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Speed of Adjustment of Stock Prices to Macroeconomic Information:

Evidence from Ghanaian Stock Exchange (GSE)

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Abstract: This study examines the speed of adjustment of stock prices to macroeconomic information using monthly Databank stock Index (DSI) from November 1990 to December 2007. We use Granger-Causality test to show unidirectional causality from macroeconomic information to stock prices. Our findings suggest slow adjustment of stock prices to macroeconomic information with exchange rate being the slowest. We argue that the speed of adjustment of exchange rate reflects the behaviour of foreign investors.
Key words: Speed of adjustment; Price delay; Half-life; Market efficiency

1. INTRODUCTION

The relationship between macroeconomic factors and stock market returns has received considerable attention in both the academic and practitioners' literature over the past decades. A survey in the literature gives a support to different stock markets returns' sensitivity to at least one fundamental macroeconomic variable such as exchange rate, interest rate, industrial output and inflation; and has been argued to be the determinant of stock prices (see Cheung and Ng, 1998; Kwon and Shin, 1999). In developing economies, macroeconomic information holds serious implication for all economic activities including stock market activities. Adam and Tweneboah (2008) find stock prices in Ghana response to interest rate, inflation and exchange rate. Adjasi, Harvey and Agyapong (2008) observed from EGARCH (1, 1) the presence of volatility shocks of the exchange rate on stock returns on the Ghana Stock Exchange. How fast stock prices adjust to this macroeconomic information is central to market efficiency, given that an efficient market is characterized as one in which stock prices respond instantaneously to the arrival of new information. The possibility of using macroeconomic factors to predict stock prices depends on how fast the market incorporates the new macroeconomic information. The inefficiency of stock market is not just prices cointegration with macroeconomic factors but its informational efficiency; because such price predictability hinges on good forecast of macroeconomic factors. Following seminal work of Fama *et al*. (1969), speed of stock prices' adjustment to various kinds of information, such as stock splits, merger and acquisitions, the sale of initial public offerings, exchange listings, spinoffs, and proxy contests have been examined (see, for example, survey articles by Armitage, 1995; MacKinlay, 1997; Binder, 1998). Though macroeconomic factors/variables and stock prices have received considerable attention in literature, little has been done on stock prices' speed of adjustment to macroeconomic information. The present study explores this area and finds the speed of adjustment of Ghana Stock Exchange to macroeconomic

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information. The findings of the study will complement the existing literature in assessing efficiency of Ghana stock exchange. The analysis reveals low speed of adjustment of Ghana Stock Market (GSE) to macroeconomic information. It takes one to two month(s) for the market to fully reflect changes in the macroeconomic information.

The rest of the paper is organised as fellows; Section 2 explores the economic fundamentals of the Ghana and behaviour of Ghana Stock exchange. Section 3 presents a simple model of price adjustment and speed of adjustment of stock markets to macroeconomic information. Section 4 describes the data. Section 5 reports the estimate of the price of adjustment and speed of adjustment in Ghana stock market to macroeconomic factors. Section 6 concludes the paper.

2. ECONOMIC FUNDAMENTALS AND GHANA STOCK EXCHANGE

Ghana's macroeconomic indicators in the year 2006 showed an improvement in the performance of the economic activity. In spite of increase in overall government fiscal deficit from 6.6% to 12.4%, real GDP growth increased from 5.9% in 2005 to 6.2%in 2006. Net foreign direct investment increased from 1.6% of GDP in 2001 to 3.37% of GDP in 2006. This only surpassed by 1994 record of 4.28% when Ashanti Goldfield Company Limited (AGC) now Anglodold Ashanti was listed on the Ghana Stock Exchange. The AGC effect saw the market capitalization accounting for 34.37% of GDP in 1994 from 1.98% in 1993. A year to date gain of 58.06% on the index was achieved by the end in December 2008. The GSE All- Share index ended the year with 10,431.64 points compared to 6,599 points in 2007. This gain was well above the 24.66% interest equivalent on 91-day Treasury bills. The US dollar in 2008 rose by 24% against the Ghana cedi. [In US dollar terms, the GSE Index growth was 28%.] Therefore the market outperformed Treasury Bills, bank fixed deposits and investment in the US dollar. It is worth noting that the index gained 65.02% with an all time high of 10,890.80 points in September 2008. The year to date gain of 58.06% in 2008 is also far above the year to date gain of 31.84% of 2007.

