A Cross-Sectional Analysis of Value-Drivers in the Knowledge Economy

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Abstract

With a rapidly evolving business environment due to the process of intense technological innovations, a new and competitive paradigm in which intellectual capital has become a critical driver of business performance has emerged. This paper conducts an initial characterisation of the value-drivers prominent in four intellectual-capital intensive sectors in Australia. This study forms a precursor to a more profound understanding of the asset pricing process in the knowledge economy. Given the need for developing new and more appropriate models for valuing intellectual assets, this research examines four industries with the primary aim of identifying value-drivers, i.e., underlying characteristics that create value in intellectual assets. The perceived value-drivers are identified from two sources, firstly for the e-commerce sector the value drivers are factors derived from market data and, secondly those identified in the biotechnology, information technology and energy and environment sectors are based on interviews conducted with firms in these sectors. The value-drivers that pervade the value of knowledge-based equity are identified, statistically tested and analysed. The implications for valuation of knowledge assets, equity investment, public policy and strategic management are discussed and explained.

Introduction

The ability to manage knowledge efficiently and effectively will provide a competitive edge in today’s commercial world. The concept of management in the knowledge-based sector includes the ability to understand and appreciate the value of the business and manage the critical factors that affect value. The knowledge economy is predominantly driven by innovative advancement manifested by proprietary endeavours that are potentially commercially viable. The commercial success of innovation is reflected as intellectual capital of a firm, which constitutes part of the overall firm’s value. The development of intellectual capital relies on the availability of funds from investors who evaluate their contributions based on the inherent value of the potential investment. For knowledge-based firms, the inherent value can be derived from the firm’s idiosyncratic attributes or characteristics, which in most cases are of an intangible nature. This paper examines the relationships between a firm’s equity value and its intellectual capital base from the perspective of the underlying value-drivers, both tangible and intangible. The motivation of this paper is the need for identification and a theoretical and systematic evaluation of the value-drivers that are important to the valuation of equity in the knowledge economy.

The application of currently available economic and accounting models to the valuation of intellectual assets has revealed fundamental inadequacies (Drucker 1993; Dabek 1999; Razgaitis 1999). But accuracy of valuation is a fundamental necessity...
for business investments to occur because such investments are likely to provide a platform for growth, profitability and competitiveness (Lehmann 1996). The traditional source of funding for innovative ventures has been private equity. This situation has made the availability of market information on the value of intellectual assets less forthcoming due to the private nature of most knowledge-based transactions. This limits the traditional role played by private equity firms in funding innovative endeavours, posing numerous risks and uncertainties. The motivation of this paper is therefore an attempt to address the intricacy of valuing intellectual assets by identifying the underlying value-drivers of intellectual assets and establishing their relationships to value creation. This approach has gained increasing recognition in recent years as a major development in valuation methodologies, and is based on the hypothesis that there are key elements that stand out as significant in the creation of value of knowledge assets (Helfert 2000). These key drivers, among others, may be financial profitability, growth potential, management ability, competitive advantage, all of which affects the expectations about the future success and cash flow generation potential of the company.

The paper is structured as follows: Section 1 provides an introduction to current situation of valuation as it pertains to knowledge assets. Section 2 conducts a review of the financial theories, concepts, and models relating to valuation and their relevance to valuing intellectual assets, while Section 3 reviews the study on e-commerce market value in relation to the underlying value-drivers and their pertinence to e-commerce equity valuation. Section 4 explains the process and results of the case study based research done on the biotechnology (biotech), information technology (infotech) and energy and environment (E&E) industries and the significance and implications of the value-drivers for equity valuation. Section 5 presents a cross-sectional analysis of the value-drivers from the empirical evidence of the tests done in the studies and develops some hypotheses as to their pervasiveness in influencing the equity value of the knowledge firm. The broader implications of this study, the direction of future research and conclusion are presented in Section 6.

