

A Financial Econometric Analysis of E-Commerce Stock Price Predictability

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ABSTRACT

The predictability of stock price changes has been a contentious issue in finance for a long period of time. Using the Australian e-commerce financial data for determining the equity value of e-commerce firms, this paper provides an empirical analysis of the issue of predictability of stock prices. The factors contributing to the predictability of equity prices in the e-commerce markets are identified, analyzed and the issues and implications are discussed and explained. This paper presents new approaches to econometric specification, estimation and testing in relation to e-commerce stock predictability including stationarity tests, co-integration modeling and analyses. The policy implications of the empirical findings are stated. The empirical findings of the Australian study are extrapolated and inferences are made for other countries.

Keywords: *Asset pricing; Risk; Equity market; Stock price predictability; Financial markets; Econometric modelling; Knowledge economy*

INTRODUCTION

The hypothesis that price changes are independent was first presented by Roberts (1959) and Osborne (1959), which came to be termed as the random walk model. The random walk hypothesis was developed, postulating

that stock price changes over time were comparable to a random series (Roberts, 1959) and that prices are generated as Brownian motion (Osborne, 1959). This gave rise to a much larger theory known as the efficient market hypothesis (EMH) that predicts that share prices fairly reflect, in an unbiased manner, all information that has been fully revealed to the market. The notion of market efficiency is usually attributed to “rationality” of traders with “homogeneous” information. As the stock price reflects all relevant information about the stock, this price must represent its fair market value. Then stock price only moves in response to new information that, intrinsically, is unpredictable.

The advent of financial deregulation and increased globalization of capital markets in the early 1980s has witnessed increased upward trend in stock prices together with a heightened degree of idiosyncratic volatility in stock returns in major equity markets around the world (Campbell *et al.*, 2001). Consequently, an important issue that has emerged from the literature is whether stock prices are predictable. The predictability of returns relates to what component of stock returns can be predicted given specific information. Shiller (1981) found that the variability of stock price indices cannot be accounted for by information regarding dividend alone since expected future dividends do not vary enough to justify aggregate stock price movement. While studies by Fama (1981 and 1990), Fama and French (1988), Chen (1991), Keim (1994) and Lee (1996) suggest that excess returns are predictable in so far as their conditional mean is not a constant.

This study makes a contribution to the literature by extending on the existing knowledge on stock return predictability by studying the value-pervasive variables of e-commerce equity and their role in the predictability of stock returns in this sector. An appreciation of e-commerce stock return predictability will provide a profound understanding of the implications for investment and contribute to the efficient management of the portfolio choice decision-making process.

Therefore this paper evaluates the predictability of e-commerce stock return by analyzing their price volatility. The e-commerce stock prices are also used to construct a volatility profile to determine the degree of systematic or unsystematic risk influence on return. The association between e-commerce stock volatility and return is hypothesized and by

removing the portion of the e-commerce return that is associated with the market's return, we are able to reduce the variance of the abnormal return. This will allow a better appreciation of the event effects of the e-commerce phenomenon on the equity market. Empirical studies relating changes in stock market volatility to movements in expected returns to stocks include those by Merton (1980), Poterba and Summers (1986), French *et al.* (1987) and Bollerslev, Engle and Wooldridge (1988). The traditional explanation for the risk-return relationship is that the higher returns are compensation for higher systematic risk (Fama & French, 1993; 1996). This is in contrast to the suggestion by Lakonishok *et al.* (1994) that firms with low book-to-market ratios or growth stocks, a possible scenario for e-commerce stocks in the study period, are more in greater demand than value stocks, thus attracting naive investors who push prices and lower the expected returns of these securities. Furthermore, Lakonishok *et al.* (1994) argue that the return premia associated with the priced factors for growth stocks are too large and their co-variances with macro factors too low, in some cases negative, to be considered compensation for systematic risk.

This paper starts by summarizing the existing financial theories pertaining to predictability by providing a review of the concept, models and empirical studies on predictability. This is followed by a review of the study conducted in this paper on e-commerce and predictability. The empirical evidence of the tests on the model developed in this paper pertaining to volatility, predictability and efficient market hypothesis is presented. The implications of predictability and other related financial issues are discussed to address the implications of results on e-commerce stock return predictability. Finally, the results are extrapolated to highlight the policy implications for other financial markets and the last paragraph concludes.