Despite the tremendous performance of Ghana Stock Exchange (GSE) in 2008 with increase in 58% in All-Share Index, the stock could not withstand the pressures of credit crunch which resulted a general decline of Global foreign inflow (UNCTAD,2007) and intensity of 2008 elections. The change in government, policy direction and accompanied microeconomic instability caused the GSE to drop by -46.58% in the All-Share index ended the year 2009 as the least performing market in Africa (GSE,2010). On monetary policy, the Bank of Ghana pursued its policy which aims at maintaining monetary stability, a strong and stable Ghana Cedi exchange rate, a low inflation rate, and low interest rates. The interest rates dropped from 40.95% by the end of 2001 to 9.95% by the end of 2006, the cedi /dollar deprecation decreased from 104.4% in 1999 to 2.0% in 2006. Inflation dropped from 59.56% in 1995 to 32.91% in 2001, 10.96% in 2006 and the to all time lowest, 9.6% in 2007 for two decades. As for the public finance performance, government overall fiscal deficit increased from 8.0% of the GDP in 2002 to 12.4% of GDP in 2006.

3. PRICE AND SPEED OF ADJUSTMENT OF STOCK MARKET TO MACROECONOMIC INFORMATION

3.1 Price Adjustment

Following Chiang, Nelling and Tan (2008), we specify price adjustment process of stocks as follows:

$$r_t = \gamma_0 + \gamma_1 r_{t-1} + \varepsilon_t \qquad (1)$$

Where γ_1 is friction parameter, $\frac{\gamma_0}{1-\gamma_1}$ is drift term of the unobserved price. A positive γ_1 is consistent with the financial system imposing price limits (Kim & Limpaphayom, 2000) while a negative value is consistent with the presence of positive feedback trading (Antoniou, Koutmos, & Percli, 2005). Chiang et al. (2008) observed that If market friction is persistent due to government intervention or some other cause, the

speed of adjustment can be nonlinear (follows a higher-order autoregressive process) and would be more convenient to generally write Eq(1) as:

$$r_t = \sum_{1}^{k} \gamma_k r_{t-k} + \varepsilon_t \tag{2}$$

It would be very naïve to think that price adjustment is as result of lag of prices only as specified in Eq. (2). Investors tend to incorporate general economic information into their decision making. Assuming that macroeconomic information are the only available economic information available to investors; incorporating that information feedback in the model permits Eq. (2) to be expressed as:

$$r_t^{\,s} = \sum_{1}^{k} \gamma_k r_{t-k}^{s} + \sum_{i}^{k} \lambda_k r_{t-k}^{m} + \varepsilon_t \tag{3}$$

To find the lead-lag relationship between stock returns and macroeconomic information we test the hypothesis:

Macroeconomic information able to Granger-Cause market returns (i.e $\sum_{i}^{k} \lambda_k \neq 0$).