The Knowledge Economy¹ and Equity Value

With the emergence of the knowledge economy, the principles, methods, and issues connected with the valuation of intellectual capital assets have become increasingly important (Bontis 1996; Smith and Parr 2000). In the New Economy, the definition of knowledge is synonymous with scientific breakthroughs in high technology industries, which open up new business opportunities. The general perception of knowledge evolution is that when it grows in applications it represents a substantial source of competitive advantage and becomes more valuable, albeit the difficulty in estimating its intrinsic value. The major characteristics of the knowledge economy are the phenomenon of increasing returns (Arthur 1996) and the uncertainty surrounding the value of an investment in knowledge. In the industrial economy, stock market value is primarily driven by tangible assets but within knowledge paradigm intangible assets drive it. The tacit nature of knowledge businesses poses a difficulty in

¹ Knowledge Economy is one in which the generation and exploitation of knowledge play the predominant part in the creation and sustenance of wealth
measuring knowledge and the literature suggests that simple financial measures are inadequate to address this issue.

The perception of value in knowledge business has traditionally been determined by the strength of ideas and potential market share. Even though it can be said that the factors contributing to the creation of value rely much on the nature of the knowledge industry, a substantial proportion of the “fixed cost” in knowledge development usually lies in creation rather than in manufacturing or distribution.

The most widely used valuation models for determining a firm’s market value are based on the discounted cash flow (DCF) method (Chew 1997). The simple “efficient market model” of stock prices maintains that the actual market value is the expected present discounted value of future cash flows. This value may be determined by capitalising either the dividends or the future earnings to which the original stockholders are or maybe entitled and the stock today is calculated as the present value (PV) of an infinite stream of dividends (the development of which is attributed to Gordon and Shapiro (1956)):

\[
\text{Value of stock} = P_0 = PV \text{ of expected future dividends} \\
= \frac{CF_1 + CF_2 + \ldots + CF_t}{1 + K} + \frac{CF_t}{(1 + K)^2} + \ldots + \frac{CF_t}{(1 + K)^t}
\]

where:
- \( CF_t \) = the dividend in period \( t \);
- \( K \) = the discount factor, and
- \( PV \) = the current stock price.

In the context of valuing a nascent knowledge-intensive firm, the absence of positive cash flow poses a problem in adopting the DCF method. Even if positive cash flows can be reasonably estimated in the absence of historical earnings, the extrapolation of growth on earnings estimates might be based on weaker foundations.

Other valuation models can be adopted for valuing a knowledge-intensive firm in the absence of earnings data necessary for using the DCF model. One such approach is factor models or index models, which are “return-generating” (Sharpe, Alexander and Bailey 1995) statistical models that assume that the return on a stock is sensitive to the movements of various factors or indices. These factors and their sensitivities to stock returns need to be determined. The two main factor models are the one-factor market model and the multiple-factor models. The technique of simple or multiple regression analyses used to define the return-generating process depends on the number of predicted variables. The method used for measuring the market value of e-commerce equity in this paper uses the multiple-factor approach.

The multiple-factor model assumes that the return on a stock is sensitive to the movements of various factors. The model implies that the returns on two stocks will be correlated through common reactions to the factors specified in the model. Any unexplained return by the model is assumed to be unique to the stock and uncorrelated with the unique elements of returns on other stocks. In testing for pervasive value-
drivers in the e-commerce sector while developing the valuation model, stationarity and cointegration procedures are also applied to test for long-run economic relationships (see Oh 2001).

The method used in this paper for determining the possibility of a linear association between any two series of data is the correlation coefficient.

**Market Value of E-Commerce Equity**

The e-commerce sector, a consumer-orientated innovation resulting from aggressive intellectual property development in recent years, have altered the competitive environment of the traditional market structure and provided a potential for enhancing the value of a firm. It can be implied from the experience with e-commerce that intellectual capital is an important integral part of its recent developments and therefore constitutes the source and impetus of market value.

The market value of an innovative asset provides a proxy for measuring investment returns and this approach is appropriate for in a market economy the value of an asset is the price at which that asset trades in the market. (i.e. the Australian e-commerce stock prices are used in the analysis below). Hall (1999) and Darby, Liu and Zucker (circa 2000) also adopted this approach in their research. The valuation methodology using the Australian E-Commerce Multifactor Model – AEMM (Oh 2001) is by regressing the market returns of Australian e-commerce firms on real economic variables to estimate market value. The sample size in the study consists of eighteen pure-play e-commerce firms listed on the Australian Stock Exchange (ASX) over the period July 1999 to June 2000. The following is the estimated regression model (AEMM) that best explains Australian e-commerce stock returns in the study period:

