011. The impact of stock market liberalization and macroeconomic variables on stock market performances. *International Conference on Financial Management and Economics IPEDR*, Vol.11.

Azman-Saini, W.N.W., Habibullah, M.S., Law, Siong Hook and A, Dayang, 2006. Stock prices, exchange rates and causality in Malaysia: a note. MPRA Paper No. 656

Bilson, C., Brailsford, T., & V. Hooper, 2001. Selecting macroeconomic variables as explanatory factors of emerging stock market returns. *Pacific-Basin Finance Journal*, 9, 401-426.

Boyd, J. H., Levine, R., & B. D. Smith, 1996. Inflation and financial market performance. Federal Reserve Bank of Minneapolis Research Department, Working Paper 573D.

Chen, N., Roll, R., & S. Ross. 1986. Economic forces and the stock market. *Journal of Business*, 59, 383-403.

Fama, E. F. 1981. Stock returns, real activity, inflation and money. *The American Economic Review*, 71(4), 45-565.

Fama, E. F., & G.W. Schwert, 1977. Asset returns and inflation. *Journal of Financial Economics*, 5, 115-46.

Fama, E. 1970. Efficient capital markets: A review of theory and empirical work. *Journal of Finance*, 25, 383-417.

Frankel, J. 1983. Monetary and portfolio-balance models of exchange rate determination. In Bhandari, J.S. and Putnam, B.H. (Eds), Economic Interdependence and Flexible Exchange Rates, MIT Press, Cambridge, MA.

Frimpong, J. M. 2009. Economic forces and the stock market in a developing economy: Cointegration evidence from Ghana. *European Journal of Economics, Finance and Administrative Sciences,* 16, 1450-2275.

Frimpong, J. M. 2008. Capital market efficiency: An analysis of weak-form efficiency on the Ghana stock exchange. *Journal of Money, Investment and Banking. ISSN 1450-288X Issue* 5, 1-12.

Hamao, Y. 1988. Japanese stocks, bonds, bills, and inflation. *The Journal of Portfolio Management*, 15, 20-26.

Hamzah, M. A., L. C., Howe, and R. C. Maysami, 2004. Relationship between macroeconomic variables and stock market indices: Cointegration evidence from stock exchange of Singapore's All-S sector indices. *Jurnal Pengurusan*, 24, 47-77.

Hsiao, C., Li, Q., and J. S. Racine, 2007. A consistent model specification test with mixed categorical and continuous data. *Journal of Econometrics*, 140, 802–26.

Humpe, A., and P. Macmillan, 2009. Can macroeconomic variables explain long-term stock market movements? A comparison of the US and Japan. *Applied Financial Economics*, 19(2), 111–119.

Hurvich, C. M., J. S., Simonoff, and C. L. Tsai, (1998). Smoothing parameter selection in nonparametric regression using an improved akaike information criterion. *Journal of the Royal Statistical Society Series,* B66, 463-477.

Hussainey, K. and L. K. Ngoc, 2009. The impact of macroeconomic indicators on Vietnamese stock prices. *The Journal of Risk Finance*, 10(4), 321-332.

Ibrahim, M., and A. Hassanuddeen, 2003. Macroeconomic variables and the Malaysian equity market: A view through rolling subsamples. *Journal of Economic Studies*, 30, 6-27.

Ibrahim, M. H. 1999. Macroeconomic variables and stock prices in Malaysia: An empirical analysis. *Asian Economic Journal*, 13(2), 219–31.

Kielyte, J. 2002. Exchange rate arrangements in the run-up to the EMU: some experience in currency board countries, EERI Research Paper Series 2002/01, Economics and Econometrics Research Institute, Brussels.

Kyereboah, C. A., and K. F. Agyire-Tettey 2008. Impact of macroeconomic indicators on stock market performance: The case of the Ghana stock exchange. *The Journal of Risk Finance*, 9(4), 365-378.

Li, Q., and J.S. Racine, 2004. Cross-validated local linear nonparametric regression. *Statistica Sinica*, 14, 485-512.

Li, Q., & J. S. Racine, 2007. *Nonparametric econometrics: Theory and practice*. Princeton University Press.

Maysami, R. C., Howe, L. C. and M.A, Hamzah, 2004. Relationship between Macroeconomic Variables and Stock Market Indices: Cointegration evidence from stock exchange of Singapore's All-S sector indices. *Jurnal Pengurusan*, 24, 47-77.

