Interrelationship of Valuation and Portfolio Selection of Stocks

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Abstract

Valuation and portfolio choice of stocks are interrelated via optimal risk management. Investors use valuation models in determining and evaluating stock values. Portfolio theory enables an optimal risk combination of the stock selected through valuation process. The portfolio optimisation problem is to determine what proportion of the portfolio should be allocated to each asset, given the investor's objective on expected return by minimising the level of risk in the portfolio. The assumption in this analysis is that investors are risk averse.

This paper illustrates the process using Australian electronic commerce stocks and other assets to highlight their risk-return characteristics and to review the behaviour of e-commerce stocks in a portfolio context.

Appropriate conclusions are drawn. The results show that the Australian E-Commerce Multifactor Model (AEMM) tested is applicable.

Key Words

Portfolio choice, Stock Valuation Models; e-Commerce; Financial Markets.

Introduction

Portfolio theory 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. The assumption in this analysis is that investors are risk averse and their main objective is to minimise risk in their portfolio selection. The objective of this paper is to analyse the selection of Australian electronic commerce (e-commerce) stocks as an investment choice along with other assets. It also highlights the risk-return characteristics in a portfolio with data over the period July 1999 to June 2000. This allows conclusions to be drawn about the investment strategy that might be adopted by portfolio managers in relation to e-commerce stocks.

E-commerce, an application of the Internet technology, has grown exponentially over the past five years and was during the study period generally expected to continue the trend in the medium-term (Coppel 2000). The Australian e-commerce sector continues to dominate stock market news as it accounts for a larger slice of the market capitalisation and market volatility. The valuation of e-commerce companies on the Australian Stock Exchange is growing in importance with more start-up firms seeking public listing for fund-raising and more established firms merging to secure synergy to exploit e-commerce opportunities.

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Due to its recent development and therefore the lack of financial history, the e-commerce sector still relies heavily on equity capital to finance its business activity. The risk-return relationship profile of the individual e-commerce stocks in the studies by Oh 2001 and Oh and Islam 2001 show the volatility (σ) band to be between 11 per cent and 800 per cent and actual return variability between –224 per cent and 316 per cent. The volatility range of the e-commerce stocks is broad compared to the variation of monthly stock return for the US market over the 1857-1987 period of 2 to 20 per cent (Schwert 1989). The excessive volatility against market return of e-commerce stock returns can be explained by the high level of unsystematic risk (low R^2) in the stocks as discovered in the regression analyses using the market model (Oh and Islam 2001). This implies a low compliance of e-commerce returns to market return in terms of their prices reflecting similar economic fundamentals. The idiosyncratic factors influencing e-commerce stock value make long-term valuation of e-commerce firms difficult. This creates a high degree of uncertainty in the market place concerning its investment value and also a high risk-aversion towards e-commerce stock as an investment choice poses a challenge to corporate managers in equity fund-raising activity. The volatility (thus low level of predictability) of e-commerce stocks would make pricing of initial public offers a daunting task for fund-raisers. Equity investment in the e-commerce sector might also be construed as speculative given its current volatility and return profile.

As an investor, the typical approach in equity investment is to hold a balanced portfolio of different stocks to provide some expected return. The theory assumes the investor chooses between alternative portfolios on the basis of the planned expected return for the minimum risk achievable. It assumes the investor is risk averse; selects investment opportunities by means of a probability distribution defined by expected return and risk (the mean-variance paradigm); behaves rationally; has a utility of increasing expected return and decreasing risk; and the capital market is perfect. A risk-based pricing model is considered to offer a powerful insight when it is used in the evaluation of a mean-variance efficient portfolio (Pastor and Stambaugh 2000). However, in a market situation where mispricing uncertainty and share trading requirements are prevalent, the Sharpe-Lintner CAPM, the three-factor model of Fama and French (1992) and the characteristic-based model of Daniel and Titman (1997) find that models with fundamentally different expressions about economic determinants of expected returns often reach similar portfolio choices.

The choice of an investor in deciding alternative risky ventures may be regarded as a two-step process (Hanoch and Levy 1969). The investor first chooses an efficient set from the available portfolios, independently of his tastes or preferences. He then applies his individual preferences to this set and selects the most desired portfolio starting from the minimum variance portfolio. The mean-variance rule assumes that the investor is risk-averse and the expected return, *E(R),* measures an investment's profitability, whereas the variance or standard deviation (β) of returns measures its risk.

Portfolio Theory and Selection of Stocks

The ideas on investment practices are attributed to few notable scholars (Sharpe 1964; Lintner 1965b), the origin of this idea goes back to decades of work by equally famous economists (such as Markowitz 1959, Hicks 1946 and Tobin 1958).