\[
e_{-stockret}(PR)_t = -0.1900 + 0.0013_{NAS} + 0.0692_{CC} - 0.3287_{FE},
\]

\[
(\hat{R}^2 = 64%)
\]

\[
e_{-stockret}(PR)_t = \text{the return of the e-commerce portfolio in period } t;
\]

\[
_{NAS} = \text{the change in value of the NASDAQ Composite Index in period } t;
\]

\[
_{CC} = \text{the change in value of consumer confidence in period } t; \text{ and}
\]

\[
_{FE} = \text{the change in the exchange rate of the Australian $ against US$}.
\]

The pervasive variables identified in the above equation are those that best explain the return of e-commerce stocks in the study period. The factor identification process in this study seeks to ensure that equity investments in the e-commerce sector will maximise financial return when these variables are included in the risk analysis – albeit the fact that changes will occur to the sensitivity (\(\_\)) of each factor to return over time subject to market conditions. Using the AEMM, forecasts can be made with the appropriate variable values. If the values are uncertain, sensitivity analysis can also be applied. The theoretical approach to factor specification is based on arguments that the factors capture economy-wide systematic risks (Chen, Ross and Roll 1986; Fama and French 1993). The Australian model was developed incorporating significant market variables and the multiple-factor model is selected for its ability to capture the essence of the fundamental economic and financial forces that affect
security returns in a concise and readily testable form. The multi-period return regressions approach is chosen in this study because regression tests have proven that expected stock returns are time-varying rather than constant as assumed by the DCF model (Campbell, Lo and McKinlay 1997).

The systematic and unsystematic risk profile in the study by Oh (2001) 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. This means that there was less of a tendency for the e-commerce stock prices to move together with the general market variability.

Interpretation of the E-Commerce Value-Drivers

**NASDAQ Composite Index**

The NASDAQ (NAS) is the equity capital exchange on which major e-commerce related companies (e.g. Dell, Oracle, Cisco, Microsoft and Intel) and many thousands of smaller technology-based companies are listed and together they account for the bulk of network hardware and software support for the new economy. The United States is the largest source of Australian merchandise imports (telecommunications equipment and computers – A$2.3 billion in 1999/2000) and foreign investment (A$165 billion as at 30/6/99).2 Australia has a relatively new e-commerce sector in a nascent global industry and relies both on technology3 and capital transfers from the United States to provide impetus to sustain its growth. The AEMM model shows a positive relationship between the NASDAQ composite index and e-commerce stock return with a coefficient of +0.0013 indicating a 0.13% percent change to stock return for every unit of change in the NASDAQ composite index.

**Consumer Confidence**

The value-driver consumer confidence (CC) in the AEMM measures the level of confidence individuals have on the performance of the economy. Traditionally, CC correlates closely with unemployment, inflation and real income growth. The consumer-goods industries are closely linked to the expectations that the Internet would serve as the platform for future e-commerce development. This would happen at both the business-to-consumer (B-2-C) and business-to-business (B-2-B) levels, and the efficiency of the Internet would increase the intensity of business volume through better efficiency. In the context of e-commerce stocks, CC reflects the fundamental state of the economy such as: CC is a leading indicator for the business cycle; CC index releases contain information on consumer assessment of the present expectations for the future; and improved expectations for the future indicates higher consumer spending now and in coming months. These indicators of the economy will invariably influence the stock valuation of the evolving e-commerce sector, which in the absence of meaningful historical financial performance relies heavily on the public sentiment, perception and assessment of the economy for its viability.

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2 Department of Foreign Affairs and Trade-Australia, www.dfat.gov.au
3 Federal Government outsourcing of its IT functions to US companies is an example.
**Foreign Exchange Rate**

The foreign exchange rate \((FE)\) as an e-commerce value-driver represents a relationship between the value of e-commerce stocks and the strength of the Australian dollar against the US dollar in two dimensions. Firstly, the significant trade between the US and Australia in computer technology merchandise which is considered fundamental to the development of the e-commerce sector and is mainly sourced from the US is nominated in US dollars; secondly, the recent flow of investments in the form of foreign direct investments (FDI) and managed-fund investment in the secondary equity market has been increasingly evident from the presence of several high profile US investment management funds companies.

