Essays on Emerging Practitioner-Relevant Theories and Methods for the Valuation of Technology

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Suvankar Ghosh

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Essays on Emerging Practitioner-Relevant Theories and Methods for the Valuation of Technology

PhD Dissertation written by: Suvankar Ghosh

Approved by:

Doctoral Dissertation Committee

Dr. Marvin D. Troutt (Committee Chairman)

Dr. Alan Brandyberry

Dr. O. Felix Offodile

Dr. John H. Thornton, Jr.

Graduate School of Management

Dr. Richard Kent, Graduate Faculty Representative

Doctoral Director, Graduate School of Management

Dean, Graduate School of Management
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1. Introduction

This introductory chapter discusses the overall theme of this dissertation and its structure as a set of essays, presents synopses of these essays, and also describes the organization of this document.

1.1 Dissertation Structure and Theme

This dissertation is comprised of three essays on emerging methods for the valuation of technology that are relevant to practitioners. The three essays in the dissertation are the following:

1. A New Approach for Empirically Assessing Practitioner Relevance of Academic Research
2. An Adoption Decision Model for Emerging Capital Budgeting Methodologies
3. Uncertainty and XML-Based Integration – A Real Options View

The theme of this dissertation is the valuation of investments in technology by newer and more powerful methods emerging from the fields of finance and economics which at the same time have the promise of being widely embraced by practitioners. These new methods such as Real Options (RO) are arguably more capable of analyzing the uncertainty and complexity inherent in technology investment decisions and assessing the options that management has in dealing with this uncertainty. Across a wide spectrum of technology investment decisions, there is uncertainty and complexity associated with the technology’s benefits and costs, its architecture, the changing market environment, the proliferation of standards, and the fallible human element that is part and parcel of every socio-technical system. This dissertation therefore examines certain promising financial and economic theories and methods which provide the appropriate framework for developing value-driven technology strategy given the complexity and
uncertainty in today’s investment decisions. While there are often non-financially quantifiable rationales for acquiring and deploying technological innovations, the basic thrust of this dissertation is that, to the extent the financial dimension is important, the firm should ideally marshal the latest advances in financial techniques and methodologies to develop technology strategies that are value-based. Furthermore, such new techniques and methods must be applicable to the real world of business. The challenge for business academics has long been about how to convert their ground-breaking yet sometimes esoteric ideas into practical reality.

While recognizing that there is clearly a place for abstract research, we have nevertheless purposefully biased the essays in this dissertation towards practical relevance and the application of theories to real-world situations.

We focus on two methods emerging from the fields of finance and economics, Real Options (RO) and Economic Value Added (EVA), for the valuation of technology investments that hold the promise of doing a better job than traditional approaches such as Net Present Value (NPV) have done in the past. These two methods were chosen on the basis of the discourse and attention that have been focused on them in academic and practitioner literature over the past ten to fifteen years. RO is arguably superior to NPV as it is able to more accurately appraise the impact of uncertainty on the value of the investment and assess the flexibility management has in dealing with this uncertainty. Dixit and Pindyck (1995) and Luehrman (1998) provide a good introduction to the concept and rationale of the RO approach. EVA is a concept that has found much resonance among practitioners since it replaces the accounting measure of profit, or earnings before interest and taxes (EBIT), by the notion of “economic profits” that takes into account the cost of all capital including equity capital in computing profits. Grant’s (2003) book *Foundations of Economic Value Added* is an excellent introduction to the notion of EVA. An
overview of both EVA and RO is given in Appendix A.1. EVA can be computed at either the
level of the firm or a given investment project. RO and EVA thus provide two new perspectives
that enhance our understanding of the value of an investment beyond what we obtain from
traditional metrics such as net present value (NPV), internal rate of return (IRR), earnings before
interest and taxes (EBIT), or payback period. RO and EVA should be viewed as methods and
measures that are not necessarily replacements for traditional metrics but as additional measures
that provide a more complete understanding of the value of an investment.

There have of course been many methods and techniques proposed over the years for the
valuation of capital investments made by the firm in IT and in other areas. Such methods include
the balanced scorecard (Kaplan and Norton, 1992), benefits-risk portfolio (McFarlan and
McKenney, 1983), investment mapping (Peters, 1988), multi-objective and multi-criteria
methods (Vaid-Raizada, 1983), return on management (van Nievelt, 1993), efficiency ratio
models (Troutt et al., 1999), information economics (Parker at al., 1988, 1989), value chain
analysis (Porter, 1985), Ward’s portfolio analysis (Ward, 1990), and many others. The focus of
this dissertation is however not on an exhaustive enumeration and comparison of all possible
methods and approaches for analyzing capital investments by firms. Other literature such as
Renkema (2000) may be consulted for a compilation and discussion of the various methods that
have been used for appraising capital investments. This dissertation focuses on two methods, RO
and EVA, which as the literature review in Chapter 3 will demonstrate, have piqued the interests
of both the academic and practitioner communities. On the basis of the literature review of RO
and EVA, it is a reasonable conjecture that interest in RO and EVA by both the academic and
practitioner communities is likely to continue; and therefore these two methods merit further
investigation. Further investigation of EVA and RO can of course explore many areas including
a detailed comparison of EVA and RO with previous methods for capital investment. Every research effort must necessarily pick a spot to focus on and this dissertation focuses mainly on comparing EVA and RO to each other, and also on applying these new methods such as RO to particular technology investment scenarios.

EVA is an approach that is reasonably well understood by industry as we shall see later in Section 3.2 given the spreading use of EVA by businesses in a variety of industries. RO is a more esoteric methodology that has its origins in the Black-Scholes (B-S) options pricing model. While there are many variants of options pricing models, not all of which derive from the B-S model, it is not unreasonable to assert that B-S is the foundational model that one should understand particularly in formulating RO models in continuous-time. Applying RO is more of a challenge for practitioners because of the complexity behind options pricing models. Because of the novelty of the RO approach and the difficulties in applying it, this dissertation in keeping with its emphasis on practitioner relevance shows how to approach a key investment decision in IT, the acquisition of enterprise integration technology, from an RO lens.

The centrality of practitioner relevance in this dissertation is further underscored by the development of a new approach to empirically assess whether new ideas forged in academia are embraced by the practitioner community or not. This dissertation thus exhorts the academic community to adopt methods such as the one developed in Chapter 2 to increase the impact of their ideas on practitioners and also to become more keenly aware of the issues affecting the practitioner community. The raison d’etre of this dissertation is to bridge the gulf between academia and the practitioner community in a bi-directional manner by focusing both on important ideas brewing in academia and how they can be applied by practitioners, and also by
developing new approaches which can gainfully be adopted by academia to measure and thence increase its impact on the business world.

1.2 Synopses of Essays

This section provides a synopsis of each of the essays.

1.2.1 A New Approach for Empirically Assessing Practitioner Relevance of Academic Research

There has been much debate on the relevance to firms of the academic research produced by business schools. However, what has not received as much attention in this debate is how the relevance of the research to businesses ought to be measured in a systematic and empirical way. We develop a systematic method to test for the relevance of academic research to businesses which focuses on whether there is healthy and vibrant cross-pollination of ideas between academia and the business community. Our method models as a vector autoregressive (VAR) process the interests of the academic and practitioner communities in some new idea by the number of articles published in the academic and also in the practitioner literature on that idea. We then study the temporal correlation between the interests of these two communities, via Granger-causality tests, to assess their influence on each other. The Granger-causality procedure, while not testing for true causality, nevertheless goes beyond merely testing for association between two stochastic processes, X(t) and Y(t), and is able to detect if historical information on X(t) can improve our ability to predict Y(t). This approach provides important insights into the degree of coupling of the discourse occurring in academia and in the business world as reflected by publications in academic and practitioner literature. The method thus serves to gauge whether these two communities are truly listening to each other or whether they are merely “ships passing in the night.” In addition to Granger-causality, we also use the technique of cointegration to
examine the relationship between academic and practitioner interest on a topic. While Granger-causality operates on a stationary VAR process, the cointegration technique is useful in finding relationships between non-stationary processes. In keeping with the dissertation’s focus on new valuation methods, the two topics to which this method of Granger-causality in cross-community discourse is applied are RO and EVA.

1.2.2 An Adoption Decision Model for Emerging Capital Budgeting Methodologies

Capital budgeting methods used by industry have historically focused on financial measures such as an investment’s Net Present Value or its Internal Rate of Return. Two new approaches to capital budgeting are RO analysis and the evaluation of an investment’s EVA. In this essay, we develop a theory about the relative likelihood of adoption by industry of new methodologies such as EVA and RO. A Methodology Adoption Decision Model (MADM) is formulated which asserts that the likelihood of adoption of a new capital budgeting methodology is driven by two key constructs: the perception of theoretical soundness and the perception of the practical applicability of the methodology. A measure of the sentiment of the academic and practitioner communities towards the two methodologies is defined based on articles published in academic and practitioner journals. The sentiment measures are used as proxies for the perceptions of theoretical soundness and practical applicability. A content analysis is done of a random sample of articles on EVA and RO to gauge the sentiments of the academic and practitioner communities. The data from the content analysis are evaluated by a panel of five experts including business school faculty to extract the sentiment of the academic and practitioner communities. Multivariate analysis of variance (MANOVA) is used to assess the relative strength of the sentiment towards EVA and RO by the academic and practitioner communities.
1.2.3 Uncertainty and XML-Based Integration – A Real Options View

RO is rapidly emerging as the most appropriate framework for developing strategy in the face of uncertainty. A real options heuristic frame is also being increasingly applied to assess investments in IT (Bardhan et al., 2004). Enterprise integration (EI) is a key area of investment by IT organizations as it enables firms to integrate their data and business processes. XML is the primary technology underlying enterprise integration. This essay takes the novel approach of viewing a firm’s EI investment strategy from a real options lens. We develop a taxonomy of use cases of XML-based enterprise integration and then analyze uncertainty in these integration scenarios in terms of four principal factors: technical architecture, market, standards, and performance. Based on the uncertainty model, EI is viewed as representing a high volatility-high payoff investment to which management may respond with a variety of strategies ranging from simply deferring the decision to a full and immediate exploitation of EI technology. We develop a decision-making framework where the choice between various investment alternatives such as deferring versus immediate exploitation or deploying an Enterprise Application Integration (EAI) suite versus an Enterprise Services Bus (ESB) is based on RO principles. EAI suites and ESBs are two core technologies used by firms to implement their enterprise integration infrastructure with the difference being that while ESBs offer less functionality than EAI suites they allow for a more flexible deployment of value-added services. Unlike the traditional Net Present Value (NPV) method, the RO approach chooses among alternatives by focusing on an investment’s Strategic Net Present Value (SPNV), which includes the value of the managerial flexibility inherent in the investment strategy (Miller and Park, 2002). Given the high level of uncertainty in the EI investment decision, the maturity of an organization with XML-based integration is a key factor in the choice of the investment path that maximizes SNPV. In other
words, the decision-making framework considers both decision-context uncertainty and firm capability with XML-based EI in developing managerial prescription for preferred real option strategies.

1.3 Document Organization

The three essays are discussed in detail in Chapters 2, 3, and 4. Each of these chapters is written as an essentially self-contained essay complete with its literature review, research methodology, results, and conclusion. This structure facilitates understanding each essay on its own while the common theme running through them is discussed in this introductory chapter. As each essay is self-contained, there could be a little bit of duplication of material in the literature reviews or background discussion accompanying the essay because there is some level of commonality in the background material for each essay. Nevertheless each essay also has a specific focus which is indeed quite different for each essay so the duplication in the background discussion, to the extent that it exists, is not extensive. There is a common bibliography section at the end of this document. Appendices containing the data for the essays have also been placed at the end of the dissertation.

The first essay, Chapter 2, presents a new technique for the practitioner relevance of academic research. This is a novel empirical approach to assessing practitioner relevance as it tracks the discourse on any new idea by tracking publications on that idea in both the practitioner as well as the academic literature. While there is some recognition that perhaps a good deal of academic research is not relevant to businesses (BusinessWeek 1990), this issue of relevance has to a certain degree been anecdotally informed and the method described in Chapter 2 is possibly the first attempt to critically examine this issue from a rigorous empirical standpoint.

Furthermore, given this dissertation’s focus on valuation methods, it is indeed quite apropos that
the new empirical approach to assessing practitioner relevance of academic research, and also whether academia is picking up on the discourse occurring in the business world, is applied in the context of two ideas for the valuation of capital investments, EVA and RO.

After having discussed this new empirical notion of practitioner relevance in the context of EVA and RO, we move on to developing in Chapter 3 a theory for the adoption of new methods such as EVA and RO by the industry. This new theory, the MADM, posits that the likelihood of adoption of a new method is based on the theoretical soundness and practical applicability of that method. We assess theoretical soundness and practical applicability of a new method such as EVA or RO by means of a sentiment extraction experiment whereby the sentiment of the practitioner and academic communities towards a given method as expressed in articles published in practitioner and academic literature is gauged by a panel of experts. This sentiment extraction experiment, together with the propositions of the MADM, is used to come to a conclusion on the preferred sequence of adoption of the EVA and RO methodologies.

Finally, in Chapter 4, we show an application of RO to a key investment decision in IT, that of the deployment of enterprise integration technology. We focus on an application of RO because RO, given its roots in the complex Black-Scholes or other options pricing models, is relatively less accessible to practitioners. We approach the application of the RO methodology to this IT investment problem by focusing on the use of a new valuation construct called SNPV (Miller and Park, 2002), which differs from the traditional NPV in that SNPV also embeds within it the value of managerial flexibility, or equivalently, the value of the options available to management in a given investment strategy. A decision-making framework is developed in terms of a set of heuristics based on an imputation of the SNPV values for different EI investment strategies.
2. A New Approach for Empirically Assessing Practitioner Relevance of Academic Research

2.1 Introduction

The relevance of the research output of business school faculty to businesses remains an issue that generates a good deal of controversy. Some of the harshest criticism of the relevance of academic research has come from academia itself (BusinessWeek, 1990). In a BusinessWeek article (1990), the dean of Case Western Reserve’s Weatherhead School of Management at the time was quoted as saying “As much as 80% of management research may be irrelevant.” Many academics have through the years examined this issue of relevance in more depth, some within the confines of their own disciplines such as strategy or information systems (IS). In the field of strategy, Gopinath and Hoffman (1995) find significant differences between the views of CEOs and that of academic researchers as to what is important in the field of strategic management, hence pointing to a relevance gap in the strategy field. In the IS field, Benbasat and Zmud (1999) readily acknowledge that much of IS academic research does not hold much relevance for IS practitioners as it does not produce the knowledge that practitioners can apply in their daily work; it does not address the problems and challenges of IS professionals; and it does not focus on current technological and business issues. The relevance gap debate has also at times seen insightful exchanges between eminent practitioners on the one hand and respected academics on the other such as that between Citigroup CEO at the time, John Reed, and Stanford’s James March at the American Academy of Management Annual Conference in 1999. March (2000) has quite effectively articulated the viewpoint shared by many academics that management research should focus on seeking knowledge rather than relevance, since searching for immediate relevance could tie research to various sorts of passing management fads and fashions.
Management research should be about basic ideas that shape thinking such as those that relate to conflict of interest, bounded rationality, incentives, quality of information, organizational coupling, and absorptive capacity (March, 2000). Reed (2000), while resonating with March’s views to a certain degree, however, never loses sight of the primacy of integrating management research with practice.

There are of course many in this debate who do not view this “relevance gap” quite so seriously. They see academia as rightly focusing on more basic or fundamental research whose purpose is the advancement of knowledge which may or may not have any economic or social benefits. According to the Australian Research Council, there is no requirement for such basic research to be accompanied by efforts to apply the results to practical problems or to transfer the results to sectors responsible for its application (Australian Research Council Home Page, 2008). While this camp would allow a place in academia for applied research that is directed towards a practical aim, nevertheless it tends to view pure or basic research as necessarily holding a more exalted place in academia since applied research is often less rigorous and more prone to various biases. It is prone to bias because of the very fact that applied research is laden with other objectives rather than simply advancing “understanding”. The ulterior commercialization motive in applied research taints it thus. Furthermore, this camp would also argue that academia is primarily the place where basic or pure research is funded and if it is not done here then it won’t be done elsewhere, at least not to the same extent, and society would be poorer as a result. Like research in any other discipline, business research too may have characteristics of being more basic versus more applied in orientation and the arguments supporting basic research in any other discipline can also apply to basic business research.
There are clearly many perspectives on this debate on the type of research that academia should be pursuing; and engaging in a full-blooded debate on these large issues about the place of basic versus applied research in academia and whether the research relevance gap is a good or a bad thing is beyond the scope of this dissertation. This essay does however voice an opinion on this debate, in so far as business research is concerned, in that it sides with the many respected business academics who view the relevance gap in the research produced by business schools as a problem (BusinessWeek, 1990; Gopinath and Hoffman, 1995; Benbasat and Zmud 1999). These academics have already weighed the pros and cons of this issue, have evaluated the arguments advanced by both camps, and while certainly not saying that there is no place for basic research in business have concluded that the pendulum has shifted too far in the direction of irrelevance and needs to be brought back somewhat. In other words, the definition of the problem is exogenous to this research as it has been already defined by noted academics in the business field itself. To the extent that we see this as a problem, this essay points to a way for doing something about it by first developing a technique to measure the problem. Regardless of whether one views the relevance gap as bad or not, simply having an objective measure of the “gap” advances our understanding of the phenomenon. Consequently, the main purpose of this essay is not so much to stake out a position in this debate as it is to provide an empirical methodology to test for the relevance of academic research to businesses.

This is an important contribution because, while clearly much has been written on this topic, what has been missing to a large extent is the use of rigorous empirical methods to test for the relevance of academic research to businesses. In other words, how do we really know whether academic research is or is not relevant to businesses? If changes are made to the research programs, how can we really tell if the level of relevance has improved or not? A good
deal of the relevance debate has been informed by anecdotes shared and the feelings and beliefs of various stakeholders based on their personal experiences and those of others they know. As an example of the sort of anecdotal evidence that is often produced in many articles on this topic, Benbasat and Zmud (1999) cite the 1995 decision by the Society of Information Management (SIM) International to discontinue the practice of including a subscription to MIS Quarterly (MISQ) as part of the membership dues because of the lack of relevance of MISQ articles to the practitioners among the SIM membership. In another article highlighting the relevance issue, Starkey and Madan (2001) cite the UK Industry-Academic Links report to highlight the relevance gap. Starkey and Madan (2001) excerpt from this report to state that “some managers do not feel that research contributes directly to their managerial role” and “users believe that research can benefit them but do not regard many research topics as focusing on key issues of relevance.” Time and again, it is anecdotes, beliefs, and feelings, albeit sometimes of some very eminent people such as CEOs or renowned scholars, which are used to buttress positions taken in this debate on the relevance of management research. Little work has gone into rigorously defining a measure of relevance that lends itself to empirical testing. This essay formalizes such a quantitative measure of relevance which allows us to rigorously test for whether academic research is relevant or not to businesses.

2.2 Towards a Testable Notion of Relevance

One approach to a rigorous quantitative study of the research relevance gap would be to administer a survey to gather opinion from practitioners about whether the research output of business schools helps them in their jobs or not; and the same survey could also gather academic opinion on this issue as well. While this would be a worthwhile project and surveys of this nature may indeed have been done, though our research to date has turned up more interpretive
rather than rigorously positivistic studies on this score, surveys do suffer from various issues. Limitations of surveys include sample bias, non-response bias, common methods bias, high administration costs particularly for large-scale surveys, and the snapshot-in-time nature of surveys. In other words, the survey must be repeatedly administered over time to update changes in the state of affairs over time. The academic research relevance issue happens to be a large footprint problem that crosses different disciplines, industries, and businesses. So to do justice to this issue, a large-scale survey would be called for and also this survey would need to be repeatedly administered to track how the situation is changing over time, both of which significantly add to the costs of this approach. Consequently, we develop a novel empirical but low-cost method for studying this issue of academic research relevance that eschews the survey-based approach. In our testable notion of relevance, publications in the academic and practitioner literatures play a key role. It is through publications in the academic and practitioner journals that we get a sense of where the discourse is at in the academic and practitioner communities. It is through tracking these publications, we can determine whether or not ideas that are broached and debated in the practitioner community are picked up and researched in the academic community, and also if ideas developed by academia are being absorbed and implemented by practitioners. Ideas flowing between these communities could include those on new business concepts, methods, techniques, practices, systems, and processes. Monitoring the articles in these journals therefore provides important clues as to whether there is cross-pollination of ideas between the academic and practitioner communities, or whether these two are merely “ships passing in the night.” The existence of a healthy bi-directional flow of ideas would be indicative of the relevance of the academic community to businesses while the absence of such would support the perception of a relevance gap.
This method of assessing relevance begins with counting the number of articles published in a time period on some topic, such as Real Options (RO), in the academic literature and then also in the practitioner literature. These two numbers thus represent the academic and practitioner interests in that topic for a given time period, such as a calendar quarter. A time-series analysis of this two-element interest vector is then done to test for Granger-causality in the direction from practitioner to academic interest and vice versa. Significant Granger-causality tests would indicate there is indeed a coupling of the academic research agenda with that of businesses. The technique of cointegration is also used to examine the relationship between academic and practitioner interests on a given topic.

2.3 **Granger-Causality**

As this study centers on the notion of Granger-causality, it is useful to take a closer look at Granger-causality and to understand both what the notion implies and what it does not imply. Granger (1969) in developing the technique that bears his name stipulated that a cause cannot come before an effect. He thus reasoned that if a variable \( x \) causes a variable \( y \) then information on all past values and the present value of \( x \) should improve our ability to predict values of \( y \).

This idea may be formalized as follows (Lutkepohl, 1993): Let \( \Omega_t \) represent the information set containing all relevant information in the universe up to and including \( t \) and let \( y_t(h|\Omega_t) \) be the optimal, or minimum mean square error, \( h \)-step predictor of the stochastic process \( y_t \) at origin \( t \) based on \( \Omega_t \). The corresponding forecast mean square error (MSE) is denoted as:

\[
MSE = \sigma_y^2(h|\Omega_t) = E(y_{t+h} - y_t(h|\Omega_t))(y_{t+h} - y_t(h|\Omega_t))'
\]  

(2-1)

Then the process \( x_t \) is said to cause \( y_t \) in the Granger sense if
\[ \sigma_y^2(h \mid \Omega_t) < \sigma_y^2(h \mid \Omega_t \setminus \{x_s \mid s \leq t\}) \quad \text{for at least one } h = 1, 2, \ldots \quad (2-2) \]

where \( \Omega \setminus \{x_s \mid s \leq t\} \) represents the information set \( \Omega_t \) but without the information on the past and present values of \( x_t \). In other words, if we can obtain better predictions of \( y_t \) when we add information about \( x_t \) to the overall information set \( \Omega_t \) then \( x_t \) is said to Granger-cause \( y_t \). Note that the notion of Granger-causality is a step towards true causality because built into this definition is the fact that a cause precedes an effect. However, this definition of course does not exclude the possibility of the presence of a third force \( z_t \) which has a differential lag on \( x_t \) and \( y_t \). Hence, a significant test for the presence of Granger-causality should strictly be interpreted as supportive of a causal relationship between \( x_t \) and \( y_t \) rather than a definitive proof that such a causal relationship in fact exists. However, if there isn’t a good theoretical basis for the presence of a third factor \( z_t \) which differentially lags \( x_t \) and \( y_t \), then the presence of Granger-causality assumes somewhat greater significance regarding whether \( x_t \) and \( y_t \) may in fact be causally related. Of course, it is not possible to prove that such a third factor cannot exist as that is akin to proving a negative; or in other words a Turing machine searching for such a third factor is not guaranteed to stop. Another way of looking at Granger-causality is that it is a necessary but not a sufficient condition for true causality.

In this paper, whenever a test of Granger-causality is found to be significant, no claim of true causality is made. The result is to be interpreted as being supportive of true causality or at any rate that a necessary condition for causality has been met. It should be noted though that, in the context of this study, there doesn’t appear to be any \textit{a priori} basis for assuming that there is a third factor that is both causing academic and practitioner interests and providentially also
differently lagging them. This lends some credence to treating Granger-causality as true causality in this study. Nevertheless the limitations of Granger-causality and that only Granger-causality is being tested must be borne in mind while interpreting the results of this study. So any statement of causality in the remainder of this essay should be interpreted in light of the caveats stated in this section including the possibility of a third factor that is differentially lagging the variables of interest. However, rather than repeat all of these caveats with each significant test of Granger-causality, the terms “causality” or “causal” will be used henceforth in the essay without embellishment simply as a matter of stylistic convenience while bearing in mind the strictures on interpretation as discussed in this section.

2.3.1 Applications of Granger-Causality

The technique of testing for Granger-causality has been applied in diverse financial, economic, socio-economic, sociological, and socio-political studies. Bar-Yossef et al. (1987) used Granger-causality to study the relationship between a firm’s investments and its earnings. Sims (1972) Thornten and Batten (1985), Hsiao (1981), and McMillin and Fackler (1984) have all applied Granger-causality in macroeconomic studies of the relationship between the rate of growth in the money supply and rate of growth in national income. Granger-causality has also been used to study whether economic growth stimulates defense spending and vice versa. Chen (1993) and Wolde-Rufael (2001) have focused on whether there is Granger-causality between economic growth and defense spending in mainland China. Chang et al. (2001) further develop this theme to study if there is an arms race occurring between mainland China and Taiwan, again by using Granger-causality to study the comparative relationship between defense spending and economic growth in the case of these two countries. In a recent study, Croes and Vanegas Sr. (2008) used Granger-causality to study if growth of the tourism industry helps alleviate poverty in Nicaragua.
In the political science area, Hurtwitz et al. (2004) use Granger-causality to study the link between public opinion and decision-making by the US Supreme Court, in particular to assess if justices are swayed by popular preferences. This brief review shows that Granger-causality is a technique that has been used in diverse economic, sociological, and political studies. Building upon this long tradition, we apply Granger-causality to study another societal problem – the relevance or the lack thereof of academic research to the business world.

