SYSTEMATIC RISK FACTORS FOR AUSTRALIAN STOCK MARKET RETURNS: A COINTEGRATION ANALYSIS

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ABSTRACT

This paper identifies the systematic risk factors for the Australian stock market by applying the cointegration technique of Johansen. In conformity with the finance literature and investors' common intuition, relevant *a priori* variables are chosen to proxy for Australian systematic risk factors. The results show that only a few systematic risk factors are dominant for Australian stock market price movements in the long-run while short-run dynamics are in place. It is observed that the linear combination of all *a priori* variables is cointegrated although not all variables are significantly influential. The findings show that bank interest rate, corporate profitability, dividend yield, industrial production and, to a lesser extent, global market movements are significantly influencing the Australian stock market returns in the long-run; while in the short-run it is being adjusted each quarter by its own performance, interest rate and global stock market movements of previous quarter.

JEL Code: G10, G11, G12
Key words: *Systematic risk factors, returns, APT.*

1. INTRODUCTION & BACKGROUND

In the finance literature, total risk of an investment comprises of both systematic and non-systematic risks. This classification is conceptualized by the standard deviation of an investment return from the point of view of diversification. The diversifiable risk is the unsystematic risk, while non-diversifiable risk is systematic risk. The systematic risk principle states that the reward for bearing risk depends only on the systematic risk of an investment and thus the expected return on a risky asset depends only on its systematic risk. Accordingly, systematic risk is also the market risk.

From the literature it is observed that asset pricing theories do not specify the underlying economic forces or systematic risk factors that drive securities prices (Chen et al., 1986; Chen, 1991; Faff, 1988; Fama, 1981; Hamao, 1986; Maysami and Koh, 2000; McGowan and Francis, 1991; Paul and Mallik, 2001; Roll and Ross, 1980; Sinclair, 1982; Valentine, 2000; Wongbangpo and Sharma, 2002). In general, empirical analyses depend on the availability of data and access to specialized software. The rationale for the selection of variables is essentially based on financial theory and investors' intuition (Chen et al., 1986; McMillan, 2001; Mukharjee and Naka, 1995).

The core idea of Ross's (1976) arbitrage pricing theory (APT) is that only a small number of systematic influences affect the long-term average returns on securities. Hence, original APT is a "factor" model. Unlike Sharpe's (1963, 1964) "single-index" capital asset pricing model (CAPM), APT includes multiple factors that represent the fundamental risks in asset returns and thus the prices of securities. Multi-factor models allow an asset to have not just one, but many, measures of systematic risks. Each measure captures the essential sensitivity of the asset to the corresponding pervasive factor. Thus, APT is also a multi-factor equilibrium pricing model that is more general than the CAPM. On both theoretical and empirical grounds, APT is an attractive alternative to CAPM. It is argued that APT requires less stringent and presumably more plausible assumptions and is more readily testable since it does not require the measurement of market portfolios. Often, APT explains the anomalies found in the application of CAPM to asset returns (Dhrymes et al., 1984, 1985).

APT conventionally assumes that the returns on securities are linearly related to a small number, *k*, of common or systematic factors rather than a single factor, β. The model applies to any set of securities as long as their number, *n*, is much larger than the number *k* of common factors. APT does not specify what the *k*-factors are; rather it has kept this open for consideration by researchers. Moreover, the model does not require that investors hold all outstanding securities; hence the market, which is central to CAPM, plays no role in APT (Dimson and Mussavian, 1999).

Most APT tests employ the methodology suggested by Roll and Ross (1980), commonly known as the RR method. A major weakness of RR method is its inability to identify the nature of common factors since they are treated as inherently latent. An alternative approach that *pre-specifies* a set of economic and/or financial variables to act as common factors performs well. Upon determination of *a priori* variables, usually this approach of testing APT examines whether the sensitivity coefficients of stock returns to these factors explain the cross-sectional variation of average stock returns (Chen, et al. 1986 and Hamao, 1986).

Faff (1988) examines issues concerning the Asset Pricing Theory on Australian equity data by employing the Chamberlain and Rothschild (1983) approach which is modified in Faff (1992) using the asymptotic principal component technique. Aitken et al. (1996) deal only with the stock market trading system of Australia. Brailsford and Easton (1991) observe the impact of seasonality factor on Australian equity returns for the period 1939-1957. Later Easton and Faff (1994) investigate the robustness of the day–of-the-week effect on Australian stock market returns. Faff and Heaney (1999) study the relationship between inflation and equity returns in Australia from January 1974 to March 1996 by using monthly and quarterly data. Faff and Brailsford (1999) test the sensitivity of Australian (industrial) equity returns to an oil price factor between 1983 and1996. Shamsuddin and Kim (2003) observe the cross-country stock market relationships by employing the cointegration technique of Johansen (1995). Paul and Mallik (2001) examine the long-run relationship of pre-specified macroeconomic variables and stock price index of the Australian Banking and Finance sector from January 1980 to January 1999 using Auto Regressive Distributed Lag (ARDL) model of Pesaran and Shin (1995).