LITERATURE ON PREDICTABILITY

There is a well-developed strand of literature on predictability (Cuthbertson, 1997). Some examples of the existing literature on predictability of stock returns have focused on issues such as, Granger's anomaly (Samih, 2002), model uncertainty (Avramov, 2000), asset allocation (Kandel, 1996) and dividends (Shiller, 1981). However, the question of the predictability of stock prices in the emerging knowledge economy, such as those of the

e-commerce sector, has not been specifically studied. The study of the predictability of e-commerce stocks is important since the e-commerce financial market has several special characteristics (Islam & Oh, 2003) such as volatility and returns, the high level of unsystematic risk and idiosyncratic factors that influence equity returns and their predictability in a portfolio context.

The objective of this study is to test the predictability of stock return by adopting the following techniques:

1. To identify and estimate return pervasive factors that are most likely to affect the predictability of stock return;
2. To develop an econometric multi-beta model for e-commerce equity returns and test the predictability of stock returns, using the combined explanatory power of the factors;
3. To conduct other empirical tests that may assist in evaluating stock predictability, such as volatility study, portfolio choice modeling and covariance and correlation analyses; and
4. To make inferences from the perspective of public policy decision making.

The interests in finance on the predictability of returns center on the premise that their predictability has consequences for asset price behavior. Therefore it is necessary that we study, understand and be able to estimate returns explicitly. Empirical studies by Cowles (1933; 1944), Kendall (1953), Roberts (1959) and Osborne (1959) suggested that financial prices could not be predicted from either changes in the series themselves or from past price changes in other time series. Technically, this implies that the best prediction of the next period's stock price is the spot price plus a drift term. However, much of the recent predictability literature suggests that aggregate dividend yields strongly predicts long horizon returns whereas they weakly predict future dividend growth (Fama & French, 1988b; Campbell & Shiller, 1988a; 1988b; Stambaugh, 1999; Campbell & Yogo 2002; Lewellen, 2003; Valkanov, 2003). The existing literature documents studies on the predictability of stock index returns using lagged macroeconomic and

financial variables, lagged returns and calendar dummies. It is generally accepted that dividend yields and interest rates are factors that seem to have some significant predictive power.

Traditional asset pricing methodologies, such as those of Sharpe (1964), Merton (1973), Ross (1976) and Breedan (1979) show that the expected return on a financial asset is a linear function of its betas or covariances with some systematic risk factors or market factors. The capital-asset pricing model (CAPM) is a widely used economic model that predicts a trade-off between systematic risk, known as beta (b), and expected return under specific conditions in the following equation:

$$E(R_i) = R_f + b_i(E(R_m) - R_f)$$

Where, $E(R_i)$ represents the expected return on investment, R_f denotes the risk-free rate of return, b is the asset's systemic risk and $(E(R_m) - R_f)$ is the expected risk premium in the market. The CAPM is specified *ex ante* or before the event and it is a theory based on investors' unobservable beliefs about future returns on securities in equilibrium. The CAPM proves that the relationship between prices of assets in a general equilibrium, where the investors select assets to maximise the mean-variance utility, is linear. The criticisms against the CAPM include the suggestion that since the market portfolio could never be observed, the CAPM could never be tested (Roll, 1977) and that all tests of the CAPM were effectively joint tests of the model and the market portfolios used in the tests.

The multi-beta pricing models generalize the concept of risk under the traditional CAPM that market risk, risk that cannot be diversified away, underpins the pricing of assets. The arbitrage pricing theory (APT) is an alternative to the CAPM and measures systematic risk in smaller component risks (Ross, 1976). The APT (Ross, 1976) is a multiple-factor model that assumes in markets where there are arbitrage activities, all assets with similar characteristics trade at similar prices because the arbitrage activities will remove any mispricing. In the multi-beta model, market risk is measured using a series of risk factors that determine the behavior of asset returns, whilst the CAPM measures risk only relative to market return. Chen (1991), Schwert (1990), Fama (1989; 1990) suggest that the variations in expected returns are rational variations in response to market conditions. The analysis

of e-commerce stock price predictability sector in this study is based on this premise. The Australian E-Commerce Multifactor Model (AEMM) developed in this study epitomizes the multi-beta model and the risk factors estimated in the multi-beta models are all non-diversifiable sources of risk.

LIMITATIONS OF LITERATURE ON PREDICTABILITY

The doubts raised by Fama and French (1992; 1993) about the validity of the CAPM, on the absence of historical relationship between stock returns and their market betas, may render the CAPM a less effective model for valuing e-commerce stocks. The adoption of the CAPM in this research poses the problem that only realized returns can be observed whilst CAPM refers to expected returns, which in turn should reflect all known information about e-commerce stocks. The evolving nature of the e-commerce sector creates a situation where the information set is dynamic subject to the unanticipated operating conditions of the industry, creating information surprises that may cause e-commerce stocks to move in a magnitude or direction not predicted by the CAPM.