2.3.2 Testing for Granger-Causality

Granger-causality between two stationary processes \( x_t \) and \( y_t \) can be tested by representing these variables as a vector auto regressive (VAR) process of order \( p \):

\[
\begin{bmatrix}
  x_t \\
  y_t
\end{bmatrix} = \begin{bmatrix}
  A_{11}(L) & A_{12}(L) \\
  A_{21}(L) & A_{22}(L)
\end{bmatrix} \begin{bmatrix}
  x_t \\
  y_t
\end{bmatrix} + \begin{bmatrix}
  u_t \\
  v_t
\end{bmatrix}
\]

where \( u_t \) and \( v_t \) are conventional zero-mean constant-variance error terms and \( A_{ij}(L) \) is a lag polynomial where:

\[
A_{ij}(L) = \sum_{k=1}^{p} A_{ij,k} L^k \quad \text{and} \quad L^k x_t = x_{t-k}
\]

From the representation (2-3), it is seen that \( x_t \) will not Granger-cause \( y_t \) if and only if \( A_{21}(L) = 0 \). Similarly, \( y_t \) will not Granger-cause \( x_t \) if and only if \( A_{12}(L) = 0 \). In general, three cases are considered: 1) where there is no Granger-causality in either direction, 2) there is Granger-causality in one direction but not the other, and 3) there is Granger-causality in both directions. The third scenario is referred to as feedback where the two variables mutually influence each other and \( A_{12}(L) \) and \( A_{21}(L) \) are both non-zero. The feedback scenario can also be characterized in terms of improving the forecast errors where both of the following conditions hold simultaneously:
\[ \sigma_y^2(h \mid \Omega_t) < \sigma_y^2(h \mid \Omega_t \setminus \{x_s \mid s \leq t\}) \] and
\[ \sigma_x^2(h \mid \Omega_t) < \sigma_x^2(h \mid \Omega_t \setminus \{y_s \mid s \leq t\}) \]
for at least one \( h = 1, 2, \ldots \).

This study explores if there is Granger-causality between academic interest \( ai_t \) and practitioner interest \( pi_t \) in some new idea, the direction of the causation and also whether there are any feedback effects, that is, whether both directions of causation are present simultaneously.

### 2.4 VAR Model of Academic and Practitioner Interest Processes

We model the time-varying academic and practitioner interests in a given idea as a vector autoregressive (VAR) process:

\[ Y_t = A_1 Y_{t-1} + A_2 Y_{t-2} + \ldots + A_p Y_{t-p} + \epsilon_t \]

where

\[ Y_t = \begin{bmatrix} ai_t \\ pi_t \end{bmatrix}, \quad \epsilon_t \sim iid(0, \sigma^2) \]

\( ai_t \) or academic interest in period \( t \) = number of articles published in academic literature in period \( t \) (a calendar quarter) on some idea of interest.

\( pi_t \) or practitioner interest in period \( t \) = number of articles published in practitioner literature in period \( t \) on the same idea.

The \( A \)'s are \( 2 \times 2 \) parameter matrices. Since the Granger-causality tests are applied on stationary processes, \( Y_t \), which could contain non-stationary components, is transformed into a stationary form \( Y_t^s \) where

\[ Y_t^s = \begin{bmatrix} \Delta^n ai_t \\ \Delta^n pi_t \end{bmatrix} \]
and $\Delta$ is the differencing operator $(1 - L)$. Denoting any stochastic process $x_t$ with an order of integration of $d$ as $x_t \sim I(d)$, the components of $Y_t$ are

$$\Delta^d x_t \sim I(0)$$

$$\Delta^d p_t \sim I(0)$$

Hypotheses of the following form are then tested:

H1: $\Delta^d a_t$, Granger-causes $\Delta^d p_t$,

H2: $\Delta^d p_t$, Granger-causes $\Delta^d a_t$,

A significant test of hypotheses H1 or H2 indicates some form of coupling of the discourse between the academic and practitioner communities, which is what this study is assessing in the specific cases of EVA and RO; and more importantly this research is also presenting this type of testing as a general approach for gauging the coupling between the academic and practitioner communities on any given topic of interest.

An issue with the Granger-causality tests is that they are quite sensitive to the selection of the lag length in the VAR model (Thornton and Batten, 1985). Hsiao (1979a, 1979b, 1981) presents a procedure to find the optimal lag length to use in the Granger-causality tests that is based on Akaike’s Final Prediction Error (FPE) criterion (Akaike, 1969). Thornton and Batten (1985) investigate different approaches to lag length selection including selecting the lag length arbitrarily, that is, based on the context of the problem rather than have it be computed by the data as is done in the FPE approach. In their study of Granger-causality between money and income, they present the significance levels of the Granger-causality tests as the lag length is varied arbitrarily. We follow the approach of arbitrary lag length selection and vary the VAR lag
length in our tests over a certain range, such as from 2 to 8, which corresponds to 6 months to 2 years if the unit is a calendar quarter.

2.5 Cointegration

Granger-causality tests performed on components of a VAR process assume that those components are stationary stochastic processes. Cointegration is a technique that focuses on the relationships between components of a stochastic vector \( Y_t \) that exist even when the individual components of \( Y_t \) are themselves non-stationary. The idea of cointegration essentially is that unstable processes that wander widely individually may nevertheless have a stable long-run relationship between themselves. This idea is formalized as follows (Dhrymes, 1998): An \( n \)-component multivariate process \( Y_t \) is said to be cointegrated of order \( d, b, b \leq d \) and denoted as \( Y_t \sim CI(d, b) \) if each component of \( Y_t \) is integrated of the order \( d \), or \( y_{i,t} \sim I(d) \), and there is a cointegrating vector \( \beta \) such that:

\[
\beta \prime Y_t \sim I(d-b)
\] (2-8)

In other words, the cointegrating vector \( \beta \) degrades the “randomness” in \( Y_t \) from an \( I(d) \) process to a process with the lower order of integration of \( (d - b) \). Furthermore, there need not be a unique cointegrating vector. If there are \( r \leq n \) linearly independent cointegrating vectors \( \beta_i \) such that for \( B = (\beta_1 \beta_2 \ldots \beta_r) \) and

\[
B \prime Y_t \sim I(d-b)
\] (2-9)

then \( Y_t \sim CI(d, b, r) \) or the multivariate process \( Y_t \) is said to be cointegrated of order \( d, b \) with rank \( r \). A particularly interesting form of cointegration occurs when \( Y_t \sim CI(d, d, r) \) or when cointegrating vectors exist that degrade the randomness in \( Y_t \) to stationarity or \( B \prime Y_t \sim I(0) \).
CI(d, d, r) processes are characterized by having a covariance matrix which can be decomposed as follows:

\[
\text{Cov}(Y_t) = \psi_0 + \psi_t
\]

\[
B'\psi_t = 0
\]

where \(\psi_0\) is independent of time and \(B\) is a matrix of rank \(r\). The characterization of cointegration in terms of the decomposition of the covariance matrix of \(Y_t\) allows us to operationalize the more general definition of the concept of cointegration given by equation 2-9. As we shall demonstrate later in this essay, the cointegration approach is not particularly useful in this study given the particular characteristics of the stochastic vector \(Y_t\) under examination. However, cointegration is very clearly an important technique in stochastic analysis and is thus treated in this study for methodological completeness.

2.6 Testing the Research Relevance Model on Two Recent Topics

This model of the relevance of academic research to businesses is tested on recent topics: Real Options (RO) and Economic Value Added (EVA). These two topics are relatively new in that they have been the subject of discourse only in the last fifteen years or so, but also as opposed to other new ideas they appear to have some gravitas and are not mere passing fads. Both have the potential of having a high impact, with EVA possibly being further along in terms of being embraced by businesses.

2.6.1 RO

Real options is a powerful new method for appraising capital investments under conditions of uncertainty and the options that management has to address this uncertainty (Dixit and Pindyck,
RO is based on the theory of options pricing, which essentially began with the seminal Black-Scholes continuous-time model for pricing financial call options (Black and Scholes, 1973). Since the Black-Scholes model, several discrete-time options pricing models have also been built over the years such as the binomial model of Cox, Ross, and Rubinstein (1979) and its trinomial (Boyle, 1988) and multinomial variants (Kamrad and Ritchken, 1991). There is some evidence of interest in RO among practitioners. Graham and Harvey (2001) claim in a survey of 392 CFOs that approximately 27% of these CFOs are adopting real options analysis in capital budgeting. RO methods have been applied in different business functions such as R&D (Santiago and Vakili, 2005), mergers and acquisitions (Kogut, 1991), and manufacturing (Kogut and Kulatilaka, 1994). Erdogmus (2000) applies real options analysis to software development projects such as developing a Java application server and bringing older software products in compliance with XML standards. RO analysis has also been utilized in major infrastructure projects such as the Minami Alps forest road construction project in Japan (Kitabatake, 2002). In a novel application of the real options approach, Alleman and Rappoport (2002) use it to model the cost of regulatory constraints in the telecommunications industry. RO has been used not just in correctly valuing projects in the face of risk, but also in pro-actively controlling risk in information technology (IT) projects (Benaroch, 2002).

It is interesting to note that a lot of the articles on the applications of RO have actually been published by academics in scholarly journals. While clearly academics do play a key role in bringing the output of their scholarly research to practitioners through consulting relationships with industry, the preponderance of academic journals in what has been published on the applications of RO does raise questions as to how much of the RO approach has actually been embraced by practitioners. This is why our methodology of tracking relevance places equal
importance on practitioner literature as well, since it is these trade publications that serve as the primary outlet for discourse within the practitioner community.

2.6.2 EVA

The term Economic Value Added (EVA) was coined by the consulting firm Stern-Stewart and Co. and they have been quite successful in gathering substantial support for EVA among businesses in a variety of industries. EVA embodies the notion of “economic profits” which accounts for the cost of all capital, including equity capital. EVA is thus defined as the amount by which net operating profit after taxes exceeds the cost of all capital, including both its debt and equity components (Grant, 2003). The chemical industry is a good example of where EVA adoption is spreading widely (Henry, 1995a). Companies in the chemical industry have not only introduced EVA into their corporate financial systems, but some such as Millenium Chemicals have also structured their acquisition and divestment strategies based on EVA principles (Chemical Market Reporter, 1997; Tullo 1998). In a survey by A. T. Kearney of 60 CFOs, including 19 from the chemical industry, over 90% stated that EVA was an enduring principle and not a passing management fad (Freedman, 1997). Financial services is another industry where EVA is taking hold. A number of banking industry analysts are turning to EVA to measure the performance of banks (Padgett, 1997). Insurance industry analysts have advocated the use of EVA for the management and analysis of insurance companies (McDonald, 1998a). Mortgage banks such as Triad Guaranty have also successfully used EVA (Kreger, 1998). Manufacturing is yet another industry in which companies such as Case, a manufacturer of agricultural and construction equipment, have relied on EVA to assess major capital investments (Violino, 1998).
2.7 Academic and Practitioner Interest Data

Data were collected on the $ai_t$ and $pi_t$ time series for EVA and also for RO. Two VAR processes are analyzed, $Y_{EVA,t}$ consisting of $ai_{EVA,t}$ and $pi_{EVA,t}$, and $Y_{RO,t}$ consisting of $ai_{RO,t}$ and $pi_{RO,t}$. If necessary, the elements of $Y_t$ are appropriately differenced to meet stationarity requirements. The academic and practitioner interests, $ai_t$ and $pi_t$, are simply measured by the number of articles published on the topic of interest in the time period $t$. A major electronic database called EBSCO is utilized to determine the number of articles published on the topic. EBSCO is a recognized leader in providing information services to academia and businesses. The specific EBSCO electronic databases utilized in this study are Business Source Premier and Academic Search Premier. Business Source Premier includes 1,100 peer-reviewed business journals in a variety of disciplines. It also has an extensive list of practitioner journals and periodicals. Academic Search Premier includes 3,600 peer-reviewed journals in a variety of disciplines. EBSCO also helpfully distinguishes the journals it considers as academic from the various trade publications for practitioners. EVA articles from these electronic databases were obtained by setting the search terms to “Economic Value Added” or “EVA” and limiting the period to the quarter of interest. Similarly, RO articles were found by searching for “Real Options Analysis.” Quotation marks are not used to enclose the search terms, which means that a very large result set is returned where articles containing any subset of the search term such as “Real Options” or “Options Analysis” or simply “Options” in the fields examined by the search engine would be in the result set. The goal is to obtain as large a result set of articles as possible, which is then sifted and pruned to remove those articles unrelated to the topic being studied. The time frame for this study is 1992 to 2005, which means 56 quarters of publication data were collected. The $ai_t$ and


\[ \pi_t \] time-series data for EVA and RO are given in Appendix A.2 and are also shown in Figures 2-1 and 2-2, respectively.

\begin{figure}
\centering
\includegraphics[width=\textwidth]{figure2-1.png}
\caption{Academic and Practitioner Interest Time Series for EVA}
\end{figure}

2.8 Results

We first checked for the presence of unit roots in the \( a_i \) and \( \pi_t \) time series for EVA and RO using the Augmented Dickey-Fuller (ADF) test (Dickey and Fuller, 1981). Checking for unit roots is done to determine if the academic and practitioner interest processes are already stationary or if they need to be differenced to reduce them to stationary processes on which the
Granger-causality tests are then performed. Table 2-1 shows the results of the ADF tests. The Schwartz Criterion (Schwartz, 1978) is used to compute the optimal number of lags in the autoregressive process models in the ADF tests. Using a 0.05 level of significance for all the ADF unit root tests, the hypothesis that the practitioner interest process has a unit root is easily rejected in either the case of EVA or RO. However, as the unit root hypothesis cannot be rejected at the 0.05 level for the EVA and RO academic interests, both the EVA and RO academic interests...
interests are assumed to be non-stationary processes. First-differencing of the academic interest processes is then explored to see if this makes the processes stationary. Table 2-2 shows the results of the ADF test conducted in first differences on the academic interest processes. As the results show, the academic interests in the two methodologies are easily reduced to stationary processes after first differencing.

<table>
<thead>
<tr>
<th>Null Hypothesis</th>
<th>EVA</th>
<th>RO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic interest has a unit root</td>
<td>( t_{\text{statistic}} = -2.525645 )</td>
<td>( t_{\text{statistic}} = -1.318945 )</td>
</tr>
<tr>
<td></td>
<td>( t_{05} = -2.917650 )</td>
<td>( t_{05} = -2.916566 )</td>
</tr>
<tr>
<td></td>
<td>( p)-value = 0.1153</td>
<td>( p)-value = 0.6145</td>
</tr>
<tr>
<td>Practitioner interest has a unit root</td>
<td>( t_{\text{statistic}} = -4.282622 )</td>
<td>( t_{\text{statistic}} = -6.879976 )</td>
</tr>
<tr>
<td></td>
<td>( t_{05} = -2.915522 )</td>
<td>( t_{05} = -2.915522 )</td>
</tr>
<tr>
<td></td>
<td>( p)-value = 0.0012**</td>
<td>( p)-value = 0.0000**</td>
</tr>
</tbody>
</table>

** significant at 0.05

Table 2-1: ADF unit root tests in levels

<table>
<thead>
<tr>
<th>Null Hypothesis</th>
<th>EVA</th>
<th>RO</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \Delta ) (Academic interest) has a unit root</td>
<td>( t_{\text{statistic}} = -11.08723 )</td>
<td>( t_{\text{statistic}} = -10.71760 )</td>
</tr>
<tr>
<td></td>
<td>( t_{05} = -2.917650 )</td>
<td>( t_{05} = -2.916566 )</td>
</tr>
<tr>
<td></td>
<td>( p)-value = 0.0000**</td>
<td>( p)-value = 0.0000**</td>
</tr>
</tbody>
</table>

** significant at 0.05

Table 2-2: ADF unit root tests in first differences

The \( Y_{t}^{\times} \) in each of the two VAR models is then:

\[
\begin{align*}
Y_{EVA,t}^{\times} &= \begin{bmatrix}
\Delta a_{EVA,t}^{i} \\
p_{EVA,t}^{i}
\end{bmatrix}
\quad \text{and} \quad
Y_{RO,t}^{\times} &= \begin{bmatrix}
\Delta a_{RO,t}^{i} \\
p_{RO,t}^{i}
\end{bmatrix}
\end{align*}
\]  

(2-11)
The causality hypotheses tested are the following:

Hypothesis 1: *There is Granger-causality in the direction from EVA practitioner interest levels to EVA academic interest level changes.*

Hypothesis 2: *There is Granger-causality in the direction from EVA academic interest level changes to EVA practitioner interest levels.*

Hypothesis 3: *There is Granger-causality in the direction from RO practitioner interest levels to RO academic interest level changes.*

Hypothesis 4: *There is Granger-causality in the direction from RO academic interest level changes to RO practitioner interest levels.*

These hypotheses were tested following the approach of Thornton and Batten (1985) where the significance of the test is explored as a function of the lag length of the VAR model. We varied the lag length in the tests from 2 to 8, that is, from 6 months to 2 years. The Granger-causality test results for EVA and RO are shown in Tables 2-3 and 2-4, respectively. Table 2-3 shows that Hypothesis 2 is not supported. However, for a VAR model specification where the lag length is 7, Hypothesis 1 can be established at a 0.05 level of significance to conclude there is some evidence of Granger-causality in the direction from EVA practitioner interest to EVA academic interest level changes, or that practitioner interest in EVA does influence academic interest in EVA. Table 2-4 shows that Hypothesis 4 is not supported. However, for a VAR model specification where the lag length is 8, Hypothesis 3 can be established at a 0.05 significance level. Hence, we find some support for the notion that academic interest in real options as measured by publication activity is influenced by practitioner interest in real options. Again, all tests are Granger-causality tests and the strictures on the interpretation of such tests as discussed in Section 2.3 apply.
<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>VAR Lag Length</th>
<th>F Statistic</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypothesis 1: EVA practitioner interest Granger-causes $\Delta$(EVA academic interest)</td>
<td>2</td>
<td>2.08319</td>
<td>0.13565</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>1.06968</td>
<td>0.37147</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>1.90356</td>
<td>0.12768</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>2.32490</td>
<td>0.06104</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>1.94020</td>
<td>0.10072</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>2.38708</td>
<td>0.04316**</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>1.97352</td>
<td>0.08504</td>
</tr>
<tr>
<td>Hypothesis 2: $\Delta$(EVA academic interest) Granger-causes EVA practitioner interest</td>
<td>2</td>
<td>1.56198</td>
<td>0.22019</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>1.46789</td>
<td>0.23598</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>0.90970</td>
<td>0.46713</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>0.69573</td>
<td>0.62982</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>0.85180</td>
<td>0.53908</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>1.05581</td>
<td>0.41292</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>1.01948</td>
<td>0.44298</td>
</tr>
</tbody>
</table>

**Significant at 0.05

Table 2-3: EVA Granger-causality Significance as a Function of VAR Lag Length

2.8.1. Cointegration and the Academic-Practitioner Interest Relationship

We also approach the question of how $ai_t$ and $pi_t$ are related from a cointegration perspective. The basic ideas behind cointegration are discussed in Section 2.5. The traditional definition of cointegration assumes that the components of the multivariate process under study are integrated of the same order. Many of the early studies on cointegration have indeed focused on applications where the components of the multi-variate process were integrated of the same order.
The results of the unit root tests as discussed in the previous section show that neither $Y_{EVA,t}$ nor $Y_{RO,t}$ can be of the form $CI(d,b)$ because the components $ai_t$ and $pi_t$ in either $Y_{EVA,t}$ or $Y_{RO,t}$ are not integrated of the same order. Consequently, approaching this particular study from a cointegration perspective requires a broader notion of cointegration.

Various broader definitions of cointegration have been advanced (Lütkepohl, 1991; Flôres and Szafarz 1996) that allow for the components of $Y_t$ to be integrated of different orders.

**Table 2-4: RO Granger-causality Significance as a Function of VAR Lag Length**

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>VAR Lag Length</th>
<th>F Statistic</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypothesis 3: RO practitioner interest Granger-causes $\Delta$(RO academic interest)</td>
<td>2</td>
<td>0.39558</td>
<td>0.67546</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>0.86793</td>
<td>0.46473</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>1.01511</td>
<td>0.41056</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>1.91679</td>
<td>0.11360</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>1.26961</td>
<td>0.29564</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>1.62354</td>
<td>0.16337</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>2.36245</td>
<td>0.04201**</td>
</tr>
<tr>
<td>Hypothesis 4: $\Delta$(RO academic interest) Granger-causes RO practitioner interest</td>
<td>2</td>
<td>0.20134</td>
<td>0.81832</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>1.63622</td>
<td>0.19432</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>1.14867</td>
<td>0.34708</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>1.13352</td>
<td>0.35903</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>0.90370</td>
<td>0.50309</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>0.78903</td>
<td>0.60153</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>0.63929</td>
<td>0.73856</td>
</tr>
</tbody>
</table>

**Significant at 0.05
In the enlarged notion of cointegration, where the multivariate process under study can have different orders of integration, we denote such a multivariate process $Y_t$ with a total of $n$ components as

$$Y_t \sim I((n_1, d_1), (n_2, d_2), \ldots, (n_k, d_k)) \text{ where } n = n_1 + n_2 + \ldots + n_k \text{ and } d_1 > d_2 > \ldots > d_k$$  \hspace{1cm} (2-12)$$

In other words, $n_1$ components of $Y_t$ are $I(d_1)$, $n_2$ components are $I(d_2)$, ..., and $n_k$ components are $I(d_k)$; and $d_k$ could be 0 or that some components of $Y_t$ could in fact be stationary. A non-trivial cointegrating vector $\beta$ then reduces the highest order of integration $d_1$ in $Y_t$ or

$$\beta' Y_t \sim I(d^*) \text{ where } d^* < d_1$$  \hspace{1cm} (2-13)$$

As illustrated in Flôres and Szafarz (1996), this reduction in the order of integration of $Y_t$ by a non-trivial cointegrating vector $\beta$ implies that there are at least two components in $Y_t$ that are $I(d_1)$ and that the components of $\beta$ corresponding to these two components of $Y_t$ are non-zero scalars. In this study, however, $Y_{EVA,t}$ and $Y_{RO,t}$ are of the form

$$Y_{EVA,t} \sim I((1,1), (1,0)) \text{ since } a_{EVA,t} \sim I(1) \text{ and } p_{EVA,t} \sim I(0)$$  \hspace{1cm} (2-14)$$

$$Y_{RO,t} \sim I((1,1), (1,0)) \text{ since } a_{RO,t} \sim I(1) \text{ and } p_{RO,t} \sim I(0)$$  \hspace{1cm} (2-15)$$

In the $Y_{EVA,t}$ and the $Y_{RO,t}$ multivariate processes, the highest order of integration is 1 and there is only one component with that order of integration. In other words, cointegration analysis is not a useful approach to reveal the relationship between the $a_i$ and $p_i$ components since there can be
no non-trivial cointegrating vector that exists for either $Y_{EVA,t}$ or $Y_{RO,t}$. Consequently, Granger-causality analysis is the substantive approach for this study.

2.9 Limitations

An apparent limitation is whether the article search procedure which is keyed by terms such as “Economic Value Added”, “EVA”, or “Real Options Analysis” finds all the articles in the databases about these methodologies. In this study, we have taken the approach of including those articles that are primarily rather than peripherally about these topics. It should be noted that the search engine of the electronic databases used looks at many fields including the title, abstract and subject keywords to find articles. It is therefore quite safe to assume that an article that is mainly about the topic in question would have the search terms, or some subset thereof, in the default fields looked at by the search engine rather than have these terms be buried somewhere deep in the text. The issue that not all journals are in EBSCO is considerably mitigated by the very large number of journals and periodicals in both the academic and the practitioner literature that EBSCO does track. The limitation that what has been tested is Granger-causality which differs from true causality and therefore the results are to be interpreted with some caution has already been discussed in Section 2.3.

2.10 Conclusion

Keeping in view the caveats on the interpretation of Granger-causality as discussed in Section 2.3, the Granger-causality test results for the two topics studied are supportive of the notion that practitioner interest in a topic or idea does influence academic interest in that idea, but that this link does not work too well in the reverse direction. The practitioner community does not appear to be sufficiently interested in ideas that are the focus of much interest in the academic community. We did not pick up any Granger-causality in the direction from academic interest to
practitioner interest. This could have been due to the fact that, given the novelty of ideas such as RO to the business world, interest in RO among practitioners is still at a nascent stage. This also underscores the necessity for academia to do more to raise the practitioner community’s consciousness about RO. While the Granger-causality results obtained with respect to the two specific topics of EVA and RO are interesting, the main contribution of this paper, however, is not so much in discovering the direction of Granger-causation in any specific topic but in providing a general approach that academics can use to assess their impact on the business world. This is a timely study as it comes on the heels of a report issued by the Impact of Research Task Force commissioned by AACSB International (AACSB International, 2008; Shinn, 2008). The key conclusions of that report include:

- Business schools must find ways to increase the value of their research to students, practitioners, and society at large
- Business schools should be required to demonstrate the impact of their intellectual contributions
- A business school cannot separate itself from practice and focus only on theory and still serve its function

Many proposals have indeed been made in the past to strengthen linkages between academia and businesses such as new institutional arrangements linking industry, universities and government (Gibbons et al., 1994), reforming business school education (Davis and Botkin, 1996; Brookfield, 1987), and changes in academic mind-sets (Starkey and Madan, 2001). What is new in this article is that it formalizes a notion that is also empirically testable of how academics can demonstrate that their ideas are indeed making an impact on businesses by virtue of whether their new ideas Granger-cause discussion among the practitioner community about these ideas.
The relevance debate no longer needs to be entirely informed by anecdotal information or by feelings and beliefs either expressed by eminent stakeholders in various forums or more broadly gathered through a formal survey. Finally, our empirical method of testing relevance can be used over time to detect the efficacy of various actions taken to bridge the relevance gap. Increased significance of the Granger-causality tests, significance observed in both directions, and smaller lags between the time interest in an idea in one community generates interest in the other would all be manifestations of increased coupling between academics and practitioners, and hence of a narrowing of the relevance gap.
3. An Adoption Decision Model for Emerging Capital Budgeting Methodologies

3.1 Introduction

Two methodologies for capital budgeting that have garnered increasing attention from both academics and practitioners over the last ten years are real options (RO) analysis and Economic Value Added (EVA). EVA embodies the notion of “economic profits” which accounts for the cost of all capital, including equity capital. EVA is thus defined as the amount by which net operating profit after taxes exceeds the cost of all capital, including both its debt and equity components (Grant, 2003). RO draws upon options pricing models developed in finance to the valuation of opportunities for investment in real assets (Dixit and Pindyck, 1995). EVA is championed by the consulting firm Stern-Stewart & Co. and is gathering substantial support among businesses in a variety of industries. Given the growing importance of these two new approaches to the valuation of capital investments, it is important to undertake a formal investigation of the question of which of these two methodologies is more likely to be adopted by industry. We approach this question by building a Methodology Adoption Decision Model (MADM) which asserts that the likelihood of adoption of a new methodology for capital budgeting is determined by the theoretical soundness and the practical applicability of the methodology. The formulation of the MADM draws upon the literature on cognitive models for the acceptance of something new, such as the Technology Acceptance Model (TAM) for the acceptance of new technology (Davis, 1989), and it is structured in a manner analogous to the TAM. The theoretical soundness and practical applicability constructs are measured by proxy variables. The proxy for the theoretical soundness construct is the sentiment of the academic community towards the methodology, either favorable or unfavorable, as expressed in published
articles in the academic literature on the methodology. Similarly, the proxy for practical applicability is the sentiment of the practitioner community expressed in practitioner literature towards the methodology. In this study, the sentiment towards these two methodologies is gauged by doing a content analysis of a random sample of articles that have appeared on EVA and RO in the academic and the practitioner literature from 1992 to 2005, and then rating these articles for their sentiment by a panel of expert judges. Various hypotheses on this sentiment data are tested to determine which methodology is viewed more positively by the academic and practitioner communities.