The primary objective of this paper is to identify the systematic risk factors and their influences in the return generating process of the Australian stock market by utilizing the cointegration technique of Johansen (1995, 2000). In the context of application of empirical approach, this paper seems to be distinctive as no previous research has utilized this specific technique in identifying systematic risk factors for Australian stock market returns. For the purpose of empirical analysis of this study, the time series properties of the selected variables are assessed.

The structure of this paper is as follows. Section 2 outlines the data and hypothesized relationships of *a priory* variables with the stock market returns. Section 3 provides the unit root and break point tests. The modeling for empirical analysis is provided in Section 4; while test results followed by discussions are provided in Section 5. Section 6 concludes the paper.

2. DATA, VARIABLES & HYPOTHESIZED RELATIONSHIPS

Based on both finance literature and the common intuition of investors, a set of variables are identified that represent the money market, the goods market, and the global stock market performances. Upon appropriate scrutiny and validation process these initial variables are reduced to a manageable number to represent as *a priori* variables. The relationships among these *a priori* variables are also hypothesized before considering them in the model for empirical analysis.

2.1. Data and Variables

Initially 15 relevant macro-variables are considered to proxy for systematic risk factors for the Australian stock market. Relevant data for this study are gathered from various sources. The data on gross domestic product (GDP), per capita GDP (GDPPC), the industrial production index (IPI), the manufacturing commodity price index (MPI), the unemployment rate (UR), imports (M) and exports (X) to derive net exports (X-M=NX), and the consumer price index (CPI) are collected from the Australian Bureau of Statistics (ABS). The data on the M3 money supply (MS), the standard variable bank interest rate (BVIR), the 11AM cash rate (IR11AM) and net exports (NX) are acquired from both the ABS and the Reserve Bank of Australia. Corporate profits (CP), the price earnings ratio (PER), dividend yields (DY), and the Australian to US dollar exchange rate (ER) are obtained from the Reserve Bank of Australia. The data on the Morgan Stanley Capital International World Index (MSCI) which is used as a proxy for global equity market influences is acquired from the Morgan Stanley. Time series data from the first quarter of 1983 to the second quarter of 2002 are used in this study.

For ensuring model adequacy and parameter stability, several statistical tests are performed at the outset. To eliminate the problem of potential multicollinearity among the variables the relevant correlation values of all variables and stock market returns are taken into account. To validate the variables selection decision, principal components method is applied. The results are not reported here to conserve space. However, through the variable selection process initial fifteen variables are reduced to six for consideration in the model as *a priory*. These six *a priori* variables are industrial production, the bank variable interest rate, corporate profits, the dividend yield, the price earnings ratio, and MSCI. All variables are transformed into natural logarithm for empirical analysis.

2.2. Hypothesized relationships of variables

The industrial production index (IPI) is considered to represent the goods market. The money market is represented by the bank variable interest rate (BVIR) which is also linked to the exchange rate (ER) representing the foreign exchange market. The security market is represented by the stock price index (ALLORDS), which is also linked to the dividend yield (DY) and the price earnings ratio (PER). The global stock market influence is represented by the performance of the global index MSCI.

The relationship between interest rates and stock prices from the perspective of asset portfolio allocation is commonly negative. An increase in interest rates raises the required rate of return, which in turn inversely affects the value of the asset. Measured as opportunity cost, the nominal interest rate affects investors' decision on stock holdings. A rise in the opportunity cost may, however, motivate investors to substitute shares for other assets. Also, an increase in interest rates may trigger a recession and thus cause a decline in future corporate profitability. Furthermore, higher interest rates have a discouraging effect on mergers, acquisitions and buyouts. Interest rates might have a positive relationship with stock returns, as an increase in the rate of interest raises the opportunity cost of holding cash and is likely to lead to a substitution effect between stocks and other interest bearing assets. Changes in interest rates are also expected to affect the discount rate in the same direction through their effect on the nominal risk-free rate (Mukharjee and Naka, 1995). Nominal interest rates often contain information about future economic conditions and state of investment opportunities in stocks. Generally, short-term interest rates have a significant negative influence on the stock market. However, a negative relationship between interest rates (BVIR) and stock prices (ALLORDS) is hypothesized.

An increase in production is likely to influence stock prices through its positive impact on gross domestic product and corporate profitability. An increase in output is likely to increase expected future cash flows and thereby raise stock prices, while the opposite effect would occur in a recession. A positive relationship between ALLORDS and industrial production (IPI) is hypothesized.

Movements in the dividend yield (DY) are considered to be related to long-run business conditions as they represent a predictable component of stock market returns. It is hypothesized that the dividend yield has a positive relationship with stock prices. Although, in the short-run, the price would drop immediately after the dividend payout for a specific stock due to speculation about the lack of an immediate profit-taking opportunity and a longer holding period to receive another dividend payout.