3.2 Speed of Adjustment

Different models have employed in the literature to estimate the speed of stock market adjustment to information mainly market-wide microeconomic information (see Lim, 2009 for detail of available models). Unlike the previous studies we regress aggregate stock returns on contemporaneous and lagged returns of macroeconomic factors.

$$r_t^{\,s} = \alpha_i + \gamma_i r_{i,t}^{m} + \sum_{i}^{k} \lambda_{i,k} r_{i,t-k}^{m} + \varepsilon_{i,t} \tag{4}$$

Where r_t^s is the market index returns at period t and $r_{i,t}^{m}$ is the returns of macroeconomic factor i in period, t . Our model is a logical extension of Bae *et al*. (2008) and Lim (2009); who regressed individual stock returns on contemporaneous and lagged world market returns, and aggregate stock market on world market news respectively. Using the estimated coefficients from Eq. (4), the speed of adjustment ratio is derived as:

$$x_i = \frac{\sum_{k=1}^{4} \lambda_{i,k}}{\gamma_i} \tag{5}$$

The price delay as suggested by Chordia and Swaminathan (2000) which involves applying a logit transformation to reduce the effects of extreme observations is defined as

$$Delay_{\,i} = \frac{1}{1 + e^{-x_i}} \tag{6}$$

The range of possible values for $DELAY_i$ is from 0 to 1 and interpreted as the proportion of the speed of adjustment attributable to past information. A higher value of $DELAY_i$ indicates a slower speed of adjustment.

4. DATA DESCRIPTION

We employed Databank stock price index from November 1990 to December 2007 obtained from Databank Group research, 3- month Treasury bill rate to proxy interest rate, cedi/dollar exchange rate and year on year consumer price index change to proxy inflation. The Treasury bill rate, exchange rate and

inflation were obtained from the International Financial Statistics (IFS of the IMF) covering 1990M11 to 2007M12. The return of each variable is calculated as log-difference of each variable. A plot of the variables involve are shown in figure 1. Evidence from figure 1 show varied behaviour of the all the variables with cedi-dollar exchange rates exhibiting high volatility especially between 1990 and 2000 while the stock price trended upward.

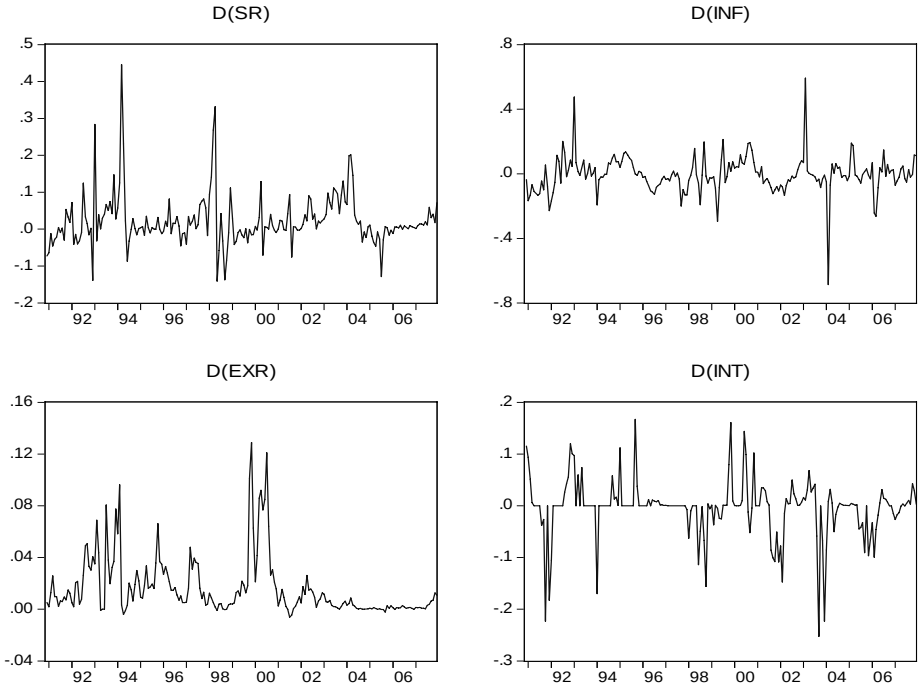

Figure 1: Stock Market Returns and macroeconomic Factors in Ghana

5. GRANGER-CAUSALITY AND SPEED OF ADJUSTMENT OF INFORMATION

We estimate the pair-wise Granger-Causality between macroeconomic factors and stock market returns. The results reported in Table 1 indicate unidirectional causality running from macroeconomic indicators indentified to stock market returns implying that information on macroeconomic factors have causal effect on stock market returns. It will also mean that stock return could be predicted using macroeconomic information but this will depend on how fast the information fuses into the market. Markets with slow speed of adjustment to information can easily be beaten by market analyst and are said to be information inefficient.