The CAPM is an *ex-ante* model based on assumptions that the statistical process generating asset returns is stationary and that *ex post* rates of return are sample observations of the *ex ante* distributions. For the latter to be acceptable, the market must be information efficient where prices are generated by rational expectations. This position does not hold when the strong form of the EMH prevails and abnormal returns can be made from private information. The current evolutionary nature of e-commerce as a business medium tends to support the strong form of the EMH where relevant information may not be obvious to investors without intimate, clear and detailed knowledge of e-commerce potentials and therefore is not fully reflected in the stock price.

E-COMMERCE STOCK PRICES AND PREDICTABILITY

The implications of the EMH in e-commerce stocks relate to the efficient allocation of capital and under the EMH market financing conditions, the firm's cost of capital is optimal. The measure of volatility of the

e-commerce stocks vis-à-vis other market benchmarks and statistical analysis is crucial as a further test of market efficiency for the allocation of financial resources (Thomas, 1995). If the e-commerce prices do not reflect market fundamentals, then resources will be misallocated and hence, volatility tests are joint test for informational efficiency. The predictability of e-commerce stock returns depends on the statistical analysis of the random walk hypothesis of the stock prices. If e-commerce stock prices were unpredictable, such test would support the rational expectation element of the EMH that forecast errors should be zero on average and uncorrelated with any information available at the time the forecast was made. The EMH emphasizes that it is impossible for investors to persistently make supernormal profits.

Three types of risk are estimated in this volatility study by using beta: market risk, sector risk and company risk. The implication is that if e-commerce stock prices (returns) are excessively more volatile than the market, then this constitutes a rejection of the efficient market hypothesis and that the e-commerce sector does not reflect the same economic fundamentals as the general market.

ECONOMETRIC TECHNIQUES AND DATA

We explain the predictability of e-commerce equity returns by using time series models to extrapolate from past behavior of returns. This is conducted using descriptive statistics, auto regressive and multivariate models to analyze the past behavior of e-commerce equity returns to deduce a predictability profile.

The e-commerce firms analyzed are from the population of pure-play e-commerce companies from a variety of sectors listed on the Australian Stock Exchange. The proxy for market return for the study period is calculated from the closing SP/ASX 200 index on the last trading day of the month over the period July 1999 to June 2000 from the Australian Stock Exchange. The macroeconomic variables tested use monthly data for the corresponding period from the Australian Bureau of Statistics and the Reserve Bank of Australia.

VOLATILITY AND EFFICIENT MARKET HYPOTHESIS ANALYSIS

The relationship between volatility and predictability are intricately linked and the purpose of volatility analysis in this paper is to determine the volatility of e-commerce stocks and their associated returns according to financial theory using stock prices and the market stock index to measure volatility of individual stock. The results of such analysis provide an indication of the degree of volatility in e-commerce stock returns vis-à-vis the market and will enable us to draw implications on the predictability of the stocks.

The volatility test for EMH involves plotting the expected return of the e-commerce portfolio against its beta value on the SML with all actual returns to be distributed randomly around the line. The weak form of the EMH is tested for market returns and the monthly returns of the *S&P/ASX 200* in the study period are used as the proxy for the market.

Following the practice for testing market efficiency in the literature, asymptotic analysis can be used to test for the efficient market hypothesis (EMH) that information observable to the market prior to month t should not help to predict the return during the month t for the e-commerce sector return. If we use past information on y (representing e-commerce stock return in this study), the EMH is stated as (Wooldridge, 2000):

$$E(y_t | y_{t-1}, y_{t-2}, \dots) = E(y_t) \tag{1}$$

If equation (1) is false, then past information can be used to predict the current return and under EMH conditions arbitragers will take advantage of such investment opportunities and the market will quickly move back into equilibrium again. The following AR(1) model is used as the alternative model to test equation (1):

$$y_t = a + by_{t-1} + m_t \tag{2}$$

Where the error m_t has a zero expected value, given all past values of y :

$$E(m_t | y_{t-1}, y_{t-2}, \dots) = 0 \tag{3}$$

The combined equations (2) and (3) imply that when the y lagged one period has been controlled for, no further lags of y affect the expected value of y_t and the relationship is considered to be linear:

$$E(m_t | y_{t-1}, y_{t-2}, \dots) = E(y_t | y_{t-1}) = a + by_{t-1}$$

The null hypothesis is stated as $H_0: b = 0$ against $H_1: b \neq 0$ and under the null hypothesis, stock returns are serially uncorrelated. This regression tests the weak form informational efficiency of the EMH by examining the autocorrelation coefficients between $return_t$ and $return_{t-1}$ to see if they are non-zero. If H_0 is not rejected, the inference is to confirm the weak form efficiency. The EMH does not specify the horizon over which return should be calculated and the period tested is the study period from July 1999 to June 2000.