A positive relationship is assumed between corporate profits (CP) and market stock price because it captures predictable elements in future returns. This often relates to the price-earnings ratio (PER) which boosts the confidence of investors by encouraging them to invest in the stock market. Thus, it is hypothesized that both CP and the PER have positive relationship with ALLORDS.

Due to globalization the global stock market price index (MSCI) would have some spillover effect on the Australian stock market. Changes in the MSCI may have either a direct or indirect impact on the local stock market depending on the trading relationship with other markets. Thus, a positive relationship between ALLORDS and MSCI is hypothesized.

Based on above assumptions, it is expected that the modeled *a priori* variables will have a significant impact on the Australian stock market performance. This study thus aims to assess both the long and short run relationships between the Australian stock market returns ($\Delta ALLORDS$) and the *a priori* variables that represent as proxies to systematic risk factors.

3. UNIT ROOT & BREAKPOINT TESTS

For cointegration analysis, it is important to check the unit roots at the outset to ascertain whether the variables are I(1) at levels and I(0) at differences. Johansen cointegration analysis requires the use of those variables that are nonstationary with unit root I(1). This is because generally an application of standard estimation and testing procedures in a dynamic model requires that the variables be stationary, i.e., I(0) and/or both response and explanatory variables are of same order of integration. Otherwise, regressing a nonstationary I(1) response variable (regressand) like LNALLORDS on nonstationary I(1) explanatory variables (regressors) such as LNIPI, LNBVIR, LNCP, LNDY, LNPER, and LNMSCI may lead to spurious regression. An exception to this rule occurs when two or more I(1) variables are cointegrated, meaning that a linear combination of these nonstationary I(1) variables is stationary I(0). In such case a long-run relationship between these variables exists which also provides valid information about the short-run behaviors of the I(1) variables. To capture the combined long and short run behaviors, an error correction mechanism (ECM) is required.

Accordingly, unit root tests are conducted by using the Augmented Dickey-Fuller (ADF) and the Phillips-Perron (PP) tests. These results of the unit root tests are presented in Table 1. The test results are compared against the MacKinnon (1991) critical values for the rejection of the null hypothesis of no unit root. Table 1 shows that all variables (except LNMSCI and LNIPI in model C of ADF test) are integrated of order one I(1) in levels and of order zero I(0) in first differences, meaning that they are nonstationary in levels and stationary in first differences.

Table 1: Unit Root Test Results

MacKinnon critical values at levels: for model A. -2.9851; model B. -3.469; model C. -1.9439, and at 1st difference: for model A. -2.8955; model B. -3.4626; model C. -1.9445.

Variables	Augmented Dickey-Fuller (ADF)			Phillips-Perron (PP)		
	Model: A (intercept, notrend)	Model: B (intercept with trend)	Model: C (nointercept, notrend)	Model: A (intercept, notrend)	Model: B (intercept with trend)	Model: C (nointercept, notrend)
At level						
LNALLORDS	-0.7693	-2.5204	1.6447	-0.9158	-3.1529	1.8879
LNBVIR	-1.0780	-2.8031	-0.7916	-1.1332	-2.2060	-1.1586
LNMSCI	-2.0051	-2.5200	2.4765	-2.7021	-3.4094	2.6647
LNIPI	-1.5737	-3.0819	3.2505	-1.9306	-3.1799	4.5530
LNER	-1.5525	-2.1974	0.3993	-1.6695	-2.2856	0.4539
LNDY	-2.0014	-2.6032	-0.5466	-2.4353	-2.7896	0.8648
LNPER	-1.8346	-2.9635	0.2156	-1.8475	-2.5987	0.4182
At 1st diff.						
ΔLNALLORDS	-6.7377	-6.6898	-5.9812	-11.9180	-11.8279	-11.0715
ΔLNBVIR	-4.5835	-4.6497	-4.6254	-6.0566	-6.0173	-6.0533
ΔLNMSCI	-6.0321	-6.1883	-5.2225	-9.1863	-9.3631	-8.4619
ΔLNIPI	-4.6453	-4.7518	-3.3183	-9.1809	-9.2496	-7.5641
ΔLNER	-3.9624	-3.9067	-3.8699	-7.8623	-7.8127	-7.8161
ΔLNDY	-4.9831	-4.9657	-5.0108	-8.3097	-8.2527	-8.3542
ΔLNPER	-4.4205	-4.3887	-4.4167	-6.5535	-6.5088	-6.5723

Additionally, it seems important to identify if the 1987Q4 data that reflects the stock market crash of October 1987 has adverse series breaking effect. To this effect, the Chow Breakpoint Test is conducted to ascertain if the null hypothesis of no significant break in 1987Q4 data series can be rejected. The Chow Breakpoint test produced F-statistic of 6.55 (probability 0.000015) and log likelihood ratio statistic of 41.71 (probability 0.000001), as reported in Table 2.

