The Impact of Macroeconomic Risk on Asset Prices in Ghana, 1997–2002

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Abstract: The dwindling nature of overseas development assistance in the early part of the 1990s called for the establishment of capital markets in some African countries, including Ghana, with the view to increasing foreign direct investments and achieving sustainable inflows, growth and development. One important factor which affects the determination of prices and the growth of capital markets is macroeconomic risk which is quite high in developing countries. Following works done on advanced stock markets, this study seeks to investigate the impact of six macroeconomic risk factors on asset pricing in the various industrial classification — financial, manufacturing, food and beverages, distribution and mining under the Ghana Stock Exchange (GSE) for the period January 1997 to December 2002. Using the arbitrage pricing methodology developed by Ross (1976) and Chen *et al.* (1986), the study revealed that investors in Ghana considered three main macroeconomic risk factors — short-term interest rate risk, inflation risk and the term structure of the country's interest rate in the determination of the various industrial asset prices during the period under consideration. Analysis of the risks and returns profile of the industries also shows that financial assets made the best gains on the market. Both general and specific policy recommendations aimed at improving the performance of the GSE are explored.

1. Introduction

Over the last decade, the economic development paradigm has increasingly shifted towards private sector approaches to achieving sustainable

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growth and development. As a result, the financial sector, and in particular, the development of efficient capital markets, are now considered as an essential aspect of the development process. As African economies attempt to develop their private sectors, it is becoming clear that the growth of the equity market can offer an important catalyst for sustainable growth and development.

A well-functioning stock market is regarded by many as a core component of the financial sector, and proponents of stock market development argue that such markets play a critical role in realizing sustainable economic growth (Isimbabi, 1997; Kumar and Feldman, 1995). This is achieved in a number of interrelated ways. First, an efficient capital market is a source of equity finance for corporations, thereby enabling them to raise long-term capital (Levine and Zervos, 1996). Secondly, the development of a stock market attracts foreign capital and strengthens linkages between domestic and international capital markets (Singh, 1993). Due to the importance of stock markets in the development process, the World Bank and the International Finance Corporation (IFC) has assisted many African countries to establish stock markets. Today, eighteen African countries have established new stock exchanges. Others have worked to revitalize existing but largely moribund exchanges.

Investors' returns on the market come from either capital gains or dividend payments. In emerging exchanges, dividends are usually paid during the end of the year and in some cases no are dividends are paid at all. Due to these developments, many investors focus on the price movements to access their returns from investments. Stock prices therefore become a vital indicator of risk to investors.

In capital markets, prices are information driven, in that stock prices are based on the demand and supply mechanism and on performance information documented in either periodic reports or briefs by any official of the listed companies to the dealing members of the market. Also, the ability to demand and supply securities on the market are informed largely by the performance of key macroeconomic indicators.

In Ghana the situation is no different; financial analysts rely on government policies in their analysis. Government macroeconomic targets at the beginning of the year are factored into business operations, which invariably feed into the determination of stock prices of listed companies on the Ghana Stock Exchange (GSE). Gross inconsistencies in set targets are common and likely to derail business operations. For example, the 2002 budget targeted a 4.5 per cent Gross Domestic Product (GDP) growth rate, 25 per cent growth in broad money supply, 13 per cent year-to-year inflation and a 0.3 per cent Net Domestic Financing/GDP ratio to mention a few. Apart from the achievement of the GDP

growth rate, the rest of the cited macroeconomic factors were not achieved by the end of 2002. Year-to-year inflation stood at 15.2 per cent, broad money supply grew by 50 per cent and the Net Domestic Financing/GDP ratio ended at 4.9 per cent.

These inconsistencies are likely to affect the performances of financial assets since their performance could trend the path of key macroeconomic factors and eventually lead to cyclical trends in cash flows, which affect asset prices on the market. Such tendencies ultimately result in the channelling of resources to other areas to the disadvantage of Ghana's 'infant' capital market and indirectly affect companies' ability to raise long-term capital for investments.

The Government of Ghana for some time now has been making efforts to create a stable macroeconomic environment for private investors in fulfilment of its 'golden age of business'. One way to achieve this is to formulate and implement sound macroeconomic policies that would improve the operations of the GSE, which acts as a mobilization centre for capital. Evidently, such policies will require a foreknowledge on the impact of changes in macroeconomic factors on returns of companies listed on the GSE.

Unfortunately, very little quantitative research exists on the exchange with regards to the determinants and unexpected changes in macroeconomic factors which affect stock prices. This study investigates the effects of unanticipated macroeconomic changes on asset pricing at the GSE, estimates the effects of these factors on the various industries and provides the risk and return levels of each industry as categorized by the GSE for the period January 1997 to December 2002.

Investigation of the effects of unanticipated macroeconomic changes (risk) on asset pricing (returns) becomes very necessary because of the impact it could have on policy formulation in the area of mobilizing long-term capital for investment and development. Also, the results will serve as a guiding tool for stockbrokers, financial analysts, portfolio and fund managers in advising and managing their clients' resources.

The paper is divided into four sections of which this is the first. The second section discusses the analytical and methodological framework. The third section looks at the empirical estimation and its interpretation while the last section concludes the paper and makes policy recommendations.

2. Analytical Framework

In financial economics, there are mainly two theories that provide rigorous foundations for computing trade-offs between risk and return. These

are the Capital Asset Pricing Model (CAPM), and the Arbitrage Pricing Theory (APT).

The CAPM predicts that there is only one type of non-diversifiable risk that influences expected security returns, and that risk is the 'market risk'. The CAPM, developed almost simultaneously by Sharpe (1964), Lintner (1965) and Mossin (1966) is a set of predictions concerning equilibrium expected returns on risky assets. Its development was based on several simplifying assumptions of a price taker, risk-averse investors seeking to maximize expected utility of their end-of-period wealth. The model also assumes that investors have homogeneous expectations concerning asset returns and that expected returns are normally distributed. The CAPM asserts that risk premium on any individual asset or portfolio is the product of the risk premium on the market portfolio and the beta coefficient. CAPM started well as an equilibrium model to explain the linearity between risk and return. A large number of empirical works were conducted to test the validity of the CAPM (see Copeland and Weston, 1988)

Until 1977, all empirical outcomes pointed to the validity of the CAPM. However, subsequent studies provided evidence that is less conclusive. Roll (1977) queried all the previous tests on methodological grounds by showing that as beta is measured against the market portfolio, which is assumed to be efficient, any regression analysis between average returns and betas would, tautologically, give a perfectly linear relationship. Moreover, if the market index, which is used as a proxy for the market portfolio, is not efficient, return on each share will be only approximately related to the betas as measured on that index. In response to the apparent inadequacy of the CAPM to adequately test for market efficiency, Ross (1976) developed the APT model based on the premises that arbitrage possibilities should not be available in the market. If they are, then investors can make risk-free gains by exploiting them.