Maysami, R. C., and Sim, H. H. 2002. Macroeconomics variables and their relationship with stock returns: Error correction evidence from Hong Kong and Singapore. *The Asian Economic Review*, 44(1), 69-85.

Maysami, R. C., and T. S., Koh, 2000. A vector error correction model of the Singapore stock market. *International Review of Economics and Finance* 9: 79-96.

Mukherjee, T. K., and A., Naka, 1995. Dynamic relations between macroeconomic variables and the Japanese stock market: An application of a vector error correction model. *The Journal of Financial Research*, 18(2), 223-237.

Muradoglu G., K., Metin and R. Argae, 2001. Is there a long-run relationship between stock returns and monetary variables? Evidence from an emerging market. *Applied Financial Economics*, 7(6), 641-649.

Osei, K. A. 2006. Macroeconomic factors and the Ghana stock market. *The African Finance Journal*, 8(1), 26-38.

Pal, K. and Mittal, R. 2011. Impact of macroeconomic Indicators on Indian capital markets. *The Journal of Risk Finance*, 12(2), 84-97

Quartey, P. and Gaddah, 2007. Long run determinants of stock market development in Ghana. *Journal of African Business*, 8(2), 105-125.

Rahman M. L. and J. Uddin 2009. Dynamic Relationship between Stock Prices and Exchange Rates: Evidence from Three South Asian Countries. Vol. 2, No. 2 International Business Research

Somoye, R., I., Akintoye, and J. Oseni, 2009. Determinants of equity prices in the stock markets. *International Research Journal of Finance and Economics*, 30, 177-189.

Vuyyuri, S. 2005. Relationship between real and financial variables in India: A cointegration analysis. Available at http://ssrn.com/abstract=711541.

Table 1 Consistent Model Specification Tests

Consistent Model Specification Test
[a]Parametric null model: lm(formula = log(*GSE*) ~ log(*EXR*) + log(*INTR*) + log(*INFL*) + log(*M2*), *x* = TRUE, *y* = TRUE)
Test Statistic '*Jn*': 6.89652 [2.22e-16]***

[b]Parametric null model: lm(formula = log(*GSE*) ~ log(*EXR*) + log(*INTR*) + log(*INFL*) + log(*M2*) + log(*OILP*), *x* = TRUE, *y* = TRUE)

Test Statistic '*Jn*': 6.287327 [2.22e-16]***

Notes: Significant codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1. a. Number of regressors: 4. b. Number of regressors: 5. IID Bootstrap (399 replications). Values in parentheses [] indicate p-value. Null of correct specification is rejected at the 0.1% level.

Table 2 Optimal Bandwidth Estimation

Bandwidth Selection Method: Expected Kullback-Leibler Cross-Validation	
Regression Type: Local-Linear	Bandwidth Type: Fixed
Panel A	
[a]Formula: log(GSE) ~ log(EXR) + log(INTR) + log(INFL) + log(M2)	

Regressor	Bandwidth	Scale Factor
log(EXR)	0.247633	0.419684
log(INTR)	0.1650461	0.6784393
log(INFL)	0.2939306	1.207521
log(M2)	0.3313761	0.3851024
Panel B		
[b]Formula: log(GSE) ~ log(EXR) + log(INTR) + log(INFL) + log(M2) + log(OILP)		
log(EXR)	1008974	1585980
log(INTR)	0.4820423	1.837785
log(INFL)	265502.6	1011632
log(M2)	0.2028585	0.2186514
log(OILP)	0.1810649	0.5689968

Notes: Number of observations is 226. Continuous Kernel Type: Second-Order Gaussian. a. Objective function value: 3.381484 (achieved on Multistart 2). b. Objective function value: -3.507752 (achieved on Multistart 1).

Table 3 Estimated Local-Linear Nonparametric Regression

Kernel Regression Estimator: Local-Linear				Bandwidth Type: Fixed
	log(EXR)	log(INTR)	log(INFL)	log(M2)
Bandwidth(s)	0.247633	0.1650461	0.2939306	0.3313761

$R^2 = 0.998$ Residual Standard error = 0.005785092

	log(EXR)	log(INTR)	log(INFL)	log(M2)	log(OILP)
Bandwidth(s)	1008974	0.4820423	265502.6	0.2028585	0.1810649

$R^2 = 0.998$ Residual Standard error = 0.004756166

Notes: Regression Data: 226 training points, in 4 and 5 variable(s) respectively. Continuous Kernel Type: Second-Order Gaussian. Number of Continuous Explanatory Variables: 4 & 5.