Markowitz (1952) identified the trade-off facing the investor as the risk versus the expected return of an asset only after eliminating all the non-systematic risk that is easily diversified away. The investment decision is not only on which stocks to invest, but how to divide the investor's wealth between the investment options. Markowitz showed that risk is measured by the ratio of the stock's covariance to the product of risk of any two assets in a

portfolio, or taken in the context of the market portfolio (Lintner 1965b):

$$\frac{Cov(R_i, R_m)}{(\sigma_m)^2}$$

Where:

R_i = the return of the stock i;
R_m = the market return;
$Cov(R_i,R_m)$ = the covariance for i^{th} stock with the market as a whole; and
$(\sigma_m)^2$ = the variance of the stock market.

Portfolio Selection

The intention of this study is to utilise the expected returns estimated by the Australian E-Commerce Multi-factor Model (AEMM) developed by Oh 2001 for portfolio choice analysis, and to compare the results with that generated using historical data in a two-asset portfolio choice context. The AEMM is the estimated regression model that best explains Australian e-commerce stock returns in the study:

$$e\text{-}stockret(\Delta\hat{\boldsymbol{PR}})_t = -0.1900 + 0.0013\Delta NAS_t + 0.0692\Delta CC_t - 0.3287\Delta FE_t$$

where:

$e\text{-}stockret(\Delta\hat{\boldsymbol{PR}})_t$ = the estimated portfolio return for e-commerce stock of order one in period t;
ΔNAS_t = the value of the NASDAQ composite index of order one in period t;
ΔCC_t = the value of consumer confidence of order one in period t; and
ΔFE_t = the exchange of the Australian dollar against the US dollar of order one in period t.

The factor identification process in the study seeks to ensure that equity investments in the e-commerce sector will maximise financial return when these factors are included in the risk analysis – albeit the fact remains that changes will occur to the sensitivity (β) of each factor to return over time. Using the AEMM, forecasts can be made with the appropriate variable values. If the values are uncertain, sensitivity analysis can be applied.

Different portfolio selection models with different characteristics are also used to test and compare the e-commerce portfolio results. An analysis based on the modern capital asset pricing model is conducted in a later section of this paper to highlight the theoretical underpinnings of the model in a portfolio context for e-commerce sectors using historical data. This analysis also provides an opportunity to evaluate the CAPM as an appropriate model for valuation of e-commerce stock from a portfolio investment perspective. The other portfolio selection model used in this study to test e-commerce stock portfolio characteristics is the Sharpe's Diagonal Model (Thompson and Thore 1992).

From the data in Oh and Islam (2001) on e-commerce stocks, we construct an efficient e-commerce stock portfolio reflecting the past variability (for the period from July 1999 to June 2000) of returns, based on the assumption that the risk profile of these stocks remain unchanged over time, or at least over the short term (Thompson and Thor 1992). Generally, where historical measures are used a proxy for expected future returns, a longer time series may be a better indicator. Fama and French (1988) and others found that long horizon returns (i.e. over several years) are more forecastable than short horizon (i.e. over a year or a month). Therefore, there are limitations to the results of this study which must be considered when the results are used for extrapolation. The AEMM is a static model, it has the limitation 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)

It must be noted that with the proliferation of e-commerce the number and trade of e-commerce stocks continue to increase. Fund managers who include e-commerce stocks in their portfolios would do so by minimising risk for any given level of return. It is therefore imperative that we study the appropriate investment proportions of e-commerce stock in a portfolio given their risk profile has been

evaluated. The implications drawn from the portfolio selection analysis would also provide an indication of e-commerce stocks from a market perspective. This in turn allows an insight and conjecture of the equity funding activities in this sector. The crux of this study is, therefore, to construct a risk–return profile for e-commerce portfolio investment using the mean-variance approach to select an efficient frontier of optimal portfolios.