**Correlation Analysis for E-Commerce Stock**

The degree of relationship between the returns of e-commerce stocks among themselves and the market returns is measured and analysed in order to estimate the behaviour of e-commerce stocks as a portfolio and against the general market. The analysis of the correlation coefficients seems to support and confirm that the general returns and price behaviour of the e-commerce stocks display predominant positive correlation with each other (Oh 2001). There is a consistent positive relationship between each other indicating a high level of association and volatility characteristics between the stocks.

**Biotech, Infotech and E&E Value-Drivers Research**

The choice of research subjects is the Australian biotech, infotech and E&E sectors. The biotech industry, seen as a key sector in the knowledge economy, offers substantial opportunities for growth and profitability. Infotech has emerged as a major form of intellectual property with the heavy reliance on information in today’s world. The E&E sector has played a pivotal role in ensuring the economic success of countries, which is increasingly judged on the basis of the degree of consumption of produced goods and services achieved by its citizens without damaging and degrading the environment. These situations present the opportunities for firms to develop intellectual assets for sustained profitability and growth, but considerable investments in new technologies are necessary to turn potential into financial reality. Under such circumstances, valuation of these technologies, to attract venture capital for the development of intellectual assets, is critically important to make potential into reality.

The research methodology adopted in this section is two-pronged involving primary and secondary data collection from a case study survey conducted on three Australian companies from each of the three sectors, and a literature review of pervasive value-drivers in knowledge-based firms. This section presents the findings of the research, which attempts to identify, evaluate and analyse the key factors, from a valuation perspective, that drive the value chain of intellectual assets.

The primary data collection is based upon the case study approach. This is an exploratory research and the selection of the case study method was based on its suitability both to the purpose of the investigation and to the nature of the data to be collected and analysed (Yin 1993). The case study approach examines a single social phenomenon or single unit of analysis (Singleton, Straits and Straits 1993) in order to give meaning based on both the tacit and explicit knowledge of those who experience
that phenomenon (Bailey 1996). The exploratory case study approach builds theory, and is therefore, suitable in situations where there is inadequate theoretical basis, as is the case with value-driver based valuation methodologies. An explanatory case study approach is suitable where cause-effect explanations are sought. The analysis of the data from the case studies has been carried out using the NVIVO case analysis software, which uses its pattern matching logic as the dominant mode of analysis to establish the key value-drivers in each of the three industries.

The motivation of this research is to identify the pervasive value-drivers, which are vitally necessary to underpin innovations, consistent with the potential for sustainable growth. However, even more critical are valuation issues connected with innovations, because they facilitate and influence developmental investments.

**Interpretation of the Value-Drivers**

The results from the case study analysis have been tabulated in Table 1 and Table 2, below. In Table 1, the key value-drivers are ranked in order of frequency of observations.

<table>
<thead>
<tr>
<th>Value-Driver</th>
<th>Biotech</th>
<th>Infotech</th>
<th>En &amp; Env</th>
<th>Total</th>
<th>Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Profitability</td>
<td>16</td>
<td>7</td>
<td>12</td>
<td>35</td>
<td>1</td>
</tr>
<tr>
<td>Uniqueness of innovation</td>
<td>11</td>
<td>9</td>
<td>14</td>
<td>34</td>
<td>2</td>
</tr>
<tr>
<td>Reputation of research team &amp; firm</td>
<td>6</td>
<td>11</td>
<td>8</td>
<td>25</td>
<td>3</td>
</tr>
<tr>
<td>Growth prospects</td>
<td>16</td>
<td>4</td>
<td>4</td>
<td>24</td>
<td>4</td>
</tr>
<tr>
<td>Quality of management</td>
<td>11</td>
<td>8</td>
<td>4</td>
<td>23</td>
<td>5</td>
</tr>
<tr>
<td>Economic factors</td>
<td>6</td>
<td>7</td>
<td>2</td>
<td>15</td>
<td>6</td>
</tr>
<tr>
<td>Risks</td>
<td>6</td>
<td>6</td>
<td>2</td>
<td>14</td>
<td>7</td>
</tr>
<tr>
<td>Patent protection</td>
<td>7</td>
<td>3</td>
<td>1</td>
<td>11</td>
<td>8</td>
</tr>
<tr>
<td>Productivity</td>
<td>6</td>
<td>4</td>
<td>1</td>
<td>11</td>
<td>8</td>
</tr>
<tr>
<td>Governmental support</td>
<td>0</td>
<td>0</td>
<td>10</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td>Cost effectiveness</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>4</td>
<td>10</td>
</tr>
</tbody>
</table>