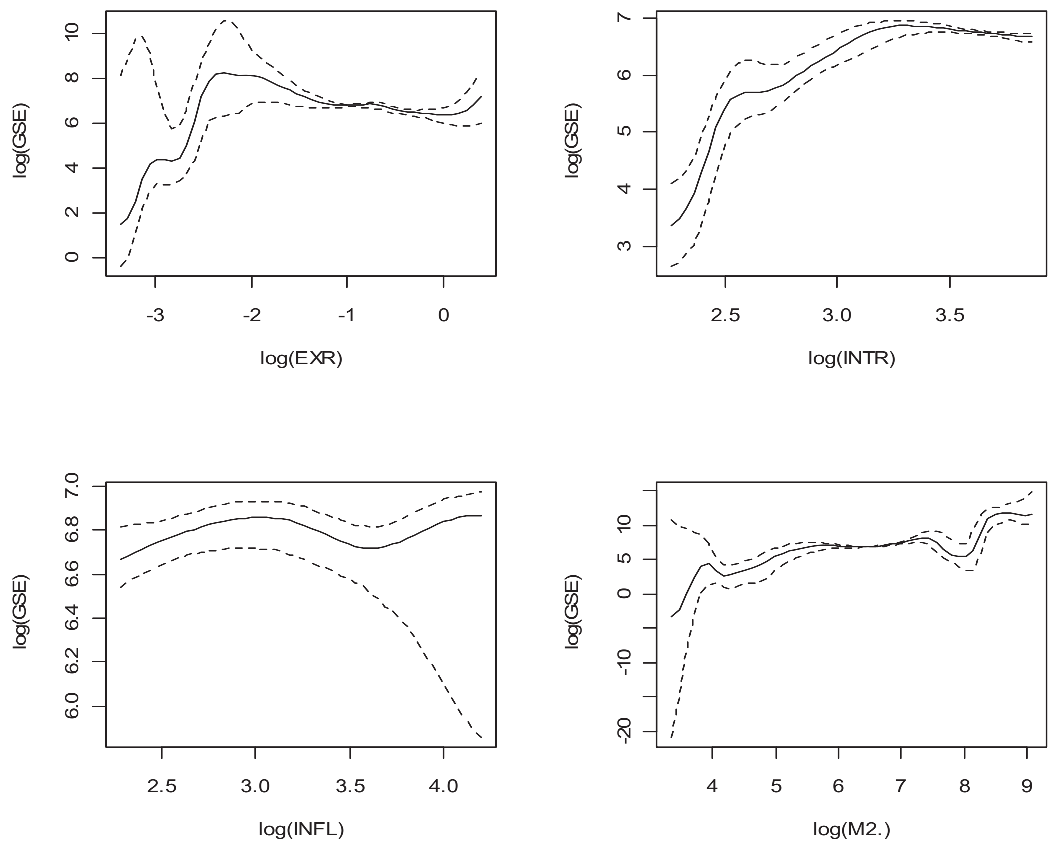

Figure 1 Plot of Partial Regression Surface (model without oil price)