The Chow Breakpoint test rejects the null hypothesis of no-effect of the October 1987 (1987Q4) stock market crash on the Australian stock prices. Thus, the breakpoint test implies that the October 1987 stock market crash is significant for the analysis. Accordingly, a break-point dummy is included in the model which takes the value 1 (one) for the 4th quarter of 1987 and 0 (zero) elsewhere as an exogenous variable in the model for the investigation of the cointegrating relationship between the Australian stock market returns and selected *a priori* variables.

Table 2: Chow Breakpoint Test

Critical values of *F*-statistic (1 df) are 2.71, 3.84 and 6.63 at 10%, 5% and 1% significance levels respectively.

Chow Breakpoint for 1987Q4			
F-statistic	6.547	Probability	0.000015
Log likelihood ratio	41.711	Probability	0.000001

As the autoregressive model is sensitive to the lag lengths, appropriate lag length is ascertained prior to conducting the cointegration analysis. The optimal lag length is determined based on various model selection criteria like the Akaike Information Criterion (AIC), Schwarz Bayesian Criterion (SBC) criteria, Hannan-Quinn Information Criterion (HQ), Final Prediction Error (FPE) and sequential modified LR test statistic (LR). The results are provided in Table 3a and Table 3b. The optimal lag length is one on the basis of SBC test. Although other criteria including Hannan-Quinn Criterion (HQ) and AIC suggested a higher lag length, to avoid risk of over-parameterization because of the "shortness" of sample size, lag length 1 is considered.

Table 3a: Test Statistics and Choice Criteria for Selecting the Order of the VAR Model
List of variables included in the unrestricted VAR are: LNALLORDS, LNBVIR, LNCP, LNDY, LNIPI, LNMSCI, LNPER. Test results of AIC, SBC, LR, Adjusted LR, corresponding χ^2 values are reported; while probability in [ ].

Lag	AIC	SBC	LR test		Adjusted LR test
5	922.6844	677.6844	419.1023	------	------
4	853.5152	657.5152	450.6496	χ^2 (49) = 138.3383[.000]	58.9639[.156]
3	766.6831	619.6831	464.5339	χ^2 (98) = 312.0025[.000]	132.9847[.011]
2	711.1570	613.1570	509.7242	χ^2 (147) = 423.0547[.000]	180.3184[.032]
1*	632.4021	583.4021	531.6857	χ^2 (196) = 580.5645[.000]	247.4537[.007]
0	-22.6793	-22.6793	-22.6793	χ^2 (245) = 1890.7[.000]	805.8838[.000]

Table 3b: VAR Lag Order Selection Criteria
Endogenous variables: LNALLORDS LNBVIR LNCP LNDY LNIPI LNMSCI LNPER; Exogenous variables: C. Where, LogL = Log Likelihood; LR = sequential modified Likelihood Ratio test statistic; FPE = Final prediction error; AIC = Akaike information criterion; SBC = Schwarz information criterion; HQ = Hannan-Quinn information criterion; and * indicates lag order selected by the criterion (each test at 5% level of significance).

Lag	LogL	LR	FPE	AIC	SBC	HQ
0	301.7397	NA	1.50E-13	-9.663595	-9.421364	-9.568662
1	646.5622	599.1998	9.29E-18	-19.36269	-17.42484*	-18.60323
2	19.4107	109.8700	4.52E-18	-20.14461	-16.51114	-18.72062
3	779.4621	76.78697	3.71E-18	-20.50695	-15.17786	-18.41843
4	66.4853	91.30303*	1.51E-18*	-21.75362	-14.72890	-19.00057*
5	934.6668	55.88645	1.53E-18	-22.38252*	-13.66219	-18.96494

4. MODELING

The general purpose model of this study is specified in the following form:

$$\Delta ALLORDS_t = f(\Delta BVIR_t, \Delta CP_t, \Delta DY_t, \Delta IPI_t, \Delta MSCI_t, \Delta PER_t) \quad (1)$$

However, for ultimate analysis a vector autoregressive (VAR) model is considered which has a constant (but no trend) and the breakpoint dummy as exogenous. This is presented in following equation 2:

$$y_t = \mu_0 + \sum_{i=1}^{k} \beta_i y_{t-i} + \varphi D_t + u_t \quad (2)$$

where $y_t = (LNALLORDS, LNBVIR, LNCP, LNDY, LNIPI, LNMSCI, LNPER)'$ a 7×1 vector of I(1) variables considered as endogenous in the model; D_t is a vector of breakpoint dummy exogenous variable; μ_0 is a constant and u_t is white noise.

In order to perform Johansen's cointegration analysis the VAR in equation 2 is converted into a vector error correction model (VECM) by incorporating an error correction mechanism (ECM_{-1}) into the system. The transformed VECM is presented in equations 3 and 4:

$$\Delta y_t = \mu_0 + \sum_{i=1}^{p-1} \Gamma_i \Delta_i y_{t-i} + \delta ECM_{t-1} + \varphi D_t + \varepsilon_t \quad (3)$$

or,

$$\Delta y_t = \mu_0 + \sum_{i=1}^{p-1} \Gamma_i \Delta_i y_{t-i} + \alpha \beta' y_{t-1} + \varphi D_t + \varepsilon_t \quad (4)$$

where $\varepsilon_t \sim iidN(0, \Omega)$.