3.2 Background

The motivation to delve deeper into the methodologies and models for the valuation of technology stems in large part, at least in the field of information technology, from the IT Productivity Paradox. The notion of a productivity paradox in IT was first broached in the mid-1980s (Strassmann, 1985; Roach 1987). The paradox was that while companies were investing heavily in IT there was little evidence that the benefits of IT were actually showing up in the company’s bottom line or in aggregate studies of the national economy. The years following the initial recognition of this paradox saw many firm-level studies supporting its existence. There were estimates that as much as 20% of all IT spending is wasted and 40% does not contribute to business performance (Willcocks and Lester, 1993). Another disturbing report (Hochstrasser and Griffiths, 1990) showed that 70% of all IT investment provides no ROI. The pendulum began to swing in the other direction from the late nineties when there were many compelling publications on the other side of this vigorous debate showing that the value of IT is significant (Jorgenson, 2001; Brynjolsson and Hitt, 1998; Jorgenson and Stiroh, 2000; Oliner and Sichel, 2000), and that the paradox issue should essentially be considered as closed. Brynjolsson and others asserted that
since their studies used larger data sets, and were more recent than those that had first pointed to the paradox, a clear link between IT and significantly increased firm productivity had finally been established.

The question of the value of IT continues to focus the attention of researchers. More recently, some have recast the question of the value of IT in different terms to assert that IT has no more value than any other type of utility (Carr, 2003). Carr’s (2003) contribution introduced a new dimension in the evolving debate, and it is only proper that the terms of the debate should expand. Still, there was always some lingering doubt as to whether the original IT productivity paradox had indeed been entirely resolved. Even among studies that purport to show the clear payoff of IT, many fundamental questions continue to be raised, for example, the lack of a clear correlation between IT investment and its impact on process-oriented variables (Kohli and Devaraj 2003). Process or intermediate variables that are often looked at in IT impact studies in lieu of firm-level output variables, such as revenue and profitability, include items such as customer satisfaction, lead times, defect rates, inventory levels, and service quality.

The question of the value of IT is closely intertwined with the debate on how this value is best measured. In fact, one of the basic arguments of the proponents of IT is that those who have argued against IT’s value have not used the right instruments to measure its value (Robey and Boudreau, 1999; Brynjolfsson 1993). The issue of deciding on the value of IT can be approached from two broad perspectives – one of which is rooted in financial analytics and the other in the theory of organizational decision-making. The latter approach views IT investment decisions as having many intangible organizational and strategic consequences with far-reaching impact on human and organizational behavior. Making good IT investment decisions is then essentially viewed as part and parcel of how organizations arrive at high-quality decisions. There is a large
body of literature in this field covering the various areas of decision quality (Vroom and Jago, 1998; Butler et al., 1993), behavioral aspects (Janis and Mann, 1977), bounded rationality (Simon 1969, 1977), and organizational learning (Gregory and Jackson, 1992; Senge 1990). Renkema (2000) developed an insightful P4 decision-making model where a decision is characterized along the dimensions of product, process, participation, and politics. This dissertation, while acknowledging the importance of the strategic and other intangible organizational benefits of technology, is firmly rooted in the school of thought that approaches technology investments on the basis of sound financial and economic value.

Sound IT decision-making is best approached from multiple perspectives which include both the sociological and behavioral as well as the more quantitatively-oriented financial approach. The quantitative approach also recognizes the strategic nature of IT and its broader organizational impact. However, the financial analytic school of thought remains relentless in its quest for newer and more powerful measures of the true value of IT. This debate on the value of IT has not gone unnoticed by economists who have brought the sophisticated analytic tools of their profession to increasingly bear on the many open questions about value in the IT field. Bakos and Kemerer (1992) provide an excellent review of the many areas where economic theory is being applied to IT research from the economic models of organizational performance to the macroeconomic impact of IT. Alpar and Kim (1990) take an interesting microeconomic approach to the measurement of IT value, basing their models on well-established theories of production and cost functions. One of the more promising measures emerging from the domain of financial economics is Economic Value Added or EVA (Grant, 2003; Chen and Dodd, 2001; Garvey and Milbourn, 2000). EVA embodies the notion of “economic profits” which accounts for the cost of all capital, including equity capital. EVA is thus defined as the amount by which
net operating profit after taxes exceeds the cost of all capital, including both its debt and equity components (Grant, 2003). The explicit inclusion of the cost of equity capital in the calculation of the returns from a project reinforces the notion that equity capital is not free and the shareholders can deploy it to alternative uses. Thus EVA achieves a greater congruence between the objectives of managers and those of the shareholders who are focused on maximizing their wealth.

EVA is gathering a good deal of support in the industry. The chemical industry is a good example of where EVA adoption is spreading widely (Henry, 1995a). Companies in the chemical industry have not only introduced EVA into their corporate financial systems, but some such as Millenium Chemicals have also structured their acquisition and divestment strategies based on EVA principles (Chemical Market Reporter, 1997; Tullo 1998). In a survey by A. T. Kearney of 60 CFOs, including 19 from the chemical industry, over 90% stated that EVA was an enduring principle and not a passing management fad (Freedman, 1997). Financial services is another industry where EVA is taking hold. A number of banking industry analysts are turning to EVA to measure the performance of banks (Padgett, 1997). Insurance industry analysts have advocated the use of EVA for the management and analysis of insurance companies (McDonald, 1998a, 1998b). Mortgage banks such as Triad Guaranty have also successfully used EVA (Kreger, 1998). Manufacturing is yet another industry in which companies such as Case, a manufacturer of agricultural and construction equipment, have relied on EVA to assess major capital investments (Violino, 1998).

RO is the other promising new methodology for evaluating capital investments that is creating a stir in the academic and practitioner communities. The real options approach has slowly but steadily been making inroads into the mainstream of corporate finance. A compelling
case has already been made by the proponents of RO that it is the most appropriate framework for analyzing investment programs under uncertainty (Dixit and Pindyck, 1995; Luerhman, 1998; Trigeorgis and Mason, 1987). Evidence that the corporate world is getting this message is in the survey that Graham and Harvey (2001) did of 392 CFOs where they found that approximately 27% of this group is adopting RO in capital budgeting. The versatility of the RO approach can be seen in the breadth of industries, from bio-technology to natural resources, and the range of business functions to which this methodology is being applied (Miller and Park, 2002). Business functions that are benefiting from real options thinking include manufacturing (Kogut and Kulatilaka, 1994), R&D (Santiago and Vakili, 2005), information technology (Bardhan et al., 2004; Erdogmus, 2000; Benaroch, 2002), and mergers and acquisitions (Kogut, 1991). RO has also been used by government entities in major infrastructure projects such as the Minami Alps forest road construction project in Japan (Kitabatake, 2002). In a novel application of RO, Alleman and Rappoport (2002) use it to model the cost of regulatory constraints in the telecommunications industry. RO has been used not just in correctly valuing projects in the face of risk but also in pro-actively controlling risk (Benaroch, 2002).

We note at this stage that a comparison of all possible methods and techniques for appraising capital investments falls outside the scope of this dissertation. As acknowledged in Section 1.1, there have been many methods and techniques proposed over the years for the valuation of capital investments. A comparison of these various techniques is a different research question and has been tackled to some degree by other authors such as Renkema (2000). The focus of this dissertation is on two emerging methods of capital investment appraisal, RO and EVA, which show some promise of holding the attention of the academic and practitioner
communities. However, no claim is made that RO and EVA are the only two emerging methods that have the potential of capturing the imagination of academics and practitioners.

Neither EVA nor RO are without their share of critics. Some have said that EVA proponents, by clamoring for a broad-based change in the corporate culture, may actually end up hurting companies as the infatuation with EVA could reduce the focus on other critical success factors such as customer satisfaction (Dodd and Johns, 1999) or cash flow (Mariotti, 1997). Others have questioned whether EVA is really more highly correlated with stock returns than is the traditional accounting measure of earnings (Garvey and Milbourn, 2000). Some industry watchers have warned that EVA is not a panacea, and that strategy and innovation count for more as determinants of wealth creation (The Economist, 1997). The formidable challenges in implementing EVA in the real world have also been noted, particularly, in the practitioner literature (Freedman, 1995). Stern-Stewart, however, claims that implementation problems can be effectively dealt with and that training and management commitment are critical success factors in ensuring effective implementation of EVA plans (Stewart III, 1995). Others maintain that having an effective corporate governance system is the key to successful EVA implementation (Pettit, 1998). The battle between different consulting groups continues apace with some favoring alternative measures of value such as the Cash Return on Original Capital (CROC) as opposed to EVA (Vames, 1998).

RO has its share of criticism as well. Miller and Park (2002) identify a number of problems with the RO approach including the non-tradability of the underlying real asset, limitations in using a geometric brownian motion process for valuing a real asset, the non-discrete nature of the “exercise price” of a real asset, and the poor quality of information on the timing and amount of project payoffs or “dividends” as compared to the case of financial
options. The complex mathematics behind various options pricing models has led some researchers to simplify the model so that practitioners in the field accustomed to using Net Present Value (NPV) will find RO more accessible to them (Feinstein and Lander 2002). Feinstein and Lander (2002) show that if a properly weighted average of the risk-free rate and the NPV discount rate is used to discount future cash flows, then the RO and NPV models lead to equivalent results.

Given the range of accolades as well as criticism that both RO and EVA have received, the MADM makes a timely contribution by providing a theoretical basis for determining which of these two methodologies has better prospects of being adopted first. We turn next to the formulation of the MADM.

### 3.3 Methodology Adoption Decision Model

We formulate a simple and intuitive model for the likelihood of adoption of a new capital budgeting methodology. This Methodology Adoption Decision Model (MADM) is analogous to the Technology Acceptance Model (TAM) (Davis, 1989; Davis et al., 1989) of how humans embrace a new technology. The TAM is a simple and powerful cognitive model that emphasizes just two fundamental constructs – the perceived ease of use and the perceived usefulness of new technology – as the drivers for the acceptance of the new technology. According to the TAM, perceptions of ease of use and usefulness of a technology shape attitudes, either favorable or unfavorable, towards the technology, which in turn drive its actual use. In a similar fashion, the MADM posits that the adoption of a new methodology is fundamentally determined by whether it is perceived to be theoretically sound and whether it is perceived to be practical (Figure 3.1). Perceptions of theoretical soundness and practical applicability shape attitudes towards the new
methodology, which in turn influence its likelihood of adoption. The MADM can also be formally stated in terms of the following propositions:

Proposition 1: The more theoretically sound a new capital budgeting methodology is perceived to be by the academic community, the more favorable is a business firm’s attitude to it.

Proposition 2: The more practical a new capital budgeting methodology is perceived to be by the practitioner community, the more favorable is a business firm’s attitude to it.

Proposition 3: The more favorable a business firm’s attitude to a new methodology is, the more likely it is to adopt it.

Note in this model that perceived theoretical soundness and perceived practical applicability are community-level constructs. These are perceptions held by the academic and practitioner communities. It is the academic and practitioner communities who pass judgment on the theoretical soundness and practical applicability of a new methodology, respectively. The other two constructs, attitude to the methodology and the propensity or likelihood of adopting it are firm-level constructs. Furthermore, it is assumed that the strong form of the Efficient Market
Hypothesis operates where all information in all forms is available to all actors (Copeland et al., 2005). In other words, there is no notion of private or secretly-held information. Business firms know at all times the sentiments or perceptions of the academic and practitioner communities. The Efficient Market Hypothesis is a standard assumption made in financial theory (Copeland et al., 2005).

These propositions lead to the following theorem.

Theorem 1: Methodology i has greater likelihood of adoption than methodology j if i is superior to j in one of the two dimensions of theoretical soundness and practical applicability and at least as good as j in the other dimension.

Proof: Let $A = f(T, P)$ where $A$ is the firm’s attitude towards a methodology and $T$ and $P$ are the levels of theoretical soundness and practical applicability, respectively, of that methodology. Propositions 1 and 2 imply that $f$ is strictly increasing in each of the variables $T$ and $P$. Therefore, for any two methodologies $i$ and $j$, we have the following cases:

First suppose $T_i > T_j$ and $P_i = P_j$. Then,

$$A_i = f(T_i, P_i) = f(T_i, P_j) > f(T_j, P_j) = A_j$$

(3-1)

since $f$ is strictly increasing in $T$ for each value of $P$. Next suppose $T_i > T_j$ and $P_i > P_j$. It follows similarly that

$$A_i = f(T_i, P_i) > f(T_j, P_i) > f(T_j, P_j) = A_j$$

(3-2)
Similarly, by exchanging the variables T and P, we see that $A_i > A_j$ when $P_i > P_j$ and either $T_i = T_j$ or $T_i > T_j$. Let $L = g(A)$ be the likelihood of adoption for attitude level $A$. From Proposition 3, we know that $g$ is a strictly increasing function of the attitude variable $A$. Therefore, when $A_i > A_j$, then

$$L_i = g(A_i) > g(A_j) = L_j.$$

(3-3)

This concludes the proof.

The model is operationalized by measuring the constructs of theoretical soundness and practical applicability via a proxy variable, the methodology sentiment vector. The time-varying methodology sentiment vector is a $2 \times 1$ vector where the first component is the sentiment of the academic community, either favorable or unfavorable, towards the methodology in a given time period, e.g., a calendar quarter, as expressed by articles published in the academic literature. The second element is the sentiment of the practitioner community towards the methodology in a given quarter, as expressed in practitioner articles.

### 3.4 Why Not Use the TAM?

The TAM is a clear proximal model to the MADM since perceived theoretical soundness may be recast as perceived usefulness and perceived practical applicability as perceived ease of use. Therefore, it is reasonable to ask: Why not use the TAM as the theoretical model to study the adoption of the methodologies that this dissertation focuses on? While recognizing that the TAM is a useful and important model, and the 2007 special issue of the Journal of the Association for Information Systems (JAIS) presents a lively debate on the place of the TAM in IS research (Hirschheim, 2007), there were a number of larger reasons for the decision to not use the TAM
for this research. First of all, this research concerns itself with the adoption of methodology rather than of technology, and it can be argued that methodology is an ontologically different construct from technology. While the TAM has recently been applied to study the adoption of methodology such as software development methodology (Hardgrave et al., 2003), the TAM for most of its history has been mainly applied to the study of technology adoption (Davis et al., 1989; Mathieson, 1991; Szajna, 1996; Venkatesh and Davis, 2000; Venkatesh and Morris 2000; Venkatesh et al., 2003). Furthermore, this dissertation focuses on the adoption of methodologies from the finance and economics disciplines rather than on methodologies of the IS discipline, which is another distinction between where the TAM has generally been used and the focus this research.

Technology adoption by a firm if one thinks of information technology (IT) is generally viewed as the adoption of IT artifacts such as an enterprise resource planning (ERP) system or a business process management (BPM) engine. Such artifacts are clearly different from a methodology such as EVA or RO in several key aspects that matter in adoption. The people in the firm who have intimate knowledge of IT innovations, for example, BPM and Web Services orchestration engines, or who can serve as the champions of such technologies are typically quite different from those who can champion EVA in a firm. More broadly, the modalities for how an IT artifact is brought in and adopted by the firm are typically distinct from those for a methodology including in the respects of who has the domain expertise, who can serve as the champions, how much management support is involved, and what the broader impact on the firm is. As an example, adopting a methodology such as EVA has broad-ranging impact on the corporate culture and changes everything from how a firm’s performance is measured to management incentive schemes to corporate governance structures (Booth, 1997; Stewart III,
Adoption of most IT artifacts does not involve such a broad-ranging impact on the culture and functioning of the firm. The adoption of many IT artifacts, particularly at the IT infrastructure layers, can be done in a manner that is transparent to the firm’s lines of business and the employees in these organizations.

In addition to the technology versus methodology distinction, the other key difference between the TAM and the MADM is that the unit of analysis in the TAM is the individual and in the MADM it is the firm. The original conception of the TAM and also its evolution through the years is such that the individual has primarily been the unit of analysis (Davis et al., 1989; Venkatesh and Davis, 2000; Venkatesh et al., 2003). This dissertation acknowledges that the TAM can be used even in contexts where the firm is the unit of adoption and indeed there are some studies of firm-level adoption using the TAM as the theoretical lens (Premkumar et al., 1994). However, it is also true that TAM-based studies where the firm is the unit of analysis are far fewer in number compared to where the individual is the unit of analysis. Now, as opposed to the TAM, the MADM has been conceived from the start as a firm-centric model. Adoption of a methodology by the firm of course implies adoption of that methodology by all individuals within the firm such as mid-level managers, financial analysts, project managers and the like that the firm deems as important for the successful adoption by the firm of the methodology. The adoption of a new methodology by an individual in a firm that is unrelated to firm-level adoption is viewed in this dissertation as a problem of second order importance since it is assumed that methodologies that truly matter and are mission-critical to the firm will be ushered in through firm-level adoption processes. This raises the question whether the MADM can serve as a theoretical lens for adoption of a new methodology by an individual outside of the firm context such as a researcher in academia. It is possible in such an individual adoption context that the
strong driver of practical applicability to the business world driving methodology adoption by the firm may not be quite so instrumental, particularly for an academic researcher whose focus is more on fundamental rather than applied research. Consequently, some variant of the MADM developed in this essay may be necessary to capture the main drivers of methodology adoption for an individual such as an academic researcher. This MADM variant falls outside the scope of this essay because of this dissertation’s focus and strong emphasis on the business world. While it is possible to argue that the TAM could be used where the MADM is used, and vice versa, the real issue is the natural habitat and strength of each of these two theoretical lenses. In other words, the strength of the MADM lies in the adoption of methodology by firms whereas the strength of the TAM is in the adoption of technology by individuals. This positioning of the TAM and the MADM is reflected in Figure 3.2.

Finally, the TAM itself is in a rather unsettled state in the IS discipline at this time with some such as Benbasat and Barki (2007) asserting that the intense focus on the TAM in the IS discipline has diverted attention from investigating other important phenomena such as the performance impact of adopting IT. Others such as Fichman (2004a) have also called for going beyond the dominant paradigm defined by the TAM and innovation diffusion theory (IDT) (Rogers, 1995; Moore and Benbasat, 1991) and looking at other factors that influence adoption such as social contagion and management fashion. The IS field is thus at a point of introspection with a vigorous debate going on as to the best path forward. In such a state of flux, rather than anchoring to a model that is perhaps not the most stable at this time, offering a new theoretical viewpoint such as the MADM is a positive step. Doing so both shields this research from the stability issues affecting the TAM at this time and it also contributes to the TAM debate itself by allowing a broader consideration of models as the IS field deliberates on the model that will
propel it forward. While the MADM can enrich the current debate in the IS discipline, it should also be emphasized that the MADM has uses beyond just IS and is truly a cross-disciplinary model that applies to the adoption of any methodology by the firm. The constructs of theoretical soundness and practical applicability indeed have this broad cross-disciplinary appeal.

![Figure 3.2: Positioning the MADM and the TAM](image)

### 3.5 Research Methodology

Having argued in the previous section that a new model such as the MADM is indeed called for the particular context of methodology adoption by firms, this section continues with the development of the methodology for this research. The focus of the analysis of sentiment is on the differences in the sentiment of the academic and practitioner communities between the two methodologies under study, RO and EVA. The dependent variable is the $2 \times 1$ methodology sentiment vector and the independent variable is categorical, with the two categories being EVA and RO. A random sample of quarters is drawn from the total population of 56 quarters in the
period 1992 to 2005. All articles that appear on the methodology in question in a given quarter in the random sample are then scored to obtain a value for the methodology sentiment vector for that quarter.

All articles are drawn from the electronic research databases provided by EBSCO, a recognized leader in providing information services to the academic and business communities. The specific EBSCO electronic databases utilized in this study are Business Source Premier and Academic Search Premier. Business Source Premier includes 1,100 peer-reviewed business journals in a variety of disciplines. It has also an extensive list of practitioner journals and periodicals. Academic Search Premier includes 3,600 peer-reviewed journals in a variety of disciplines. EVA articles from the electronic databases are obtained by setting the search terms to “Economic Value Added” or “EVA” and limiting the period to the quarter of interest. Similarly, RO articles are found by searching for “Real Options Analysis.” Quotation marks are not used to enclose the search terms, which means that a very large result set would be returned where articles containing any subset of the search terms such as “Real Options” or simply “Options” in the fields examined by the search engine would be in the result set. The goal here is to obtain as large a result set of articles as possible, which is then sifted and pruned to remove those articles unrelated to the methodology being studied.

The net sentiment of a community, either academic or practitioner, towards a methodology in a given calendar quarter is computed by first scoring all articles published in that quarter on that methodology in the associated literature category on the following scale: Very Favorable +3, Favorable +2, Partly Favorable +1, Neutral 0, Partly Unfavorable -1, Unfavorable -2, Very Unfavorable -3. Academic articles are those that appear in the academic literature and practitioner articles are those that appear in the practitioner literature. EBSCO itself marks the
journals it deems as academic and the ones it considers as non-academic or practitioner. Net sentiment towards a methodology by a community in a given quarter is then the sum of the scores of all articles appearing in that quarter on the methodology in the associated literature category. A panel of five knowledgeable raters is used to independently score the articles, and the average of the scores is used as the score for the article. Prior to the ratings, a content analysis is done of each article to extract the key conclusions, assertions, factual statements, and data from the article to form a summary of the article. Each rater is then given these article summaries to score.

Each article’s final score is obtained by multiplying its average score by the weight given to the quality of the journal. The weights assigned to academic journals are based on the classification of the quality of journals into various categories as defined on a departmental basis by Kent State University’s College of Business Administration. If a given journal from the electronic databases does not show up in the A+, A or B categories of the departmental lists, then it is treated as a C journal. The weights assigned to the academic journals are: A+ = 4, A = 2, B = 1, C = 0.5. It should be noted that the journals in which RO and EVA articles appear come from all disciplines of business with many of them being in finance, accounting, IS, and general management journals. While the journal rating lists for many departments began as simply representative rather than exhaustive lists, it is also true that these lists have grown over time to become more comprehensive in nature. In addition to using the university’s weighting system for journal quality as our primary assignment of weights, the issue of the sensitivity of the hypothesis tests to journal weights is addressed by utilizing four different weighting strategies to test for the robustness of the results:
I. Weigh higher quality A+ and A journals more heavily than B and C journals as compared to the university system: A+ = 9, A = 3, B = 1, C = 0.5.

II. Weigh higher quality A+ and A journals more heavily than B and C journals as compared to weighting strategy I while keeping the A+ to A ratio the same as in I: A+ = 12, A = 4, B = 1, C = 0.5.

III. Weigh the highest quality A+ journals most heavily while preserving the other journal weights as compared to weighting strategy II: A+ = 16, A = 4, B = 1, C = 0.5.

IV. Weigh lower-quality B and C journals more heavily as compared to the university system: A+ = 6, A = 4, B = 3, C = 2.

These weighting strategies allow for testing various combinations of weights including exploring the two poles of weighing the higher quality journals more heavily and the inverse where the lower quality journals are given greater consideration.

Practitioner-oriented journals are not classified by quality and are all assumed to have a quality rating of 1. The reason for not differentiating among practitioner journals is that there really isn’t a well-regarded classification system of practitioner journals by quality available that could be used for the study. Also, it should be noted that academic article scores are not directly compared to practitioner article scores, so academic and practitioner journal quality weights do not need to be normalized to the same base.

3.6 Results

3.6.1 Inter-rater Reliability

The intra-class correlation coefficient (ICC) is computed on the scores of the five raters in our panel to assess the inter-rater reliability of our scoring instrument. An ICC of 0.84 was obtained
and the average of the Kendall τ-b coefficients computed on the scores of pairs of raters was 0.72, which indicates a reliability that is quite good for a new instrument (Nunnally, 1978).

### 3.6.2 Analysis of Variance

The 25% random sample of calendar quarters was taken by using a random number generator to pick 14 numbers from 1 through 56, representing the total number of calendar quarters in the period from 1992 to 2005. The scores of the articles published in these quarters, from which the methodology sentiment vector is computed for each quarter, are given in Appendix A.4. The methodology sentiment vectors per quarter for EVA and RO are shown in Tables 3-1 and 3-2. The first hypothesis tested is the so-called omnibus test of MANOVA where the hypothesis is:

**Hypothesis 1:** There is a difference in the overall (combined) academic and practitioner sentiment towards EVA and RO.