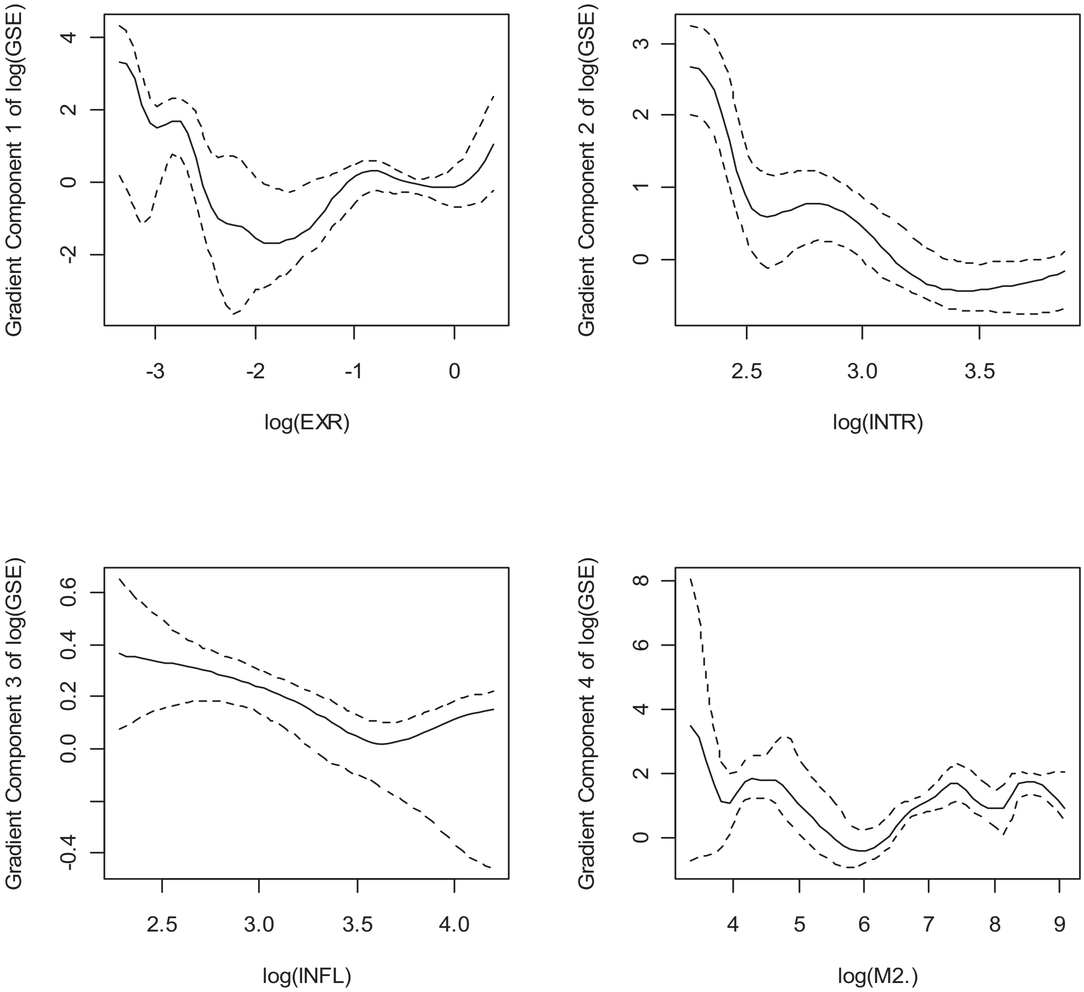

Figure 2 Plot of Partial Gradients (model without oil price)