E-COMMERCE LINEAR MULTIVARIATE MODEL AND CO-INTEGRATION TESTS

The advent of e-commerce has been pervasive and significant, affecting all market aspects including government policies, competition, lifestyle, costs and growth perception. Since e-commerce as a business medium is still at a relatively early stage of development, complex and not fully exploited and therefore requires a broad-based approach, such as the multi-beta model to capture its full returns implication (Islam & Oh, 2003). The objective of using multiple regressions in this study is to identify the relationship between an exogenous variable (return) and multiple endogenous factors (factors) and the selected factors are deemed to capture economy-wide systematic risks. The model assumes no hierarchical structure for the factors hence no orthogonalisation is done.

The co-integration analysis is conducted in two steps. The unit root hypothesis test, introduced by Dickey and Fuller (1979; 1981), is carried out to determine stationarity and when the results show that the first-difference series of the variables are stationary, a co-integration test is done. The results of the co-integration tests conducted in this study imply an association between the factors. Engle and Granger (1991) states that 'when the factors are $I(1)$ and co-integrated, there must be Granger causality in at least one

direction, as one variable can help forecast the other'. The specific model developed in this study is presented below.

PORTFOLIO SELECTION MODELING AND ISSUES

The theory of portfolio choice is an investment procedure developed for the selection of risky assets by determining what proportions of the portfolio should be allocated to each assets so that the amount in a selected combination of stocks has the minimum risk. As an investor, the typical approach in equity investment is to hold a balanced portfolio of different stocks to provide some expected return (also known as diversification). The theory assumes that investors choose between alternative portfolios on the basis of the expected return and risk of that return. It assumes that: the investor is risk averse; selects investment opportunities in terms of a probability distribution defined by expected return and risk; behaves rationally; has an expected utility of increasing expected return and decreasing risk; and the capital market is perfect. In the evaluation of a mean-variance efficient portfolio, a risk-based pricing model offers a powerful insight (Pastor & Stambaugh, 2000). The simulation models developed in this study were used to test the portfolio characteristics vis-à-vis e-commerce stock returns and from the results, an attempt is made to construct an efficient e-commerce stock portfolio reflecting the past variability (over the study period) of returns, based on the assumption that the risk profile of these stocks remains unchanged over time, or at least over the short term. It would be possible to extrapolate or predict future risk from historic risk if the underlying probabilistic structure of these stocks remains unaltered (Thompson & Thor, 1992).

EMPIRICAL FINDINGS

E-Commerce Stock Volatility

The systematic and unsystematic risk profile, as measured by the market index, indicates that the e-commerce stocks were to a large degree subject to unsystematic risk (82%) rather than systematic risk (18%) in the study period (Islam & Oh, 2003). This means that there was less of a tendency for the e-commerce stock prices to move together with the general

market variability and unsystematic or firm-specific risk explains 82% of their variance. This situation can also be illustrated by the higher return variability of the e-commerce stock portfolio (Islam & Oh, 2003); where monthly s equals 49.82%, compared to the general market; monthly s of 3.13%. Also, volatility measured against the market, represented by beta, is generally higher for most sectors (Table 1). This indicates that the majority of e-commerce stock returns were more volatile than the market return in the study period. From the perspective of risk-return relationship, the risk and return trade-off appears not to hold in the sample stocks in the study period.

Table 1: E-commerce sector volatility and trade-off between risk* and return

Sector	Beta	Return	SD
Health & Medical Services	19.86	0.39%	1105.33%
Miscellaneous Services	6.39	5.41%	47.04%
Retail/Retail Investment	5.22	4.20%	29.74%
Diversified Media	5.00	0.67%	28.99%
Computer & Office Services	4.93	0.07%	30.32%
Equipment & Services	4.25	26.97%	140.37%
Other Telecommunications	3.74	2.67%	21.38%
Miscellaneous Financial Services	0.57	0.44%	30.69%
Casino & Gaming	0.03	24.06%	56.33%
High Technology	-0.26	-1.26%	27.45%

Source: Islam and Oh (2000); *ranked in order of beta

This confirms the general systematic risk level of the e-commerce stocks and that they move predominantly in a volatility sphere of their own and relatively independent of the market (Islam & Oh 2003).