This hypothesis is easily established since Wilk’s Lamda was found to have a value of 0.7528 with an associated p-value below 0.0001. Therefore, there is a difference in the overall or combined sentiment towards these two methodologies. Using the protection afforded by the significant MANOVA test, the univariate or the so-called “protected” F-tests can be performed. The hypotheses for the univariate F-tests are:

**Hypothesis 2:** There is a difference in the academic sentiment towards EVA and RO.

**Hypothesis 3:** There is a difference in the practitioner sentiment towards EVA and RO.

The F-value found for the test of Hypothesis 2 was 0.44 with an associated p-value of 0.8194. Hence, this test is not significant and the hypothesis that there is a difference in the academic sentiment towards EVA and RO cannot be established. The F-value found for the test of Hypothesis 3 was 9.12 with an associated p-value of below 0.0001. Thus Hypothesis 3 can be
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A – Academic, P - Practitioner

**Table 3-1: EVA Sentiment**

easily established to conclude that there is a statistically significant difference between EVA and RO as far as the sentiment of the practitioner community is concerned. Based on the significant result of the univariate F-test for the practitioner sentiment, the t-test to compare the practitioner sentiment mean values for EVA and RO leads to a statistically significant result at the 0.05 level
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A – Academic, P - Practitioner

**Table 3-2: RO Sentiment**

that the mean practitioner sentiment for EVA is higher (more favorable) than that for RO.

The favorable sentiment towards EVA in the practitioner community is quite in line with expectations. The practitioner interest in EVA has been galvanized by Stern-Stewart, the company that coined the term EVA, and they appear to have been quite successful in creating a
groundswell of interest in EVA within the industry. However, it is interesting that EVA did not fare poorly relative to RO when it came to the net sentiment of the academic community. It should be noted that the sentiment construct combines both the intensity (volume) of the interest as well as the direction this is leaning towards, and this could have contributed to the result of the Hypothesis 2 test since RO is still relatively new. RO’s novelty is also supported by the fact that the RO articles in the random sample all appeared in the years 2000 to 2005. Furthermore, there were no practitioner articles at all on RO in this random sample.

3.6.3 Sensitivity Analysis

The robustness of the results of the tests of Hypothesis 1 and Hypothesis 2 to the four different weighting strategies for academic journals described in Section 3.5 is also explored. The changes in the p-values of these tests as the weights are changed are shown in Table 3-3. As can be seen from Table 3-3, Hypothesis 1 of an overall difference in the academic and practitioner sentiments towards EVA and RO remains significant under all four weighting systems. This is precisely the same result that was obtained using our university’s weighting system for academic journals. Furthermore, as found using the university’s weights, Hypothesis 2 of a difference in the academic sentiment is not supported under the various weighting systems. We propose that this establishes the robustness of the results to different weighting systems.

3.7 Limitations

Some of the issues with this research go to the heart of the validity of MADM theory since the core propositions of this theory have not been directly subjected to falsification tests, which is of course a limitation if one takes a Popperian view of epistemology (Popper, 1959). Other limitations are of a more narrowly technical nature. We discuss all issues relating to the
validation of MADM theory in Section 3.8 while tackling the narrower technical issues in this section. These technical issues include: 1) some important journals may be missing from the two

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<tr>
<td>Hypothesis 1</td>
<td>( \lambda = 0.7491 ) p-value &lt; 0.0001</td>
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<tr>
<td>Hypothesis 2</td>
<td>F-statistic = 0.7 p-value = 0.6245</td>
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\( \lambda \) – Wilk’s lambda * significant at 0.1 level

**Table 3-3: Sensitivity of Hypothesis Tests to Weights**

electronic databases used for this study, 2) the text of some articles may not be electronically accessible even though the journals are in the electronic databases, 3) some articles may be misclassified in that keywords such as Economic Value Added and EVA are not associated with the articles even though these concepts are the focus of such articles, and 4) departmental lists of journals are representative rather than exhaustive in nature. With regard to all of the above issues, it can be readily argued that there is no *ex ante* basis to assume that the error introduced by these issues is such that there is any systematic bias in favor of any given methodology. Since the focus of this study is on comparing the two methodologies, EVA and RO, rather than on
looking at the absolute levels of various variables, the presence of these measurement errors is not expected to exert much influence on the results. The third issue in the above list is further mitigated by the fact that the search engine looks at many fields and not just the subject keywords to find articles. With regard to the departmental lists being representative and not exhaustive, while that is typically how they started out, it is also true that over the years these lists such as those in the finance and accounting departments have become more comprehensive as journals have been added to them. The comparative focus of this study and the lack of any *ex ante* bias in favor of a particular methodology apply to this issue of the departmental lists as well. The problem with the departmental lists not being comprehensive which could lead to the wrong weighting of some journals is also mitigated by the fact that, as the sensitivity analysis in Section 3.6.3 demonstrates, the results were not that sensitive to journal weights anyway.

Another apparent limitation is whether the article search procedure which is keyed by terms such as “Economic Value Added”, “EVA”, “Real Options”, or “Real Options Analysis” finds all the articles in the databases about these methodologies. In this study, the approach taken is to include those articles that are primarily rather than peripherally about these methodologies. The focus is on those articles that are mainly about the methodologies since the purpose is to gauge how these articles are shaping opinion towards the methodologies. An article that is primarily about a methodology can be expected to exert a greater influence in shaping opinion rather than one that merely makes a passing reference to the methodology. It is assumed that an article that is primarily about a methodology, such as EVA, would very likely have “EVA” or “Economic Value Added” or some subset of the full term such as “Value” or “Value Added” in the default fields that are looked at by the search engine in locating articles. These default fields include the title, subject terms, author-supplied keywords, and the abstract of the article. It is
further assumed that if the search terms or subsets of the search terms do not show up in any of these default fields, then the article is either unrelated or at best tangentially related to the valuation methodology. It should be noted that the number of articles returned in any given search is many times more than the number of articles that are truly about the methodology in question. The result set from a search is pruned by looking at the title and the abstracts of the articles. Therefore, the search process is quite broad and it is reasonable to assume that the process picks up the vast majority of articles that are primarily on the methodology in question.

The time frame for the study is 1992 to 2005. While more recent articles in the 2006 to 2009 time frame are not part of the formal study, they were examined to get a sense of where the discourse on EVA and RO stands today. This discussion of the current state of the literature is in Section 3.9.

3.8 Validation of the MADM

In this section, we discuss the issue that since the core propositions of the MADM were not directly subjected to falsification tests, does that not mean that the MADM is essentially an un-validated theory? First, it is important to note that the validation of the MADM is an issue that has to be considered wholly on its own merits and the question of basing this research on the TAM to derive support from the validated strength of the TAM doesn’t really arise because of all the reasons discussed in Section 3.4. This research of course does not directly test the core propositions of the MADM theory and treats all of them as axioms. The tests performed in this research are for measuring the comparative levels of theoretical soundness and practical applicability of EVA and RO rather than for testing the falsifiability of the core propositions of MADM theory. Since the core propositions of the theory are not tested, falsificationists of the Popperian school (Popper, 1959) would argue that the MADM is an un-validated theory. This
discussion on whether the MADM is an un-validated theory or not will pursue two strands: one that focuses on the essential epistemology of the MADM and the other on the nature and extent of the validation that is presented in this essay.

3.8.1 Popperian Versus Lakatos Falsification in MADM Epistemology

Positivists of the Popperian school (Popper, 1959) insist that in order to validate a theory all the tenets and propositions of a theory must be subjected to the test of empirical falsification. The TAM research program over the past two decades has indeed followed traditional Popperian precepts in subjecting all of its fundamental propositions to the brunt of empirical falsification. The TAM is not structured as a set of axioms upon which auxiliary hypotheses are developed, which are then subjected to empirical falsification while the core set of axioms are themselves not targeted for falsification. The TAM from its initial conception by Davis (1989) through its various iterations such as TAM 2 (Venkatesh and Davis, 2000) to its present day incarnation as the UTAUT (Venkatesh et al., 2003) has continued to test and retest the basic propositions of the theory. An example of such a basic proposition in the TAM is that perceived usefulness of a technology positively influences the intention to adopt it. It does not treat basic propositions such as these as axioms based on which more complex auxiliary hypotheses are built, and then test for the falsifiability of these downstream hypotheses rather than target falsifiability at the core propositions of the theory. In doing so, the TAM has essentially been faithful to Popperian epistemology.

Karl Popper’s one-time student Imre Lakatos (1976, 1978) has long sought to reorient the fundamental role of falsification in epistemology by arguing that a theory is invalidated not by empirical falsification of its basic propositions but when a better theory emerges that is better able to explain the phenomenon under consideration. In Lakatos’ framework, upsetting a theory
by targeting its basic tenets and propositions is considered as naive falsification (Lado et al., 2006) whereas sophisticated falsification operates at the level of competing theories (Lakatos 1978) rather than at the level of the basic propositions of the theory. If the core set of propositions are to be treated as axioms at which falsification is not targeted, the target of falsification in Lakatos’ epistemology shifts to an outer layer of auxiliary hypotheses or downstream implications of the theory. Unlike the TAM which follows Popperian falsification, the epistemology of the MADM adheres to Lakatos’ precepts for the reoriented role of falsification in theory development. In the MADM, all of its three basic propositions are treated as belonging to the core set of axioms and as such are not treated as targets of falsification by definition. In this epistemological approach, only auxiliary hypotheses or downstream implications of MADM theory are appropriate candidates for empirical falsification.

3.8.2 MADM Implications as Falsification Targets

Before discussing a specific implication of the MADM for which an implicit test is provided in the essay, it is important to first note that the downstream implications or auxiliary hypotheses of a theory can be many and their formulation and testing is viewed as a natural continuation and extension of the research program. For a theory developed in the Popperian mode where the core propositions are also hypotheses to be tested, the falsification tests targeted at these core hypotheses is less separable and essentially an integral part of the formulation of the hypotheses themselves. For a theory developed in the Lakatos mode such as the Resource-Based View (Barney, 1991), the gestation of the research program is often simply the formulation and discussion of the logic of the basic axioms of the theory and the development of any immediately proximal propositions that follow deductively from the basic axioms. The first stage of research in this framework need not and often does not contain any form of empirical validation.
whatsoever. The initial papers in the Resource Based View (RBV) follow this model (Barney, 1991). Empirical tests of the implications of RBV theory came later in Henderson and Cockburn (1994) and Makadok (1999). If research on the MADM were to follow a path similar to the RBV, then the initial offering in such a research program could simply have constituted the three axioms discussed and the theorem that was derived in Section 3.3. Where the MADM essay goes beyond that is that the essay actually contains an implicit yet powerful test of an implication of the theory.

An implication of the MADM is: If EVA has greater practical applicability than RO and if it is also no worse than RO in theoretical soundness then EVA is more likely to be adopted. Furthermore, if EVA is more likely to be adopted then this would manifest itself in a higher rate of adoption of EVA by firms. This is an implication of MADM theory that is a legitimate candidate for empirical falsification. It is this implication of the MADM that is targeted for testing as part of this research. It should be noted that the consequent side of the hypothesis is not tested through collecting any primary data on the comparative rate of adoption of EVA relative to RO. However, there is secondary data in the literature review that does clearly point to the spreading use of EVA in industry and also that it is spreading faster than RO. As the literature review in Section 3.2 shows, EVA is indeed a method that is spreading quickly and widely from the chemical industry (Henry, 1995a; Chemical Market Reporter, 1997; Freedman, 1997; Tullo 1998) to financial services (Padgett, 1997) including insurance (McDonald 1998a, 1998b) and banking (Kreger, 1998) to manufacturing (Violino, 1998). While there is interest in RO and it is growing, it does not appear to be as extensive as that in EVA. Using secondary data to make an assertion about the occurrence of a phenomenon is of course not the same thing as actually surveying companies to gauge the comparative rate of adoption of EVA versus RO. Positivists
would argue that primary data through a direct survey should be conducted before one can conclude that EVA is indeed spreading faster than RO. While a direct survey of companies to gauge the differential rates of diffusion of EVA and RO would indeed be useful and could be conducted under the auspices of a future research project, one cannot so easily dismiss the fact that the extensive literature review of EVA and RO done in this dissertation does point to the growing use of EVA in industry both in absolute and relative terms. Interpretive studies often do analyze and provide an interpretation of secondary data. This study is of course largely positivistic but it could be characterized as mixed-mode to the extent that in one small part it deviates from the positivistic model and invokes interpretation of secondary data.

3.8.3 **Sophisticated Falsification in Lakatos’ Epistemology**

In Lakatos’ epistemology, sophisticated falsification operates at the level of competing theories whereas Popperian falsification, which targets the basic propositions of a theory, is viewed as naive falsification (Lado et al., 2006). Critics of the RBV such as Priem and Butler (2001) have attempted to use naive falsification targeting the basic propositions of the RBV in order to discredit it. However, as Lado et al. (2006) note, the more powerful way to refute a theory is via Lakatos’ strong falsification approach. Based on Lakatos’ precepts for falsification, Mahoney (1993) and Powell (2001) have discounted naive falsification as a way for criticizing the RBV. The more fruitful approach is the search for better alternative explanations for the phenomenon in question.

While the MADM could be viewed as an attempt to seek a rational explanation for the growing use of EVA that is rooted in the theoretical soundness and practical applicability of EVA, the theory of management fads and fashions (Abrahamson, 1991; Abrahamson, 1996; Abrahamson and Fairchild, 1999) could be advanced as an alternative explanation for the same
phenomenon. The theory of management fads and fashions avers that enthusiastic waves of discourse or “hype” about some new idea triggers managerial interest in it and that becomes a self-reinforcing mechanism that causes rapid adoption of the idea. Carson et al. (2000) state that such ideas that qualify as management fashions are subject to social contagion because they are novel and perceived to be progressive and innovative, are purportedly aimed at encouraging better organizational performance, enhance the image of the organization, and are motivated by a desire to remedy some existing operational deficiency. Thus a management fashion has the trappings of value but could in fact be devoid of substance.

A competing theory that explains the diffusion of EVA is that it could simply be a management fashion. EVA does appear in some respects to have the characteristics of a management fashion. EVA is championed by the consulting firm Stern-Stewart and management fashions are indeed often aggressively marketed by consultants and business groups that have a commercial interest in fostering their adoption. The positive sentiment in the practitioner community as reflected in the practitioner publications could, instead of affirming the practical applicability of EVA, may be nothing more than a manifestation of the very mechanism by which management fashions propagate, namely, by generating a lot of discourse and positive hype. Consequently, management fashion could be a competing theory to the MADM. It is precisely the formulation of competing theories and the targeting of falsification at the level of competing theories that Lakatos saw as a more worthwhile effort than Popperian falsification targeted at the basic elements of a theory. Competing theories within a given field of inquiry emerge and are refined and tested as part of a progressive research program (Lakatos, 1978). A budding research program in this framework essentially starts with some theory that a community of scholars interested in that line of inquiry deems as a useful trigger to generate the
development of competing theories and the to-and-fro of arguments between them to search for better and deeper explanation of the phenomenon at hand (Lado et al., 2006). The catalyst event that starts such a research program among an interested community of scholars is the publication of the initial theory, imperfect though it may be and however little or no empirical validation it may contain. Barney’s 1991 paper with all its imperfections was this catalyst paper for the RBV, which is now regarded as one of the seminal contributions in the theory of competitive strategy. The future publication of the research being pursued in this dissertation could similarly serve as the catalyst for the MADM research program. In order to make the MADM into a progressive research program, a future research project could focus on devising a way to test the MADM, a theory seeking to provide a rationalistic explanation for the spread of EVA, against a competing theory such as management fashion providing an alternative non-rationalistic explanation for this phenomenon. This would of course be a major new research project separate from the current dissertation and could indeed be undertaken by different researchers within the interested community of scholars.

3.8.4 Validity of the MADM Measurement Model

The validity of the measurement model for a theory is typically ensured through several stages of evaluation and testing of the measures. In the first stage, the items or measures for a construct are assessed for face and content validity by a panel of judges followed by one or more pilot tests where Cronbach alpha values and convergent and discriminant validities are evaluated in order to further refine the set of measuring items for each construct before the instrument is used in the actual study. Moore and Benbasat’s (1991) effort to develop a measuring instrument for innovation diffusion theory (IDT) is a good example of this multi-stage process. Factor analysis
is the staple technique used in measurement model validation in the latter stages after the panel of judges has agreed to the content validity of the measurement model.

There is a fundamental difference between the MADM and technology adoption and diffusion theories with regard to the measurement model in that the key constructs of the MADM are not individual-centric but are community-centric. Two key constructs of the MADM, perceived theoretical soundness and perceived practical applicability are community-centric constructs rather than perceptions of individuals. In other words, the goal is to gauge the aggregate perception of the academic community who are capable of pronouncing a judgment on theoretical soundness, and similarly the aggregate perception of the practitioner community who can pronounce a judgment on the practical applicability of the methodology. A community-centric construct is different even from firm-centric constructs where high-level executives can be polled to represent a firm’s position. Since the research stream on technology adoption or innovation diffusion has always used individual- or firm-centric constructs measured by gathering data via surveys sent to those individuals, a methodological innovation in this research is the development of a way to measure the aggregate perception of an entire community. This is done by looking at the literature of the practitioner and academic communities to obtain a sense for where these communities stand. The opinions and judgments of those who publish in well-regarded academic or business journals can be deemed to have more of an influence on the community than simply the opinions of those who respond to a survey sent out at random to businesses. As the net academic and net practitioner sentiment measures consider both positive and negative opinions, a sense for where the balance of the sentiment lies is obtained.

The MADM has two community-centric constructs and one measure for each such construct: net academic sentiment as expressed in academic publications for perceived
theoretical soundness and net practitioner sentiment as expressed in practitioner publications for perceived practical applicability. This structure makes the validation of this measurement model different from traditional measurement models where all the constructs are typically both individual-centric and have multiple items or measures associated with each construct. The multiple stages of factor analysis that can be done in those contexts where there is a set of subjects in the pilot, and sometimes there are multiple pilots with different sets of subjects as in Moore and Benbasat (1991), is simply not applicable for measurement models of community-centric constructs. Even if more measures could be defined for the perceived theoretical soundness and perceived practical applicability outside of content analyzing and rating academic and practitioner articles, we would still be left with the problem of sole subjects. To do factor analysis, one needs multiple instances of subjects. Having multiple instances of subjects injects variance into the measures, and this variance can then be analyzed for its common and specific components. In this study, one doesn’t have multiple instances of the academic and practitioner communities, which makes factor analysis inappropriate as a technique for measurement model validation. The only part of the measurement model validation process in the traditional positivistic paradigm that is applicable in this case is the face and content validity assessment. Face and content validity assessment is done in this project using the panel of raters who rate the articles.

Questions may still linger as to whether the measurement model chosen truly has content validity or not. In other words, there could still be some concern whether net academic sentiment as expressed in academic publications is a reasonably good proxy of the theoretical soundness of a methodology. This issue can be seen in light of Lakatos’ epistemological perspective that all theories are inherently falsifiable (Lado et al., 2006); and a theory’s
measurement model is actually a facet of the theory. In other words, just as there is a progression of better theories in a research program developed under a Lakatos framework, one can similarly expect a progressive improvement in the measurement model. An alternative, some might argue an improved, measurement model would be where instead of extracting sentiment from academic publications to gauge theoretical soundness one could ask a set of highly regarded scholars their opinion of the theoretical soundness of the methodology in question. So this alternative approach would involve sending a survey to the Robert Fichmans, Fred Davis’s, and Fischer Blacks of this world, or whomever is viewed as a top scholar in the field, to ask them their opinion about some new theory or method in their field and then aggregating the opinions of these top few scholars. We think that this approach, while it does have some strong points, could be fraught with many challenges and issues as well not least being issues of equity. This method anoints a set of “gurus” and simply shuts out the voice of everyone else. Of course, we are not advocating that some kind of a “democratic” process ought to be used in arriving at a determination of the value of a new method or theory. A top scholar’s views should indeed matter more which is why we believe that simply sending out a survey at random to academics is problematic as well. But consider that in the options pricing debate, Samuelson (1965) a known luminary actually got it wrong while Black and Scholes (1973), who were much less well-known before their 1973 breakthrough, got it right. So it is really the academic journals and their publications that provide the appropriate forum and level playing-field where high-quality ideas are debated and forged, and this forum is open to all – top scholars and others with compelling ideas. In other words, while this instrument may not be the best, it may be better than various other alternatives. In spite of this, the search for a better instrument can certainly be expected to be a part of the evolution of the MADM research program.
Another refinement of the measuring instrument that could be considered in the future is to take a lifecycle view of academic sentiment. In other words, when a theory succeeds and stabilizes then the “chatter” on its theoretical soundness can be expected die down. It should be noted however that taking a lifecycle view of academic sentiment does not invalidate the basic premise of using academic sentiment as a measure of theoretical soundness but it simply introduces the stage in the life cycle as a further refinement of this measure. In this study, both EVA and RO are essentially in the emergent phases of their lifecycle. Neither can be even remotely considered as comparable to a stable theory such as linear programming in terms of maturity and stability. It would however be reasonable to consider a future research project to develop a taxonomy of stages in the lifecycle of a theory and to develop a more comprehensive measure that incorporates this lifecycle stage; but at least in this context such a refinement would at best have a second-order effect given that both theories are essentially in their emerging phases. While the current instrument is adequate for this study, a more powerful instrument would indeed be necessary for comparing methodologies that are in significantly different stages in their evolution. However, it should also be noted that the MADM has essentially been conceptualized for emerging methodologies, hence comparing methodologies that are in significantly different stages of evolution, which presumably means at least one or both are past the emerging phase, would involve a reconceptualization of the theoretical model.

Another issue affecting the validity of the measures could be that academic writing tends to be more objective and neutral whereas practitioner writing is more opinionated. So apparently it would be more difficult to pick up positive or negative sentiment in academic articles. Now what the raters were asked to do in rating the academic articles is to gauge the position of the author. Academic authors despite their objectivity and neutrality do indeed take
positions on various topics and issues. An academic author’s study, empirical or otherwise, will weigh the issues from different angles and will typically have a section on limitations but it is not hard to detect where in the main his position lies. The position is simply couched in perhaps less strident or more objective terms than in practitioner pieces. Also, it should be noted that nowhere in the methodology for this research is practitioner sentiment compared to academic sentiment. Academic sentiment of EVA is compared to academic sentiment of RO and practitioner sentiment of EVA is compared to practitioner sentiment of RO.

3.9 Current Discourse on EVA and RO

Before concluding this essay, we provide an update on the current state of the academic and practitioner discourse on EVA and RO by looking at articles published in the 2006 to 2009 time frame. As mentioned earlier, the formal study and statistical analysis is based on a random sample of articles published in the 1992 to 2005 time frame. It should be noted that many 2008 and 2009 articles are too recent for their text to be in the EBSCO databases. Only those articles in the 2006 to 2009 time frame whose full text was available are reviewed to provide this update on the most recent discussions occurring on EVA and RO.

3.9.1 EVA

As seen from the most recent batch of articles, companies from diverse industries continue to deploy EVA. The practitioner sentiment towards EVA continues to be quite favorable as evidenced in practitioner publications. Home security systems vendor Brinks credits EVA for its impressive balance sheet (Treasury and Risk, 2009). EVA is being increasingly used in the real estate sector to assess the value of properties (De Klerk, 2008). Colvin (2008) reports on the relative ease of computing EVA of not just a company but of the market as a whole because of the ready availability of corporate data electronically over the Internet. The pricing of favored
stocks, such as Google, is increasingly being discussed from an EVA perspective (Colvin, 2007), pointing to the growing use and acceptance of this metric. Shapiro (2007) argues for using EVA not just in the large company context but also in S corporations such as his medical practice. Gray (2006) indicates an increasing use of the EVA methodology among small companies in the US.

Academics continue to remain engaged with EVA research both at the theoretical and the applied level. On the theoretical level, there continues to be a camp of academics in favor of EVA and another that is opposed. This is quite consistent with the results seen in the random sample. Drew et al. (2008) report that when portfolios are formed based on the EVA values of the stocks in them, the cumulative returns from the high-EVA portfolio is statistically different from the low-EVA portfolio thus supporting the notion that EVA as a measure does contain useful information. Adjaoud et al. (2007) find that there is no statistically significant relationship between the quality of the board, which is a measure of corporate governance, and traditional accounting-based performance measures such as Return on Investment (ROI), Return on Equity (ROE), and Earnings per Share (EPS), but that there is indeed a statistically significant correlation between corporate governance and value-based measures such as EVA and MVA (Market Value Added or the present value of a future stream of EVAs). This lends further credence to the usefulness of EVA as a measure. However, there are other academic studies that are more equivocal about the value of EVA. De Wet and Du Toit (2007) find weak correlation between financial measures, whether they are EVA-based or traditional accounting-based such as ROE, and shareholder returns on a current year basis. Correlations improve significantly when 5-year medians for the financial measures are correlated with current shareholder returns; but this may lend more support to the expectations theory rather than to EVA per se. More negative
towards EVA is the study by Kyriazis and Anastassis (2007) on the correlation of EVA to shareholder returns for the stocks traded on the Athens Stock Exchange. They find that traditional accounting measures such as net income and operating income are actually more correlated with shareholder returns than is EVA. Similar to the results of the Kyriazis and Anastassiss study (2007) is Tsuji’s (2006) work on Japanese stocks which showed that cash flows and traditional accounting measures were more correlated with corporate market values in Japan than was EVA. Zinkin (2006) provides an interesting argument on the need to balance the importance of shareholder value with customer value, and underscores the role of the strategic marketing function to provide this balance. While Zinkin (2006) explores the broader issue of whether shareholders or customers matter the most to the firm, he nevertheless favors the use of EVA as a measure of shareholder value based on the evidence in some studies that EVA correlates better with stock performance than other accounting measures (Drew et al. 2008). The evidence on this issue is however mixed as Griffith (2006) finds EVA and MVA to be poor indicators of stock performance. While Griffith (2006) does not find value in EVA and MVA as predictors of stock performance, he nevertheless does support the use of EVA in compensation systems which would motivate employees from top to bottom to maximize shareholder wealth.