5. RESULTS

Considering the identified lag length as the order of the VAR, the necessary analysis is performed following the trail of Johansen. Accordingly, a likelihood ratio (LR) test, the maximum eigenvalue (λ_{max}) test and the trace (λ_{trace}) test are conducted. The cointegration results along with test statistics are presented in Table 4. It is evident from the results that the null hypothesis of $r = 0$ against the alternative $r = 1$ can be rejected from the λ_{max} test. The same outcome is achieved from the λ_{trace} test which has rejected $r = 0$ against $r \geq 1$. The results show that only one stationary linear combination of variables is cointegrated in the long-run. As per the Johansen (1995) procedure coefficients of the cointegrating equation (B) in Table 4 are normalized by $\hat{\beta}S_{11}\hat{\beta} = I$ since the long-run multiplier matrix Π_y does not generally lead to a unique choice for the cointegrating relations. The identification of β in $\Pi_y \alpha_y \beta'$ requires at least *r* restrictions per cointegrating relation (*r*). As *r* =1 is found, one restriction is applied for normalizing the LNALLORDS variable. LNALLORDS is considered as the cointegrating equation, because it is the vector that contains the maximum eigenvalue.

Table 4: Cointegration Results (long-run) for Australia

Cointegration tests' results and long-run solutions are provided in (A) and (B). Both trace and maximum eigenvalue test statistics are reported in (A). In Cointegration test[a], *r* = the number of cointegrating vectors; a. Optimal lag structure is 1 and the VAR contains a constant without trend and breakpoint dummy as exogenous to the model. In long-run equation[b], the cointegrating vector is normalized on the Australian stock price index (LNALLORDS). The LR test statistics, given in parentheses, are used to test the null hypothesis that each coefficient is statistically zero. The test statistic is asymptotically distributed as a chi-square distribution with 1 degree of freedom. The critical values of chi-square distribution at 5% and 10% significance levels are 3.841 and 2.706 respectively.

Hypothesis		Test Statistic	Critical Value		Eigenvalue
Null	Alternative		5%	1%	
(A) Cointegration test[a]					
Test Statistic: Maximal Eigenvalue (λ_{max})					
$r = 0$	$r = 1$	82.50867	45.28	51.57	0.724508
$r \leq 1$	$r = 2$	56.39844	39.37	45.10	0.585725
$r \leq 2$	$r = 3$	37.22766	33.46	38.77	0.441043
$r \leq 3$	$r = 4$	30.79637	27.07	32.24	0.381955
$r \leq 4$	$r = 5$	14.77187	20.97	25.52	0.206110
$r \leq 5$	$r = 6$	6.831499	14.07	18.63	0.101243
$r \leq 6$	$r = 7$	0.393115	3.76	6.65	0.006124
Test Statistic: Trace (λ_{trace})					
$r = 0$	$r \geq 1$*	228.93	124.24	133.57	0.73
$r \leq 1$	$r \geq 2$	146.42	94.15	103.18	0.59
$r \leq 2$	$r \geq 3$	90.02	68.52	76.07	0.44
$r \leq 3$	$r \geq 4$	52.79	47.21	54.46	0.38
$r \leq 4$	$r \geq 5$	22.00	29.68	35.65	0.21
$r \leq 5$	$r \geq 6$	7.23	15.41	20.04	0.10
$r \leq 6$	$r = 7$	0.39	3.76	6.65	0.016

(B) The long-run equation[b]

$LNALLORDS_{(3.5776)} = - 0.3557LNBVIR_{(5.4923)} + 1.2869LNCP_{(24.4554)} + 0.8600LNDY_{(4.7723)} - 4.24174LNIPI_{(8.1860)} - 0.9201LNMSCI_{(2.3277)} - 0.0047LNPER_{(0.0010)}$

or,

$LNALLORDS_{(3.5776)} + 0.3557LNBVIR_{(5.4923)} - 1.2869LNCP_{(24.4554)} - 0.8600LNDY_{(4.7723)} + 4.24174LNIPI_{(8.1860)} + 0.9201LNMSCI_{(2.3277)} + 0.0047LNPER_{(0.0010)} = 0$

From the likelihood ratio (LR) test results of restrictions concerning each variable in equation (B) of Table 4, the null hypothesis of no significance is rejected in relation to four *a priori* variables including interest rate (LNBVIR), corporate profit (LNCP), dividend yield (LNDY) and industrial production (LNIPI) at the 5% level. Although, in terms of LR test results, both LNMSCI and LNPER are not significant even at the 10% level, the global stock market index is significant on the basis of the *t*-statistic (–2.7196) for LNMSCI. Respective *t*-statistics for LNBVIR, LNCP, LNDY, LNIPI, LNMSCI, and LNPER are –3.5762, 11.3262, 4.4858, –4.2826, –2.7196 and –0.0484. It appears that only 4-5 *a priori* variables are significant to the Australian stock price movements or returns in the long-run.