The APT postulates that several factors can, and do describe the risk-returns relationship of risky assets. It is therefore essentially a multifactor model. The number of factors is unimportant to the theory of APT, although it is crucial to any empirical implementation of the model. The model is derived under the usual assumptions of perfectly competitive and frictionless capital markets.

APT has two claimed advantages over the CAPM. First, its assumptions on investor preferences towards risk and return are less restrictive, and secondly, it is testable empirically because it does not accord any special role to the market portfolio, and does not assume that expected returns are normally distributed.

With APT, factors can generally be extracted by means of statistical procedures or be pre-specified using macroeconomic variables. The first

statistical procedure to test the APT model was conducted by Gehr (1975) who applied factor analysis to US stock returns. Roll and Ross (1980) reported a five-factor structure of which two are priced after cross-sectional testing. In a closely related paper, Chen (1983) assumes, *a priori*, a five-factor structure and finds that the factors change over time. His model was robust to the inclusion of size and specific risk.

Using factor analysis has been criticized for many reasons: the factors are not selected in the same order between two different samples; their signs are not reliable; and they have scaling problems (Elton and Gruber, 1984). Also, the number of factors extracted and priced increases with the number of stocks in the sample and the length of the time series (Dhrymes *et al.*, 1984). Furthermore, the estimates of the risk premia are sensitive to seasonality (Cho and Taylor, 1987) and to the choice of the criteria used to construct portfolios. They also suffer from the standard error-in-variables problem.

To help address these criticisms levelled against the factor analysis methodology, Chamberlain (1983) used an alternative method — Principal Component Analysis (PCA). This technique also has some drawbacks. First, the number of factors increases with the number of stocks included in the analysis (Trzcinka, 1986). Secondly, it overestimates the number of factors (Brown, 1989) and the estimates are biased unless a very large number of assets are considered (Grinblatt and Titman, 1983).

Connor and Korajczyk (1988) propose an alternative procedure — the Asymptotic Principal Component Analysis (APCA) — that yields more robust estimates, but also requires a very large number of assets. Jones (2001) proposes an extension of their method that is robust to heteroscedasticity. Vessereau (2000) applies a new method — Independent Component Analysis (ICA) — to extract factors for the Swiss market. He compares his result to those of the traditional PCA. While the traditional technique leads to one to four factors being priced, ICA always culminates in a two-factor model. He suggests that these factors are related to the market and a liquidity premium.

Various works have also pre-specified factors using macroeconomic variables. Chen *et al.* (1986) used a six-factor macroeconomic APT model and found that only three variables are significant determinants of US stock returns. Burmeister *et al.* (1999), using a similar procedure to that used by Chen *et al.* (1986) concluded that confidence risk, time horizon risk, inflation risk and business cycle risk explain stock returns better than the market return.

On the Mexican market, De la Calle (1991) concluded that four macroeconomic variables had significant explanatory power on the returns of diversified portfolios. The returns are sensitive to the four variables —

unexpected domestic inflation, unexpected changes in the Standard and Poors (S&P), dollar oil price shocks, and money growth — and the market prices such sources of risk. Broillet (1991) specifies initially 38 candidate variables that are divided into 13 groups and upon using stepwise regressions, he finds that the best factor structure consists of three variables on the Swiss market — the change in unexpected inflation, the volume of loans granted, and the US two-month interest rate.

As in the case of statistical procedure, the macroeconomic models also have some important drawbacks. The factor structure is not robust to the portfolio formation criteria (Clare and Thomas, 1984), it changes over time (Chen *et al*., 1986), and it suffers from the standard error-in-variables problem resulting from the use of generated regressors.

Other studies that have implemented macroeconomic APT for other countries find the same types of variables as those used by Chen *et al*. (1986), together with some country specific variables (see, for example, Van Rensburg, 1996 for South Africa; and Groenewold and Fraser, 1997 for Australia).

Studies on the macroeconomic effects of risk on stock prices in Ghana is quite lacking. Also, most of the studies are not directed at the effects of changes in macroeconomic variables and are not quantitative in nature. Antwi-Asare and Addison (2000) assess the existence of requisite economic factors necessary for the establishment of a stock exchange. They concluded that the establishment of the GSE around the time was in the right direction and cited factors such as the unavailability of money in the hands of the public and the probable competition between the existence of a stock market and the other financial institutions for the limited public funds as reasons for the late establishment of the Exchange.

Osei (1998) contends, among other things, that lack of national awareness, lack of knowledge about stock markets and low incomes in the country has resulted in a low number of listed stocks and poor patronage on the GSE and recommends serious attempts to be made to bring the then inflation of about 60 per cent and the rapidly depreciating currency to sanity levels in order not to erode capital base and subsequent gains. Ziorklui (2001) on the development of capital markets and growth in sub-Saharan Africa, using Ghana as a case study, revealed that the stock market is influenced by a multiplicity of factors including institutional, policy and structural.

In this study, we employ the macroeconomic APT to investigate the relationship between macroeconomic risk and asset prices due to its inherent advantages. The advantage of the macroeconomic APT is that it provides an intuitively appealing set of factors that admit economic interpretation of the risk exposures and the risk premia. This method is a step ahead of the other. From a purely statistical view, it has the

advantage of using economic information in addition to stock returns, whereas the others use 'stock returns to explain stock return'.

2.1 Model Specification

The APT model assumes that the rate of return on any security is a linear function of k factors plus the asset-specific (idiosyncratic) error term. That is:

$$R_i(t) = \alpha_i(t) + \beta_{i1}(t)f_1(t) + \ldots + \beta_{ik}(t)f_k(t) + \varepsilon_i(t) \quad (1)$$

where $R_i(t)$ is the *ex-post* rate of return on the ith asset at time t; $\alpha_i(t)$ is the expected rate of return on the ith asset at time t; $\beta_{ik}(t)$ is the sensitivity or factor loading of the ith asset's return to the kth factor at time t; $f_k(t)$ is the mean zero kth factor common to the returns of all assets under consideration; and $\varepsilon_i(t)$ is a random zero mean noise term for the ith asset at time t.

Six macroeconomic (risky) factors are considered in our study and the model to be estimated is specified econometrically as follows:

$$R_{it} = \alpha + \beta_1 w_i SIR + \beta_2 w_i ERR + \beta_3 w_i FR + \beta_4 w_i MSR + \beta_5 w_i BAR + \beta_6 w_i THR + \varepsilon \quad (2)$$

where R_{it} is the total holding period return on industry i realized at the end of period t; SIR is the unanticipated changes in short-term interest rates; ERR is the unanticipated changes in nominal exchange rates; FR is the unanticipated changes in inflation rates; MSR is the unanticipated changes in nominal money supply; BAR is the unexpected changes in the levels of real business activity proxied by imports; THR is time horizon risk; and w_i is the weight of industry i.