Covariance and Correlation Analyses

The e-commerce stocks in this study displayed predominant positive covariance with each other. This suggests that the behavior of e-commerce stock returns is largely consistent or similar in characteristics among the stocks in the portfolio. The process for factor selection is based on the average correlation coefficients of the individual stock returns by sector and those pervasiveness variables are included in the model. By computing a frequency over a cross-section of the e-commerce stocks, the intent is to eliminate idiosyncrasies of individual stocks so that a general behavior

between the returns and variables can be established and aid in factor selection by highlighting the more pervasive factors.

Market Efficiency and Predictability Findings

The results of the weak form EMH hypothesis tests imply that for all sectors the information efficient markets hypothesis prevails at the 10% significance level (critical value = 1.812).

Table 2: Summary of results for Efficient Market Hypothesis Tests

Sector/return	a	return _{t-1} b	R ²
Casino & gaming	0.3080	-0.2154	0.0466
t-statistic	1.5486	-0.6992	
Computer & office services	0.0180	0.2540	0.0643
t-statistic	0.2358	0.8293	
Diversified media	0.0071	0.0832	0.0068
t-statistic	0.1055	0.2625	
Equipment & services	0.3048	-0.1128	0.0126
t-statistic	0.6745	-0.3579	
Health & medical services	2.5156	-0.1135	0.0129
t-statistic	1.0342	-0.3614	
High Technology	-0.0842	-0.1091	0.0121
t-statistic	-1.3801	-0.3505	
Miscellaneous financial services	-0.1039	-0.3255	0.1079
t-statistic	-1.7035	-1.0998	
Miscellaneous services	0.1416	0.2634	0.0621
t-statistic	1.1165	0.8137	
Other Telecommunications	0.0257	0.0573	0.0032
t-statistic	0.3802	0.1800	
Retail/retail investments	0.0599	0.1551	0.0169
t-statistic	0.7788	0.4149	
Portfolio	0.1658	0.1578	0.025
t-statistic	1.0487	0.5061	

Source: Islam and Oh (2003)

The results in Table 2 suggests that e-commerce stock prices reflect all historical information regarding the underlying firm and the market responds immediately to new information regarding the firm. This characteristic can be reconciled with the dynamic nature of recent Internet development that is constantly changing as the virtual market evolves to incorporate new technologies, ideas and business models. Any piece of past information

would be rendered irrelevant or obsolete, whilst new information is rapidly factored into the stock price by investors.

The weak-form EMH tests using the autocorrelation of returns data suggest the validity of the EMH for the returns of the e-commerce stocks in this study. The low R -squared of these tests supports the EMH. This indicates the tests based on (*ex-post*) real returns cannot be used to predict excess returns. De Bondt and Thaler (1985) finds stocks with extreme price movements appear to have strong negative serial correlation of returns and are thus mean reverting. This would be contrary to the EMH in that it would be possible to make supernormal profits from predictability in stock prices. For the constructed e-commerce portfolio, there is no evidence of negative serial correlation except for some industry groups at the sector level.

Australian E-Commerce Multifactor Model

The underlying hypothesis of the multi-factor model in this study is that the set of estimated factors is important in determining and explaining the movements in e-commerce stock prices. The econometric analysis is conducted by first carrying out the stationarity test and when the results show that the first-difference series of the variables are stationary. A test of stationarity in a financial model is used to test for stability of the relationship of the explanatory variables on the dependent variable and enables a better understanding of the relationship when there is stationarity in the time series and the b does not change arbitrarily over time. A co-integration test is done to test if the economic variables are significant and consistently priced in e-commerce stock returns and they should be co-integrated if affirmative. This co-integration relation between e-commerce stock returns and the underlying factors is a necessary condition of the equilibrium model of stock market returns.

The set of factors include the relevant forces in the Australian financial market, international and the global financial system, the influence of which is represented by the NASDAQ composite index and the US dollar to Australian dollar exchange rate. The AEMM presented is a static model, it has the limitations that time is not incorporated here. However, AEMM is relatively appropriate if it is assumed that investors are myopic (no systematic variations in the investment opportunity set) and the utility function of the investors is logarithmic.