Accordingly, this result suggests that although the linear combination of all variables is cointegrated although not all variables are equally influential. The significantly influential *a priori* variables in the long-run cointegrating relationship for the Australian stock market are the bank variable interest rate (BVIR), corporate profitability (CP), dividend yield (DY), and industrial production index (IPI). In addition, the global stock market index (MSCI) also has some influence. However, the price-earnings ratio (PER) seems to have insignificant effect based on both LR and *t*-tests statistics.

Taking ΔLNALLORDS as the left hand side variable in the short-run model (which may be thought of as the dependent variable in structural time series), it is found that the Australian stock market is dynamic and has been continually corrected from its own disequilibrium of the previous quarter at a speed of 4% per quarter, while all individual variables are contributing to the process of adjustment towards equilibrium. The bank interest rate (ΔLNBVIR), global influence (ΔLNMSCI) and the previous performance of Australian market itself (ΔLNALLORDS) are found significant in the dynamic adjustment process, although the error correction mechanism (ECM_{-1}) is small in magnitude. The interest rate (ΔLNBVIR) and company profits (ΔLNCP) are found to significantly contributing towards long-run equilibrium as their related error correction mechanisms are significant.

The results of dynamic time series and their corresponding error correction mechanisms for the Australian market relevant to this study are presented in Table 5, while Table 6 reports the long-run equilibrium position for Australia. The identified long-run cointegrating relation amongst seven variables including ΔLNALLORDS is plotted in Figure 1.

Table 5: Results (Short-Run) for Australia

Critical values for *t*-statistics (2-sided test) are 1.64, 1.96 and 1.58 at 10%, 5% and 1% significance levels respectively.

Variables	Coefficient	Standard Error	*t* statistic[probability]
LHS variable: ΔLNALLORDS			
ΔLNALLORDS(-1)	-0.4259	0.0391	-4.8797
ΔLNBVIR(-1)	-0.2139	0.1091	-1.9595
ΔLNCP(-1)	0.0239	0.0362	0.6593
ΔLNDY(-1)	0.3247	0.2233	1.4540
ΔLNIPI(-1)	0.7837	0.1938	1.2332
ΔLNMSCI(-1)	1.0964	0.6355	4.8393
ΔLNPER(-1)	-0.1174	0.0727	-1.6148
ECM(-1)	-0.0401	0.0391	-1.0270
CHSQ(1)	0.6852	—	[0.4078]

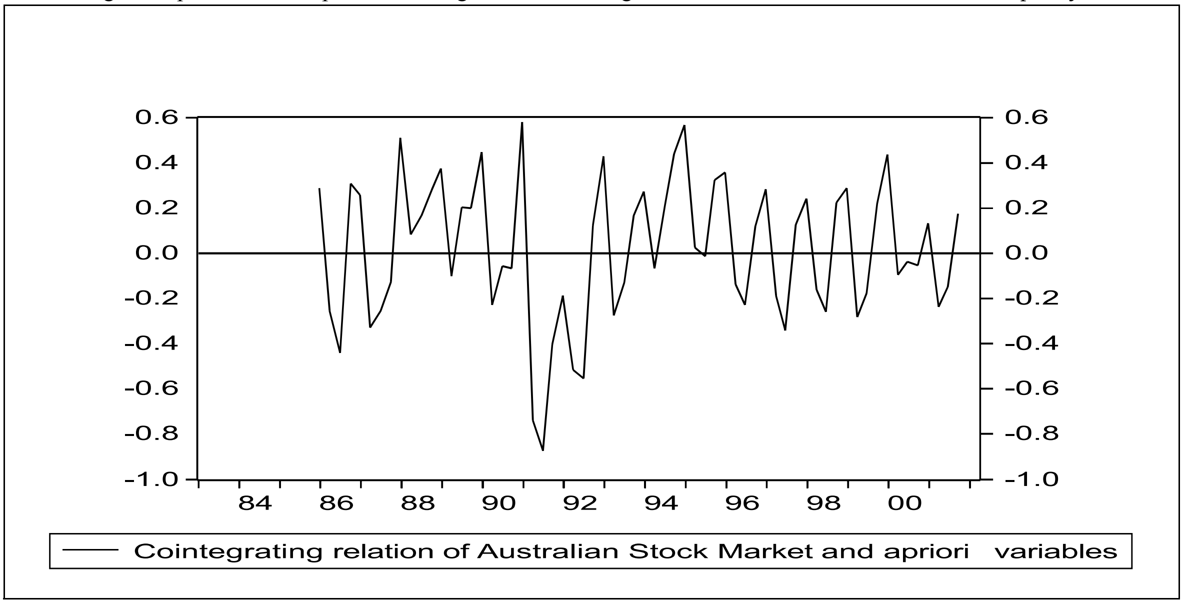
Table 6: Results (Long-Run) for Australia

Coefficients of the long-run parameter $\beta'_{ALLORDS}$ upon normalization for LNALLORDS. Critical values for *t*-statistics (2-sided test) are 1.96 and 1.58 at 5% and 1% significance levels respectively; while, the critical values of LR-statistic at 5% and 10% significance levels are 3.841 and 2.706 respectively.