**Profitability**

There is an intuitive notion that most individual stocks move with the aggregate market (Reilly 1989) and the aggregate market returns over a specified time period has traditionally been used as a benchmark to measure the performance of individual portfolios. The perceived value-driver with the highest observations (i.e. a total of 35 observations across all sectors) is “profitability”, indicating the underlying importance of commercial viability of a venture for wealth creation. However, profitability among the three sectors is features less prominently in the infotech sector compared to the other two.

This perception of profitability as a key value-driver is consistent with the belief that investments in knowledge assets are no different to tangible assets in their role as a vehicle of wealth creation. The objective of achieving profitability is a reflection of the awareness of managers to make commercially viable investments. Day (1999) states that profitability, a major objective of any business, is the reward for making
investments in the past, which is also a strategic step in establishing a firm’s competitive position, and intended market share. Reflecting this view, Anthony (1995) states that the dominant purpose of firms is to earn profits, and therefore, resources are invested in assets with the objective of deriving profits from their employment. Assets sourced from a firm’s innovation extend its technological capabilities, and contribute to the wealth of the firm and society Narayanan (2001).

Uniqueness of Innovation

The “uniqueness of an innovation” has the next highest number of observations with 34 and again infotech has far less observations to the other two sectors. Nevertheless, there is a strong indication that firms view uniqueness of products as a major determinant of value.

Uniqueness of innovation arises out of creativity, and this has a major role to play in the creation of products that are genuinely unique as distinct from those that are merely extensions or improvements Kuratko (1998). Most innovations result from a conscious, purposeful search for new opportunities (Josty 1990). Intellectual (or knowledge based) assets are products of innovative thinking, new methods or new knowledge (Drucker 1985). Further, there is a strong perception that firms in the knowledge economy succeed because they are able to develop range of unique products and services (Karakaya 1994).

Reputation of Research Team and Firm

This perceived value-driver by management in the case studies has the third highest observations with the infotech sector considering it as being relatively more critical than the others. This ranking is consistent with the findings of Darby et al. (1999) who hypothesised that high-tech ventures with strong link to “star scientists” should be more highly valued by investors and examined the effects of ties to star scientists on the market value for new biotechnology firms. They concluded that an increase in a firm’s intellectual human capital would lead to higher market valuation.

Growth Prospects

This is the fourth most important value-driver and Lee (1992), Fama (1990) and Schwert (1990) found that aggregate annual stock return variations could be explained by future values of measures of aggregate real activity, such as GNP, in the United States.

Growth is derived from a firm’s market share, competitive positioning and profitability. Thus business managers are keenly aware of the need to make the necessary investments to maintain and increase their market share (Kotler 2001). Competition is played out over many time periods, while the rules of the game keep changing. Thus business managers may consider it dangerous to extend the interpretation of market share from an indication of past performance to a predictor of future advantages (Day 1999). Thus firms invest in assets that yield long term value creation by giving them a strong market position based on superior customer value, or the lowest delivered cost (Narayanan 2000; Westland 2002), which in turn, give them the competitive advantages of growth in market share and profitability, both of which are strongly related (Day 1999).
Quality of Management

This value factor has 23 observations across the three sectors with the highest in the biotechnology sector. These firms appear to be well aware of the need to understand and manage all aspects of a firm’s operations in order to profit in the knowledge economy. Successful management involves not merely discovering new solutions or adopting seemingly effective innovations, but also finding a home for the discovered products and services in the marketplace (Day 1999). The key to effective management in knowledge-based companies lies in linking products and services to market realities (Narayanan 2001). Further, the costs and risks inherent in developing intellectual assets must be issues of careful management consideration (Weil 1983; Contractor 1988).