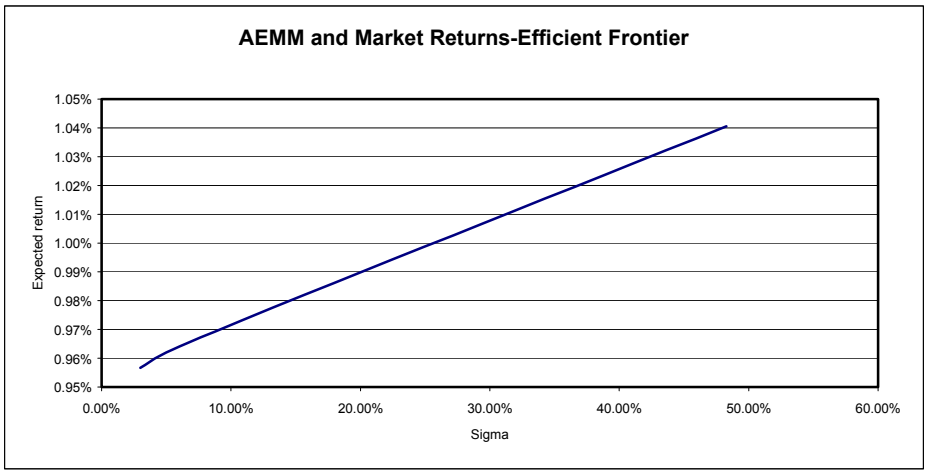
Results 1: Two Risky Assets Portfolio Choice Analysis

The portfolio choice scenario of two risky assets consisting of e-commerce stocks (represented by the AEMM and e-commerce portfolio returns) and market-stocks (S&P/ASX 200 index) is evaluated in this section. First, the AEMM estimated and S&P/ASX 200 returns are used to construct the efficient frontier. Next, the historical e-commerce portfolio return data of eighteen e-commerce firms (Appendix 1, Table A1) is used with the market returns for estimating the efficient frontier. The purpose is to compare the AEMM portfolio results with those derived from applying two-asset portfolio choice analysis on the e-commerce portfolio.

Portfolio Choice Based on AEMM Estimated Returns and S&P/ASX 200 Stocks

The correlation between the AEMM and market returns is 0.4763, which shows a low degree of similarity in return behaviour between the two groups of data. Figure One presents the efficient frontier with different proportions (from Appendix 2, Table A2) of the two groups in the portfolio. The shape of the efficient frontier supports the traditional risk-return relationship in finance Markowitz (1959).

Figure One: The Efficient Frontier, AEMM/Market Returns

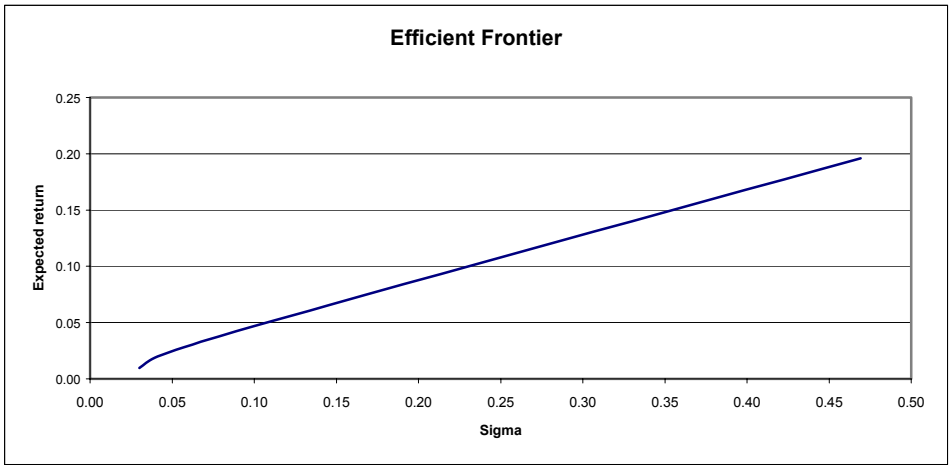


Portfolio Choice Based on E-Commerce Stock Portfolio and S&P/ASX 200 Stocks

In this section the historical returns of the e-commerce stock portfolio and the market are used for building the efficient frontier. The correlation coefficient of these two risky assets is 0.1382 indicating a relative lower level of correlation between the two classes of stock compared to the analysis reported in the earlier sub-section. This implies a lower degree of comovement between the e-commerce stock portfolio returns and the market returns.

Figure Two depicts the different investment proportions between the two classes of stock. The risk-return behaviour of the portfolio standard deviation to expected return appears to be directly correlated with a greater proportion of e-commerce stock in the portfolio (Appendix 3, Table A3). That is, a higher risk profile resulting from a greater proportion of e-commerce stock, is compensated by higher expected return.

Figure Two: The Efficient Frontier, E-Commerce Stock Portfolio/Market Returns



The characteristics highlighted in this section confirm the high volatility nature of the e-commerce stocks under portfolio conditions. The portfolio selection process tested above allows for only 10% of the portfolio to be invested in e-commerce stocks and represents the most efficient portfolio in terms of risk per unit of return.