The model assumes that the expectations, at the beginning of the period, for all factor realizations and for the asset-specific shock are zeros; asset-specific shock is uncorrelated with the factor realizations and that all factor realizations and the asset-specific shocks are uncorrelated across time.

2.2 Data Description and Sources

The study made use of data from firms in good standing (those listed by January 1997 and had remained on the Exchange by December 2002). Table A1 in the Appendix provides the list of 19 companies which qualified for the study. Monthly primary data covering the period

1997:1 to 2002:12 and obtained from the GSE was used. Industries were weighted using their equity capitalization and the calculation of industrial capitalization weights is presented as Table A2 in the Appendix. The study uses weighted average interest rates instead of discount rates and end-of-month stock price series are adjusted for dividends. *Ex-post* return for a period on each stock/asset is computed using the formula:

$$R_{jt} = \frac{P_t - P_{t-1} + D_t}{P_{t-1}} \tag{3}$$

where R_{jt} is the holding period return in time t of asset j; P_t is the market price at the end of period t; P_{t-1} is the market price at the end of period $t - 1$; and D_t is the total dividend per share paid at the end of period t.

For data consistency, annual dividends are converted into monthly figures and the total dividends included in the computations did not incorporate withholding dividend tax of 10 per cent. Since the analysis is industry-based, the study computes industry (portfolio) value-weighted returns using the method of Copeland and Weston (1988) as:

$$R_{it} = \sum_{j=1}^{n} w_{ij} R_{jt} \tag{4}$$

where R_{it} is the industry-constructed portfolio as per GSE categorizations; w_{ij} is the capitalization weights of asset j included in portfolio i; n is the total number of assets included in the portfolio; and R_{jt} is the holding period return of asset j included in the portfolio at period t.

Table 1 presents the measurements of variables. Most of the data were obtained from the GSE, Bank of Ghana, Ghana Statistic Services, the Ministry of Finance and Economic Planning, Data Bank Financial Services, Ministry of Trade and Industry and the International Financial Statistics of the International Monetary Fund. The co-integration and Parsimonious Error-Correction Modeling (PECM) of asset pricing is employed to estimate Equation (2) using 72 data point and the Eviews software (versions 3.1).

3. Empirical Estimation and Interpretation

Statistically, the model reductions are dictated by the values of the *F*-statistics and its associated probabilities of rejecting the null in square brackets. Details of the process are presented in Table A3 of the Appendix. The Schwarz criterion is equally considered, even though it

Table 1: Summary of measurement of variables

Variable	Measurement
SIR	This is the difference between the actual end-of-month weighted average interest rate on the 91-day T-bill and what investors expect — the mean expected rate
ERR	This is the difference between the actual inter-bank mid-rate of the cedi-dollar rate at the end of the month and the average mean expectation of the exchange rates
MSR	This is computed as the actual money supply (M2 +) less its mean expected value at the end of the month
FR	This is computed as the difference between the actual inflation and what is expected
BAR	This is calculated as the difference between the actual end-of-month value of imports and its mean expected value
THR	This is measured as the difference between the return on the 1-year T-bill and the return on the 91-day T-bill.

is not the sufficient condition. After dropping insignificant variables, Tables 2–6 present the final parsimonious error-correction models for each industry. The diagnostic test results are presented as Table A4 in the Appendix.

The first differences of the regressors capture the short-run disturbances in their respective asset returns whereas the error-correction terms (ECTs) capture the adjustment towards the long-run equilibriums. If the ECTs are significant statistically, then they demonstrate what proportion of the disequilibria in their respective returns in one period is corrected in the next period.

The results show that all the models converge toward their respective long-run equilibriums. These are evident by the values of their respective ECTs. In fact, at 1 per cent the respective ECTs are statistically significant. This means that disturbances occurring in the previous months are corrected (or adjusted) in the subsequent months.

However, the speeds of adjustments differ from industry to industry. Whereas some adjust slowly, others take a longer time. For instance, about 58 per cent of the previous discrepancy between the actual and the long-run or equilibrium returns of financial assets is eliminated or corrected in subsequent months. In a similar pattern investors remove about 90 per cent of the resulting disequilibrium in breweries and food assets in the previous month to the following month. The mining industry's model reveals a total or complete disequilibrium adjustment.

Overall, apart from the financial and distribution industries that showed statistically significant levels in all the chosen explanatory

Table 2: Financial industry, final PECM

Dependent variable: DRFIN
Included observations: 65 after adjusting endpoints

Variable	Coefficient	Std. error	*t*-statistic	Prob.
C	−0.000506	0.010318	−0.049055	0.9611
DSIR	−0.101569	0.032611	−3.114606	0.0032
DSIR(−1)	0.150324	0.035945	4.182101	0.0001
DFR	0.109624	0.028518	3.844026	0.0004
DFR(−1)	−0.125708	0.029354	−4.282543	0.0001
DFR(−4)	−0.083712	0.022606	−3.703132	0.0006
DFR(−6)	−0.029861	0.013099	−2.279564	0.0273
DERR(−3)	−0.000250	9.97E–05	−2.503978	0.0159
DERR(−4)	0.001009	0.000265	3.802785	0.0004
DERR(−6)	0.000382	0.000124	3.083150	0.0035
DMSR	−0.000174	8.12E–05	−2.140857	0.0376
DMSR(−4)	−0.000595	0.000180	−3.299092	0.0019
DMSR(−5)	0.000166	7.67E–05	2.166414	0.0355
DTHR	−0.121977	0.028902	−4.220388	0.0001
DTHR(−1)	0.105023	0.027358	3.838822	0.0004
DBAR	−0.000219	0.000108	−2.039458	0.0472
DBAR(−5)	−0.000567	0.000169	−3.356370	0.0016
DBAR(−6)	−0.000594	0.000151	−3.947997	0.0003
ERFIN(−1)	−0.576893	0.109141	−5.285765	0.0000

R-squared	0.680469	Mean dependent var.	−0.000292
Adjusted R-squared	0.555435	S.D. dependent var.	0.123180
S.E. of regression	0.082131	Akaike info. criterion	−1.922127
Sum squared resid.	0.310295	Schwarz criterion	−1.286537
Log likelihood	81.46912	F-statistic	5.442282
Durbin–Watson stat.	1.995359	Prob(F-statistic)	0.000002

variables, the other models recorded mixed levels of significance. The reported insignificant variables were not dropped because the *F*-statistics and its associated probabilities rejected such restrictions. Besides, the Schwarz criterion worsened in attempting to drop reported insignificant variables. The constant terms are insignificant in all cases.