The three pervasive factors of NASDAQ composite index (*NAS*), consumer confidence (*CC*) and the strength of the local currency to US\$ (*FE*), selected from twenty-four independent variables using correlation analysis and factor-loading procedures (Islam & Oh, 2003) are tested for co-integration separately, using regression involving the first-difference, Dy_t and Dx_t , in each of the following equations (4) to (6), on the dependent variable *e-stockret*, being the e-commerce portfolio return.

$$e\text{-stockret}(DPR)_t = \hat{\alpha} + \hat{\beta} DNAS_t; \tag{4}$$

$$e\text{-stockret}(DPR)_t = \hat{\alpha} + \hat{\beta} DCC_t; \tag{5}$$

$$e\text{-stockret}(DPR)_t = \hat{\alpha} + \hat{\beta} DFE_t; \tag{6}$$

From Table 3, the *t*-statistic of $(\hat{\mu}_{t-1})$ for the all the explanatory variables *NAS*, *CC* and *FE* are all below the asymptotic critical value of -3.04 at the 10% significance level. This is evidence that the $y_t - bx_t$ is an *I*(0) process and that the variables are co-integrated for variables running a regression involving the first difference of their time series.

Table 3: Co-integration statistics of series with First Differences

Cointegration Series	t -statistic $(\hat{\mu}_{t-1})$	
(<i>DNAS</i>)	-5.3614	Co-integration
(<i>DCC</i>)	-3.7237	Co-integration
(<i>DFE</i>)	-3.7076	Co-integration

*Asymptotic Critical Values ($c = -3.04$) from Davidson and MacKinnon (1993), at the 10% significance level and no time trend. (Source: Islam and Oh, 2003).

On the basis of the criterion of goodness of fit, the following equation of the first difference is selected for analyzing e-commerce stock return and the three explanatory variables have the strongest influence on e-commerce portfolio return across all the stocks and sectors evaluated in this study. Of the three pervasive factors, *NAS* and *CC* have a positive correlation and *FE* has a negative correlation with the e-commerce portfolio return. They are statistically significant at the significance level of 10% ($c = 1.943$):

$$e\text{-stockret}(\Delta\hat{PR})_t = -0.1900 + 0.0013DNAS_t + 0.0692DCC_t - 0.3287DFE_t \quad (7)$$

(-1.2772)
(3.7657)
(1.9345)
(-2.1045)

$$R^2 = .6421$$

Where:

$e\text{-stockret}(\Delta\hat{PR})_t$ = the expected return e-commerce stock portfolio at time t ;

$DNAS_t$ = the value of the factor: *NAS* at time t ;

DCC_t = the value of the factor: *CC* at time t ;

DFE_t = the value of the factor: *FE* (US\$) at time t ;

The three estimated factors in the AEMM equation are statistically significant (t -statistics in parentheses) and this validates the present model and supports the evidence of their pervasiveness on the portfolio return of the e-commerce stocks. In the midst of the Internet market euphoria, e-commerce stocks are perceived as growth stocks whose value is driven partly by the NASDAQ composite index, consumer confidence and strength of the Australian currency. The AEMM only explains part of the e-commerce value ($R^2 = 64\%$) due to these systematic factors. Such systematic risk level is consistent with empirical study done by Drummen et al. (1992) where systematic risk explains almost half of the variance of European stocks. The estimated model therefore provides a better measure of e-commerce portfolio return compared to the average 17% systematic risk level by the market model using the *S&P/ASX 200* as the market index in this study.

PREDICTABILITY ISSUES AND THEIR FINANCIAL IMPLICATIONS

As in the literature on time-series return predictability, this study uses lagged historical returns to test EMH for studying the predictability of e-commerce stock prices. Fama and French (1988) and Poterba and Summers (1988) study long horizon return predictability and found some evidence of mean reversion in returns over long-horizons with two years or more.

EFFICIENT MARKET HYPOTHESIS AND RANDOM WALK THEORY

The strict random walk concept of stock prices suggests that stock returns are unforecastable. The EMH predicts that share prices fairly reflect all information that has been fully revealed to the market and stock price only moves in response to new information that, by definition, is unpredictable and should behave in a random manner. The prices of stocks are affected by investor perception and interpretation of conditions pertaining to the firm, industry and economy and such conditions are contained in a continuous stream of new information about investments concerning new technologies and new market opportunities. For the e-commerce market analyzed in this study, the three significant and pervasive factors that contain such information about e-commerce equity investment opportunities are reflected in the NASDAQ composite index (*NAS*), consumer confidence (*CC*) and the strength of the local currency to the US dollar (*FE*). The risk arises that new information may be left out of past information or that the pervasive factors, which influence e-commerce sector returns may change over time due to the fast changing technological and business environment of the virtual economy. Such a situation would result in systematic errors if future risk were to be deduced from past risk.