Results 2: Efficient Portfolios of the E-Commerce Sector

This section estimates the efficient portfolios and the efficient frontier for the e-commerce stock sectors analysed in this study, based on the principles of the classical capital asset pricing model.

In the analysis, there are $n = 10$ risky assets based on the 10 e-commerce sectors used in the study by Oh and Islam (2001), each with expected return $E(R_s)$, where s represents the individual sectors. The risk-free rate (R_f), represented by the constant c, is 5.63 per cent and is the geometric mean used in our study. The method for calculating the variance-covariance matrix in this section involves using the excess return matrix and this approach underlies the security market line (SML of the CAPM). The objective of this section is to identify the set of feasible portfolios, consisting of the e-commerce sectors, represented by the area inside and to the right of the curved line in Figure Three below. A feasibility portfolio is on the envelope of the feasible set with a minimum variance for a given return. The data for the e-commerce envelope is presented in Appendix 4.

Figure Three: E-Commerce Sector Efficient Frontier

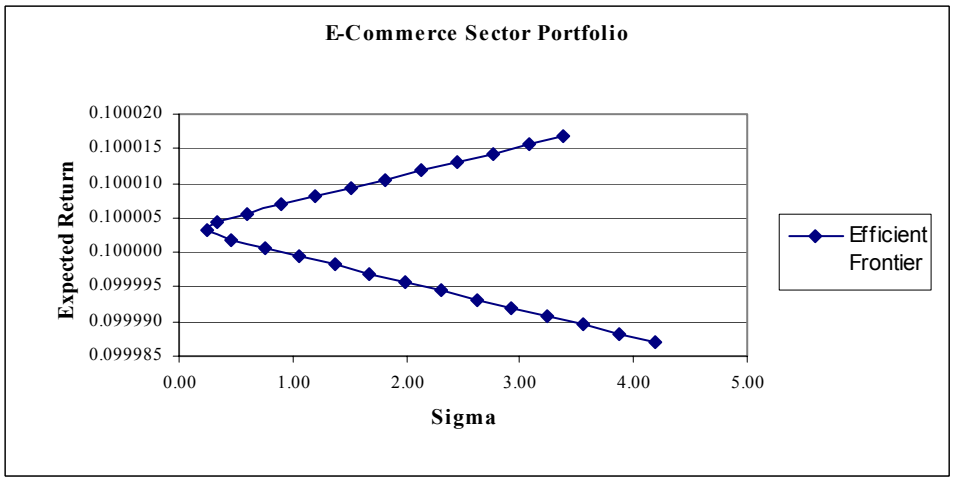


Figure Three depicts the efficient frontier of the e-commerce sector envelope derived from the primary stock returns data for the e-commerce sectors. The convex combination of efficient portfolios *x* and *y* are represented by the envelope (see Appendix 4, Table A4). The set of efficient portfolios start with the portfolio $\sigma = .2549$ and $E(R) = 0.10000313$ with weight on $x =$ 70 per cent and $y = 30$ percent. The efficient portfolios consist of the weight on *x* being less than or equal to 70 per cent (i.e. $x \leq$ 70% of total portfolio). The portfolios with weights of *x* greater than 70 per cent ($x >$ 70%), which are still on the envelope of the set of feasible portfolios are considered not efficient due to their lower expected returns. For each portfolio with greater than 70 per cent of *x* (downward sloping section of the envelope in Figure Three) a superior (efficient) portfolio can be found (with combinations that lie on the upward slope of the envelope) that gives a higher return for the same level of risk.

The conclusions we can draw from the analyses in this section pertaining to the investment quality of e-commerce stocks as a portfolio choice are that the e-commerce sectors are highly correlated and volatile. These findings are consistent with our earlier results pertaining to the two risky assets portfolio choice analysis. This is also evident from the efficient frontier in Figure Five, which shows only a narrow differential in expected return (from 0.10000313 to 0.10001181) with a corresponding wider band of risk (σ) of 1.8792 (from 0.2549 to 2.1341). The optimal portfolio with the lowest risk per unit of return, i.e. CV of 2.549 (Table A4) consists of 70 percent of *x* portfolio and 30% of *y* portfolio. We can therefore conclude that the right choice of e-commerce sectors in a portfolio can substantially reduce risk through risk diversification but it would has very little impact on expected return.