The first variable for discussion is short-term interest rate risk (*SIR*). We expected a positive sign indicating that anytime investors' expectation of the return on the 91-day Treasury bill exceeds actuals, they tend to reorganize their portfolio in favour of a government risk-free short-term financial instrument (91-day T-bill). This leads to excess supply of assets of listed companies. Those who continue to hold these assets would demand higher return compensation for the risk of keeping them. A higher return leads to lower asset prices. The adjustment or transmission mechanism is not immediate due to our inefficient market situation.

Table 3: Manufacturing industry, final PECM
Dependent variable: DRMFG
Included observations: 64 after adjusting endpoints

Variable	Coefficient	Std. error	*t*-statistic	Prob.
C	−0.000774	0.006864	−0.112729	0.9107
DBAR(−1)	−0.000237	0.000176	−1.350317	0.1832
DERR(−5)	0.000936	0.000426	2.195851	0.0330
DERR(−7)	0.001022	0.000432	2.367548	0.0220
DFR(−2)	−0.049066	0.030980	−1.583790	0.1198
DFR(−5)	−0.113623	0.038391	−2.959639	0.0048
DFR(−6)	0.119484	0.040392	2.958123	0.0048
DFR(−7)	−0.077331	0.036934	−2.093786	0.0416
DMSR(−3)	−0.000176	0.000121	−1.453120	0.1527
DMSR(−5)	−0.000734	0.000305	−2.402854	0.0202
DMSR(−7)	−0.000485	0.000298	−1.627077	0.1103
DSIR(−2)	0.065738	0.035308	1.861841	0.0688
DSIR(−6)	−0.139595	0.050291	−2.775752	0.0078
DTHR(−3)	0.056266	0.026525	2.121224	0.0391
DTHR(−6)	−0.093688	0.040944	−2.288186	0.0266
EMFG(−1)	−0.826086	0.127650	−6.471518	0.0000

R-squared	0.567618	Mean dependent var.	−0.000523
Adjusted R^2	0.432498	S.D. dependent var.	0.072224
S.E. of regression	0.054409	Akaike info. criterion	−2.772269
Sum squared resid.	0.142095	Schwarz criterion	−2.232548
Log likelihood	104.7126	F-statistic	4.200855
Durbin–Watson stat.	1.899370	Prob (F-statistic)	0.000072

The variable under discussion showed a 10 per cent negative impact on financial asset returns. Though statistically significant at 1 per cent, it fails to secure the expected sign. Its first lag, nevertheless, reported a positive impact. To be precise, a 1 per cent change in *SIR* causes about a 15 per cent reduction in asset prices in the financial industry. In the manufacturing industry, *SIR* in the previous six months has a negative effect on its returns at a 1 per cent significance level. This unexpected impact, however, tapers off to the second lag where it attains the expected positive sign. Thus, at lag two, a 1 per cent change in *SIR* is likely to increase its assets return by nearly 7 per cent, but at a 10 per cent significance level. The reported mixed signs are not too strange considering the fact that the GSE is not efficient even at the weak form (Osei, 2001). The study also reported positive impacts of about 2 per cent and 9 per cent on the returns of breweries and food, and distribution assets respectively at a percentage change in *SIR*. Investment in the mining industry is likely to experience, on average, a capital loss (reduction in asset prices) of about 0.4 per cent between the period January 1997 and December 2002.

Table 4: Breweries and food industry, final PECM
Dependent variable: DRBF
Included observations: 65 after adjusting endpoints

Variable	Coefficient	Std. error	*t*-statistic	Prob.
C	0.000412	0.001179	0.349551	0.7281
DSIR(−3)	0.020241	0.010590	1.911345	0.0616
DSIR(−4)	−0.044308	0.013400	−3.306516	0.0017
DFR	0.030043	0.009113	3.296888	0.0018
DERR	−0.000165	7.70E-05	−2.142919	0.0369
DERR(−3)	−0.000150	7.55E-05	−1.986832	0.0523
DERR(−4)	0.000370	0.000142	2.604799	0.0120
DMSR(−1)	−0.000105	5.70E-05	−1.845900	0.0707
DMSR(−4)	−0.000321	0.000108	−2.959588	0.0047
DBAR(−6)	−0.000140	8.30E-05	−1.685025	0.0981
DTHR	−0.033769	0.011591	−2.913326	0.0053
DTHR(−3)	0.037917	0.013703	2.767114	0.0079
DTHR(−5)	−0.031751	0.012697	−2.500693	0.0156
EBF(−1)	−0.898673	0.116032	−7.745062	0.0000
R-squared	0.659040	Mean dependent var		4.77E-05
Adjusted R^2	0.572129	S.D. dependent var		0.014430
S.E. of regression	0.009439	Akaike info. criterion		−6.299805
Sum squared resid.	0.004543	Schwarz criterion		−5.831476
Log likelihood	218.7437	F-statistic		7.582914
Durbin–Watson stat.	1.820425	Prob(F-statistic)		0.000063

The low impact on mining assets could be due to the fact that the mining industry is powered by huge quantum of financial resources and as such would like to access long-term credit, unlike the other four industries that normally favour short-term to medium-term credits. This is evident by the adoption of a hedging stand taken by the Ashanti Goldfields Company Limited in 2000.

The *a priori* sign for unanticipated changes in the exchange rate (*ERR*) is positive. We define the exchange rate as the total amount of Ghanaian cedis needed to purchase one US dollar. Depreciation implies higher cost of production, especially for those listed companies that import raw materials. This is likely to distort dividend payout to shareholders. A chronic occurrence would cause less confidence in foreign investors, who hold majority shares in the listed companies.