Variables	Coefficient	t-statistic	LR statistic
LNALLORDS	1.0000	_____	3.5776
LNBVIR	-0.3557	-3.5762	5.4923
LNCP	1.2869	11.3262	24.4554
LNDY	0.8600	4.4858	4.7723
LNIPI	-4.2418	-4.2826	8.1860
LNMSCI	-0.9201	-2.7196	2.3277
LNPER	-0.0047	-0.0484	0.0010

Figure 1: State of Equilibrium Pricing in the Australian Stock Market

The cointegration plot shows the pattern of integration in the long-run for Australian Stock Market with *a priory* variables.



Alternatively, coefficients of the long-run parameter $\beta'_{ALLORDS}$ upon normalization for LNALLORDS are –0.3557, 1.2869, 0.8600, –4.2418, –0.9201 and –0.0047 for LNBVIR, LNCP, LNDY, LNIPI, LNMSCI and LNPER respectively. The corresponding *t*-statistics are –3.5762, 11.3262, 4.4858, –4.2826, –2.7196 and –0.0484. The estimated $\beta_{ALLORDS}$ (prior to transposing for $\beta'_{ALLORDS}$) with corresponding *t*-values in the parentheses is presented as under:

$$\hat{\beta}_{ALLORDS} = \begin{pmatrix} \beta_{11} \\ \beta_{21} \\ \beta_{31} \\ \beta_{41} \\ \beta_{51} \\ \beta_{61} \\ \beta_{71} \end{pmatrix} = \begin{pmatrix} 1.000000 \\ -0.3557_{(-3.5762)} \\ 1.2869_{(11.3262)} \\ 0.8600_{(4.4858)} \\ -4.2418_{(-4.2826)} \\ -0.9201_{(-2.7196)} \\ -0.0047_{(-0.0484)} \end{pmatrix} \qquad (5)$$

It appears from the estimated $\beta_{ALLORDS}$ that the LNBVIR, LNCP, LNDY, LNIPI and LNMSCI variables are significant in the long-run cointegrating relationship for Australia as they are also significant when compared with the critical value for the *t*-statistic (1.96) at the 5% significance level.

The short-run dynamic system provides coefficients of α corresponding to ΔLNALLORDS, ΔLNBVIR, ΔLNCP, ΔLNDY, ΔLNIPI, ΔLNMSCI and ΔLNPER. The estimated coefficients of α in respective order are –0.0401, 0.1048, –0.0104, –0.0102, 0.0010, 0.0414, and –0.0715. Corresponding *t*-values for α are –1.0270, 2.2884, –6.9414, –0.2135, 1.2111, 0.9220 and –1.1223 respectively. The estimated coefficients of α is provided in equation 6.

$$\hat{\alpha} = \begin{pmatrix} \alpha_{11} \\ \alpha_{21} \\ \alpha_{31} \\ \alpha_{41} \\ \alpha_{51} \\ \alpha_{61} \\ \alpha_{71} \end{pmatrix} = \begin{pmatrix} -0.0401_{(-1.0270)} \\ 0.1048_{(2.2884)} \\ -0.0104_{(-6.9414)} \\ -0.0102_{(-0.2135)} \\ 0.0010_{(1.2111)} \\ 0.0414_{(0.9220)} \\ -0.0715_{(-1.1223)} \end{pmatrix} \tag{6}$$

The ECM$_{-1}$ for the LNALLORDS that refers to as the adjustment parameter in the cointegrating equation is $\alpha_{ALLORDS} = \alpha = -0.0401$. The *t*-statistics in parentheses corresponding to α_{11} indicate that ECM$_{-1}$ for LNALLORDS is not significant although the linear combination of all variables is found cointegrated. This implies that the Australian stock market is yet to be efficient in terms of its auto correction.

The estimates of the short-run parameters for the Australian market $\Gamma_{ALLORDS}$ are observed as –0.4259, –0.2139, 0.0239, 0.3247, 0.7837, 1.0964, and –0.1174 for ΔLNALLORDS $_{-1}$, ΔLNBVIR $_{-1}$, ΔLNCP $_{-1}$, ΔLNDY $_{-1}$, ΔLNIPI $_{-1}$, ΔLNMSCI $_{-1}$ and ΔLNPER $_{-1}$ respectively. The corresponding *t*-statistics for $\Gamma_{ALLORDS}$ are –4.8797, –1.9595, 0.6593, 1.4540, 1.2332, 4.8393, and –1.6148. This suggests that in the process of the short-run adjustment for the Australian stock market, ΔLNALLORDS$_{t-1}$, ΔLNBVIR$_{t-1}$ and ΔLNMSCI$_{t-1}$ are significant at the 5% level. This means that Australian stock market prices are being adjusted each quarter dominantly by the influences of the market's own performance as well as interest rate and global stock market movements of previous quarter. Accordingly, the short-run estimated parameter $\Gamma_{ALLORDS}$ is depicted in equation 7.