Results 3: Portfolio Choice and the Capital Market Line

In the Results Sections 1 and 2 above, mean-variance analysis is used as a framework for asset allocation by drawing the efficient frontier in standard deviation-expected return space. With the opportunity to borrow and lend at the risk-free rate, the investor is no longer restricted to holding a portfolio that lies on the efficient frontier. It is possible for the investor to hold combinations of risky and risk-free assets according to their risk preference. Under such circumstances, the straight line passing through the expected return axis and tangential to the efficient frontier can estimate the portfolio that maximises the probability of realised return. Points on the line to the right of the tangential point (i.e. this point implies the market portfolio (*M*) and essentially consists of all risky assets in the market) require borrowing at the risk-free rate and points to the left involve lending at the risk-free rate. If all investors in a particular market behave according to portfolio theory, then they must hold at least part of portfolio *M* in their total portfolio. The market portfolio is construed to be efficient, since investors only hold efficient portfolios, as it provides the maximum expected return for the relevant level of risk. In the context of this study, if the total value of the stocks in the e-commerce portfolio represents 10 per cent of the total market capitalisation of all stocks, then each investor's investment in the e-commerce portfolio stocks would be 10% of the investor's total investment in risky assets.

Results 4: Portfolio Optimisation under Kuhn-Tucker Conditions

The analysis under the Kuhn-Tucker conditions will consider constrained optimisation within the context of a three-asset portfolio, consisting of e-stocks, S&P/ASX 200 stocks and cash, and is based on data of the study period in this research. The portfolio evaluation program, *"PORTFOLIO"* in Thompson and Thore (1992), is used to run the data on *GAMS*[1] software in this section. The program selects the portfolios by solving a series of

[1] General Algebriac Modelling System (GAMS) software.

problems with different lambda (λ), representing risk aversion.

Monthly return data are used for this portfolio optimisation study. The monthly returns of the e-commerce stock are the average returns of the stocks in the e-commerce portfolio on the last business day of each month. The market stock's monthly returns are the returns of the S&P/ASX 200 market index on the last trading day of the month in the same period. The investment budget is $1.394 billion, which represents the monthly average total in monetary value of trade in the sample e-commerce stocks of this study, calculated by multiplying the average monthly turnover with the average of the high-low prices for each stock. The mathematical expectations of the stocks returns are the following:

E-Stock	(i = 1)	19.59%
Market Stock	(*i* = 2)	0.96%

and the covariance matrix is shown in Table One:

Table One: Covariance Matrix

	Portfolio	**S&P/ASX 200**
Portfolio	0.220093	
S&P/ASX 200	0.001946	0.000901

The expected returns are used as forecasts and the holding of cash is denoted by x_3. Thus the Lagrangian, incorporating the expected stock returns of the two assets and their covariances and the portfolio problem to be optimised is presented in equation (2) below.

Maximise:

$$19.95x_1 + 0.96x_2 + x_3 - \lambda(0.22x_1^2 + .0009x_1x_2 + .0019x_2x_1 + .0009x_2^2) \quad (2)$$

Subject to:

$$14.66x_1 + 7.47x_2 + x_3 = \$1{,}394{,}004{,}000$$
$$x_1, x_2, x_3 \geq 0$$

The risk parameter is denoted by λ and when λ is large, there is greater risk aversion. The results of a series of parametric tests for various values of λ are shown in Table Two:

Table Two: Optimal Solution

λ	ESTOCK*	MKT STOCK*	CASH*	Expectation	Variance
0.0005	31.62	0	1,393,972	41.452	9836.148
0.0006	26.34	0	1,393,978	34.544	6830.658
0.0007	22.59	0	1,393,981	29.609	5018.444
0.0008	19.76	0	1,393,984	25.908	3842.244
0.0009	17.57	0	1,393,986	23.029	3035.848
0.0010	15.81	0	1,393,988	20.726	2459.037
0.0015	10.55	0	1,393,993	13.817	1092.906
0.0020	7.91	0	1,393,996	10.363	614.759
**$'000s*					

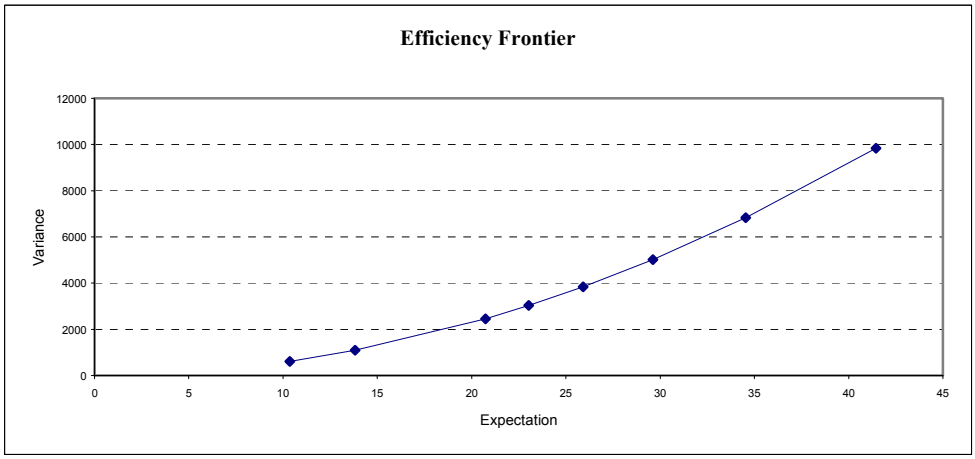
[2] Summarised from GAMS output.