The results show that *EER* had virtually no significant influence in the determination of assets prices in any of the industries during the period under discussion. Apart from financial and manufacturing assets that recorded about a 0.1 per cent positive impact on their respective returns, the rest show worsening results. The low impacts could be due to the relative stable exchange rate policy pursued in 2001 and 2002, which saw marginal depreciation of the cedi against the dollar. Investors'

Table 5: Distribution industry, final PECM

Dependent variable: DRBF

Included observations: 65 after adjusting endpoints

Variable	Coefficient	Std. error	*t*-statistic	Prob.
C	0.000412	0.001179	0.349551	0.7281
DSIR(−3)	0.020241	0.010590	1.911345	0.0616
DSIR(−4)	−0.044308	0.013400	−3.306516	0.0017
DFR	0.030043	0.009113	3.296888	0.0018
DERR	−0.000165	7.70E–05	−2.142919	0.0369
DERR(−3)	−0.000150	7.55E–05	−1.986832	0.0523
DERR(−4)	0.000370	0.000142	2.604799	0.0120
DMSR(−1)	−0.000105	5.70E–05	−1.845900	0.0707
DMSR(−4)	−0.000321	0.000108	−2.959588	0.0047
DBAR(−6)	−0.000140	8.30E–05	−1.685025	0.0981
DTHR	−0.033769	0.011591	−2.913326	0.0053
DTHR(−3)	0.037917	0.013703	2.767114	0.0079
DTHR(−5)	−0.031751	0.012697	−2.500693	0.0156
EBF(−1)	−0.898673	0.116032	−7.745062	0.0000
R-squared	0.659040	Mean dependent var.		4.77E–05
Adjusted R^2	0.572129	S.D. dependent var.		0.014430
S.E. of regression	0.009439	Akaike info. criterion		−6.299805
Sum squared resid.	0.004543	Schwarz criterion		−5.831476
Log likelihood	218.7437	F-statistic		7.582914
Durbin–Watson stat.	1.820425	Prob(F-statistic)		0.000063

expectations during these periods deviated marginally from the actual. The USA's threat of going to war with Iraq in early 2002 could also have contributed to the weakened trend of the dollar with quite a number of investors switching to the euro. For instance, before the war, the dollar was stronger than the euro. A few months into the war, the euro became much stronger than the dollar. The combined effects of events in 2001 and 2002 might have offset the worsening situation in the country, especially in the year 2001. We believe that if the research period had ended in year 2001, the cedi–dollar exchange rates would have fed significantly in the determination of assets prices.

At different lags, all the industries confirmed the expected negative sign for Business Activity Risk (*BAR*), indicating a positive correlation on asset prices. A negative realization of *BAR* indicates that the actual growth rate of the economy has increased beyond investors' expectations. Under such circumstances, assets that are more negatively exposed to business activity risk tend to do better than those that do not respond much to increased levels in business activity. Portfolios are likely to alter in favour of more stocks, because of the economic growth spillover. The created excess demand would hike asset prices leading to lower return compensation.

Table 6: Mining industry, final PECM

Dependent variable: DRMIN
Included observations: 66 after adjusting endpoints

Variable	Coefficient	Std. error	*t*-statistic	Prob.
C	0.001696	0.004145	0.409123	0.6840
DBAR(−5)	−3.60E–05	2.26E–05	−1.593493	0.1166
DERR(−1)	4.73E–05	3.12E–05	−1.514445	0.0154
DFR	0.004086	0.002164	1.888167	0.0641
DMSR(−1)	4.60E–05	2.36E–05	1.946214	0.0566
DMSR(−3)	−4.23E–06	1.20E–05	−0.351315	0.0266
DSIR(−1)	0.004107	0.002879	1.426524	0.0592
DTHR(−4)	−0.001070	0.002852	−0.375110	0.0490
EMIN(−1)	−1.099091	0.177173	−6.203506	0.0000
R-squared	0.508542	Mean dependent var.		0.003712
Adjusted R^2	0.446758	S.D. dependent var.		0.043824
S.E. of regression	0.033468	Akaike info. criterion		−3.830304
Sum squared resid.	0.063848	Schwarz criterion		−3.531715
Log likelihood	135.4000	F-statistic		6.805760
Durbin–Watson stat.	1.877228	Prob (F-statistic)		0.000693

The impact of *BAR* on all the assets is not significant (less than 0.1 per cent at all lags). The reason could be that imports, which is a proxy for economic growth for some time now, has become more predictive and this could be one of the reasons for the low influences. For example, the average annual real growth rate of GDP has not exceeded 5 per cent over the past decade. This means that investors' anticipation of growth had always fallen within actuals. Chen *et al.* (1986) reported a significant economic growth factor. Unlike this work, they used industrial production as a proxy for economic growth.

Even though the expected negative signs were obtained, money supply risk plays very little role in the returns of industries assets. De la Calle (1991) also reports that money supply risk has insignificant influence on asset prices on the Mexican stock market. On the contrary, Groenewold and Fraser (1997) found that money supply risk feeds significantly into the equation of assets pricing on the Italian stock market.

Inflation risk is vital in the determination of asset prices in Ghana. In fact, asset prices are strongly influenced by inflation risk at different lags at both 1 per cent and 5 per cent significant levels. Manufacturing assets recorded as high as 12 per cent positive impact on its returns whereas the mining industry showed the least (0.4 per cent). On the negative side, assets in the manufacturing industry again recorded the highest inflation risk impact. A percentage increase in inflation risk causes about 12 per cent reduction in assets returns. Like the fifth and seventh lags in the

manufacturing industry, the financial industry showed significant levels of inflation surprise at the first, fourth and sixth lags. However, all the lags assumed negative signs.

Nearly 11 per cent of inflation risk fed positively into the returns accrued to holders of financial assets. In a similar trend, distribution assets recorded mixed signs. Chen and Ingersoll (1983) also reported similar outcome-alternating signs in the factors. Their work concluded, 'Factors change over time.' A positive sign is a premise on the fact that, in times of higher inflationary pressures, investors prefer extremely higher return investments, but at a lower risk. It is easy to conclude that a negative inflation risk coefficient confirms the inefficient nature of our market but Burmeister *et al.* (1999) argue that some assets are likely to have negative exposures to inflation surprise (risk). They contended that expected future inflation rates are computed from historical inflation rates, interest rates, and other economic variables that influence inflation. Zhou (1999) on the other hand, reported insignificant inflation risk on the Japanese stock market.

We expected time horizon risk (*THR*) to carry a negative sign as against a positive reported in most empirical findings on the industrialized countries. This is because, unlike the advanced countries whose yield curves are upward sloping, Ghana's yield curve has for some time now been downward sloping.

The reason is not far fetched. The term structure of interest rates in the country dictates the shape of the yield curve. In Ghana, interest rates on short-term government borrowing (proxy by the 91-day Treasury bill) exceed that of long-term (proxy by the 1-year Treasury note). Practically, this means that investors tend to be better off if they engage in short-term ventures.

With respect to the term structure the outcomes were mixed. Assets in the financial industry, over the period of study, were more sensitive to *THR*. Approximately 1 per cent increase in the difference between the interest rate on the 91-day Treasury bill and that of the 1-year Treasury note, over a period of 72 months, caused about a 12 per cent reduction in assets returns in the financial industry. The impact was about 9 per cent on manufacturing assets during the same period. The rest of the industries showed less than 5 per cent negative impacts.