$$\hat{\Gamma}_{ALLORDS} = \begin{pmatrix} -0.4259_{(-4.8797)} \\ -0.2139_{(-1.9595)} \\ 0.0239_{(0.6593)} \\ 0.3247_{(1.4540)} \\ 0.7837_{(1.2332)} \\ 1.0964_{(4.8393)} \\ -0.1174_{(-1.6148)} \end{pmatrix} \tag{7}$$

Based on the above results, the estimated model (VECM) for Australia is provided in solved equations 8 and 9. The estimated model showing both short- and long-run components is presented in equation 8. While the solved model in reduced form for long-run equilibrium state is presented in equation 9.

$$\Delta LNALLORDS_t = -0.0401*[1*LNALLORDS_{-1} -0.3557*LNBVIR_{-1} + 1.2869*LNCP_{-1} + 0.8600*LNDY_{-1} - 4.2418*LNIPI_{-1} - 0.9201*LNMSCI_{-1} - 0.0047*LNPER_{-1}] - [-0.4259*\Delta LNALLORDS_{-1} - 0.2139*\Delta LNBVIR_{-1} + 0.0239*\Delta LNICP_{-1} + 0.3247*\Delta LNDY_{-1} + 0.7837*\Delta LNIPI_{-1} + 1.0964*\Delta LNMSCI_{-1} - 0.1174*\Delta LNPER_{-1}]. \quad (8)$$

$$\Delta LNALLORDS_t = -0.0401*LNALLORDS_{-1} + 0.0143*LNBVIR_{-1} - 0.0516*LNCP_{-1} -0.0345*LNDY_{-1} + 0.1701*LNIPI_{-1} + 0.0369*LNMSCI_{-1} + 0.0002*LNPER_{-1}. \quad (9)$$

These results are interesting and useful in understanding the Australian stock market pricing mechanism as well as its return generating process. Accordingly, from the cointegration analysis it is ascertained that in the long-run all variables are cointegrated of which interest rate, corporate profit, dividend yield, industrial production and to some extent the global stock market movements truly represent as proxy for the systematic risk factors of the Australian stock market returns generating process.

6. CONCLUSION

This paper performs an empirical analysis to examine whether or not the selected *a priori* variables can explain the return generating and pricing process of the Australian stock market. The results are in conformity with the prevailing finance theory, yet interestingly different on some points. It is found that only a few *a priori* variables explain the Australian stock market pricing mechanism and these variables have a long-term relationship with Australian stock returns. The observed coefficients of normalized long-run parameter $\beta'_{ALLORDS}$ are –0.3557, 1.2869, 0.8600, –4.2418, –0.9201 and –0.0047 for LNBVIR, LNCP, LNDY, LNIPI, LNMSCI and LNPER respectively; while the corresponding *t*-statistics are –3.5762, 11.3262, 4.4858, –4.2826, –2.7196 and –0.0484. These imply that at least 4 (four) *a priori* variables are significant at the 5 % level. These significant variables are the interest rate, corporate profit, dividend yield and industrial production. Although the likelihood ratio test indicated that both the global stock market index and price-earnings ratio are insignificant even at the 10% level, yet the global stock market index is found significant at the 5% level, along with the interest rate, corporate profit, dividend yield, industrial production, and price-earnings ratio from the *t*-statistics.

The linear combination of all modeled variables in the long-run is cointegrated even though not all variables are significantly influential. While, the short-run dynamic system is viewed from coefficients of α . The estimated values of short-run parameters for the Australian market are seen from $\Gamma_{ALLORDS}$. Corresponding *t*-values for α are –1.0270, 2.2884, –6.9414, –0.2135, 1.2111, 0.9220 and –1.1223 respectively; while that of $\Gamma_{ALLORDS}$ are –4.8797, –1.9595, 0.6593, 1.4540, 1.2332, 4.8393, and –1.6148. These suggest that in the process of the short-run adjustment for the Australian stock market, $\Delta LNALLORDS_{t-1}$, $\Delta LNBVIR_{t-1}$ and $\Delta LNMSCI_{t-1}$ are significant at the 5% level.

Accordingly, this paper suggests that in the long-run the Australian stock market returns are being influenced by only 4 or 5 systematic risk factors and in the short-run the Australian stock market is being adjusted each quarter by its own performance, interest rate and global stock market movements of previous quarter. These outcomes seem consistent and supportive to prevailing literature and common intuitions of investors. This paper seems to be useful to cross-section of audiences that include investors, academics and fund managers. The ordinary investors and fund managers would gain benefits in managing investments risks when Australian stocks are included in their portfolio; while academic and research audience would find the paper interesting as it has used a distinct empirical approach to analyze systematic risk factors for Australian stock market returns.

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