The general conclusion about the market-stock drawn from this parametric test is that it would not be a portfolio choice under all circumstances. This is largely due to its insignificant impact, in a portfolio context, and the stock's relatively small expected return (0.96%) in relation to its risk (standard deviation = 3%). When risk aversion is less (i.e. λ is small) there is a tendency to purchase more of the riskier e-commerce stocks. When risk aversion is high (i.e. λ is large), the preference would be to hold more cash rather than the less risky market-stock, as the trade-off between the risk-return of the market-stock would tend to favour holding cash. This optimisation test confirms the riskiness of e-commerce stocks as an investment choice as manifested by the small amount allocated for investment in this highly volatile asset.

When risk aversion is at its lowest in the test (i.e. $\lambda = 0.0005$), the amount invested in e-commerce stocks is only $31,620 out of the sum of $1.394 billion for investment (or 0.000023%). This suggests that the investor would rather choose to hold cash than to invest substantially in any of the two stocks when the e-commerce stock is too risky and volatile and the market-stock's return is too low for its risk level to be considered an advantage to holding cash. Conversely, the analysis suggests that the investor has to have relatively low risk aversion to remain invested in e-commerce stock.

The relationship between 'expectation' and variance of the three-asset portfolio is depicted in Figure Four (see Table Two for details).

Figure Four: Efficient Frontier of the Three-Asset Portfolio



In a three-asset portfolio selection scenario consisting of one risk-free asset, the e-commerce stock becomes a portfolio choice in preference to the market stock. The trade-off in portfolio choice is between the riskless asset and the highly volatile e-commerce stock. The relevant optimal portfolios would consist of a very small proportion in e-commerce stock and consists of mainly cash. From Table Two, with increasing proportion of e-commerce stock in the optimal portfolios, from $\lambda = 0.0020$ to $\lambda = 0.0005$, we are able to see a four-fold increase in expected return but a sixteen-fold increase in portfolio risk. This confirms the earlier results that the inclusion of e-commerce stock in a portfolio leads to a disproportionate increase in portfolio risk.

Conclusions

This paper has provided a framework for undertaking a portfolio choice study of the e-commerce sector, which also illustrates some of the characteristics of e-commerce stocks in a portfolio context. In the two-risky-asset portfolio choice analysis using AEMM and seven market returns as portfolio choices, the preferred efficient portfolio would consist of no e-commerce stocks. When the e-commerce stock

portfolio and market returns are used the efficient portfolio consists of 90% market stock to 10% e-commerce stock. The portfolio analyses confirm the highly correlation and volatility of the e-commerce sectors. The efficient frontiers constructed highly consistent risk-return characteristics where only a marginal differential in expected returns corresponds with a bigger change in risk in the optimal portfolios. It can be concluded from this evaluation that the right choice of e-commerce sectors for equity portfolio investment can substantially reduce risk, through diversification, but with very little impact on expected return. In the three-asset portfolio context, the results reconfirm that the inclusion of e-commerce stock in a portfolio leads to a disproportionate increase in portfolio risk. This shows that the inclusion of e-commerce stocks in a portfolio could substantially increase portfolio risk with only marginal contribution to the portfolio's expected return.

This consistency in portfolio characteristics between the AEMM and e-commerce portfolio findings reinforces the risk-return behaviour of e-commerce stocks. The portfolio choice tests show a consistency of results in respect to their aversion against the selection of e-commerce stock. For the three-asset portfolio, the less risky alternative would be to hold a substantial percentage of the investment sum in cash for all scenarios, and the proportions of cash in the portfolio increases as risk aversion (λ) increases. The option of holding market-stock in the portfolio is ruled out with the introduction of a third asset in the form of cash for reasons stated above. This indicates and confirms that the rate of return on the portfolio and the allowance for risk must be balanced and holds as equality under the Kuhn-Tucker conditions.