On positive impacts of *THR* on assets return, the financial industry topped the list with 10 per cent, followed by 8 per cent and 6 per cent in the distribution and manufacturing industries respectively. The rest showed values less than 5 per cent. A positive *THR* exposure means that some investors have not yet explored the actions of the government. They continue to undertake long-term investments either in assets on the Exchange or other investments elsewhere. This may be largely due to lack

of awareness on the part of investors in this direction. The majority of domestic investors fail to monitor macroeconomic indicators in the country and even if they do, they find it difficult to reorganize their portfolios. Chen *et al*. (1986) also reported high significant term structure of interest rate on asset price determination in the New York Stock Exchange. Nevertheless, they reported a positive impact as against negative by this work. The main reason for this difference lies in the structure of interest rates. Whereas the USA offers a higher return on long-term government financial instruments as against all short-term ones, the reverse is what pertains in Ghana.

Table 7 shows the risk and return profile of each industry for the period under discussion. The results suggest that during the period under consideration, holders of financial assets on the market made the best gains. This outcome could be as a result of the Financial Sector Adjusted Programme (FINSAP) implemented to 'clean up' the financial system (Antwi-Asare and Addison, 2000). Investment in distribution assets made the worst gains and the most risky investment was that of the financial industry assets. Investment in distribution assets was the least volatile.

Total asset volatility could be reduced through effective diversification. For this to happen, we expect the correlation matrix between the combined industries to be negative. Our results show that investors could have reduced the total risk on their investments only if distribution and mining assets were combined in a capitalization weighted manner as shown in Table A5 of the Appendix. Any other form of combination would lead to greater risks.

Table 7: Risk and return profile of industries

Industry	Mean (industry) return	Industry risk
Financial	0.0544	0.1146
Manufacturing	0.0269	0.0580
Breweries and Food	0.0033	0.0118
Distribution	0.0015	0.0043
Mining	0.0025	

Note: Values are in industry weights.

4. Conclusion and Recommendations

Following works on advanced stock markets in the developed world, this study seeks to investigate whether the pricing of assets on the GSE during the period January 1997 to December 2002 has significant macroeconomic risk factors.

We applied the error-correction approach to the macroeconomic APT methodology developed by Ross (1976) and Chen *et al.* (1986). Six macroeconomic factors were employed for the study. For easy analysis, qualified companies listed on the GSE were grouped into five industries: financial, manufacturing, distribution, mining, and food and breweries. This led to the construction of industry capitalization weighted portfolios.

The study revealed that investors in Ghana considered three main macroeconomic risk factors in the determination of asset prices during the period under consideration. These are the short-term interest rate risk, inflation risk and the term structure of the country's interest rate. Short-term interest rate reported mixed signs at different lags and this could be due to the inefficient nature of the stock market even at the weak form. Inflation risk is vital in the determination of asset prices in Ghana. Asset prices in all the industries are strongly influenced by inflation risk; however, the signs are different at different lags. The outcomes on term structure were mixed. On the negative side, assets in the financial and manufacturing industries were more sensitive to *THR* compared with the rest of the industries which showed impacts of less than 5 per cent.

On positive impacts of *THR* on asset returns, the financial, manufacturing and distribution industries showed impacts of more that 5 per cent while the rest showed values less than 5 per cent. In general, financial assets recorded the highest risk exposure of all the three factors. Analysis of the risks and returns profile of the industries shows that financial risks made the best gains on the market.

Following from the results it is imperative for the government to stay within its borrowing limit in order to reduce risks associated with the short-term interest rate. This is because in an attempt to over borrow through open market operations, the interest equivalent on the 91-day Treasury bill escalates. Investors feed on this action only to the downtrend of asset prices on the GSE.

The term structure of interest rate in the country only favours short-term investment, which is not healthy for a developing country like Ghana. Long-term savings are needed to undertake long-term investments. As such, policies should be put in place to reverse the yield curve which has assumed a negative slope for a long time. To do this, the government should be prepared to offer higher rates on its 1-year Treasury note while a lower rate should be paid on the 91-day Treasury bill.

Improvements in efficiency in the GSE will also go a long way to enhance the work of the exchange. For the market to move towards the frontiers of efficiency, investors and fund managers must be information-sensitive. This could be achieved if stock brokerage firms could carry out a more detailed and fundamental analysis of government policy initiatives and their impact on the market. In connection with this, the government must also cultivate the habit of announcing key macroeconomic

indicators as early as possible to avoid delays which may fuel speculation. Such tendencies are not healthy for the development of the market.

The above recommendations will, of course, need to be supplemented with other measures, which do not directly arise from this study. Such measures include speeding up the automation of the GSE; adhering strictly to the ethics and standards guiding world exchanges; intensifying education on the operations and benefits of the exchange especially, in the major local Ghanaian languages (Akan, Ga and Ewe); encouraging licensed stock brokerage firms to have libraries to aid public research; establishing a monthly bulletin (the *Ghana Journal of Finance — GJOF*) to serve as the mouthpiece of financial statistics in the country, empowering the Institute of Finance and Economic Journalists to carry out a more detailed financial analysis and making funds available through the research department of the GSE to attract researchers in that direction.

References

Antwi-Asare, T. O. and E. K. Y. Addison (2000), *Financial Sector Reforms and Bank Performance in Ghana*, Russell Press Ltd, Nottingham.

Broillet, P. (1991), 'Specification empirique des facteurs de l'APT sur le marche Suisse des actions', *Swiss Journal of Economics*, Vol. 127, No. 3, pp. 491–510.

Brown, S. J. (1989), 'The Number of Factors in Security Returns', *Journal of Finance*, Vol. 44, No. 5, pp. 1247–62.

Burmeister, E., R. Roll and S. Ross (1999), 'Using Macroeconomic Factors to Control Portfolio Risk, BIRR Portfolio Inc.

Chamberlain, G. (1983), 'Funds, Factors and Diversification in Arbitrage Pricing Models', *Econometrica*, Vol. 51, pp. 1305–21.

Chen, N-F. (1983), 'Some Empirical Tests of the Theory of Arbitrage Pricing', *Journal of Finance*, Vol. 38, pp. 1393–1414.

Chen, N-F., and J. Ingersoll (1983), 'Exact Pricing in Linear Factor Models with Finitely Many Assets: A Note', *Journal of Finance*, Vol. 38, pp. 985–88.

Chen, N-F., R. R. Roll and S. A. Ross (1986), 'Economic Forces and the Stock Market', *Journal of Business*, Vol. 59, No. 3, pp. 383–404.

Cho, D. and W. Taylor (1987), 'The Seasonal Stability of the Factor Structure of Stock Returns', *Journal of Finance*, Vol. 42, pp. 1195–211.