Economic Factors

The fundamental value of a firm is the expected present value of the firm’s future payouts if these expectations take all currently available information into account, consistent with the efficient market hypothesis. Thus future payout must ultimately reflect real economic activity as measured by, for instance, gross domestic product – GDP (Shapiro 1988). Consequently, stock prices should react to these measures of real activity as stock prices are built on expectations of these activities. Barro (1990) and Fama (1990) support the argument that stock price should lead real activity.

This value factor would be a proxy for market conditions. From Table 1, all the sectors have a relatively low number of observations for this value-driver. The interpretation of the low ranking could be that most nascent knowledge-based firms may be unable to fully evaluate or significantly appreciate the impact of market conditions on their business performance. This is understandable as most of these intellectual firms are in the process of developing their innovation and would not yet have a fully developed product or process to market. It is therefore difficult for the management of this type of firms to relate their firms’ business performance to market conditions. The marketability of and the scope of application that the technology under development may be capable of could still be relatively unclear at this stage. The focus at this stage of business development would be on ensuring the success of the R&D activity.

Risks

The view of risk derived from the extensive work in portfolio theory and capital market theory by Markowitz (1952) and Sharpe (1964) is that investors incorporate risk considerations in making financial decisions. Judging from the low observations, it appears that the risk factors inherent in the intellectual ventures are either not a major concern or still not fully understood or acknowledged by the management of the firms. This situation could possibly be due to the lack of appreciation about the full implications of both financial and operational risks that exists in the knowledge-based industries. There is a systematic risk component associated with the cash flows of technology-intensive ventures while the technical risks are idiosyncratic (Berk, Green and Naik 1998; Oh 2001). The relevant risks affecting the valuation of technology ventures need to be determined and measured in the evaluation process for high-tech firms be they in the form of risk premia earned for firm external factors such as NAS, CC and FE (Oh 2001), during development (Berk et al. 1998) or human capital (Darby et al. 1999).
**Patent Protection**

This value factor reflects the legal environment in regard to the protection of intellectual assets. The highest number of observations is in the biotechnology industry followed by infotech and this implies a major concern about this aspect of the legal environment pertaining to proprietary rights to innovations developed in these industries.

The value implication of patent protection is in the challenges posed by the knowledge economy in calculating the value of intellectual assets, primarily because of their intangibility. Nevertheless managers are well aware that these assets need to be protected as vehicles of wealth creation, just as much as any tangible assets (Cheeseman 2002). And the very reason why firms invest in intellectual assets is to gain rewards from their use in the knowledge economy (Hovey 2002). Patents not only protect a firm’s investments in intellectual assets, but also provide a basis of valuation (Leuhrmann 1997).

**Productivity**

This factor defines the productivity benefits that the end-user would derive from using the technology developed by the knowledge firm. The level of productivity in an economy can be measured using the industrial production index, which measures the change in output in manufacturing, mining, and electric and gas utilities, in conjunction with labour expenditure. Chen, Roll and Ross (1986) suggest that industrial production is one of the economic variables that have a high correlation with the value factors derived from their factor analysis. Therefore, the low ranking of this factor is unusual as it is closely related to performance, growth and profitability.

**Governmental Support**

This aspect of the value chain scores very low overall, with the biotechnology and infotech sectors regarding it as of zero importance. A plausible explanation for this could be that the firms are already experiencing R&D and infrastructure support through operating in an established technology park and thus consider this type of support less critical for success. Some would argue that the knowledge economy is a new market impetus, in a relatively nascent stage of development, and with its potential to pervade all facets of the economy, is probably too important to be left entirely to market forces (Oh 2001).