Table 1: Granger-Causality Test

Null Hypothesis:	Lag	F-Statistic	Prob
ΔINF does not Granger Cause ΔSR	1	5.42322	0.0209***
ΔSR does not Granger Cause ΔINF		0.20859	0.6484
ΔEXR does not Granger Cause ΔSR	2	3.83246	0.0517*
ΔSR does not Granger Cause ΔEXR		0.10911	0.7415
ΔINT does not Granger Cause ΔSR	1	2.5035	0.0844*
ΔSR does not Granger Cause ΔEXR		0.82911	0.4379

***, **, * indicates significance at the 1%, 5% and 10% levels respectively

Table 2 reports the estimates of information delay of monthly returns of Ghana stock market, average daily trading delay and half-life of information delay to three fundamental macroeconomic factors: interest rate change, inflation change and exchange rate change. Evidence from the Table 2 shows low speed of adjustment of Ghana stock market to macroeconomic information. Each of the three fundamental variables takes over one month or 21 trading days to fully fuse into the market. The estimated daily delay based on 21 trading days in a month indicates excess of over 95% delay in changes in exchange rate, interest rate and inflation rate to reflect in market returns with half-life of thirteen (13) , twelve(12) and twelve(12) trading days respectively. The results of the delay is consistent with the Granger-causality results which indicate unidirectional causality running from change in inflation and interest rate to monthly stock returns with lag length of one(1). The half-life of twelve (12) trading days (approximately half a month) signifies that the market adjust to the two macro-factors within a month of change which is the same as the lag length in Granger-causality. The same is true for the exchange rate change. Since information processing by investors and their corresponding reaction to news are reflected in the speed of adjustment of prices in their respective markets, our findings reveal slow reaction of investors to the macro economy and their trading decision are not based on rumour or sentiment. This may due to domination of Ghana Stock Exchange by shares of foreign-owned subsidiaries, including mining, oil, brewing and financial-services firms; their investment behaviour is likely to be more prudent and rational or concern with long term effect of macroeconomic change. In the market perspective our findings reveal information inefficiency of Ghana Stock Exchange and extent to which investors can outperform the market.

Table 2: Delay in Speed of Adjustment

Macroeconomic information	Change in Exchange Rate	Change in Interest Rate	Change in Inflation
Delay	0.174177	0.114306	0.075379
Average daily trading delay	0.960675	0.957824	0.95597
Half-life(in trading days)	13	12	12

6. CONCLUSION

Although macroeconomic variables have identified to be a major determinant of stock prices and possible predictor of stock prices especially inefficient market but how fast they reflect fully in the stock price have not been looked at. We proposed extension of the delay measures used by Bae, Ozoguz andTan (2008), and Lim (2009) and examine the speed of adjustment monthly return of Ghana Stock market to macroeconomic information. Our finding reveals approximately the same speed of adjustment to changes in inflation and interest rate. This probably reflects the behaviour of the domestic investors who may not much interested in the exchange rate because of their trading in domestic currency while the speed of adjustment to exchange exhibit the behaviour of the foreign investors. This observation is consistent with the finding of behaviour of domestic and foreign investors (Chiang et al., 2008); that domestic investor's decision is influenced by rumour, sentiment or herding behaviour. In economic perspective, the speed of price adjustment can be used as a measure of the extent to which stock market is integrated with macro economy. From an investor perspective, the speed of price adjustment can be used to investigate how investor or macroeconomic factors are related to the reaction of market participants to information

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