Clare, A. D. and S. H. Thomas (1984), 'Macroeconomic Factors, the Arbitrage Pricing Theory and the UK Stock Market', *Journal of Business Finance and Accounting*, Vol. 21, No. 3, pp. 309–30.

Connor, G. and R. A. Korajczyk (1988), 'The Attributes, Behavior and Performance of U.S. Mutual Funds', Research Program in Finance Working Papers 181, University of California at Berkeley.

Copeland, T. E. and J. F. Weston (1988), *Financial Theory and Corporate Policy*, 3rd edn, Addison-Wesley Publishing Company, Inc., Massachusetts.

De la Calle, L. (1991), 'Diversification of Macroeconomic Risk and International Integration of Capital Markets: The Case of Mexico', *The World Bank Economic Review*, Vol. 5, No. 3, pp. 415–36.

Dhrymes, P., I. Friend and B. Gultekin (1984), 'A Critical Reexamination of the Empirical Evidence of the Arbitrage Pricing Theory', *Journal of Finance*, June, pp. 323–46.

Elton, E. J. and M. J. Gruber (1984), *Modern Portfolio Theory and Investment Analysis*, 2nd edn, John Wiley and Sons, New York, pp. 350–72.

Fama, E. and J. D. MacBeth (1973), 'Risk, Return and Equilibrium: Empirical Tests', *Journal of Political Economy*, Vol. 81, pp. 607–36.

Gehr, A. (1975), 'Some Tests of the Arbitrage Pricing Theory', *Journal of the Midwest Finance Association*, Vol. 7, pp. 91–105.

Groenewold, N. and P. Fraser (1997), 'Share Prices and Macroeconomic Factors', *Journal of Business Finance and Accounting*, Vol. 24, Nos. 9/10, pp. 1367–73.

Grinblatt, M. and S. Titman (1983), 'Factor Pricing in a Finite Economy', *Journal of Financial Economics*, December, pp. 497–507.

Isimbabi, M. J. (1997), 'Stock Markets, Foreign Investment and Economic Growth in Africa', *SAIS Review*, Vol. 17, No. 2, pp. 141–52.

Jones, C. S. (2001), 'Extracting Factors from Heteroskedastic Asset Returns', *Journal of Financial Economics*, Vol. 62, pp. 293–325.

Kumar, M. S. and R. S. Feldman (1995), 'Emerging Equity Markets: Growth, Benefits and Policy Concerns', *The World Bank Research Observer*, August, pp. 181–200.

Lehmann, B. N. and D. M. Modest (1988), 'The Empirical Foundations of the Arbitrage Pricing Theory', *Journal of Financial Economics*, Vol. 21, No. 1, pp. 213–54.

Levine, R. and S. Zervos (1996), 'Stock Markets Development and Long-run Growth', *The World Bank Economic Review*, May, New York.

Lintner, J. (1965), 'The Valuation of Risky Assets and the Selection of Risky Investment in Stock Portfolios and Capital Budgets', *Review of Economics and Statistics*, Vol. 47, pp. 13–37.

Mossin, J. (1966), 'Equilibrium in a Capital Asset Market', *Econometrica*, Vol. 34, pp. 768–83.

Osei, K. A. (1998), 'Analysis of Factors Affecting the Development of an Emerging Capital Market: The Case of the Ghana Stock Market', AERC Research Paper 66.

Osei, K. A. (2001), 'Asset Pricing and Information Efficiency of the Ghana Stock Market', AERC Research Paper (RP 115).

Roll, R. and S. Ross (1980), 'An Empirical Investigation of the Arbitrage Pricing Theory', *Journal of Finance*, Vol. 35, pp. 1073–103.

Ross, S. A. (1976), 'The Arbitrage Theory of Capital Asset Pricing', *Journal of Economic Theory*, Vol. 13, pp. 341–60.

Ross, R. (1977), 'A Critique of the Asset Pricing Theory', *Journal of Financial Economics*, pp. 129–76.

Ross, S. A. and R. Roll (1984), 'The Arbitrage Pricing Theory Approach to Strategic Portfolio Planning', *Financial Analyst Journal*, May–June, pp. 14–26.

Sharpe, W. F. (1964), 'Capital Asset Prices: A Theory of Market Equilibrium under Conditions of Risk', *Journal of Finance*, pp. 425–42.

Singh, A. (1993), 'The Stock Market and Economic Development: Should Developing Countries Encourage Stock Markets', *UNCTAD Review*, Vol. 4.

Trzcinka, C. (1986), 'On the Number of Factors in the Arbitrage Pricing Model', *Journal of Finance*, Vol. 41, No. 2, pp. 347–68.

Van Rensburg, P. (1996), 'Macroeconomic Identification of the Priced APT Factors on the Johannesburg Stock Exchange', *South African Journal of Business Management*, Vol. 27, No. 4, pp. 104–13.

Vessereau, T. (2000), 'Factor Analysis and Independent Component Analysis in Presence of High Idiosyncratic Risks', Scientific series (CIRANO), Working Paper 2000s-46.

Zhou, G. (1999), 'Security Factors as Linear Combination of Economic Variables', *Journal of Financial Markets*, Vol. 2, No. 4, pp. 403–32.

Ziorklui, S. (2001), 'The Development of African Capital Market and Growth in Sub-Saharan Africa: The Case of Ghana', Equity and Growth through Economic Research (EAGER) Paper.

Appendix

Table A1: Listed companies in good standing

Company name	Equity code	Date of incorporation	Date listed	Nature of business	Total shares issued (mil.)	Share price (¢) (31/12/02)
Accra Brewery Comp. Ltd.	ABL	01/04/75	12/11/90	Brewery	166.30	410.00
Ashanti Goldfields Co. Ltd.	AGC	19/08/74	17/05/94	Mining	127.22	27,000.00
Aluworks Ltd.	ALW	24/02/78	29/11/96	Alum. Prod.	41.68	3,700.00
BAT (Gh.) Ltd.	BAT	01/11/52	12/11/90	Tobacco	69.13	1,001.00
CFAO Ghana Ltd.	CFAO	24/01/73	21/02/92	Trading (Auto)	56.00	67.00
Enterprise Insurance Co. Ltd	EIC	31/08/76	12/11/90	Insurance	5.00	4,600.00
Fan Milk Ltd.	FML	06/01/60	12/11/90	Dairy Prod.	19.78	1,785.00
Ghana Comm. Bank Ltd.	GCB	20/05/53	17/05/96	Banking	165.00	3,516.00
Guinness Ghana Ltd.	GGL	29/08/60	12/11/90	Brewery	117.48	1,050.00
Home Finance Co. Ltd.	HFC	07/05/90	17/03/95	Mortgage	79.75	955.00
Metalloplastica Ghana Ltd.	MGL	29/10/59	18/10/90	Plastic Prod.	18.00	254.00
Mechanical Lloyd Co. Ltd.	MCK	07/08/70	10/05/94	Trading (Auto)	40.08	270.00
Mobil Oil Ghana Ltd.	MOGL	31/12/51	19/07/91	Petroleum	4.05	19,730.00
Pioneer Alum.Factory Ltd.	PAF	11/07/59	25/08/95	Alum. Prod.	16.50	750.00
PZ Cussons Ghana Ltd.	PZ	24/05/58	12/11/90	Pharmac.	28.00	2,005.00
Standard Chart. (Gh.) Ltd.	SCB	1970	12/11/90	Banking	17.60	28,700.00
Super Paper Prod. Co. Ltd.	SPPC	23/05/67	02/05/92	Paper Prod.	19.44	387.00
SSB Bank Ltd.	SSB	07/02/75	13/10/95	Banking	71.25	3,966.00
Unilever Ghana Ltd.	UNIL	1931	12/11/90	Conglomerate	62.50	4,805.00