The mean-variance analysis offers a powerful framework for portfolio selection but there are limitations that must be considered when using this approach. The Markowitz model assumes expected returns, standard deviations and correlations as population parameters and these population parameters are unlikely to be available in practice. The use of mean-variance analysis in portfolio optimisation applications must be done with a sound understanding of the underlying market behaviour of the asset classes, in this case factoring e-commerce characteristics into the optimisation process, to enable efficient asset allocation. This would enable a more relevant and comprehensive analysis of portfolio investment, rather than merely the choice among alternative, independent portfolios. The AEMM model (Oh and Islam 2001) developed endeavours to fulfil some of these aspirations using a multivariate approach to value e-commerce stocks by capturing the effects of the underlying real economic factors and their inherent risks on valuation.

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Appendix One

Table A1: Data on E-Commerce Portfolio Returns, July 1999 to June 2000

Month	131 shop	AOL	B2N Net	Candle	Coms21	Ecorp	Lib. One	My Casino	Pocketmail	Reckon	Sausage	Solution 6	Spike	Swish	Travel. Com	Webjet	Wine P.	Etrade	Portfolio Returns
Jul-98		0	0	0	0.00			0.00	0.00		0.00	0.00				0.00	0.00	0.00	0.0000
Aug-98		-0.23	-0.35	0	-0.10			0.00	-0.10		-0.26	-0.14				-0.17	-0.21	-0.01	-0.0872
Sep-98		-0.13	0.11	0.1	0.05			-0.43	0.11		0.22	-0.15				-0.44	0.08	-0.07	-0.0306
Oct-98		0	-0.39	0.04	0.16			1.50	-0.06		-0.13	-0.14				0.25	0.00	-0.13	0.0611
Nov-98		0.5	0.45	0.23	-0.13			-0.40	0.03		0.41	0.23				0.14	0.04	0.23	0.0961
Dec-98		0.13	-0.13	0.15	-0.01			0.50	0.00		0.08	0.45				-0.10	-0.09	2.00	0.1656
Jan-99		0.03	0	0.02	-0.22			-0.11	-0.07		0.50	0.34				1.22	0.02	-0.01	0.0956
Feb-99		0.37	12.14	0.05	-0.17			-0.38	-0.21		0.10	0.59				-0.16	0.25	-0.17	0.6894
Mar-99		-0.17	-0.9	0.09	-0.09			-0.10	-0.18		0.56	-0.08				-0.30	-0.09	0.83	-0.0239
Apr-99		0.25	-0.71	-0.05	0.17			-0.09	0.00		1.12	0.36				-0.16	1.05	1.35	0.1828
May-99		-0.3	-0.12	0.1	0.47			0.22	0.89		0.29	-0.10				-0.06	0.00	-0.23	0.0644
Jun-99		-0.11	-0.13	0.07	0.03			0.72	0.76		0.21	0.17				0.00	0.00	-0.18	0.0856
Jul-99	0	-0.03	1.4	0.15	-0.16	0.00	0.12	0.16	0.00	0.00	0.20	0.27	0.00	0.00	0.00	-0.04	0.00	-0.20	0.1040
Aug-99	-0.4	0.3	0.04	0.01	-0.27	-0.19	-0.05	-0.30	0.00	-0.23	-0.12	-0.09	-0.31	-0.08	-0.10	0.17	0.00	0.20	-0.0791
Sep-99	-0.08	-0.36	-0.1	-0.05	-0.14	0.02	0.58	0.29	0.00	-0.05	0.22	0.35	-0.05	-0.22	-0.20	0.17	-0.20	-0.24	-0.0032
Oct-99	0.04	0.12	0	0.07	-0.10	0.08	0.35	-0.07	0.00	0.18	-0.04	0.26	0.20	-0.02	0.07	0.38	0.42	-0.05	0.1048
Nov-99	0.21	0.29	0	0.06	0.02	0.20	0.01	0.19	0.00	0.27	0.55	0.61	0.22	0.46	0.44	0.04	0.15	0.01	0.2074
Dec-99	-0.02	0.22	0	0.07	-0.02	0.46	-0.14	1.00	0.00	-0.05	0.22	0.50	0.82	-0.05	-0.03	0.32	-0.02	-0.12	0.1758
Jan-00	-0.18	1.61	0	-0.09	-0.11	0.11	-0.30	0.00	-0.20	0.17	0.00	-0.39	-0.07	0.05	-0.11	0.30	-0.04	-0.19	0.0310
Feb-00	-0.06	1.96	0	-0.02	0.43	0.71	-0.13	0.00	9.83	-0.14	-0.03	-0.20	0.87	0.27	0.09	0.00	0.53	0.03	0.7858
Mar-00	-0.28	-0.13	26.78	-0.05	-0.14	-0.26	0.03	0.00	-0.18	-0.12	0.20	0.30	-0.31	0.14	0.16	0.17	-0.04	0.31	1.4766
Apr-00	-0.43	-0.58	-0.51	-0.01	-0.35	-0.44	-0.53	1.80	-0.41	-0.29	-0.51	-0.51	-0.55	-0.15	-0.30	-0.52	-0.49	-0.41	-0.2886
May-00	-0.62	-0.41	-0.41	-0.21	0.03	-0.30	-0.39	-0.04	-0.52	-0.35	-0.31	-0.42	-0.39	-0.39	-0.14	-0.40	-0.16	-0.15	-0.3101
Jun-00	0.01	1.03	-0.08	-0.21	-0.12	0.09	-0.20	-0.15	-0.25	0.09	0.24	0.08	0.23	0.08	-0.12	0.42	1.63	-0.13	0.1466
																		Total	2.3509