A few interesting academic studies on the application of EVA have appeared recently, particularly in an international context. Ramesh and Ramanayya (2007) apply EVA in an emerging markets context to assess the performance of government-owned entities such as the state transportation system in India. Hui et al. (2007) use EVA to study the performance of companies in the real estate sector in Hong Kong and Singapore. While Hui et al. (2007) are generally supportive of EVA, given that EVA is central to their research methodology, they do
inject a note of caution in interpreting EVA results in that poor performance from an EVA standpoint should not automatically mean that these companies are poorly managed.

On the whole, information from recent publications on EVA is consistent with what was seen in the random sample in the study, with practitioner sentiment in favor and academic sentiment somewhat mixed. It did appear that on the academic side, while there is a camp that is fundamentally opposed to EVA, many other academics while not necessarily viewing EVA as an unalloyed good are coming around to seeing some benefits in EVA, particularly if the scope of the issue is limited in certain ways such as to the impact of EVA-based compensation systems.

3.9.2 RO

The importance of RO appears to be rising among academics given the volume and diversity of academic papers on RO in recent years. There also seems to be a certain “coming-of-age” quality to the academic discourse in that the research has gone beyond simply focusing on uncertainty and the value of managerial flexibility, the staple issues in the early development of the RO field, to integrating RO with a range of other theories such as game theory, Bayesian learning, and behavioral theories such as regret theory and the attention-based view. These developments do point to a maturing of the RO field. Ferreira et al. (2009) have developed an interesting tool called Option Games which combines RO with game theory to approach decision-making from an RO perspective that also considers moves that competitors make from a game-theoretic perspective. The team that built this Option Games tool is interesting in that it is comprised of practitioners from the highly-regarded consulting firm McKinsey and respected RO academics such as Lenos Trigeorgis who developed some of the seminal concepts in this field (Trigeorgis and Mason, 1987; Trigeorgis 2005). Another paper which integrates RO analysis with game theory is by Chu and Sing (2007) where they approach investments by real estate companies to
develop land from an RO lens but from within a competitor move-counter move game-theoretic framework. Xinping and Hongbo (2006) also integrate game theory and RO analysis to examine mergers and acquisitions between a set of target and bidding firms. Other examples of this apparent trend to integrate RO with other theories and models include Herath and Herath’s (2008) work to incorporate Bayesian learning in their analysis of investments in information security assets. Lankton and Luft (2008) look at behavioral theories such as regret theory and competitive behavior theories to highlight the variation between what is implied by RO analysis and behavior theory-based managerial judgment. Another example of combining RO and the behavior theory lens is Barnett’s work (2008) on examining when managers acquire real options, champion them, and then exercise them from an attention-based view that considers the attention span of managers and the structures within a firm that allows managers to pay attention to developments in their environment.

Aside from the work underway to integrate RO with other theories, the staple theoretical issues of the RO field itself such as the optimal timing of the exercise of real options, estimation of the degree of uncertainty, effects of hedging, investment cost risk, market completeness, and degree of decision irreversibility continue to engage the attention of RO academics. Han and Park (2008) develop a decision rule for the early exercise of real options and use simulation to validate their rule. Lewis et al. (2008) develop a method for estimating the volatility parameter in real options analysis based on the notion of expected internal rate of return that also considers the risk in the investment cost. Luo et al. (2008) approach R&D investments from an RO perspective but they also consider the effects of project diversification as a way of hedging project-specific risk. Eschenbach et al. (2009) focus on the issue of opportunity cost of forgone cash flows when the defer option is exercised. Henderson and Hobson (2006) look at the optimal timing for
exercise of real options in incomplete markets where the stochastic cash flow from the real asset is not spanned by portfolios tradable assets.

The third category of academic publications has to do with the application of RO techniques and models to various real-world contexts in real estate, mining, infrastructure, IT, and other types of investment projects. Towe et al. (2008) approach the conversion of farmland to developed uses and find as predicted by RO theory that an increase in the variance of returns to development tends to slow the conversion of the land, or that the defer option is exercised. Morgan et al. (2008) apply RO reasoning in forest management decisions in Canada such as harvesting timber that considers the uncertainties relative to the possible extinction of the caribou population resulting from timber harvesting. Mogi and Chen (2007) approach multi-stage mining projects from an RO perspective and develop a compound (nested) options model to address the multiple-stage nature of such projects. Tong et al. (2008) assess International Joint Ventures (IJV) from the perspective of the value of the growth options that these IJVs contribute. In the IS field, Benaroch et al. (2006) build upon Benaroch’s (2002) work to develop a taxonomy of real options that can be embedded in IT projects and validate this taxonomy by examining several IT projects in a large Irish financial services organization. Pennings and Altomonte (2006) study how the rate of investment by multinational corporations in Eastern Europe is affected by uncertainties or hazards of investing in these environments.

Compared to this wealth of activity in academic journals, the dearth of practitioner publications on RO is disappointing. This relative lack of practitioner publication activity in recent years is also consistent with what was observed in the formal study where a random sample of articles in the 1992 to 2005 time frame was taken. Hence, the situation does not appear to have changed much in more recent years. Of course, a factor that could explain the dearth of
recent practitioner publications is the time lag between publication and getting into the EBSCO databases. All the recent applied studies in EBSCO were essentially scholarly studies by academics applying complex RO models and techniques to real-world contexts; and these applied studies have all been published in academic media outlets. Hence, they don’t represent a broad-based discourse on RO occurring within the practitioner community and expressed through practitioner media outlets. It is thus not clear how accessible these abstruse RO models and techniques really are to the practitioners from the high-level executives such as CFOs down to the people more in the trenches such as Production Managers or IT Project Managers – the people in whose thinking RO must permeate if this new approach is to make a broad-ranging impact on the business world.

3.10 Conclusion

The main conclusion from the Methodology Adoption Decision Model theory and the measurements of the comparative levels of perceived theoretical soundness and practical applicability is that the EVA has a greater likelihood of being adopted by businesses. Here, we do not specify a time frame for the adoption of EVA, such as within the next five years, since this study is purely a comparative study rather than a study on predicting the time horizon for the adoption of EVA per se. In other words, the only assertion that is being made here is that if in some planning horizon, such as three years, the firm is considering adopting a new methodology and it has narrowed the choice to EVA and RO then it is likely to adopt EVA before it adopts RO. Note also that we do not rule out the simultaneous adoption of EVA and RO. However, given the wide-ranging impact on business practices, and indeed the corporate culture, entailed in the adoption of these methodologies, it is likely that a firm would digest these methodologies sequentially. The assertion is with regard to sequencing regardless of the time horizon in which a
firm chooses to adopt these methodologies. One may ask at this point that if MADM theory says that EVA is more likely to be adopted and firms are indeed rapidly adopting EVA as would appear from the secondary data in the literature review, what is the point of this research? Does this research then develop any new managerial prescription? The contribution of this research is precisely in providing a rationalistic and value-based explanation for the phenomenon of rapidly spreading EVA. The logic of the MADM is that EVA is spreading rapidly because it is practical to apply and is also theoretically sound (at least no worse off than RO). So firms with greater levels of what Fichman (2004a) calls “innovation mindfulness” who have a more watchful and vigilant state of mind can look at MADM theory and adopt EVA taking comfort in the fact that they are making a decision that adds value rather than simply jumping on a bandwagon or adopting a passing fad.

3.9.1 Implications for Research

This research can be extended in several directions. As discussed in Section 3.7.3, under Lakatos’ epistemology, falsification is tested at the level of competing theories and an important new research project would be to test the MADM against an alternative theory such as the theory of management fashion as an explanation for the spreading use of EVA. Also as discussed in Section 3.8.2, in this essay there was only an implicit test of the MADM done in that a key implication of the MADM was found to be consistent with what secondary data is saying about the comparative rate of diffusion of EVA and RO among companies. The comparative rate of diffusion of EVA and RO could also be directly measured by surveying companies. This would allow a direct test of this implication of the MADM using primary data. Another direction in which this research can be extended is to include other emerging methodologies for capital investment such as the Balanced Scorecard (Kaplan and Norton, 1992). The MADM can be
repeatedly applied to arrive at a rank ordering of the adoption likelihoods of several emerging methodologies for capital budgeting.

Another promising avenue to explore further is the relative contribution of the two constructs of the perception of theoretical soundness and the perception of practical applicability of a methodology to the overall perception of value of that methodology, and hence its rate of diffusion. In other words, the focus of this new research will be on estimating the coefficients $\beta_1$ and $\beta_2$ in:

$$r = \beta_1 T + \beta_2 P$$

where $r$ is an objective measure of the rate of diffusion of the methodology, and $T$ and $P$ are the academic and practitioner communities’ perceptions of theoretical soundness and practical applicability as measured by the academic and practitioner sentiment variables.

### 3.9.2 Implications for Practice

A key conclusion is that management should pay more attention to EVA given its higher likelihood of adoption. However, as the practitioner literature on EVA readily acknowledges, implementing EVA in the real world can be a formidable challenge (Freedman, 1995). Training, management commitment, and effective corporate governance structures appear to be critical success factors in ensuring the success of a company’s implementation (Petit, 1998; Stewart III, 1995). EVA training programs are not cheap and can cost anywhere from $250,000 to $1 million depending on the size of the company and the extent of the training delivered (Christinat, 1997). The literature also points out that EVA is not a panacea, and strategy and innovation are perhaps more important drivers of wealth creation (The Economist, 1997). Therefore, while this statistical analysis finds that practitioners favor EVA over other methodologies such as RO, there are clearly certain important caveats that management must bear in mind as it comes to grips
with EVA. Management must consider in its EVA plan the formidable complexity of implementation, the overall impact on corporate culture, and the necessity of a continued focus on business strategy and innovation. There is help however available in the form of software to do EVA analysis and with implementing EVA. The company that developed the EVA notion Stern Stewart & Co. has a software product called Finanseer and another consulting company L.E.K Consulting has a competing product called Alcar for Windows for doing EVA analysis (FinanceAdvisor.com Home Page, 2008). These products are not cheap, however, and licenses can cost about $10,000 per user with additional expenditure for consulting services from these companies on how to use these products effectively.

RO is also an important emerging methodology of investment valuation being used in diverse industries (Miller and Park, 2002) as well as in many application scenarios ranging from software development to large infrastructure projects undertaken by government entities (Benaroch, 2002; Erdogmus, 2000; Kitabatake, 2002). The complex mathematics underlying the options pricing models will continue to make RO relatively less accessible to practitioners as compared to EVA. RO will therefore take some time to mature from an industry interest standpoint and efforts such as the one by Feinstein and Lander (2002) to make the analysis of real options more NPV-like could be a welcome step from the standpoint of practitioners. While EVA is ready to be embraced by businesses, it will take some more time for practitioners to become comfortable with RO. However, given the power of RO in analyzing investments under uncertainty and its slowly but surely growing importance, firms would be well-advised to invest in learning more about this new methodology. As in the case of EVA, there are some software products that facilitate the use of the RO methodology. Real Options Valuation, Inc. offers a range of software tools for solving RO models and doing risk simulation (Real Options
Valuation Home Page 2009). Licenses for these products appear to be more reasonable and are in the $1000 to $1500 per user range.
4. **Uncertainty and XML-Based Integration – A Real Options View**

4.1 **Introduction**

IT investment decisions are often made under conditions of high uncertainty. In addition to uncertainty, a key factor that confounds good IT investment decision-making is that it is often difficult to assess the value of an IT investment. This essay develops a decision-making framework that ties together uncertainty, a firm’s capabilities with regard to the technology invested in, and new approaches to measuring the value of IT investments particularly under conditions of uncertainty such as Real Options. The question of the value of IT and effective methods to measure this value is rooted in the IT Productivity Paradox, which was discovered in the mid-eighties (Strassman, 1985; Roach, 1987). The paradox is that, while companies spend heavily on IT, the benefits of IT investments often don’t show up in the bottom line measures of firm performance. The years following the initial recognition of this paradox saw many firm-level studies confirming its existence. There were estimates that as much as 20% of all IT spending is wasted and 40% does not contribute to business performance (Willcocks and Lester, 1993). Another disturbing report (Hochstrasser and Griffiths, 1990) showed that 70% of all IT investment provides no ROI. The pendulum began to swing in the other direction from the late nineties when there were many compelling studies on the other side of this vigorous debate showing that the value of IT is indeed significant (Jorgenson, 2001; Brynjolsson and Hitt, 1998; Jorgenson and Stiroh, 2000; Oliner and Sichel, 2000), and that the paradox issue should essentially be considered as closed. Brynjolsson and Hitt (1998) asserted that since their studies used larger data sets, and were more recent than those that had first pointed to the paradox, a clear link between IT and significantly increased firm productivity had finally been established. However, an issue of the magnitude of the value of IT itself continues to generate lively debate.
More recently, some have recast the issue of the value of IT in different terms to assert that IT creates no unique value and should simply be regarded as any other type of utility (Carr, 2003).

One of the useful byproducts of this debate on the value of IT is that it has focused attention on the methods and techniques used to measure this value. Some have claimed that those who have argued against the value of IT have simply not used the right instruments to measure its value (Robey and Boudreau, 1999; Brynjolfsson, 1993). The pursuit of better measures for the value of IT has naturally led to attention being focused on theoretical advances made in the fields of economics and finance. Bakos and Kemerer (1992) provide an excellent review of the many areas where economic theory is being applied to IT research, from the economic models of organizational performance to the macroeconomic impact of IT. In this essay, we approach the value of IT from a financial analytic perspective. In many IT investment scenarios, the role that uncertainty plays is crucial in determining preferred investment paths. Consequently, the methodology of real options (RO) is suitable for evaluating these investments since RO is emerging as the most effective approach in valuing investments under conditions of uncertainty (Dixit and Pindyck, 1995) and where management possesses various options to respond to this uncertainty. RO is also being seen as the right approach to formulating strategy, as strategy can be viewed as nothing but a series of exercises of real options held by the firm (Bowman and Hurry, 1993).

There is mounting evidence that RO has been steadily gaining converts in the field. Graham and Harvey (2001) found in a survey of 392 CFOs that approximately 27% of this group is adopting real options analysis in capital budgeting. RO is being utilized in industries as diverse as bio-technology, manufacturing, and natural resources (Miller and Park, 2002). RO has also been applied in various business functions such as R&D (Santiago and Vakili, 2005), mergers
and acquisitions (Kogut, 1991), and manufacturing (Kogut and Kulatilaka, 1994). Erdogmus (2000) applies real options analysis to software development projects including developing Java application servers and bringing older software products in compliance with XML standards. In a novel application of the real options approach, Alleman and Rappoport (2002) use it to model the cost of regulatory constraints in the telecommunications industry. RO has been used not just in correctly valuing software projects in the face of risk, but also in pro-actively controlling risk (Benaroch 2002). Fichman (2004b) argues for integrating the theories of IT innovation adoption with that of RO particularly with regard to investments in IT “platforms” and in environments characterized by high uncertainty and irreversibility of the investment decision. IT platforms, such as a firm’s wireless network or its enterprise services bus, allow for later deployment of value-added services and applications and hence represent an investment scenario with plenty of expansion and growth options. Fichman (2004b) integrates theories and perspectives from strategy, organizational learning, innovation bandwagons, and technology adoption in assessing the value of the firm’s options in IT platform investment scenarios.

We approach a firm’s investments in enterprise integration (EI) technology from an RO perspective. EI solutions integrate applications, systems, data, business processes, and organizations, and so EI is vital to a firm’s quest to become a seamless and agile business that is able to meet a rapidly changing environment. XML is the key technology for EI, and XML is indeed becoming the *lingua franca* of the enterprise. EI embraces both the integration of business processes as well as the integration of data; and it subsumes the markets for Enterprise Application Integration (EAI), Enterprise Information Integration (EII), and Business Process Integration (BPI). As we demonstrate in this essay, investing in XML-based integration solutions represents a decision context that is characterized by much information uncertainty,
imperfection, and complexity. EI is an area marked by complex product technology, overlapping market segments, too many market players with finely differentiated products, and multiplying and overlapping standards. In this essay, a taxonomy of use cases of EI technology is built and also an uncertainty model for EI formulated that analyzes the uncertainty in these canonical integration use cases in terms of four principal factors: technical architecture, market, standards, and performance. Given the high level of uncertainty in the information frame of the decision-maker, it is thus appropriate to view the EI investment decision in RO terms.

4.2 Enterprise Integration - XML to the Rescue

Almost since the beginning of the computing age, the problem of how to get computers to talk to each other has plagued the computer industry. Getting computer systems, applications, and organizations to electronically communicate with each other in mutually intelligible ways defines the problem of enterprise integration, and the term ‘enterprise’ here is understood to refer to the larger enterprise which could include customer and partner organizations as well.

Integration has historically been a chaotic and ad-hoc affair involving everything from “sneakernet” or the physical movement of data between computers by humans, to using FTP (File Transfer Protocol) for moving files, to humans manually transcribing information from various applications and then inputting it to other applications. While the problem of the “plumbing” or the network infrastructure was long since resolved in the 1980s with TCP/IP winning the protocol wars against OSI (Zimmerman, 1980; Comer, 2000), the issue of achieving agreement on the upper layers of the computing stack where different applications can understand each other’s information and invoke each other’s services continued to bedevil the computing industry. There had been spirited attempts made throughout the 1990s to indeed achieve agreement on these upper layers. The Distributed Computing Environment (DCE) was
the first serious effort undertaken in the late 1980s and early 1990s by a consortium of powerful vendors including IBM, Digital Equipment Corporation, and Apollo Computer called the OpenGroup to standardize on mechanisms for applications to invoke services on each other (DCE Overview Home Page, 1996). The efforts of this consortium led to the definition of the DCE Remote Procedure Call (RPC) – a key development in the industry’s long search for standards in the upper layers of the technology stack. The RPC standard defines how the parameters of a function call are marshaled and un-marshaled through the use of proxies and stubs, the format of the protocol messages that travel over the wire, and how the interface provided by a callable component is defined --- the RPC specification is available from the OpenGroup (DCE 1.1 RPC Specification Home Page, 1997). Although the DCE effort provided some useful technology nuggets such as a standard RPC, DCE never really gained much traction and the focus of the industry soon shifted to the work of the Object Management Group (OMG) to define a set of distributed computing standards called CORBA (Slama et al., 1999; Bolton, 2001; CORBA Component Model Specification V4.0 Home Page, 2006). While the UNIX vendors coalesced around the CORBA standards, Microsoft went its own way to create a distributed computing architecture for the Microsoft environment called COM/DCOM (Box, 1998). This split between the UNIX and the Microsoft worlds eventually led to both CORBA and COM/DCOM’s inability to be accepted as industry-wide standards. Ironically, as the DCOM specification indicates, DCOM actually uses much of the DCE RPC (DCOM Remote Protocol Specification V6.1 Home Page, 2008), which was part of the industry’s first serious attempt to achieve standards for distributed computing.

The rapid rise of the Internet from the mid-1990s, the failure of COM/DCOM and CORBA to become industry-wide standards, and the rise of programming models such as Java’s
component-based Enterprise Java Beans (EJB) (Matena et al., 2003) led to the search for component interoperability standards that would work over the Internet. Given the mandate for developing Internet standards and determined to avoid the failures of the past which led to various schisms in the industry, the Internet Engineering Task Force (IETF) developed a range of standards for distributed computing over the Internet built around XML or the Extensible Markup Language. XML in and of itself is nothing but a standard for marking up text, or for introducing various types of special tags in the text that give meaning to the text (Ladd and O’Donnell, 1999). XML may be viewed as a specification language that enables the creation of context-specific languages that are intelligible to some community. Creating a context-specific language from XML involves defining an XML Schema which defines the tags that give meaning to a language. This XML Schema Definition or XSD is what is shared by the members of a community to have a common understanding of any XML document whose syntax and semantics conforms to a given underlying XSD (Walmsley, 2001; Vlist, 2001). This is a powerful concept for creating many types of XML-based languages such as RosettaNet or HIPAA/HL7. RosettaNet is an XML language for electronically exchanging business information such as invoices, purchase orders, price quotes, and shipping status in a business-to-business (B2B) environment (RosettaNet Standards Home Page, 2009). The XML-based RosettaNet language is rapidly replacing the Electronic Data Interchange (EDI) standard that was previously used for electronic B2B exchanges. While RosettaNet is a general language for B2B that can be used in a variety of industries, there are also many industry-specific languages such as HIPAA/HL7 for transactions and information sharing in the health care industry (Drumke, 2008; Shaver, 2007).
XML’s ability to create customized context-specific languages is useful not only in creating mutually intelligible documents for B2B environments, but this has also been fundamental to creating standards for distributed computing for the Internet. XML is the foundation for creating standards for so-called Web Services (Web Services Architecture Home Page, 2004). A Web Service is a component in the Internet environment that provides services that are callable by other applications. A Web Service is essentially the analogue of a Microsoft COM/DCOM or a CORBA callable component in today’s Internet environment. The Web Service standards which enjoy widespread support from all quarters of the industry such as UNIX vendors, application server vendors, Microsoft, and the open source community have finally solved the puzzle of achieving agreement on basic integration standards that eluded the industry for over two decades. There are three key Web Service standards, SOAP, WSDL, and UDDI, all of which are based on XML. The Simple Object Access Protocol or SOAP is the analogue of the DCE RPC in that it allows a standard mechanism and protocol for an application to invoke the services of another application (SOAP V1.2 Specification Home Page, 2007). SOAP messages conform to XML in that there is an XSD that defines the structure and semantics of SOAP messages. The Web Service Description Language (WSDL) also uses XML syntax to describe the services that an application provides to the larger environment (WSDL 2.0 Specification Home Page, 2007). Finally these WSDL descriptions are kept in what are known as Universal Description, Discovery and Integration or UDDI directories (UDDI V3.0.2 Specification Home Page, 2004). These UDDI directories can be interrogated by applications to see what services are being offered by other applications. The power of XML can thus be seen in that it is the foundation for all integration, whether it is integration in the B2B context by creating documents that are intelligible to the firm and its customers and partners, or it is the
integration of disparate systems and applications by creating standard mechanisms for invoking services. While XML has certainly been a positive development in creating basic integration standards, the standards wars, as we shall see later, have shifted to other arenas.

4.3 Strategic NPV and RO

Before setting up the taxonomy of EI use cases and the associated uncertainty model, the notion of Strategic Net Present Value (SNPV) is discussed. SNPV is a key construct that makes appraising investments from an RO perspective different from traditional valuation approaches based on an investment’s Net Present Value (NPV). RO is arguably a better analytic approach when there is a good deal of uncertainty in the decision context and management has some flexibility in dealing with this uncertainty because RO explicitly places a value on the flexibility that management has in changing its decisions when new information comes to light. The traditional NPV computation on the other hand assumes that the investment program decided ex ante persists into the future or that there is a pre-committed investment program. RO defines a new construct called the Strategic or Expanded NPV which takes into account the value of managerial flexibility, or in other words the value of the options available to management in any given investment program to change course as new conditions emerge (Trigeorgis, 2005; Trigeorgis and Mason, 1987; Park and Herath, 2000). Quite simply, Strategic NPV is defined as:

\[
Strategic\ NPV = \text{Passive NPV} + \text{Value of Managerial Flexibility}
\] (4-1)

Here, the passive net present value (NPV) of an investment is the NPV that is obtained through traditional DCF methods where a pre-committed investment program is assumed. SNPV recognizes that an investment is not a now-or-never proposition and that management has
various options available to it such as simply deferring the decision. In the world of financial assets, the price of a call option on a stock is given by the Black-Scholes options pricing formula (Black and Scholes, 1973) or some variant thereof, and the price of the call increases with increasing volatility in the price of the underlying stock. In an analogous fashion, the opportunity to invest in a real asset can be viewed as a holding a call option on the real asset; and as the uncertainty in the decision context rises, the value of option to defer making the decision becomes more attractive. The RO approach by bringing to the attention of the investor the value of the real options in an investment strategy can sometimes lead the investor to make decisions that are quite different from what would have been made if traditional valuation approaches were followed. In fact, as the level of uncertainty and confusion faced by the decision-maker rises, the stronger becomes the argument to view the prospective investment from a real options lens.

4.4 Research Methodology

The research approach and the analysis in this essay is essentially qualitative in contrast to the quantitative positivistic studies that dominate research in the IS field (Chen and Hirschheim, 2004; Straub et al., 2005). Quantitative positivistic studies are typically characterized by the formulation of hypotheses about relationships between constructs, the development of reliable and valid instruments for measuring such constructs, the collection of sample data through surveys or other methods, the testing of the hypotheses based on the sample data, and finally the generalization of the statistical results to larger populations subject to various limitations. The positivistic approach has generally been viewed in the social sciences including the business fields as the scientific way of studying problems in these fields (Kerlinger and Lee, 2000). More recently, however, both the legitimacy of and interest in qualitative research in the business fields, including in IS, have been rising with the growing recognition that human beings with
their ability to talk and listen and develop shared meaning are quite different from physical objects (Myers and Avison, 2002; Myers, 2009; Trauth, 2001). Hence, approaching humans as measurable objects and social phenomena as relationships between measurable constructs, although valuable, is not seen as wholly satisfactory by those researchers who hew to a more interpretivist view of epistemology. Much of the information about the rich context in which an IS phenomenon occurs is lost when it is viewed strictly through a quantitative positivist lens.