Source: Fact Book (2001), Market Activity Summary (2002); GSE & Data Bank Financial Services

Table A2: Calculation of industry capitalization weights

Equity	Industry	Capitalization equity	Industry (in billion cedis)	Weight equity (w_{ij})	Industry (w_i)
EIC	Financial	23.00		0.0039	
SSB	Financial	282.58		0.0485	
GCB	Financial	580.14		0.0996	
SCB	Financial	505.01		0.0867	
HFC	Financial	76.17	1,466.90	0.0131	0.2518
BAT	Manufacturing	69.2		0.0119	
SPPC	Manufacturing	7.52		0.0013	
PZ	Manufacturing	56.14		0.0096	
PAF	Manufacturing	12.38		0.0021	
ALW	Manufacturing	154.21		0.0265	
MGL	Manufacturing	4.57		0.0008	
UNIL	Manufacturing	300.31	604.33	0.0515	0.1037
ABL	Food & Breweries	68.18		0.0117	
GGL	Food & Breweries	123.35		0.0221	
FML	Food & Breweries	35.31	226.84	0.0061	0.0399
CFAO	Retailing	3.75		0.0006	
MLC	Retailing	10.82		0.0019	
MOGL	Retailing	79.91	94.48	0.0137	0.0162
AGC	Mining	3434.91	3,434.91	0.5894	0.5894
Totals		5827.46	5827.46	1	1

Table A3: Justification of industries' final PECM

Model reduction	Degrees of freedom	Akaike criterion	*F* Test statistic*	Model selected
Financial industry				
Model 1 > 2	F[22, 21]	−1.827	0.1593(2.05)	2
Model 2 > 3	F[3, 43]	−1.922	0.0045(1.79)	3
Model 3 > 4	F[4, 46]	−1.738	4.1671(2.61)	3
Model 4 > 5	F[6, 49]	−1.674	3.0926(2.34)	4
Model 3 selected				
Manufacturing industry				
Model 1 > 2	F[4, 14]	− 1.567	0.0036(3.11)	2
Model 2 > 3	F[8, 18]	− 1.936	0.3634(2.51)	3
Model 3 > 4	F[6, 26]	− 2.046	1.3499(2.49)	4
Model 4 > 5	F[12, 32]	−2.210	2.0685(2.09)	5
Model 5 > 6	F[4, 44]	− 2.233	2.5454(2.61)	6
Model 6 > 7	F[2, 48]	− 2.211	3.4192(3.23)	6
Model 7 > 8	F[1, 50]	−2.229	4.5063(4.08)	7
Model 6 selected				
Breweries and food industry				
Model 1 > 2	F[10, 21]	− 5.150	0.1205(2.32)	2
Model 2 > 3	F[6, 31]	− 5.355	1.0172(2.42)	3
Model 3 > 4	F[5, 37]	− 5.564	0.8854(2.45)	4

Model 4 > 5	F[6, 42]	−5.757	1.4811(2.34)	5
Model 5 > 6	F[3, 48]	− 5.831	2.0054(2.84)	6
Model 6 > 7	F[5, 51]	− 5.898	10.2000(2.37)	6
Model 6 selected				
Distribution industry				
Model 1 > 2	F[9, 21]	− 7.634	0.2816(2.37)	2
Model 2 > 3	F[10, 30]	− 7.941	1.1846(2.16)	3
Model 3 > 4	F[10, 40]	− 7.904	2.0146(2.08)	4
Model 4 > 5	F[1, 50]	−7.928	2.8918(4.08)	5
Model 5 > 6	F[2, 51]	− 7.780	7.6005(3.15)	5
Model 5 selected				
Mining industry				
Model 1 > 2	F[13, 13]	− 2.634	0.0397(2.60)	2
Model 2 > 3	F[14, 26]	− 3.049	1.1875(2.09)	3
Model 3 > 4	F[12, 40]	− 3.375	1.9381(2.00)	4
Model 4 > 5	F[2, 52]	−3.483	0.6537(3.15)	5
Model 5 > 6	F[2, 54]	− 3.532	0.4188(3.15)	6
Model 6 > 7	F[1, 56]	− 3.593	4.3148(4.00)	6
Model 6 selected				

Table A4: Results of diagnostic tests on industries used in the study

Industry	Serial correlation DW	LM	Heteroscedasticity tests White Hetero. (No Cross)	Specif/Stability tests Ramsey RESET	Multicollinearity tests (R^2)
Financial	1.995	0.5118	0.3814	50.6851	0.68
		(0.6015)	(0.6728)	(0.0002)	
Manufacturing	1.899	0.4528	0.7693	11.5154	0.57
		(0.6387)	(0.7646)	(0.0014)	
Breweries and Food	1.820	0.6348	1.0542	12.1772	0.66
		(0.5343)	(0.4332)	(0.0010)	
Distribution	1.949	2.3415	1.0784	6.3143	0.63
		(0.1069)	(0.4086)	(0.0318)	
Mining	1.877	0.2342	2.8851	3.0114	0.51
		(0.7929)	(0.2247)	(0.0917)	

Note: Figures in parentheses are at 5 per cent significant levels. DW: Durbin–Watson statistic; LM: Lagrange Multiplier.

Table A5: Correlation matrix of industries returns

	FIN	*MFG*	*BF*	*DIS*	*MIN*
FIN	1.000	0.719	0.738	0.639	0.023
MFG	1.000	0.605	0.516	0.033	
BF	1.000	0.632	0.036		
DIS	1.000	−0.029			
MIN	1.000				

Note: FIN: Financial; MFG: Manufacturing; BF: Breweries and Food; DIS: Distribution; MIN: Mining.