The results of the weak-form EMH tests using the autocorrelation of returns data (by sectors) suggest the validity of that EMH for the returns of the e-commerce stocks in this study. This indicates the tests based on (*ex-post*) real returns cannot be used to predict excess returns. This essentially infers that e-commerce stock returns incorporate all relevant information immediately and price changes are a result of the arrival of new or unanticipated events. Statistically, the forecast errors are zero on average because the e-commerce prices only change on arrival of new information, which itself is a random variable and are uncorrelated with past information. This implies the efficiency of the capital markets for e-commerce stocks and their market values and returns are thus the outcome of a competitive market. However, the high degree of unsystematic risk evident in our study suggests that e-commerce firms are subject to levels of idiosyncratic factors. It is highly likely that because of time-varying expected returns due to the rapidly evolving business conditions and risks in the e-commerce sector, returns may be partly predictable, even when the EMH holds. This does

not imply that the markets are not efficient but rather testing for efficient markets depends on the return assumptions underlying the model.

In relation to the preceding observations, the following set of alternative hypothesis regarding the current state of efficiency of the Australian e-commerce sector is offered: The market sector is truly efficient and there is informational efficiency in the sector. This explanation has merit because in general the Australian equity market is efficient, as evidenced from the efficiency test of the *S&P/ASX 200* index (Section 4.5.3), with the necessary sophisticated models and tools for information analysis. Presumably, efficient market performance is reinforced when this environment filters down to the sector level promoting informational efficiency and healthy competition in capital allocation.

The alternative is that the sector is truly inefficient (assuming that the current suite of tests is sufficient to address the state of efficiency). This scenario is plausible considering the returns volatility and lackluster financial performance of the sector. Given that information about the sector may not be perfect or complete, the market mechanism failed to fully extract and digest its implications. As a result of the market's failure to factor in the full impact of new information, e-commerce stocks may be overvalued or undervalued. If this alternative is the correct, then the testable proposition is that the recent market rationalization and diffusion of germane information on the sector should quickly remove any inefficiency in a relative short period of time¹. However, if the sector is truly inefficient, but the current suite of tests only addresses a limited definition of efficiency, possible explanations for this are the limitation of the data examined in this research or the type of tests, in that the time series is too short for the tests to have sufficient power to distinguish an efficient market from an inefficient one. As the testable hypothesis implies, with better understanding of the behavior of the e-commerce sector in terms of finance theories and analysis, the market efficiency of the sector should improve. Therefore market efficiency is a dynamic concept in which a market is supposed to move towards efficiency as information is revealed in the economy.

¹ This best carried out by using event analysis around the performance announcements of e-commerce firms/sector.

E-COMMERCE STOCK VOLATILITY

The volatility of e-commerce stock returns appears to be consistent in terms of the yield spread, beta and standard deviation of the individual stocks; the systematic and unsystematic risk profile and the EMH tests of the class of stocks examined in this study. Compared to the market, the yield spreads are excessively wide, while the standard deviations and betas are very much higher. The high degree of unsystematic risk profile together with the weak form efficiency of the stocks suggests a higher level of industry-specific information turnover, reflecting the evolving nature and nascent stage of the e-commerce industry. This infers that e-commerce prices (hence returns) that alter by large amounts in the months of this study reflect the rapid changes in fundamentals of the industry. These changes may represent the opportunity sets for e-commerce firms and industry or more general structural market reform in response to Internet/ICT related developments. It is probably difficult at this stage to gauge whether the e-commerce market is excessively volatile relative to the general market, due to the lack of comparative and long-horizon earnings performance data for e-commerce firms, which could provide a yardstick against which to compare volatilities.

Lakonishok, Shleifer and Vishny (1994) suggest the return of growth stocks may be better explained by characteristics other than risk (volatility) and proposed an agency rationale, that, despite fund managers being aware of the expected returns of value stocks, they still prefer growth stocks because they are easier to justify to investors. This explanation can equally apply to e-commerce stocks, which are considered growth stocks and in the midst of Internet market euphoria, are driven partly by the surging NASDAQ composite index and heightened consumer confidence. The first difference of *estockret(DPR)*, in the estimated equation (Equation 4 above) represents the change that occurs to the return of e-commerce equity returns as a co-variation to the pervasive factors. It would be difficult for fund managers to ignore the noise and chance of higher returns despite knowing that the risk associated with these firms may be high by traditional standards and their earnings doubtful.

E-COMMERCE STOCK AND SPECULATIVE BUBBLE

The movements of stock prices in industrial economies since World War II were closely connected to the rate of economic growth and economists had no trouble in explaining the resulting stock returns by standard valuation models where stock prices are determined by market fundamentals. But the recent growth and volatility of the technology stock prices are more troublesome and the question has been asked whether these stock prices can still be explained by fundamentals, or whether speculative bubbles and fads govern these prices. Studies conducted on speculative bubbles have proven unsuccessful in testing directly for them (Ahmed et al., 1997; Hamilton & Whiteman 1985).