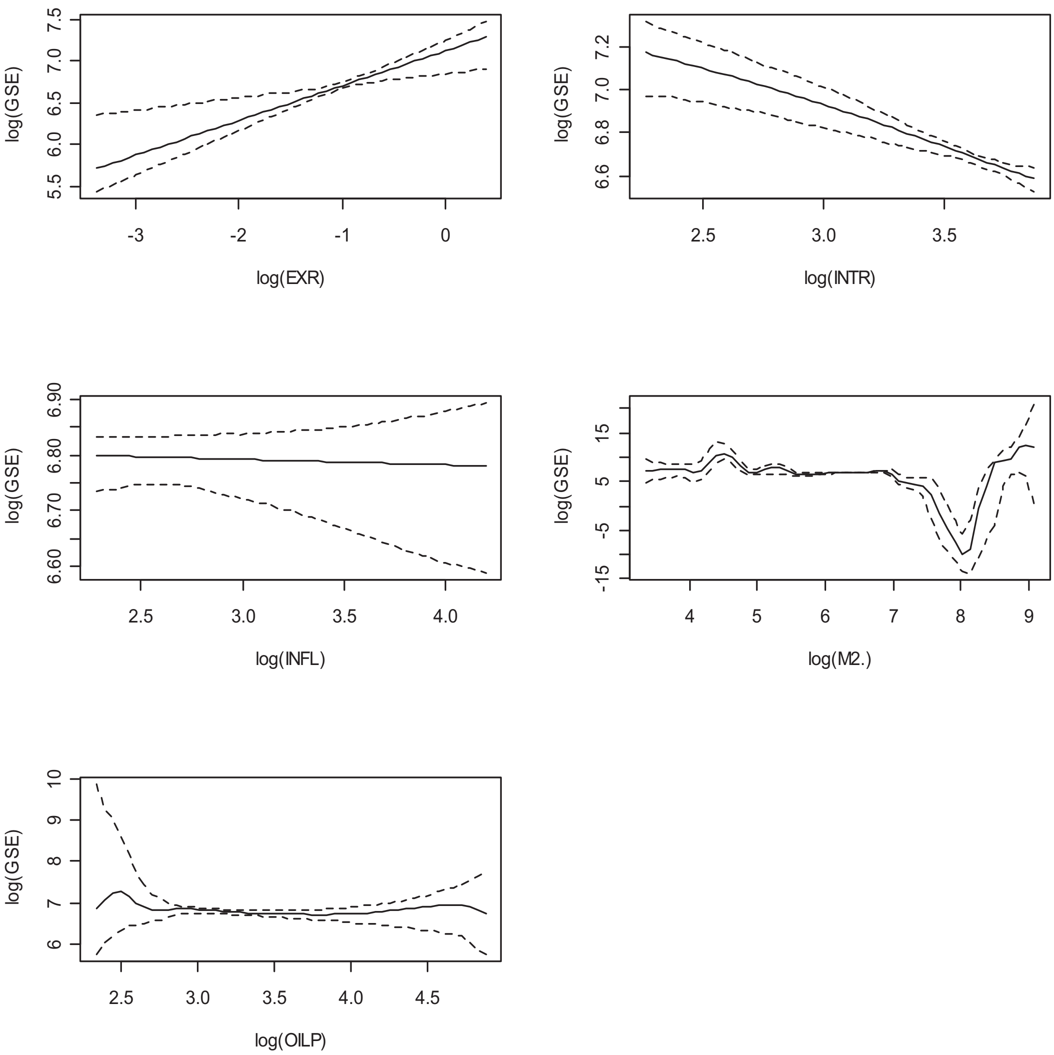

Figure 3 Partial Regression surface plots (model with oil price)