Orlikowski and Baroudi (1991) identify three distinct strains of IS research based on the epistemological underpinnings of the research: positivist, interpretive, and critical. Interpretive epistemology does not believe in an “objective” reality that can be revealed though a positivist lens; rather reality is open to interpretation and is relative to the participants in the phenomenon. Within an interpretive research framework, two prominent methods for data collection and analysis are ethnography and hermeneutics. The ethnographical approach to data collection involves the researcher being immersed in the social and cultural context of the phenomenon studied (Myers, 1999; Davies, 1991; Davies and Nielsen, 1992). The hermeneutical approach on the other hand does not require such a close-quarters immersion of the researcher and instead involves an analysis and interpretation by the researcher of textual data available about the phenomenon such as in newspapers, periodicals, and journals (Ricoeur, 1974, 1981); these days the Internet is of course also a major source of secondary data. The third category of critical studies attempts to not so much develop a theory for explaining the phenomenon at hand but it underscores that the phenomenon could entail negative outcomes for marginal groups without power; and therefore critical studies take a more uplifting and emancipative view and prescribe “how things should be” to obtain more desirable outcomes for all stakeholders (Orlikowski and Baroudi, 1991; Ngwenyama and Lee, 1997; Hirschheim and Klein, 1994).
This research largely follows an interpretive hermeneutical approach. Based on an analysis of secondary data available on the technology, market, and standards pertaining to EI, this essay first develops a taxonomy of use case cases of EI and an uncertainty model for assessing the uncertainty in each use case along the dimensions of technical architecture, market, standards, and performance. This uncertainty model then becomes a key element in the formulation of a broader RO-based decision-making framework for guiding investment decisions in the EI space. The decision-making framework takes into account the uncertainty, the real options available to management in different investment strategies, and firm capabilities with XML-based EI solutions. The decision-making framework developed is characterized by the following considerations and parameters:

- This decision-making framework is designed to facilitate the strategic sense-making process at the executive level which precedes the stage of detailed financial analysis.
- As this framework does not target the financial analysis stage, it does not develop a precise valuation model for the options available to management but allows any appropriate options valuation model to be plugged into the framework at a later stage.
- A key goal of the decision-making framework is to bring value to the strategic sense-making stage by providing a set of heuristics or “rules” which can aid executives in identifying preferred strategies that they need to explore further.
- The heuristics or decision-making rules provided as part of this framework are of the form:
  
  If uncertainty perceptions are high and the firm possesses well-developed capability with XML-based EI, then adopting an enterprise services bus (ESB) which provides options for layering services on the ESB at a later stage is preferred over adopting an EAI suite.
These heuristics are based on an imputation of the likely difference between the SPNVs of different investment strategies. In other words, the above heuristic says that under the given conditions of uncertainty and firm capability, the following relationship is likely to hold:

\[
SNPV_{ESB\text{-based strategy}} > SNPV_{EAI \text{ Suite-based strategy}}
\]

- The heuristics are high-level rules that help the strategist in narrowing the space of alternatives and provide a starting point for strategy definition but they should not be construed as applying in all contexts.

Finally, it should be stated that while the overall research follows an essentially interpretive hermeneutic approach, there are elements of positivistic thinking in this study as well. This is reflected in how the analysis approaches classifying uncertainty or firm capability into ‘high’ or ‘low’ regions, which could be viewed as a first step for developing measures for these constructs later on. Accommodating both elements of positivism and interpretivism in the same study is however not a contradiction. In other words, although Orlikowski and Baroudi (1991) classify research philosophies as positivist, interpretive, or critical, they do not explicitly rule out combining one or more these epistemological philosophies in a given study. In fact, the combining of different research philosophies and approaches in one study is also referred to as triangulation (Gable, 1994; Lee, 1991; Mingers, 2001). This study may thus be viewed as using triangulation in that there are elements of positivism within a largely interpretive hermeneutic approach. Qualitative studies also often pave the way for follow-on quantitative studies. Following an interpretive study by a positivist one is viewed as a natural evolution of a research program (Kerlinger and Lee, 2000).
4.5 Use Cases of XML-Based Enterprise Integration Technology

XML-based integration solutions are used to enable both data and process integration in the enterprise. We classify the use of XML-based EI technology in terms of the following four cases:

I. Message transformation

II. Process orchestration

III. Data storage and retrieval

IV. Heterogeneous information integration

Message transformation involves mapping messages from one format to another, such as from a proprietary format to XML to achieve integration across applications, systems, and business organizations. In process orchestration, the XML transformation capability is augmented by a process orchestration function for managing and integrating business processes. Microsoft BizTalk Server is an example of a process orchestration product (Microsoft BizTalk Server Home Page, 2007). Figure 4.1 shows the stand-alone message transformation and process orchestration use cases. An example of use case I would be an enterprise resource planning (ERP) system such as SAP R/3 exchanging information with a customer relationship management (CRM) system. While SAP offers newer interfaces based on Web Services, SAP still maintains legacy interfaces where information can only be obtained in a proprietary format called the SAP IDoc. The SAP IDoc documents would then need to be mapped into a standard XML format before being shipped to the CRM application to allow the ERP and CRM applications to collaborate in an integrated environment. The only difference between use cases I and II is that process mapping (shown as shaded in Figure 4.1) is present as an additional layer in use case II. The transformation of XML messages moving on a message transport infrastructure such as an Enterprise Services Bus (ESB) can be provided as a service on the ESB independently
of whether process orchestration is done or not. Also, as mentioned earlier, the term enterprise in this essay refers to the extended enterprise, so the scenario shown in Figure 4.1 could potentially include business-to-business integration (B2BI) flows as well, where an EDI message from another organization is transformed to an XML message before being sent on to an internal application. An example of use case II would be a situation where a business process management product such as Microsoft BizTalk manages business processes that engage the firm’s ERP system as well as a firm’s employees who participate in the business process via an employee portal. The ERP system, BizTalk, and the portal are end points on an ESB that provides the reliable messaging infrastructure. The business process being orchestrated by BizTalk could be the handling of product returns by customers which requires the approval of a manager because the price of the product being returned is above a certain threshold. In this scenario, BizTalk needs to coordinate inventory and accounting-related transactions associated with the product return that happen on the ERP system with human approvals obtained via the ESB-connected portal system.

Integration of traditional relational data stores with XML data is another major focus of enterprise integration. Currently, SQL relational databases are the dominant persistent data store technology deployed. Consequently, integrating with XML data involves mapping tree-structured XML documents to the inherent relational structure of the SQL stores (Figure 4.2). The integration of XML data is necessary not only within the context of a single persistent store but also across multiple stores of structured, unstructured, and semi-structured data in a heterogeneous environment. This heterogeneous information integration scenario is the final major use case of XML-based integration technology. This scenario is referred to as Enterprise Information Integration or EII. Figure 4.2 also shows the EII use case of information integration.
across a heterogeneous set of endpoints, which could include relational databases from different vendors, legacy applications, modern applications with Web Service interfaces, and XML documents and stores.

4.6 An Uncertainty Model for Enterprise Integration

We argue that the sources of uncertainty in the information frame of the decision-maker considering investing in XML integration solutions to the following four principal factors:

- Technical Architecture
- Market
- Performance
- Standards

The uncertainty model for investment in XML integration is given in Figure 4.3 which shows the primary causes behind each of the four principal uncertainty factors. Technical architecture refers to the architecture of a product’s technology and, depending on the product context, includes architectural aspects such as distributed versus centralized message brokering.
shredding versus opaque storage of XML documents, and federation of data versus tight schema integration. The technical architecture-related sources of confusion and uncertainty have to do with the existence of multiple and sometimes conflicting architectures in the variety of integration products. Market uncertainty is exacerbated by too many market segments with finely differentiated products that are also overlapping to a certain degree. Dissonant vendor messaging occurs when market players of different stripes such as EAI Suites and ESBs each hype their brand of product with powerful marketing and the customer is left confused as to the true
merits of each type of product. Furthermore, it often appears that there is a lack of directional clarity in some of these products with vendors sometimes trying to be all things to all people. As an example, Microsoft’s SQL Server product initially favored a shredding approach to storing XML documents but later appears to have switched to storing XML documents natively in effort to match its competitors such as IBM and Oracle (these different architectural approaches to storing XML information is discussed further in Section 4.6.1). Given the strong case that
Microsoft initially made for the shredding approach, these switches in product direction leave the market somewhat confused. Performance has always been a key customer criterion yet there are few good vendor-independent studies of performance, which makes performance claims somewhat questionable from the customer’s perspective. With newer architectures, there is also the lack of a historical base of experience in performance optimization. The state of the standards has done much to confound matters further given the plethora of standards in the integration area, some of which are overlapping. The relative immaturity of some key standards gives both users and vendors pause before they can commit to them. These sources of uncertainty are, however, present to different extents in the four canonical use cases of XML integration technology, and we discuss these interactions next. The question of course arises whether in this uncertainty model the four factors of technical architecture, market, standards, and performance span all the main sources of uncertainty that matter. In building the uncertainty model, the approach we have taken is to build a parsimonious model of large aggregated constructs in the same fashion that the TAM was developed as a parsimonious model of large constructs such as usefulness and ease of use (Davis 1989). The approach in the TAM is to have large constructs at the top level and then allow for many more granular constructs that could serve as antecedents to usefulness and ease of use. In the same fashion, our uncertainty model has a parsimonious structure at the top level and there could be many antecedents to these top-level constructs to account for a variety of more specific sources of uncertainty. The model shown in Figure 4.3 is prescriptive to a certain degree only with regard to the large constructs of technical architecture, market, standards, and performance where these constructs can be viewed as containers or mediators for many more granular constructs underneath them. Figure 4.3 is illustrative at the second level where we have given some examples of the type of antecedents that can feed the
top-level constructs. Furthermore, expansion of the top-level mediating constructs is not precluded. This would of course be an extension or modification of the current theoretical model just as the UTAUT (Venkatesh et al. 2003) many years later modified the TAM (Davis 1989) by increasing the top-level mediating constructs to four from the TAM’s original two.

4.6.1 Technical Architecture

The integration of the relational and XML-oriented worlds of data storage (Use Case III) demonstrates the most profound uncertainties in technical architecture. Three basic approaches that have been debated over the last several years by the vendor and academic communities to storing XML data in a relational database are: 1) store the entire XML document as a character large object (CLOB) or a binary large object (BLOB), 2) store it as a native XML data type, and 3) shred the document and store its contents in the database tables. Each approach has its pros and cons. Storing the XML document as a CLOB has the advantage of preserving all of the information in the original document. However, storing the document as a CLOB or a BLOB makes it opaque to transactions that need to update only parts of the document. Consequently, Kappel et al. (2004) in their review of techniques of mapping XML data to relational databases favor the shredding approach where there is a mapping schema to map the schema of the XML document to a relational schema for storing. Products such as Microsoft’s SQL Server were among the first to have embraced the shredding model.

Those vendors who don’t view the CLOB or the shredding approach to storing XML in relational databases to be the most effective method have moved quickly towards supporting a native XML data type. This new XML data type is based on the W3C standard called the XQuery 1.0 and XPath 2.0 Data Model (2007), which is also simply referred to as the XQuery
Data Model or XDM. The XDM in effect standardizes on the tree view of an XML document. The major relational database vendors have migrated their database offerings to a hybrid relational-XML architecture which supports this new XML data type (Ozcan et al., 245). However, the extent of support for the XDM and XQuery is not uniform among all vendors. Finally, as opposed to hybrid storage models favored by the established relational database vendors, there is the camp of native XML database proponents with products such as Tamino. Jagadish et al. (2002) describe the architecture of a native XML database called TIMBER which utilizes a tree-based algebra called TAX that is well-suited to the manipulation of natively stored XML data. This discussion on the various solutions for the storage and retrieval of XML data demonstrates the wide variety of architecturally different approaches to the problem. Each such approach has its own following among the vendors who continue to pull this market in different directions. All this makes for a picture of considerable confusion and uncertainty for customers. Therefore, for the data storage and retrieval use case, the uncertainty with respect to the technical architecture factor is deemed to be high.

4.6.2 Market

In the uncertainty model for EI shown in Figure 4.3, the antecedents to the principal factor that captures the market-related sources of uncertainty and complexity are overlapping market segments, finely differentiated products, dissonant vendor messaging, and lack of product directional clarity. All of these sources of uncertainty are present in the EAI, EII, and BPI product markets. In the taxonomy of use cases that was described in Section 4.5, EAI, BPI and EII products correspond to the use cases I, II, and IV. There is much confusion and overlap between the EAI, BPI and EII markets. The EII market grew out of products that were historically characterized as Extract, Transform, and Load (ETL) products used for establishing
data warehouses. Around the same time, vendors with federated database products also moved into the EII space. As opposed to the data integration-focused EII products, EAI and BPI were oriented towards process integration. However, with the advent of the real-time enterprise, the data integration and process integration worlds have borrowed heavily from each other, blurring the distinction between EAI, BPI, and EII. Today we have all of the following stripes of vendors competing in the enterprise integration space:

- **EAI Suites**: Suite players have a full range of integration functionality including message brokering, data transformation, and business process management woven into a tightly-knit suite. Examples of suite products are BusinessWorks Suite from Tibco (Tibco BusinessWorks Home Page, 2007) and the webMethods Suite from Software AG (webMethods Product Suite Home Page, 2007).

- **Enterprise Service Bus (ESB)**: ESBs are essentially distributed message brokers. ESBs by themselves have less functionality than EAI suites. However, ESBs allow for value-added services such as data transformation to be layered on top of the reliable message transport infrastructure provided by the ESB. ESB vendors include Fiorano (Fiorano ESB Home Page, 2007), Cape Clear (Cape Clear ESB Home Page, 2007), and Progress Software (Progress Sonic ESB Home Page, 2009).

- **Application Servers**: While application servers were originally developed to provide a foundation of services for building applications, application server vendors have moved rapidly into the integration market. The two major application server products with integration services are IBM WebSphere (IBM WebSphere Home Page, 2007), and BEA WebLogic Workshop (BEA WebLogic Workshop Home Page, 2007).
• Extract, Transform, and Load (ETL): ETL products were originally utilized for constructing data warehouses for decision support purposes, but these products now compete head-on in the integration space. Examples of ETL products include Informatica’s PowerCenter (Informatica Data Warehousing Solutions Home Page, 2007) and Pervasive ETL (Pervasive ETL Home Page, 2007).

• Enterprise Information Integration (EII): EII products use metadata management to offer a single enterprise-wide view of all data held in the various databases and applications of the enterprise. MetaMatrix Enterprise (Metamatrix Enterprise Home Page, 2007) and Ipedo XIP (Ipedo XIP Server Home Page, 2007) are examples of products that federate data into a global view.

• Business Process Management (BPM): BPM products are used for orchestrating business processes across applications, systems, and organizations. BPM functionality can be obtained in various ways including as part of a larger EAI suite, as a layered service on top of an ESB, or as a stand-alone product. Microsoft’s BizTalk Server (Microsoft BizTalk Server Home Page, 2007) and BEA’s AquaLogic (BEA AquaLogic Home Page, 2007) are examples of BPM products.

• Business Activity Monitoring (BAM): The churn in the integration market is also throwing up entirely new product categories such as BAM. BAM players leverage the underlying integration infrastructure to present in real-time the state of the business in what they call “executive dashboards.” Examples of BAM products include Innovalink (Innovalink Home Page, 2007) and Systar (Systar BAM Solutions Home Page, 2007).

The enterprise integration market is very much in a state of flux and one that is claimed by players of many stripes that are constantly redefining this market. The boundaries within the
many segments in this market are blurring and shifting as players try to encroach on each other’s territories. Consequently, for the use cases I, II, and IV, the level of uncertainty associated with the market factor can be deemed to be high.

Even with regard to use case III, which focuses specifically on XML storage and retrieval, the database vendors have muddied the water by presenting messages which have caused dissonance in the market place. Although the relational database vendors have moved to support the new XDM-based XML data type, the extent of support is far from uniform across these products. Vendors have also played a “check off the box” game in this market where they can notionally claim support for every type of feature the market appears to want. However, behind this nominal support for a broad range of popular features, there is a dominant model that lies at the core of each vendor’s technical architecture and strategy, and which is its true strength. It is instructive to trace the historical path that the database vendors have taken in moving towards XML support as that signals the dominant model that the vendor espouses. Microsoft was slower in providing native support for XML as the shredding model was Microsoft’s mainstay for a considerable period of time. SQL Server 2005 was essentially the first version to see support for natively storing XML. IBM and Oracle have been much quicker in supporting the XDM-based XML data type. However, as McCown (2004) noted, IBM has been in more of a watchful mode towards XQuery waiting for the standard to mature before fully supporting it in DB2 while Oracle has been the quickest in providing a full range of support for XML capabilities. This essay however does not necessarily equate the speed of support for XML capabilities with value creation and we take note of it only in so far as that reflects the different strategies and market messages with each vendor is approaching this market. The presence of different dominant models continues to pull this market in different directions, and the confusion
is exacerbated by the fact that each major vendor also tries to play in all niches of the market. Given this situation, it becomes difficult in some cases to discern a clear strategic trajectory for the evolution of these products. Hence, as in the other use cases, market-related uncertainty is also deemed to be high in the data storage and retrieval use case.

4.6.3 Standards

Standards play an important role in any investment decision to deploy XML-based technologies. XML is all about standards. The problem is that in the area of EAI, BPI, and EII there are far too many standards that would reasonably tax any user organization’s abilities to keep track of and evaluate. As an example, in the area of business process management itself, all of the following standards had been proposed at one time or the other by a medley of standards groups, consortiums, and vendors with market-moving power:

• BPML (Business Process Management Language)
• XLang
• BPEL (Business Process Execution Language)
• WSFL (Web Services Flow Language)
• WSCI (Web Services Choreography Interface)
• ebXML BPSS (Business Process Schema Specification)
• BPEL4WS (Business Process Execution Language for Web Services)

Furthermore, what often happens is that previously proposed standards don’t go away, rather they are often subsumed under other standards as a matter of political expediency and compromise, which does nothing to lessen the informational complexity faced by users as they ponder standards in this space.
Another troublesome problem with some key XML standards is that they overlap causing confusion regarding the role of these standards, the direction they are evolving in, and the appropriate positioning of products utilizing these standards. With regard to XML mapping, a core function in XML integration, XSLT and XQuery are the two key standards both of which can be applied to the problem of building a new XML document based on extracting information from one or more XML documents (Hoffman 2005). Hoffman (2005) believes that both XSLT and XQuery will continue to coexist. While the preservation of both standards may indeed be justified as each has its own distinctive strengths, the overlap between XSLT and XQuery will continue to present a confounding picture to users. Moreover, as the XQuery standard is enhanced in future to include an update facility (XQuery Update Facility Requirements, 2005), it will have the capability to modify XML messages which would potentially deepen the overlap with XSLT.

Another key issue is that many relevant standards are still in an immature state which makes both users and vendors nervous for they may feel that they are committing too early. Recently, XQuery and the XDM standard, on which the native XML data type is based, have been ascendant with many database vendors moving to support these two standards. However, despite the clamor around XQuery, this is still in many respects an immature standard. As yet, it lacks the vital capability of updating a portion of an XML document as part of a transaction. The key capability of transaction management with its support for the ACID (Atomicity, Consistency, Isolation, and Durability) properties is still in the early stages of discussion in XQuery (XQuery Update Facility Requirements, 2005). All in all, the multiplicity, overlap, and lack of directional clarity in many cases in the standards arena paint a rather confusing picture to the decision-maker particularly given the central role of standards in XML. Consequently, there
is a high level of standards-related uncertainty in the process orchestration and data storage and retrieval use cases.

4.6.4 Performance

There is a paucity of independent studies on the performance of key technologies and standards such as XLST and XQuery. Many performance reports are either produced by the vendors themselves or groups affiliated with vendors. Such performance reports show a vendor’s offerings in the best possible light in relation to its competitors. With most vendors producing such reports, this results in an environment of high information imperfection from the customer’s perspective. Some good independent research has been done on performance from a theoretical perspective where the computational complexity of XQuery has been analyzed (Gottlob et al. 2005). Gottlob et al. (2005) have studied the computational complexity of XPath 1.0 and find that the combined data and query complexity is in the Polynomial Time-Hard class of problems. They find that certain XPath constructs such as negation lead to this hardness. While this theoretical work does provide some interesting insights, we need more rigorous and vendor-unaffiliated research at the empirical level as well. It is worth reiterating that SQL query optimization techniques in the relational world have been analyzed and refined over many years. In contrast, the base of knowledge on optimizing the execution plan for XQuery calls is relatively meager. The relative immaturity of some of these integration technologies and the lack of true vendor-independent testing makes for an uncertain picture across the board as far as performance is concerned. Therefore, performance-related uncertainty is assessed to be high for all of the use cases. The bottom line is the integration industry needs to do more to improve the quality of information available about the performance of its products. This industry would do well to fully adopt the networking industry’s model where performance testing is off-loaded to
truly independent testing and certification organizations, which also sponsor product “bakeoffs” between competitors where these products are all tested for performance under the same set of scenarios.

4.6.5 The Use Case-Uncertainty Mapping Matrix

The preceding discussion on the nature of the uncertainties in the decision context to invest in XML-based EI and the use cases where these uncertainties are high is captured in the EI Uncertainty Matrix shown in Table 4-1. The cells of high uncertainty mark special areas of concern; for example, the table shows that technical architecture-related uncertainty is high in the XML storage and retrieval use case while market uncertainty is high in all the use cases.

<table>
<thead>
<tr>
<th>XML Integration Use Cases</th>
<th>Principal Factors of Uncertainty</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Technical Architecture</td>
</tr>
<tr>
<td>I. Message Transformation</td>
<td>Low</td>
</tr>
<tr>
<td>II. Process Orchestration</td>
<td>Low</td>
</tr>
<tr>
<td>III. Storage and Retrieval</td>
<td>High</td>
</tr>
<tr>
<td>IV. Heterogeneous Information Integration</td>
<td>Low</td>
</tr>
</tbody>
</table>

Table 4-1: EI Uncertainty Matrix
In composing the uncertainty matrix shown in Figure 4-1, the scenarios that were not specifically discussed in Sections 4.6.1 through 4.6.4 as being areas of high concern from an uncertainty standpoint are assumed to have low levels of uncertainty. An overall level of uncertainty can be ascribed to the EI investment decision context depending on the proportion of cells marked high in the EI Uncertainty Matrix. A high proportion of such cells would indicate a high overall level of uncertainty in this context. Where the thresholds are set in terms of what constitutes a high proportion or a low proportion is left to the decision-maker and their level of tolerance for uncertainty. It is also important to note the snapshot-in-time nature of the uncertainty matrix. As uncertainty lifts in various areas, cells marked high can convert to low; conversely those marked low can also be turned into high if new conditions arise to cause the state of affairs to become more unsettled than what it was previously.

4.7 RO Decision-Making Framework for EI Investments

The decision-making framework for EI investments is characterized in terms of uncertainty, firm capabilities, and the value of the real options available to management in different EI investment strategies. This decision-making framework helps in identifying preferred strategies for various scenarios of uncertainty and firm capability. Strategy theorists have been increasingly taking the view that strategy is nothing but a series of exercises of real options by the firm (Bowman and Hurry, 1993). IT investment strategy may be similarly conceived in terms of the real options that a firm can exercise in given scenarios. Benaroch has developed a general taxonomy of real options that are available in any IT investment scenario (Benaroch, 2002; Benaroch et al., 2006), and we utilize this taxonomy in formulating the EI decision-making framework. Benaroch’s classification comprises the following main types of real options:
**Defer** – Postponing the investment for the purpose of learning more about the potential outcomes of the investment.

**Stage** – This involves building out the investment in stages. The payoffs come only after all stages have been implemented.

**Pilot** – Similar to the staging option, this option involves implementing a pilot before the full investment; but unlike staging, a pilot is simply a smaller version of the full investment. In other words, investment payoffs do flow from the pilot project and this can usually be scaled up later to realize the full benefits from the investment. As in the case of staging, learning is an important part of the piloting phase.

**Alter Scale and Scope** – Adding new capabilities or expanding the scale, such as increasing the transactional throughput rate, after the full investment has been made entails exercising alter scale and scope options. These alter scale and scope options could either expand or contract the investment, that is, they could be scale up or scale down options.

**Abandon** – If conditions worsen, the firm may choose to exercise the abandon option and simply realize the salvage value of the investment.

**Strategic Growth** – Strategic growth options differ from the alter scale and scope options in that the alter scale and scope options are exercised in the context of the current investment. They can only add to the scope and capabilities of the current investment. Strategic growth options on the other hand refer to possibilities for entirely new investments that can be spawned from the current investment.