Appendix 2

Table A2: Risk Profile for 2-Risky-Asset Portfolio Consisting of AEMM Estimates and S&P/ASX 200 Returns

Proportion	Sigma	Expected Return	Coefficient of Variation
	24.89%	1.00%	
0	3.00%	0.96%	3.14
0.05	4.53%	0.96%	4.71
0.1	6.56%	0.97%	6.80
0.15	8.75%	0.97%	9.03
0.2	11.00%	0.97%	11.30
0.25	13.29%	0.98%	13.60
0.3	15.60%	0.98%	15.88
0.35	17.91%	0.99%	18.16
0.4	20.23%	0.99%	20.43
0.45	22.56%	0.99%	22.69
0.5	24.89%	1.00%	24.93
0.55	27.23%	1.00%	27.15
0.6	29.56%	1.01%	29.36
0.65	31.90%	1.01%	31.54
0.7	34.24%	1.02%	33.72
0.75	36.58%	1.02%	35.87
0.8	38.92%	1.02%	38.01
0.85	41.26%	1.03%	40.13
0.9	43.60%	1.03%	42.24
0.95	45.94%	1.04%	44.33
1	48.28%	1.04%	46.40

Appendix Three

Table A3: Portfolio Risk Profile, Two Risky Asset Portfolio Consisting of E-Commerce and S&P/ASX 200 Stocks

Proportion	Sigma	Exp. Return	Coefficient of Variation
	23.71%	10.27%	
0	3.00%	0.96%	3.14
0.05	3.93%	1.89%	2.08
0.1	5.73%	2.82%	2.03
0.15	7.81%	3.75%	2.08
0.2	10.00%	4.68%	2.14
0.25	12.24%	5.62%	2.18
0.3	14.51%	6.55%	2.22
0.35	16.80%	7.48%	2.25
0.4	19.10%	8.41%	2.27
0.45	21.40%	9.34%	2.29
0.5	23.71%	10.27%	2.31
0.55	26.02%	11.21%	2.32
0.6	28.34%	12.14%	2.33
0.65	30.66%	13.07%	2.35
0.7	32.98%	14.00%	2.36
0.75	35.30%	14.93%	2.36
0.8	37.62%	15.86%	2.37
0.85	39.94%	16.80%	2.38
0.9	42.27%	17.73%	2.38
0.95	44.59%	18.66%	2.39
1	46.91%	19.59%	2.39

Appendix Four
Table A4: Data Table for Efficient Frontier Graph
Of the E-Commerce Sector Portfolios

Proportion of	Sigma	Return
x	1.1999	0.1000
-0.4	3.3890	0.10001677
-0.3	3.0749	0.10001553
-0.2	2.7610	0.10001429
-0.1	2.4473	0.10001305
0	2.1341	0.10001181
0.1	1.8214	0.10001057
0.2	1.5098	0.10000933
0.3	1.1999	0.10000809
0.4	0.8935	0.10000685
0.5	0.5962	0.10000561
0.6	0.3331	0.10000437
0.7	0.2549	0.10000313
0.8	0.4662	0.10000190
0.9	0.7538	0.10000066
1	1.0571	0.09999942
1.1	1.3658	0.09999818
1.2	1.6768	0.09999694
1.3	1.9890	0.09999570
1.4	2.3020	0.09999446
1.5	2.6155	0.09999322
1.6	2.9293	0.09999198
1.7	3.2433	0.09999074
1.8	3.5575	0.09998950
1.9	3.8718	0.09998826
2	4.1863	0.09998702