**Cost Effectiveness**

This factor refers to the cost effectiveness of the R&D activity conducted in the venture firm. It has the lowest ranking in the evaluation. A plausible explanation for the low ranking could be, despite the fact that cost control is an important management function that the potential of the technology in terms of future economic benefits is still highly nebulous for the firms interviewed in this research. This would render a cost to benefit analysis challenging due to the lack of information about outcomes. Therefore the emphasis of the firm would be on achieving a successful outcome, contingent on the continuation of funding, as opposed to a preoccupation with cost-control and risk losing focus on the technical aspects. This is realistic as the majority of entrepreneurs are from a scientific background and therefore their major emphasis is on technical rather financial matters.
However, it is an established fact that investments in R&D are risk intensive because of a low probability that such expenditures will result in any tangible commercial success. In the knowledge economy, there is ongoing pressure to make those investments in developing intellectual capital assets, in order to maintain a firm’s market and competitive standing (Weinstein 2001). But expenditures on R&D are business costs, and like any other costs and expenses, they have to be effective, that is, they must yield profitable results (Narayanan 2001). Thus business managers must establish budgetary controls over R&D expenditures, and subject them to the same budgetary rigours similar to other classes of expenditures (Kuratko 1998). Thus business managers try and ensure that R&D costs are minimised, while the probabilities of commercial success are maximised.

**Correlation of Value-Drivers between Industries**

From Table 2 below, the level of correlation of value-drivers between industries seems to be higher for biotechnology and infotech than for biotechnology and energy & environment and infotech and E&E.

<table>
<thead>
<tr>
<th></th>
<th>Biotech</th>
<th>Infotech</th>
<th>E&amp;E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biotech</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infotech</td>
<td>0.4843</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>E&amp;E</td>
<td>0.2697</td>
<td>0.3125</td>
<td>1</td>
</tr>
</tbody>
</table>

**Cross-Sectional Analysis of Value-Drivers in the Knowledge Economy**

This paper evaluates the results of two different techniques, time series analysis to identify the real economic factors that are e-commerce value-drivers and the case study approach to recognise value-drivers in the three other industries. It also recognises the important role of cross-sectional modelling in empirical finance (as in the capital asset pricing model) and adopts a qualitative cross-sectional analysis in this section to specifying the value pervasive factors in intellectual assets.

**Value-Drivers Across Sectors**

The high unsystematic risk components of the e-commerce market return can be construed as an indication of the market’s lack of a consensus on the value-drivers of e-commerce equity value. The high correlation of value-drivers (even though it is more implicit in the case of the e-commerce sector) across the four industries suggests a strong relationship between value-drivers and value perception, and in the case of e-commerce market performance of equity investment. As e-commerce relies on infotech innovations to develop, there is undoubtedly a higher level of correlation between these sectors and it can be extrapolated that the risk premia earned on the relevant value drivers would be highly applicable for these two sectors.

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Correlation between Industries
The predominant positive correlation between of e-commerce stock returns suggests that their market behaviour is largely consistent or similar in characteristics among the stocks in the portfolio. This level of correlation for e-commerce stocks is not surprising as the stocks contain much idiosyncratic “noise” and react rather uniformly to e-commerce-specific information indicating a high level of association and volatility characteristics between the stocks. This positive correlation is also evident between the biotechnology, infotech and E&E sectors of the knowledge economy (see Table 2 above) when the value-drivers are tested. For all the sectors analysed in this paper, the level of correlation between sectors does not appear to be very high. The correlation level between the stocks and industries indicates the degree of association and measures the strength and the direction of the linear relationship between each pair of variables in terms of the tacit pervasiveness of underlying value-drivers.

Private Equity Market for Intellectual Investment
The role of financial markets is that of how knowledge firms raise financial resources and how they reward those who provide such resources. The private equity capital market is an important source of funding for the knowledge sector and it is by appreciating the economic factors that drive value would we understand what investors focus on that facilitates capital allocation. The financial issues relating to market efficiency, investment valuation, volatility, risk & return, price predictability, cost of capital and portfolio management are important issues since they will have an effect on the financing decisions made by a knowledge-based firm (Oh 2002).

Knowledge-Based Industries and Public Policy
The Internet, which spawned e-commerce, has drastically altered lifestyles and has the potential to pervade all facets of the economy. Likewise, the biotech, infotech and E&E are experiencing quantum leaps in new discoveries that will have a profound influence on our lives. Romer (1992) and Soete (1997) find the need for government intervention to sustain investment value in knowledge and Lehman (1996) suggests that US economic growth in the next century depends on the government creating incentives for private sector investment in R&D and fostering and promoting of intellectual property.

Implications, Future Research and Conclusion
This paper conducts a review of two empirical studies on the value-drivers in four sectors of the knowledge economy. The broader issues, implications, scope for future research and conclusion are discussed, explained and hypothesised in this section.