Our RO-based decision-making framework which combines the concepts of uncertainty, firm capability, and preferred strategies for exercising real options is shown in generic terms in Figure 4.4. This generic framework will later be specified to the case of investment in EI. When
the firm capability with XML-based EI is low and the level of uncertainty is perceived to be high (quadrant II), the preferred strategy is to exercise the defer option when it pays to wait for at least some of the uncertainty to be resolved and to learn more about the technology and the market conditions before making any investment moves. In this quadrant, the likely relationship between the SNPV of the defer option versus making any investment is:

\[ \text{SNPV}_{\text{defer option}} > \text{SNPV}_{\text{investment}} \]  

(4-2)

As some of the uncertainty around EI technology, market and standards resolves itself and we move from quadrant II to quadrant I, the SNPV relationship that is likely to apply is:

\[ \text{SNPV}_{\text{pilot or stage option}} > \text{SNPV}_{\text{no investment}} \]  

(4-3)

<table>
<thead>
<tr>
<th>Firm Capability</th>
<th>High</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Uncertainty</td>
<td>Full Investment, Strategic Growth Options (III)</td>
<td>Maximize Alter Scale/Scope, Exit Options (IV)</td>
</tr>
<tr>
<td>Low Uncertainty</td>
<td>Pilot, Stage Options (I)</td>
<td>Defer Option (II)</td>
</tr>
</tbody>
</table>

**Figure 4.4: RO-Based Decision-Making Framework**
In other words, it makes sense to invest a certain amount to explore EI technology through exercising various piloting or staging options which provide opportunities for learning about XML-based EI without incurring a large investment outlay. One approach for the firm to gain experience with XML-based EI without a large outlay is to leverage the XML-capabilities of hybrid relational and XML databases, particularly when the migration to the more recent versions of the relational databases has already occurred as part of other initiatives such as to expand the storage capacity or manageability of the firm’s persistent data infrastructure. The upgrading of the firm’s data infrastructure brings the added benefit of XML storage since all of the latest versions of the major relational databases such as IBM DB2, Microsoft SQL Server, and Oracle also now support native XML data storage capabilities. This enables the firm to experiment with a pilot application that manipulates both traditional relational and newer XML data and provides a low-cost path to implementing the larger XML-based EI strategy for the firm. Because the firm is still in a learning mode in quadrant I, it is premature to consider investments in an ESB or a full EAI suite at this stage. More formally, the likely SNPV relationships that apply in quadrant I are:

\[
SNPV_{XML \ storage \ pilot \ application} > SNPV_{ESB} \quad \text{and} \quad SNPV_{XML \ storage \ pilot \ application} > SNPV_{EAI \ Suite} \quad (4-4)
\]

It is only when firm capabilities with EI technology become sufficiently high that it makes sense for the firm to consider deploying an ESB or an EAI suite which serves as the foundation for building out the firm’s integration infrastructure. The Capability Maturity Model (CMM) may be used as a framework for organizing a firm’s progression through different levels of capability with XML-based EI. The CMM was originally developed for assessing an organization’s
capability with the software development process (Humphrey, 1989) and it was based on the Quality Management Maturity Grid developed by Crosby (1979). Crosby’s (1979) definition of different levels of maturity of the organization with regard to quality management was reinterpreted by the CMM to suit the context of the software development process (Humphrey, 1989). The five levels of maturity defined in the CMM (Humphrey, 1989; Paulik et al., 2003) are shown in Table 4-2. Since the initial development of the CMM, the CMM has actually been adapted to a number of different contexts such as to business process transformation (Hammer, 2007), organizational learning (Chinowsky et al., 2007), designing business continuity management systems (Sheth et al., 2007), and customer service operations (Bailor, 2006). The original CMM model as shown in Table 4-2 often simply serves as the basis for these new adaptations. For instance, Hammer (2007) used the CMM to define a Process and Enterprise Maturity Model or PEMM to assess how capable an organization is in effecting process-based business transformation. In such adaptations, the original CMM levels are reinterpreted to suit the new context. Following this tradition of adapting the CMM to different contexts, we define

<table>
<thead>
<tr>
<th>CMM Level</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 1 – Initial</td>
<td>Success is sporadic, ad-hoc, individually driven, and not repeatable.</td>
</tr>
<tr>
<td>Level 2 – Repeatable</td>
<td>Sufficient formalization and structure has been established to repeat successes.</td>
</tr>
<tr>
<td>Level 3 – Defined</td>
<td>Organization has developed standardized processes, processes are well documented and integrated.</td>
</tr>
<tr>
<td>Level 4 – Managed</td>
<td>Organization establishes metrics for success and monitors and controls its own processes.</td>
</tr>
<tr>
<td>Level 5 – Optimizing</td>
<td>Continuous improvement of processes.</td>
</tr>
</tbody>
</table>

Table 4-2: Capability Maturity Model
an Enterprise Integration Maturity Model or EIMM where a firm’s capability with EI is defined in terms of five levels as shown in Table 4-3. When an organization is operating at EIMM Levels 1 or 2, it can be deemed to have low capability with EI and conversely it has high capability with EI when it is operating at EIMM Levels 4 or 5.

In this decision-making framework, when the organization is capable of working with ESBs and EAI suites, EIMM Levels 4/5, the choice of an EAI suite or an ESB-based strategy to integration essentially depends on the level of uncertainty, that is, whether the firm is operating in quadrant III or quadrant IV. As indicated in Figure 4.4, the prescription for the investment strategy when the firm in quadrant IV and uncertainty is high is to choose the strategy with the maximum number of real options for altering scale and scope, either up or down. These alter scale and scope options can then be exercised depending on how the future unfolds, and

<table>
<thead>
<tr>
<th>EIMM Level</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 1</td>
<td>Organization is getting into XML, individual pockets of XML knowledge exist but it is not institutionalized, organization can handle pilot projects for migrating individual applications which use both XML and relational data.</td>
</tr>
<tr>
<td>Level 2</td>
<td>Organization is capable of handling multiple projects for migrating applications that use both XML and relational data.</td>
</tr>
<tr>
<td>Level 3</td>
<td>Organization is moderately capable of implementing well-architected and institution-wide approaches to integration based on ESBs and EAI suites.</td>
</tr>
<tr>
<td>Level 4</td>
<td>Organization is increasingly confident with ESB and EAI technology and moves from a primary focus on the integration issues to concerns of how best to manage the integration infrastructure.</td>
</tr>
<tr>
<td>Level 5</td>
<td>Organization is capable of optimizing the integration infrastructure, minimizing delays in transforming messages and managing processes, and expanding the scale of EI infrastructure.</td>
</tr>
</tbody>
</table>

Table 4-3: Enterprise Integration Maturity Model
these options are highly valued precisely because the future is seen to be so cloudy at this time. The investment strategy that best provides these options for altering scale and scope, either up or down, is an ESB-based strategy. ESBs provide the flexibility of altering scale and scope by allowing services to be layered on top of the ESB. The ESB itself is essentially nothing but a distributed message broker providing reliable message transport and with a services layer for plugging in new services (Progress Sonic ESB Home Page, 2009; Fiorano ESB Home Page, 2007). Consequently, services for adding capabilities such as data transformation, process orchestration, and business activity monitoring can be layered at later stages as shown in Figure 4.5. Services can also be easily removed from the ESB should the future unfold negatively thereby necessitating scaling down the integration infrastructure. ESBs because of their distributed architecture allow not only changing scope or the layering of new services but also changing scale by simply adding message brokering endpoints, thus increasing the aggregate message throughput and geographical footprint of the ESB. EAI suites on the other hand come with a range of functionality which is pre-integrated into a suite product including capabilities such as message brokering, data transformation, and process orchestration. Hence, suite products do not embed a rich set of alter scale and scope options. However, in quadrant III where uncertainty is low, there is not such a high premium on the value of managerial flexibility. Hence, the SNPV relationships that are likely to apply are as follows:

For quadrant IV: \( SNPV_{ESB} > SNPV_{EAI\ Suite} \) \hspace{1cm} (4-5)

For quadrant III: \( SNPV_{EAI\ Suite} > SNPV_{ESB} \) \hspace{1cm} (4-6)
It should be noted that an EAI suite-based strategy is not totally devoid of managerial options. While an EAI suite is not as rich in alter scope and scale options as an ESB, strategic growth options are available in EAI suites as these pertain to options outside the current investment. EAI suites can be integrated at a later stage with different types of products such as an executive dashboard that shows the real-time state of the business. Strategic growth options are also available with ESBs but for quadrant III where uncertainty is high, the premium is really on the alter scale and scope options, either up or down, since the future is too cloudy to take a very long range view. Hence, it is the alter scale and scope options that ESBs provide that matter more than the strategic growth options thereby making the ESB the best choice for quadrant III.

The RO-based decision-making framework shown in generic form in Figure 4.4 can now be specified to the context of EI investment by integrating all the ideas on uncertainty, firm capability and real options strategies discussed previously. This framework is shown in Figure 4.6.
4.8 Conclusion

We have argued that the decision to invest in XML-based integration technologies is associated with an information context that is fraught with much complexity and uncertainty. It is precisely such decision-making contexts to which a real options approach is most suited. The real options frame best guides the normative evaluation of the balance between exploitation and exploration (Kogut and Kulatilaka 2001). If traditional valuation approaches were to be applied to XML integration investments, they would likely favor quick exploitation since XML clearly does bring value to the enterprise. Looking at the same investments from a real options lens, however, would point to a more nuanced and cautious approach. The RO perspective encourages decision-makers to look at their alternatives by including an assessment of the value of managerial flexibility inherent in each alternative. Possible responses by management to the question of investing in XML-based integration range from simply deferring the investment decision to...
making a small exploratory investment to exploiting the technology in various ways that differ in
the degree of managerial flexibility or have different types and levels of real options embedded.
This essay’s recommendation is that the real options view and the arguments regarding
uncertainty and firm capability be utilized by decision-makers as a conceptual framework in
analyzing the decision to implement enterprise integration. The simple conscious recognition
that deferring may have real intrinsic value is a positive step. Examples where firms have moved
forward in very uncertain environments, often due to bandwagon effects associated with new
technologies, are numerous and have often resulted in negative consequences for the
organization. Furthermore, since uncertainty and firm capability both influence the real options
strategy, firms with greater capability with XML-based EI can take bolder steps such as
deploying EAI suites or ESBs whereas firms with low capabilities in the EI space are better off
deferring the investment decision or taking a small exploratory step such as migrating a
traditional application that has historically used relational data to now also handle XML data.
Consequently, the decision-making framework for EI developed in this essay considers both firm
capability and uncertainty and develops heuristics for preferred real options strategies under
different combinations of uncertainty and firm capability. This framework will clearly be useful
to management in organizing their thinking and formulating an EI strategy as they confront a
bewildering array of choices which include technologies and products such as Enterprise Service
Bus (ESB), message broker, Extract Transform and Load (ETL), Enterprise Application
Integration (EAI) suite, metadata manager, Enterprise Information Integration (EII), Business
Process Management (BPM), and Business Activity Monitoring (BAM).

Approaching investment decisions from a real options view represents a rather dramatic
departure from the traditional discounted cash flow (DCF) valuation approaches that firms are
familiar with. In recognition of the problem of the complexity behind options pricing models, there have been attempts made to make RO analysis more tractable by reducing it to a procedure that is akin to computing the net present value (NPV) of an investment. Feinstein and Lander (2002) show that if a properly weighted average of the risk-free rate and the NPV discount rate is used to discount future cash flows, then the RO and NPV models lead to equivalent results. Firms would do well to start building expertise in the real options methodology which represents perhaps the most significant advance in the areas of capital budgeting and corporate strategy in the last fifteen years.

Finally, aside from the benefit of this essay in guiding managers on how to approach strategic investment decisions in the EI space, this essay has value to IS researchers in that it details a general methodology for approaching IS research problems that falls quite a bit outside the traditional genre of positivist research seen in IS. This essay employs an interpretive hermeneutic methodology in developing a strategic decision-making framework wherein firm capability and uncertainty determine the real options value of different strategic investment choices. This general approach can be replicated in other investment contexts in IT and even elsewhere, such as in advanced manufacturing, where uncertainty is a key factor in the decision context. In this general approach, the hermeneutic analysis first focuses on understanding the technology, market, and standards pertaining to a given technology investment. The hermeneutic analysis is based on examining textual records on the relevant technology, market, and standards that exist in newspapers, journals, and the Internet. The hermeneutic analysis equips the researcher with an understanding of the strategic choices available to the firm in the given technology investment context and also the level of uncertainty attendant to the principal factors of technical architecture, market, standards, and performance. The next stage of the research then
focuses on the interpretive aspect of the interpretive hermeneutic analysis wherein the researcher provides an interpretation of the likely relationships between the real options values (SNPV) of different strategic choices for certain combinations of uncertainty and firm capability. This entire process eventually results in an RO-based decision-making framework of the kind shown in Figure 4.6 for the technology investment under consideration.
5. Conclusion

This dissertation comprises of a set of three essays on emerging practitioner-relevant theories and methods for the valuation of technology. These three essays are tied together on two dimensions: a shared theme and a shared focus. This common theme and focus in fact characterize the research area of this dissertation. Practitioner-relevance is the common theme of this dissertation and emerging valuation methods for assessing capital investments in technology is its common focus. Practitioner relevance of academic research is a controversial topic that has been much debated over the years with many who have expressed concerns about the relative lack of relevance of academic research to practitioners (BusinessWeek 1990, Gopinath and Hoffman 1995, Benbasat and Zmud 1999). More recently, AACSB International’s Task Force on the Impact of Research (AACSB International, 2008; Shinn, 2008) issued a strong call to increase the relevance of academic research and the key conclusions from their report include:

- business schools must find ways to increase the value of their research to students, practitioners, and society at large
- business schools should be required to demonstrate the impact of their intellectual contributions
- a business school cannot separate itself from practice and focus only on theory and still serve its function

There is in fact a hand-in-glove fit between this dissertation’s theme and what the AACSB is exhorting academia to do. Since practitioner relevance is the theme of this dissertation, the first essay describes an innovative new approach for empirically assessing practitioner relevance of academic research. This method involves modeling academic interest and practitioner interest in some topic as a two-component vector autoregressive (VAR) process and testing for Granger...
causality between the components of the VAR. Academic and practitioner interests in a topic are proxied by the number of publications in academic and practitioner literature, respectively, on that topic. Significant Granger causality tests would indicate a degree of coupling between the discourses of the academic and practitioner communities. Absence of any Granger causality would be supportive of the notion that the academic and practitioner communities behave akin to “ships passing in the night”. Our approach involves both examining Granger causality between components of the VAR after they have been stabilized, in case they were not stationary to begin with, and also the equilibrium relationship between these components using cointegration regardless of whether they were stationary. Given the dissertation’s common focus on emerging valuation methods and theories, we test our model against two such well-known cases: RO and EVA. As the literature review in Section 2.6 indicates, RO and EVA both have the potential of having a high impact on the business world and therefore the choice of these two methods also ties in well with this dissertation’s common theme of practitioner relevance.

The contribution of the first essay is two-fold: The primary contribution of the essay is that it specifies a general methodology that academics can use to assess if their ideas are indeed being picked up and discussed by the practitioner community thereby demonstrating the impact of their intellectual contributions. At this level, the contribution can be viewed as answering the call by the AACSB as we are providing a way of measuring if such impact is in fact occurring. The essay is also asking academics to become much more vigorous in disseminating their intellectual contributions, whose scientific validity has been pre-tested through publications in highly quality academic journals, to practitioners by publishing in practitioner media outlets. It should be emphasized that our recommendation here for academics is not to simply increase publication activity in practitioner media, which is readily achieved, but indeed to do so for only
those ideas whose veracity has been examined by the academic community beforehand. The second contribution of this essay is that it tests whether Granger causality between academic and practitioner discourses in fact exists in the context of the important topics of EVA and RO. It is interesting that we find that there is Granger causality in the direction from practitioner interest to academic interest but not vice versa. This buttresses the argument that academics must do more to promote their ideas to practitioners, particularly those ideas for which the balance of the opinion in the academic community is deemed to be favorable.

The second essay is yet another offering on the common theme of practitioner relevance and the common focus of emerging values and methods. In this essay, we develop a theoretical model for the drivers of firm-level adoption of new methodologies such as EVA and RO. Our theoretical model called the Methodology Adoption Decision Model (MADM) is inspired by the TAM (Davis 1989) but is also different from the TAM. We have argued in this dissertation that the primary strength and habitat for the TAM is the adoption of technology by individuals whereas that of the MADM is the adoption of methodology by firms. Nevertheless, we have borrowed concepts from the TAM and our model shares its parsimonious nature in that two powerful constructs, theoretical soundness and the practical applicability of a methodology, are deemed to drive its adoption by a firm. In the MADM, these two constructs are also conceived as community-centric constructs, in that theoretical soundness of a methodology is something that is perceived by the academic community as a whole and, similarly, practical applicability is in the eyes of the practitioner community. The voice of academic community is deemed to be expressed by their publications in academic literature and similarly that of the practitioner community by publications in practitioner literature. Consequently, theoretical soundness and practical applicability are measured through a sentiment extraction experiment which gauges if
the balance of the opinion of the academic and practitioner communities is favorable or unfavorable towards the methodology in question. The full validation of the MADM is expected to be done within a Lakatos epistemological framework (Lakatos, 1976, 1978) which does not target the basic propositions of a theory for Popperian falsification (Popper, 1959), and instead seeks out alternative theoretical explanations for the phenomenon thereby targeting falsification at the level of competing theories (Lado et al., 2006). Consequently, the basic propositions of the MADM are declared as axioms rather than hypotheses to be tested. In doing so, the MADM is following a development path similar to that of other theories such as the Resource Based View (RBV) (Barney, 1991, 2001). The future work of testing the MADM against competing theories is discussed more later on in Section 5.2. Based on the axioms of the MADM and the sentiment extraction experiment conducted where it was found that the practitioner sentiment is more favorable towards EVA than RO and the academic sentiment is indifferent between the two, EVA has a greater likelihood of being adopted than RO. This implication of the MADM is consistent with what the literature says about the rapid spreading of EVA. In other words, the essay implicitly tests MADM theory in that an implication of the MADM is found to be consistent with the evidence in secondary data, thus providing a partial validation of the MADM. The contribution of this paper is both in the general theory of methodology adoption which can be applied to cases other than EVA and RO, and also in the managerial prescription that it provides about the important methods of EVA and RO. The conclusion for these two specific cases is that EVA is more likely to be adopted than RO, which is consistent with the intuition that the mathematical complexity behind options pricing models could potentially stymie the adoption of RO.
The final essay is an application of the emerging valuation method of RO to the context of investments by firms in enterprise integration (EI). EI is a key area of investment by firms as it ties together the systems, applications, and organizations of the extended enterprise including the firm and its partners and customers. EI also represents a context fraught with much uncertainty in the technology, standards, and markets associated with EI, thereby making RO a particularly apt theoretical lens from which to view EI investments. This essay eschews the traditional quantitative positivist research model found in most IS research (Chen and Hirschheim, 2004) and instead utilizes an interpretivistic hermeneutic approach (Ricoeur, 1974, 1981) which relies on an analysis and interpretation of secondary data found in journals, periodicals, and these days of course also on reputable Internet sites on EI technology, standards, and markets. The essay develops an RO-based decision-making framework which identifies optimal strategies for exercising real options depending on the level of decision context uncertainty and the capability of the firm with EI. The decision-making framework is characterized in terms of heuristics identifying preferred real options strategies based on the RO value construct of Strategic Net Present Value (SNPV) (Miller and Park, 2002). Uncertainty is characterized in terms of a matrix that maps the level of uncertainty in each principal use case of EI technology arising from the four principal sources of technical architecture, performance, standards, and market. The essay’s main contribution is in providing managerial prescription in the EI context in the form of decision-making rules, such as it is preferable to adopt an enterprise services bus (ESB) to implement EI strategy as compared to an EAI suite when both firm capability and uncertainty is high.
5.1 Future Research

There is much further work that can be done in this research area that we have characterized by the theme of practitioner relevance on the one hand and a focus on emerging valuation theories and methods on the other. While some of this work could be done by other researchers, we also describe in Sections 5.2 and 5.3 specific projects that we plan on undertaking in this area. The first essay could be extended to test for Granger causality between academic and practitioner discourses in a variety of other topics in the area of newer valuation methods such as balanced scorecard (Kaplan and Norton, 1992), benefits-risk portfolio (McFarlan and McKenney, 1983), investment mapping (Peters, 1988), multi-objective and multi-criteria methods (Vaid-Raizada, 1983), return on management (van Nievelt, 1993), efficiency ratio models (Troutt et al., 1999), information economics (Parker at al., 1988, 1989), value chain analysis (Porter, 1985), and Ward’s portfolio analysis (Ward, 1990). These studies would ascertain practitioner relevance of these relatively newer concepts. The second essay on the MADM could also be expanded in scope so that, in addition to EVA and RO, some of these other methods are included in the study to assess their comparative likelihood of adoption. Other researchers could possibly undertake such studies if they are interested. The two research projects that we specifically plan on pursuing are the following:

- Testing the MADM against a competing theory such as the theory of management fashion
- Developing a general formulation of the interpretivistic hermeneutic methodology for RO analysis in the third essay so that it can be applied to contexts other than EI.

5.2 Testing the MADM Against Alternative Theories

A logical next step in a research program being developed within a Lakatos epistemological framework would be test the MADM against a competing theory. The theory of management
fashion (Abrahamson, 1991, 1996) could indeed be viewed as a competing theory to explain the spread of EVA. MADM theory is in effect providing a rationalistic explanation of the spreading use of EVA in that it is asserting that the spread of EVA can be explained by rational and value-based factors such as the theoretical soundness and the practical applicability of EVA. But could EVA be spreading because this is a fashionable and much-hyped concept and adopting firms are simply jumping on a bandwagon? The commercial interests of consulting companies such as Stern Stewart that invented EVA lends some credence to the notion that hype and the encouraging of bandwagons could have a role in spreading EVA. It is also certainly possible that EVA could be spreading as a consequence of both rationalistic factors such as theoretical soundness and practical applicability as well as “non-rationalistic” factors such as social contagion. The challenge of the new research would be to tease apart these two groups of factors in a model as shown in Figure 5.1 to determine which group of factors has the greater impact. This study could be approached from a more traditional positivist model with a survey instrument developed for measuring the rationalistic MADM factors and the non-rationalistic factors. The survey is then administered with the firm as the unit of analysis so responses would either need to be aggregated to provide a firm-level view or the firm could itself provide its consensus view on what it perceives to be the theoretical soundness and practical applicability of the methodology. Note that the structure of this proposed study does involve reconceptualizing the MADM constructs of theoretical soundness and practical applicability from community-level to firm-level constructs. This is because we would be directly measuring the perceptions of a firm of all constructs in the model by a survey instrument. Since management fashion and social contagion are known constructs, albeit relatively newer compared to the traditional adoption drivers, instrument development for these will leverage the
work of other researchers in working with these constructs. Fichman’s article (2004a) on going beyond the dominant paradigm itself has a good discussion on measuring the new constructs that go beyond the TAM paradigm. Partial F tests could be one way of analyzing whether the rationalistic group of factors has more explanatory power versus the non-rationalistic group as a determinant of the adoption of EVA. Much more thought has to go into the most effective way of statistically teasing apart the influence of the rationalistic and non-rationalistic factors.

Figure 5.1: MADM Versus Alternative Theories
5.3 General Methodology for Developing an RO-based Decision-Making Framework

The follow-on research project to the third essay would be to formulate a general methodology to develop an RO-based decision-making framework for any investment context. The current form of the third essay is such that it is primarily an application and the methodology is embedded within this application. The overweening focus on EI in the third essay obscures to a certain extent the general methodology for developing an RO decision-making framework for strategic technology decisions. The goal is to invert the current essay into a paper which describes a general methodology that can be applied in any context and then show EI as merely a specific application of this general methodology. This changes the structure of the third essay to a theory paper with an application rather than the application paper that it is now. The general formulation will view the research problem as follows:

\[
Max_{s \in S}\{SNPV\} \\
\text{subject to}
\]

\[
\text{uncertainty} = U \in \{\text{High, Low}\} \\
\text{capability} = C \in \{\text{High, Low}\}
\]

\[
S = \{\text{set of real options available in a given investment context}\}
\]

In other words, for given conditions of firm capability and uncertainty, the goal is to find the preferred real options strategy that maximizes SNPV. However, we are not formally solving a mathematical programming problem in this approach. Instead, the approach is to argue based on interpretive hermeneutic analysis that certain real options strategies are likely to be preferred under given conditions of uncertainty and firm capability. Uncertainty is assigned a value based on developing an Uncertainty Mapping Matrix for a given context which assesses a level of
uncertainty for each canonical use case of the technology that arises from each of the principal sources of uncertainty. The level of uncertainty in the decision context is then:

\[
U = \frac{\sum_{i=1}^{N_U} \sum_{j=1}^{4} c_{ij}}{N_U \cdot 4}
\]  

(5-2)

where

c_{ij} - level of uncertainty in the ith canonical use case arising from the jth source of uncertainty

= 1 if high and 0 is low

\(N_U\) - Number of canonical use cases of the technology

\(U\) – overall level of uncertainty

The number 4 in the denominator corresponds to the four principal sources of uncertainty: technical architecture, performance, market, and standards. The overall level of uncertainty \(U\) is compared with a threshold set by the decision-maker depending on the tolerance for uncertainty to determine if the overall level of uncertainty is high or low. Finally, the Capability Maturity Model (CMM) (Humphrey, 1989) is used as an organizing framework to specify different levels of capability of the firm with the technology in question. In the third essay, the CMM was adapted to EI by formulating an Enterprise Integration Maturity Model (EIMM) which then identifies the different levels of capability of the firm with EI. A given firm can recognize where it stands with respect to the EIMM levels to determine the appropriate value for capability to use in the RO decision-making framework. Similarly, a model analogous to the EIMM would need to be developed for whatever is the investment context at hand. With the procedures for determining uncertainty and firm capability specified, the interpretive hermeneutic analysis completes the RO-based decision-making framework by comparing the SNPV of various real option exercise strategies available in a given context. This section simply provides a foretaste of
what the general formulation would like and much work remains to be done in fleshing out this
general methodology.

5.4 Fit with Research Area

The two projects suggested in Sections 5.2 and 5.3 are also at the forefront of the research area of
emerging practitioner-relevant theories and methods for the valuation of technology. If the test of
the MADM against competing theories indicates that the MADM is the theory that provides a
stronger explanation of the spread of new methods such as EVA, then that raises the level of
confidence that management can have in the adoption of EVA. Depending on the results of such
a study, this project has the potential of buttressing the MADM as a theoretical model. As noted
before, testing theories against competing theories is also precisely how research performed
within a Lakatos epistemological framework evolves. In other words, this proposed research
project can be expected to engender the conversion of what is thus far a discrete study into a
richer and more diverse research program that is potentially self-sustaining in the fashion of the
RBV research program. The MADM research program thus envisioned also has an interesting
nexus with the potential evolution of the TAM as the IS field looks beyond traditional
technology acceptance models. As the TAM research strain develops further to incorporate new
constructs such as social contagion and management fashion, it is possible that a synthesis of the
TAM and MADM could be attempted in the future. While the current dissertation has positioned
the TAM and MADM as co-equal models that have different habitats, there is nothing that
prevents a convergence of the two in the future should the evolution of the MADM and TAM
research warrant such a convergence. Alternatively, the TAM and the MADM could also
continue as parallel models which nevertheless borrow concepts and constructs from each other
without necessarily having a grand integrated model.
The general methodology for developing RO-based decision-making frameworks in any investment context can provide a major impetus to the research area of practitioner relevant theories and methods for the valuation of technology. As is well understood by RO theorists, the major stumbling block to the widespread adoption of RO is the mathematical complexity behind options pricing models. The need of the hour to reduce the mathematical complexity has led to attempts to simplify the application of RO, an example of which is to make RO more like the familiar method of computing an NPV (Feinstein and Lander, 2002). The interpretive hermeneutic analytic approach used can also be viewed as an attempt to make RO concepts more accessible to practitioners. At least at a high level, our approach shows how RO thinking can be brought to bear upon strategic decision-making. Admittedly, at some point in the decision-making process, precise option valuation models would be used for evaluating the real options values in different investment paths. However, this task can be done by specialists at a later stage based on executive decisions that are informed by RO thinking. This also enables a more seamless transition from the thought processes engaged at the strategic sense-making stage to those at the more detailed technical and financial analysis stages.
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Appendix A.1  Overview of EVA and RO

A.1.1 EVA

The term Economic Value Added (EVA), coined by Stern Stewart & Co., refers to the “economic profits” of a firm. The notion of economic profits is not new. It is akin to residual income in that a firm is considered profitable only after its revenues have covered the production and operating expenses of running the business as well as the opportunity cost of all invested capital. Grant (2003) therefore defines EVA as:

\[
EVA = \text{NOPAT} - \text{COC}
\]  \hspace{1cm} (A-1)

where NOPAT is the net operating profit after tax and COC is the cost of all capital. NOPAT can be expressed in terms of the earnings before interest and taxes (EBIT) as:

\[
\text{NOPAT} = \text{EBIT} \times (1 - \text{tax rate})
\]  \hspace{1cm} (A-2)

The key to the EVA concept is that the cost of all capital including equity capital must be covered by operating income. The cost of both equity and debt capital is therefore included in the COC:

\[
\text{COC} = \text{Weighted Average Cost of Capital} \times \text{Total Capital}
\]  \hspace{1cm} (A-3)

where the Weighted Average Cost of Capital (WACC) is:

\[
\text{WACC} = \text{After-tax debt cost} \times \left( \frac{\text{Debt}}{\text{Debt} + \text{Equity}} \right) + \text{Equity cost} \times \left( \frac{\text{Equity}}{\text{Debt} + \text{Equity}} \right)
\]  \hspace{1cm} (A-4)

This explicit accounting of the cost of equity capital reinforces the notion that equity capital is not free and therefore serves to better align the interests of management and the shareholders. The interests of management in the agency model where managers act as agents of the
shareholders may not always be aligned since management may engage in activities such as “empire building” which provide private benefits to management but do not necessarily provide a return to shareholders. EVA proponents argue that using EVA as the barometer for firm and managerial performance ensures that the firm is indeed managed from the perspective of building shareholder wealth.