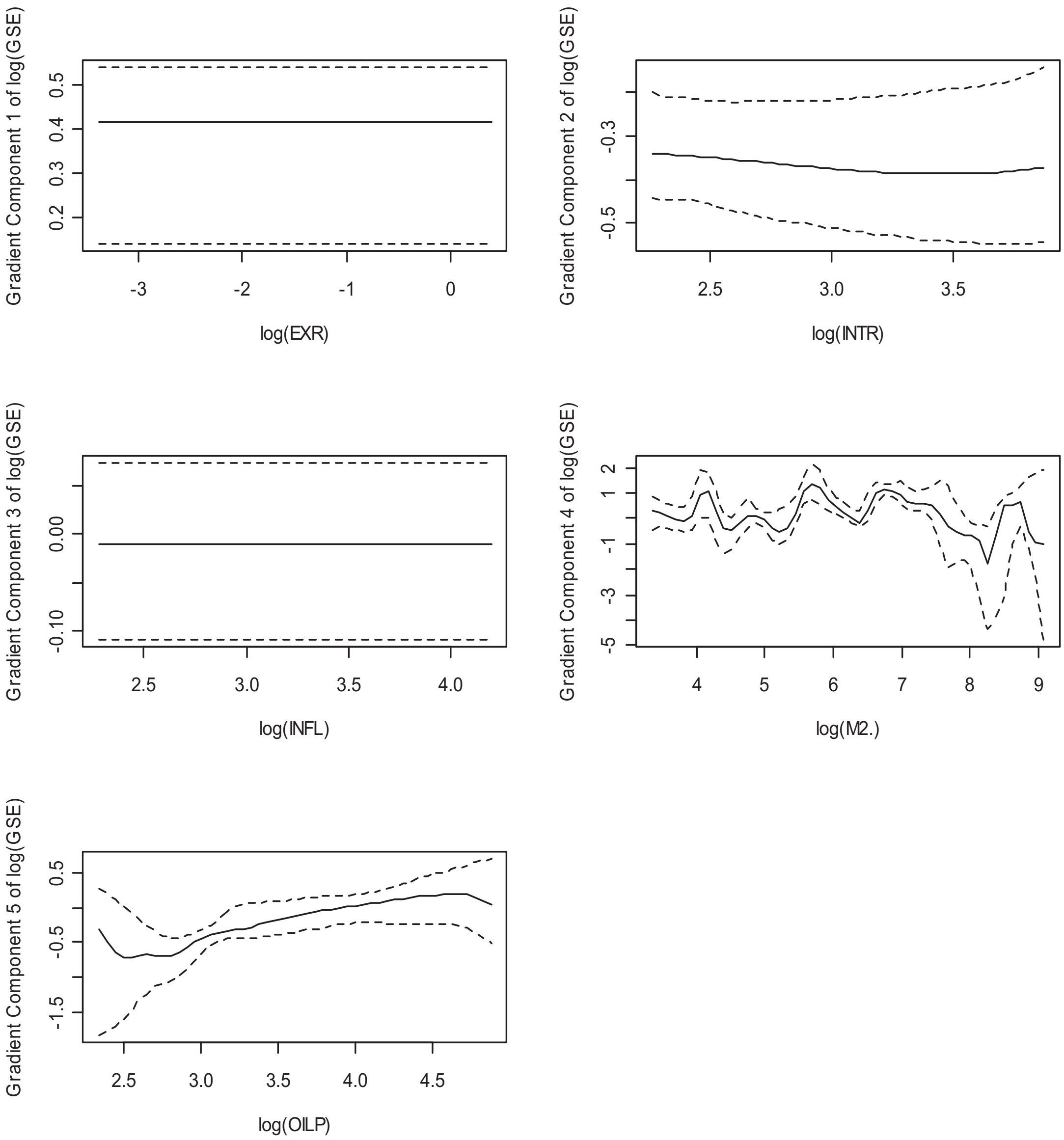

Figure 4 Partial Regression Gradient surfaces (model with oil price)

APPENDIX

Table A1 Parametric Results

Variables	Coefficient Estimates	
	Model (1)	**Model (2)**
Constant	0.75823	0.98713
log(*EXR*)	−0.09277	−0.19707**
log(*INTR*)	−0.20757**	−0.29873***
log(*INFL*)	0.17602***	0.18073***
log(*M2*)	0.96498***	1.09354***
log(*OILP*)		−0.26401***
Multiple R^2	0.963	0.9649
Adjusted R^2	0.9623	0.9641

Note: ** and *** denotes significance at 5% and 1% levels respectively

Table A2 VAR Lag Order Selection

Exogenous variables: C L_M2_ L_OILP

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-163.2497	NA	6.05e-05	1.637848	1.826594	1.714118
1	1280.173	2792.416	9.72e-11	-11.70255	-11.26214	-11.52459
2	1328.225	91.16378	7.21e-11	-12.00210	-11.31003*	-11.72244*
3	1345.684	32.47083	7.11e-11	-12.01574	-11.07201	-11.63439
4	1362.086	29.89131	7.09e-11	-12.01950	-10.82410	-11.53645
5	1383.359	37.97372	6.76e-11*	-12.06878*	-10.62172	-11.48404
6	1393.897	18.41700	7.13e-11	-12.01773	-10.31902	-11.33130
7	1401.352	12.75011	7.75e-11	-11.93787	-9.987494	-11.14974
8	1419.666	30.63697	7.61e-11	-11.95950	-9.757455	-11.06967
9	1430.930	18.42287	7.99e-11	-11.91524	-9.461535	-10.92372
10	1449.067	28.98542*	7.88e-11	-11.93521	-9.229845	-10.84200
11	1457.435	13.05899	8.52e-11	-11.86387	-8.906849	-10.66897
12	1464.223	10.34134	9.36e-11	-11.77779	-8.569098	-10.48119

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Table A3 Granger Causality Test

Null Hypothesis:	F-Statistic	Prob.
D(L_EXR) does not Granger Cause D(L_GSE)	1.82677	0.1634
D(L_GSE) does not Granger Cause D(L_EXR)	0.20454	0.8152
L_INFL does not Granger Cause D(L_GSE)	0.11131	0.8947
D(L_GSE) does not Granger Cause L_INFL	0.04646	0.9546
D(L_GSE) does not Granger Cause D(L_INTR)	0.35865	0.6990
L_INFL does not Granger Cause D(L_EXR)	0.33861	0.7131
D(L_EXR) does not Granger Cause L_INFL	3.52235	0.0312**
D(L_INTR) does not Granger Cause D(L_EXR)	1.16227	0.3147
D(L_EXR) does not Granger Cause D(L_INTR)	2.54665	0.0807*
D(L_INTR) does not Granger Cause L_INFL	3.46948	0.0329**
L_INFL does not Granger Cause D(L_INTR)	2.02957	0.1339

**, **, indicates 5% and 10% significance level respectively*