Implications for E-Commerce Equity
The absence of earnings due to early-stage development of e-commerce makes it imperative that surrogates are used for estimating a firm’s potential earnings in this study. All the three significant factors are individually integrated to e-commerce portfolio return implying that \( e\text{-stockret}(PR) \) and past \( NAS, CC \) and \( FE \) have significant explanatory power for current \( e\text{-stockret}(PR) \) movement at the 10%
significance level with $R^2$ of 0.6421. These findings provide a user of the AEMM model with a certain degree of confidence that these factors are relevant and suggest a longer term pervasive influence on e-commerce market value determination.

In a portfolio context, the portfolio stand-alone risk can be reduced when more stocks are added to the portfolio and the portfolio standard deviation, $\sigma_p$, falls as a result. Almost half of the inherent riskiness or volatility of an individual stock, $\sigma_i$, or the standard deviation of a one-stock portfolio can be eliminated through proper diversification (Anderson and Leonardi 1982; Stokie 1982; Elton and Gruber 1987). Therefore, it can be concluded that some of the risk inherent in individual e-commerce stocks can be eliminated through holding multiple stocks in a portfolio. If the average systematic risk of these e-commerce stocks is 18% of the total stand-alone risk and cannot be eliminated, the part of the stocks that represents diversifiable risk is 82% and a large part of this risk can be eliminated. The magnitude of the diversifiable risk eliminated through diversification will depend on the correlation coefficient for the returns of the e-commerce stocks in the portfolio. The low estimated systematic risk of e-commerce stocks suggests that e-commerce stock value gyrate in a unique universe.

The idiosyncratic factors (as implied by the high unsystematic risk) influencing e-commerce stock value would make long-term valuation of e-commerce firms difficult creating a high degree of uncertainty in the market place of its investment value. This would create a high risk-aversion towards e-commerce stocks as an investment choice and pose a challenge to corporate managers in the e-commerce sector in equity fund-raising activity.

**Implications for Biotech, Infotech and E&E Equity Valuation**

The implications from the research findings on these sectors, from both a corporate equity fund-raising and portfolio investment perspectives, would be to exercise prudence on the part of all parties through monitoring and evaluating the trend of the identified pervasive value-drivers to obtain an intimation of asset values in these sectors for formulating investment strategy. There appears to be a distinct agreement among the three sectors on the pervasiveness of the top five value-drivers, being profitability, uniqueness of innovation, reputation of research team & firm, growth prospects and quality of management.

**Future Research**

The significant issues related to the valuation of knowledge-intensive industries that form the agenda for further research in finance by the authors are to study the group behaviour of knowledge-economy investors, similar to that of Shiller (1989). This would help to illuminate the extent of noise-trader behaviour or herd mentality in these industries. The statistical tests and hypotheses to be conducted might be better performed under non-linear specifications (Hand 1999) rather than the linear ones to which the research in the study of e-commerce equity above is restricted.

The research conducted in this paper is generally exploratory and in the future the identification of the value-drivers may well be based on their pervasiveness on the valuation of the technology at the various stages of development. The next step of research to conducted would be to test the significance of the value-drivers identified in the biotech, infotech and E&E industries along the strand of literature by Kwon and
Shin (1999); Fifield et al. (2002); Wongbangpo and Sharma (2002)). This would first involve testing them in the broader market for prevalence and, secondly testing them directly against market data for value performance. This process would reinforce the pervasiveness of these value-drivers.

Conclusion

In empirical capital market efficiency studies, there is a presumption that government intervention is not necessary and, according to Cuthbertson (1997) the outcome of tests of the efficient market hypothesis can be used in public policy assessment of the desirability of mergers and acquisitions, short-termism and regulation of financial institutions; which are all relevant and contemporary issues related to the development of the industries evaluated in this paper, and by extension the knowledge economy as a whole. If the market is efficient, the current price reflects the intrinsic value of the investment and if the financing conditions are optimal then firms should invest in knowledge assets through internal expansion or mergers and acquisitions.5

Bibliography


5 Many firms are involved in e-commerce through internal development of e-commerce capabilities while others such as AOL-Time Warner and Telstra-Pacific Century Cyberworks prefer exploiting market opportunities through mergers and acquisitions or strategic alliances.


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