Economists have observed extreme sequences of price rises and offered fundamental explanations for their occurrence, including the “tulip mania” or the “south sea bubble” (Garber, 1990) and thus show the existence of speculative bubbles caused by unobserved fundamentals is unproven. This implies that stock prices still reflect the underlying fundamentals. There is commonality in the view that the variations in expected returns are rational variations in response to market conditions (Patelis, 1997; Chen, 1991; Schwert, 1990; Fama, 1990; Fama & French, 1989).

RESULTS AND THEIR IMPLICATIONS FOR PREDICTABILITY

Samih (2002) found that by using the lagged residuals of co-integration regression, past information can help to predict current stock returns. The co-integration tests and the results in this study imply an association between the factors and Engle and Granger (1991) state that if they are $I(1)$ and co-integrated, ‘there must be Granger causality in at least one direction, as one variable can help forecast the other’. The three pervasive factors (*NAS*, *CC* and *FE*) identified in this study are therefore helpful in predicting e-commerce equity returns. The implications of the EMH in e-commerce stocks relate to the efficient allocation of capital in the sense that under the EMH market financing conditions and the firm’s cost of capital are optimal. Therefore the degree of market efficiency helps determine the viability and optimality of e-commerce related projects and also the need for government

intervention. The measure of volatility of the e-commerce stocks is crucial as a further test of market efficiency in the allocation of financial resources, for if the e-commerce prices do not reflect market fundamentals then resources will be misallocated and hence, volatility tests are joint tests for informational efficiency. The predictability of e-commerce stock returns depends on the statistical analysis of the random walk hypothesis of the stock prices. If e-commerce stock prices were unpredictable, such a test would support the rational expectation element of the EMH that forecast errors should be zero on average and uncorrelated with any information available at the time the forecast was made. The EMH emphasizes that it is impossible for investors to persistently make supernormal profits.

Implications for Other Financial Markets

The recent global experience on the volatility of the e-commerce equity market has highlighted the need for public policy to cultivate involvement in the e-commerce sector, taking into consideration those pervasive real economic factors, so that the sector operates predictably and efficiently in an economically and socially desirable manner. In the post industrial revolution era, where knowledge as well as increasing availability of material goods, services and wealth have contributed to strong growth of national economies, the accelerated rate of economic growth has modified the traditional structure and institutional basis of the economy. This has been accompanied by by-products of fundamental consequences such as globalization, the emergence of the knowledge economy, and regional convergences and divergences of economic growth of different countries (Islam et al., 2001; Sheehan & Tegart, 1998).

The recent volatility in the e-commerce equity market reflects the uncertainty that characterizes the real world. Since the future of the e-commerce sector is still relatively unknown, the effect of uncertainty surrounding the financing decisions of individual firms is compounded by having to confront with the need to make decisions about investment and financial assets. The proof of EMH shown by tests done does not rule out the possibility of positive feedback traders or noise traders in the markets for e-commerce stocks. The results of this study show that the e-commerce stocks have a high unsystematic risk profile imply that the appropriate government actions for enhancing equity market efficiency in the e-commerce market as a means to minimize investment risk would be

more definitive public regulations and/or more adept and literal information dissemination about the e-commerce market development. Romer (1992) and Soete (1997) find the need for government intervention to sustain investment in knowledge and Lehman (1996) suggest that US economic growth in the next century will be determined by the government creating incentives for private sector investment in R&D and fostering and promoting intellectual property.

CONCLUSION

This study on the predictability of Australian e-commerce stock returns provides a policy guide to other countries on the development of the e-commerce sector. The excessive volatility of the e-commerce stock returns represented by the high level of unsystematic risk element implies a low correlation of e-commerce returns to the market return in terms of their prices reflecting similar economic fundamentals. This is interpreted as a strong presence of event effects in e-commerce stock prices. The covariance and correlation tests suggest e-commerce stocks co vary and this reflects the fact that e-commerce firms tend to have similar properties, causing them to uniformly react to market conditions influenced by systemic factors such as *NAS*, *CC* and *FE*. The relatively high unsystematic risk of e-commerce firms suggests that e-commerce sector return may react more aggressively to idiosyncratic economic factors, including market uncertainty, speculative investment, distribution and composition of national income, effective demand, public policy and openness of domestic market to international finance and trade, than the traditional factors identified in other empirical studies.

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