A.1.2 RO

RO analysis arose from theories developed in the finance discipline on the pricing of options on financial assets. Analogous to financial options on financial assets such as a firm’s stock, an opportunity to invest in a real asset may be viewed as holding an option to purchase the underlying real asset. Therefore such real options may be priced using models similar to what are used in the financial world. Although there are many variants of options pricing models, the seminal continuous-time options pricing model is the Black-Scholes (B-S) model (Black and Scholes 1973). In the B-S model, the price of a call option is given by:

\[
price\ of\ financial\ call\ option = SN(d_1) - Xe^{-r_f t} N(d_2) \tag{A-5}
\]

where:

\( S = \) current price of the stock

\( N() = \) cumulative normal probability density function

\( r_f = \) continuously compounded risk-free rate of interest

\( X = \) exercise price of the option

\( t = \) time to expiry of the option

\( \sigma = \) standard deviation of the rate of return on the stock per unit of time
Margrabe (1978) adapted the B-S option equation to the world of real assets by replacing equation A-5 by the following:

\[ \text{price of real option} = BN(d_1) - Ce^{-r/2} N(d_2) \]  

(A-7)

where:

\( B \) = present value of benefits from the real asset

\( C \) = cost to purchase the asset

\( t \) = time when the decision to purchase the real asset will be made

Similarly, \( d_1 \) and \( d_2 \) are now evaluated as:

\[ d_1 = \left[ \ln\left( \frac{B}{C} \right) + r_f t + \sigma^2 t/2 \right] \left( \frac{1}{\sigma \sqrt{t}} \right) \]  

(A-8)

\[ d_2 = \left[ \ln\left( \frac{B}{C} \right) + r_f t - \sigma^2 t/2 \right] \left( \frac{1}{\sigma \sqrt{t}} \right) \]

and \( \sigma \) is now the volatility in the value of the real asset.

The options pricing approach accommodates for both state-contingent decision-making, which the traditional passive NPV approach does not do, and it also does not use the firm’s WACC in discounting the future state-contingent flows. Using the WACC would have led to an incorrect valuation of the state-contingent flows. Inherent in the options pricing approach is the use of the technique of creating a replicating portfolio in the underlying asset and risk-free bonds to replicate the flows from holding the real option. Assuming that there are no opportunities for arbitrage, then the price of the real option is then simply the price of this replicating portfolio.
## Appendix A.2  Academic and Practitioner Interest Levels in EVA and RO

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## Appendix A.3  Article Summaries for Scoring

<table>
<thead>
<tr>
<th>Article #1</th>
<th>Practitioner EVA</th>
<th>Score</th>
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| Executive Summary | • Effective executive compensation plans should reward actions that add value and move the company in the right *economic* direction.  
• EVA has the power to motivate executive performance in a manner that the stock market will respect.  
• EVA has been found to be more correlated with stock price movements than EPS and ROE in some case studies.  
• EVA is a useful though not necessarily a sufficient measure in configuring an executive compensation plan. | |

<table>
<thead>
<tr>
<th>Article #2</th>
<th>Practitioner EVA</th>
<th>Score</th>
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</table>
| Executive Summary | • An increasing number of American chemical companies are using EVA to build shareholder value.  
• Focusing on EVA allows investors to distinguish between the performance of different types of chemical companies, e.g., diversified chemical companies generally have negative EVA earnings while specialty chemical companies have positive economic rents or EVA.  
• EVA is an effective tool for measuring creation of long-term shareholder value but has little power in predicting shorter-term price movements. | |
### Article #3: Practitioner EVA Score

**Executive Summary**

- Although some companies have been less successful in implementing EVA this is because of problems with the implementation rather than the EVA concept itself.
- Implementation problems which explain why some companies have not been as successful in implementing EVA include:
  - Not making EVA a way of life
  - Implementing EVA too fast
  - Lack of management commitment
  - Insufficient training
  - Presenting EVA in rather abstract and philosophical terms to employees.

### Article #4: Practitioner EVA Score

**Executive Summary**

- AT&T’s Customer Satisfaction Director bases creating value for the customer on the notion of EVA. He refers to his metric for customer value creation as CVA or Customer Value Added.
- In his view, just as EVA is a gauge of the returns to shareholders over and above what they can get from companies of similar risk, CVA is a measure of how much value AT&T’s products and services can deliver to customers over and above what their competitors can do.

### Article #5: Practitioner EVA Score

**Executive Summary**

- MVA, which is simply the present value of a future stream of EVAs, is a better and more accurate measure of shareholder value than other tools and metrics.
- MVA’s strength as a measure of shareholder value can be validated by looking at the MVA rankings of the 1000 companies tracked by Stern-Stewart, the firm that invented EVA and MVA.
### Article #6

**Practitioner EVA Score**

<table>
<thead>
<tr>
<th>Executive Summary</th>
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<tbody>
<tr>
<td>• The new CEO of the US Postal Service has introduced EVA in the belief that EVA can transform a loss-making, labor intensive, federally-regulated and capital-starved government organization into something that functions more like a corporation.</td>
</tr>
<tr>
<td>• The CEO believes that if the EVA program is successful it can generate up to $1 Billion in annual profits, but it is still too early to tell if this will be successful.</td>
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### Article #7

**Practitioner EVA Score**

<table>
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<tr>
<td>• Scott Paper abandoned EVA when Albert Dunlap took over as its CEO, and he instituted his own non-EVA style of management.</td>
</tr>
<tr>
<td>• Dunlap’s non-EVA dependent approach to management led to positive results as his efforts sparked a 2.5 times surge in the stock price.</td>
</tr>
<tr>
<td>• Dunlap’s own compensation also worked out very nicely under his management framework.</td>
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### Article #8

**EVA Practitioner Score**

<table>
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<th>Executive Summary</th>
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<tr>
<td>• Starting in 1995, there has been a groundswell of interest in the chemical industry for a new way of thinking about earnings called EVA.</td>
</tr>
<tr>
<td>• EVA and other value-based performance measures do a lot to align the interests of managers and employees at all levels to those of the shareholders. These new measures are better in achieving this alignment than historical measures such as return on equity.</td>
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<tr>
<td>• Implementing EVA in the real world can be a formidable challenge, and not everyone is convinced that EVA works in the real world.</td>
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<tr>
<td>Article #9</td>
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| Executive Summary | - Dow Chemical Company has adopted EVA for measuring its performance and providing incentives for its managers.  
- An analyst at Morgan Stanley, while having a more negative view of Dow Chemical’s earnings, feels that the new metric and management incentive scheme is likely to enhance future performance | |

<table>
<thead>
<tr>
<th>Article #10</th>
<th>EVA Practitioner</th>
<th>Score</th>
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| Executive Summary | - EVA brings value by directing all corporate activities including both managerial and employee actions towards creating shareholder value.  
- The finance department is uniquely positioned in providing guidance to ensure successful implementation of EVA.  
- EVA does have some problems such as it could lead to the company’s focusing too much on short-term results while obscuring the long-term. | |

<table>
<thead>
<tr>
<th>Article #11</th>
<th>Practitioner EVA</th>
<th>Score</th>
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| Executive Summary | - The chemical industry is implementing EVA not because it is the latest management buzz word but because they see it as a fundamental measure of value.  
- Over 90% of the 60 chemical industry CFOs surveyed by A.T. Kearney thought that EVA was an enduring principle and not a fad.  
- Companies putting EVA into action are still quite a bit less than those merely talking about it. | |
<table>
<thead>
<tr>
<th>Article #12</th>
<th>Academic EVA</th>
<th>Score</th>
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| Executive Summary | • A new measure called Refined EVA or REVA is defined based on EVA. REVA is different from EVA in that it is based on the market value of the firm’s assets rather than on the economic book value of the assets as is the case with EVA.  
• A statistical analysis of the 25 top REVA firms compared to the 25 top EVA firms for the years 1988 to 1992 showed that the realized stock market returns for the REVA firms was higher than that of EVA firms. In other words, REVA is a better predictor of stock market performance.  
• Recommends using REVA as a metric in senior executive compensation and EVA at lower levels in an organization. | |

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<thead>
<tr>
<th>Article #13</th>
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| Executive Summary | • Millenium Chemical, a major chemical company with operations in the US and the UK, is basing an ambitious transformation of the company to enhance profitability on EVA.  
• A major pillar of this transformation is the company’s acquisitions and capital investments strategy, e.g., Millenium has spent $500 million in the last two years on capital projects. | |

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<td>Executive Summary</td>
<td>• As companies become too infatuated and fixated on EVA, they run the risk of losing sight of other key measures of financial performance such as cash flow, which is the most important factor in the survival of a company.</td>
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<tr>
<td>Article #15</td>
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<td>Score</td>
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| Executive Summary | • As part of its strategy to strengthen shareholder value, Equifax adopted EVA in 1992 as its financial measurement system.  
• As a continuation of that financial strategy, the Equifax board in 1997 voted to raise dividend payouts and also to make an additional $100 million available for share repurchase. |       |

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<th>Article #16</th>
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| Executive Summary | • The weighted cost of capital, or WCOC, used as the cost of capital in EVA computations is composed of various components such as the cost of retained earnings, outside equity, and debt, depending on how the project is financed.  
• Shows an example of calculating the yearly EVAs or economic returns from a 4-year project using a 15% WCOC, and discounting this future EVA stream to the present.  
• Relates the notions of present value, EVA and WCOC in this example. |       |

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| Executive Summary | • Introducing EVA has improved the financial performance of Briggs and Stratton, a vendor of engines for lawn and garden equipment. The company introduced EVA in 1989 when the stock price was about $35. The split adjusted stock price in 1996 is about $90. Revenue in FY1996 was $1.3 billion and net income $92 million as compared to $876 million and $20 million, respectively, in 1989.  
• The Briggs and Stratton COO, while giving due credit to EVA, cautions that simply adopting EVA as a performance metric “isn’t going to get you anywhere in the absence of some idea on how to create value.”  
• The Boston Consulting Group has some issues with the EVA concept and prefers a different metric called Cash Value Added, but Stern-Stewart, the company that invented EVA, asserts that EVA is flexible enough to be customized to different scenarios so a different construct is not necessary. |       |
### Article #18

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<tr>
<th>Executive Summary</th>
<th>Practitioner EVA</th>
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<td>The use of EVA is increasing both in the number of industries where it is being used, such as in chemical and financial services industries, and in the areas within a business where it is being applied such as in executive compensation plans, strategic decision-making, and overall business performance evaluation. It is also starting to gain international recognition.</td>
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<td>The capital-intensive needs of the chemical industry make EVA particularly well suited to that industry as focusing on EVA helps ensure that the returns on large capital investments make up for the cost of all capital invested.</td>
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### Article #19

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<th>Executive Summary</th>
<th>Practitioner EVA</th>
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<td>In a debate between Al Ehrbar of Stern-Stewart, inventor of EVA, and noted management guru Gray Hamel, Ehrbar argues the case for EVA by asserting that MVA (present value of a future stream of EVAs) can in a single measure capture all the dynamics of corporate performance. In Ehrbar’s view, EVA/MVA is superior to other measures because they cannot represent a composite view of the company in a single measure.</td>
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<td>Gary Hamel on the other hand dismisses EVA as a mere accounting tool that at best measures capital efficiency but does not capture a company’s real capacity to create new wealth.</td>
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<td>Article #20</td>
<td>Practitioner EVA</td>
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| Executive Summary | • EVA and other metrics such as Cash Flow ROI (CFROI) are useful because they are less amenable to manipulation as compared to earnings and also because they provide a sharper focus on value.  
• EVA and CFROI are being increasingly adopted not just in the US but also across the globe.  
• There are some issues with EVA and CFROI in that they measure historical performance rather than the future potential of the company.  
• A company’s strategy and innovation capabilities count for more in terms of creating wealth in the future. | |

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<th>Article #21</th>
<th>Practitioner EVA</th>
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| Executive Summary | • Strategic Management Group, a consulting firm, has developed “Why Finance Matters” an EVA training program targeted to firms of 1,000 employees or more.  
• The price of this EVA training program ranges from $250,000 to $1 million depending on the number of users and the components purchased. | |

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<th>Article #22</th>
<th>Practitioner EVA</th>
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| Executive Summary | • International Multifoods is implementing an EVA financial management system to pare costs, improve productivity, pare working capital, and reduce debt.  
• The pursuit of shareholder value has led International Multifoods to reducing its headquarters staff from 650 to 50, moving to lower-rent facilities, consolidating the consumer foods division with the bakery business, and offering its Canadian frozen bakery unit for sale. | |
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<th>Article #23</th>
<th>Academic EVA</th>
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| Executive Summary | • Proves a theorem which states that allocating the cost of capital investment by a firm to future periods using the EVA method leads to efficient investment decisions by managers whose wage contracts are tied to the firm’s income calculated under the EVA method.  
• EVA-based management incentive schemes thus do not lead a manager to either under-invest or over-invest from the perspective of the shareholders regardless of a manager’s employment horizon or personal discount rate. | |

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<th>Article #24</th>
<th>Academic EVA</th>
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| Executive Summary | • In order to survive in the long-run, it is not sufficient to simply generate +ve GAAP net income. The company must recover the cost of all capital, hence it must generate +ve EVA income.  
• Works through an example on how to convert GAAP (Generally Accepted Accounting Principles) net income to EVA income. This involves making various adjustments to GAAP net income since GAAP income does not include the cost of equity capital. | |

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<th>Article #25</th>
<th>Practitioner EVA</th>
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| Executive Summary | • EVA has brought about a positive and wide-ranging transformation of Centura Bank’s business including its financial management system, incentive compensation plans, sales culture and decision-making processes.  
• EVA implementation issues have been and can be effectively managed. | |
### Article #26

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| **Executive Summary** | - Olin was one of the early adopters of EVA in the chemical industry, and this has enabled a positive transformation of Olin’s business by focusing the company on creating shareholder value.  
- The impact of EVA has been felt in the areas of managing capital, boosting productivity, and financing growth.  
- A key advantage of EVA from the Olin CEO’s point of view is that it can help in managing assets rather than simply focusing on profit and loss as other metrics do. |

### Article #27

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| **Executive Summary** | - In the banking industry, focusing on EVA and MVA (present value of future EVAs) is more important than on the daily fluctuations of the stock price because EVA and MVA are associated with the fundamentals of value.  
- A large number of banking industry analysts are turning to EVA to measure the performance of banks.  
- In a time of sweeping mergers in the banking industry, EVA is particularly important because it allows investors to properly analyze leverage, i.e., using borrowed funds to accomplish the buyout. |

### Article #28

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| **Executive Summary** | - The California Public Employees Retirement System (CalPERS) decided in October’97 to adopt EVA as the metric for assessing the performance of the companies in which it invests its pension funds.  
- CalPERS will now publish a focus list of companies who have –ve EVA earnings over a 3-year period and also poor corporate governance practices in order to spotlight troubled companies that are destroying wealth. |
### Executive Summary

- EVA should be made part of a firm’s corporate performance measurement framework because of the good correlation (0.44) between EVA and historical share prices.
- EVA is stated to have many advantages over alternative performance measures since it does not lead to either over- or under-capitalization, does not encourage actions that flatter short-term results, and encourages behavior which is consistent with creating shareholder value.

### Executive Summary

- In the first quarter of 1998, software became available on the market to build EVA-based financial models.

### Executive Summary

- EVA was used to make the business case for a major IT project at Case, a $6 billion maker of agricultural and construction equipment.
- The business case was accepted because the EVA analysis for the project convinced the decision-makers that the project would bring value.

### Executive Summary

- An insurance industry analyst believes that the time may be ripe for the insurance industry to take a serious look at using the EVA/MVA measures of value, as these measures bring a number of potential benefits to the management and analysis of insurance companies.
- The industry analyst also warns that studies of the applicability of EVA/MVA are still in the early stages, and that the industry should not abandon traditional measures and methodologies in favor of EVA and MVA.
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<th>Article #33</th>
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<td>Executive Summary</td>
<td>• CROC or Cash Return on Original Capital may actually be a better, simpler and more accurate tool for measuring performance in the chemical industry compared to EVA which is too complicated.</td>
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<th>Article #34</th>
<th>Practitioner EVA</th>
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| Executive Summary | • There are arguments both for and against using EVA in the insurance industry.  
• Consultants at Stern-Stewart, inventor of EVA, argue the case for using EVA by pointing to data that show that the rise in insurance stock valuations over the past three years parallels improvements in EVA performance over the same period.  
• Industry analysts at CIBC Oppenheimer however argue that the insurance industry has certain specialized capital needs and therefore this industry cannot be treated in an analogous manner to other industries where EVA has been successfully introduced. | |

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<th>Article #35</th>
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| Executive Summary | • Varity-Kelsey Hayes, a maker of braking systems for cars, subscribes to the EVA methodology.  
• The plant manager of its Jackson, MI plant also uses the EVA methodology in his assessment of plant performance. Consequently, he pays special attention to metrics such as units produced per man hour, units per hour per million dollars invested, units per square foot, and capital charge per unit. | |
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<th>Article #36</th>
<th>Practitioner EVA</th>
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| Executive Summary | • EVA has been a disappointment as an indicator of shareholder value.  
• While EVA does have a statistical association with stock returns, it cannot explain the variation in returns between firms.  
• Non-financial metrics such as the quality of a company’s business strategy and the ability to innovate may be better indicators of shareholder value. | |

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<th>Article #37</th>
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| Executive Summary | • The success of EVA in an organization is predicated on an effective corporate governance system.  
• The corporate governance system must ensure that day-to-day operating actions, capital investment decisions and strategic initiatives are all based on maximizing shareowner value.  
• EVA can and has been successfully implemented in many organizations around the world. | |

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<th>Article #38</th>
<th>Practitioner EVA</th>
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| Executive Summary | • In the mortgage banking industry, at least one company, Triad Guaranty, has been using EVA with great success for the past two years.  
• There were a number of problems in adapting EVA to a financial company like Triad but these were successfully addressed.  
• The adoption of EVA by Triad has led to positive results. EVA has increased by $8.4 million from 1996 to 1997, and 25% of that amount has been allocated to management and employees resulting in their skepticism to this new method completely evaporating. | |
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<th>Article #39</th>
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<td>Executive Summary</td>
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<td>• Millenium Chemicals is using the EVA principle in its acquisition and divestment strategy in the petrochemicals market.</td>
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<td>• Millenium’s EVA has climbed from $30 million in 1996 to $104 million in 1997.</td>
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<td>• The company remains open to more deal-making if the deals create value.</td>
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<th>Article #40</th>
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<td>Executive Summary</td>
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<td>• EVA is a useful metric to gauge the likelihood of a company becoming a takeover target. Companies that are poor in EVA performance are good takeover targets even though they are delivering +ve GAAP income because this means they are not managing as efficiently as their competitors.</td>
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<td>• In the banking industry, of the top 50 companies based on 1997 market capitalization, 5 of the 10 banks in the bottom 20% of EVA performers have already been acquired or merged and the remaining 5 are considered good takeover targets.</td>
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<th>Article #41</th>
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<td>Executive Summary</td>
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<td>• Retailers are looking beyond traditional performance metrics to newer measures such as EVA and Economic Margin that provide a better link between business performance and shareholder value.</td>
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<td>• Toys R’ Us and J.C. Penney have both adopted EVA.</td>
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<td>• EVA is better than looking at Earnings Per Share (EPS) growth since a retailer could have EPS growth without necessarily creating shareholder value.</td>
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<td>Article #42</td>
<td>Practitioner EVA</td>
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| Executive Summary | • EVA is a concept that has stood the test of time unlike other passing management fads.  
• EVA has developed a broad following among CEOs, money managers, and tough-minded industry analysts.  
• EVA correlates better with stock performance than EPS as shown by the EVA/MVA rankings of 200 of the largest US companies by market capitalization. |

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<tr>
<th>Article #43</th>
<th>Practitioner EVA</th>
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| Executive Summary | • EVA is changing how businesses are run and how employees and managers are rewarded.  
• An EVA-based incentive compensation system has to be customized to a company’s unique circumstances for it to be a success.  
• Before moving the company’s business as a whole toward EVA which entails far-reaching changes, a company should try out EVA by using it as part of the financial reporting and performance management system for a year. |

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<th>Article #44</th>
<th>Practitioner EVA</th>
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| Executive Summary | • EVA analysis can be used for justifying the valuation of high-priced Internet stocks.  
• An industry analyst from Warburg Dillon Read has used economic profit or EVA analysis to justify the recent (in 1998), lofty price of Amazon.com.  
• Adapting EVA analysis to Internet stock valuation, the analyst computes an implied revenue growth rate that would justify the price of the stock. As an example, the recent price of 214 of Amazon.com implies a revenue growth rate of 59.6% a year over the next 10 years. |
### Article #45  Practitioner EVA  Score

**Executive Summary**

- The adoption of EVA by Diageo, a UK food products company, has had a beneficial impact on both how investment decisions are made and on how senior executives are motivated and measured.

- Key examples of EVA’s impact on Diageo include: 1) a $100M investment in US breakfast products was a result of EVA analysis, 2) Diageo has generally outperformed the FTSE 100 and its financial performance is superior to that of the original companies, Grandmet and Guinness, which merged to form Diageo.

- However, some outside analysts have expressed reservations about EVA-based bonus systems, which have led to outsized compensation packages for Diageo executives.

### Article #46  Practitioner EVA  Score

**Executive Summary**

- In a presentation to a Chartered Institute of Management Accountants meeting, a representative of Stern-Stewart argues that EVA focuses the company on improving returns to existing capital, on investing in projects that earn more than the cost of capital, and on selling assets that are worth more to others than to the company.

- The Stern-Stewart representative states that EVA is more than just a wealth measuring tool; it is a new management system because it permeates so many facets of the business.
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<th>Article #47</th>
<th>Academic EVA</th>
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| Executive Summary | • Banks can improve the quality of their decision-making by combining EVA analysis with the technique of Monte Carlo simulation.  
• In this combined approach, Monte Carlo simulation is used to evaluate how much capital the bank has at risk under various scenarios of changes in interest rates. Thus Monte Carlo simulation addresses the second part of the EVA calculation by quantifying the “Capital at Risk”:  
\[
\text{EVA} = \text{Net Operating Profit After Tax} - \text{Cost of Capital} \times \text{Capital at Risk}
\] | |

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<th>Article #48</th>
<th>Practitioner EVA</th>
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<td>Executive Summary</td>
<td>• Interest by companies in newer performance measures such as CFROI (Cash Flow ROI), EVA, and CVA (Cash Value Added) has increased because these newer metrics are less amenable to manipulation, as is the case with traditional accounting measures such as ROE and ROA, and they are also more correlated with shareholder value.</td>
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<th>Article #49</th>
<th>Practitioner EVA</th>
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| Executive Summary | • In 1997, NIIT became the first IT company in India to adopt EVA, and it has used EVA successfully to focus employee activities on a day-to-day basis towards creating value.  
• A key to the success of NIIT’s EVA program has been employee communication.  
• EVA’s success is further reflected in the huge leap in the market capitalization of NIIT from Rs. 15.9 billion to Rs. 109 billion in 1999 since the introduction of the measure. | |
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<th>Article #50</th>
<th>Practitioner EVA</th>
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| Executive Summary | • Operating managers need to be familiar with both EVA and EBITDA since both economic and accounting measures of profits have their uses.  
• While EVA brings the perspective of economic profits, EVA calculations can be quite complex. In contrast, the accounting measure of profit or EBITDA is easier to compute. |       |

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<th>Article #51</th>
<th>Academic EVA</th>
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| Executive Summary | • When there are intra-firm agency problems, e.g., when headquarters and divisional interests may not be aligned, EVA is more appropriate than DCF (discounted cash flow) accounting for appraising investments, because under the EVA method headquarters can influence divisional investment decisions by setting the depreciation schedule and the cost of capital that divisions will use in their EVA calculations.  
• This advantage of the EVA approach over DCF in ensuring optimal investment levels in the face of intra-firm agency problems however comes with some constraints: 1) headquarters must know the cash flow growth profile of the divisional investment, and 2) the growth of cash flows must be independent of the amount of the investment. |       |

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<th>Article #52</th>
<th>Academic EVA</th>
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| Executive Summary | • Human resource priorities should be linked to building EVA for the company according to the Sr. VP of Human Resources for a bank.  
• This linkage of human resources with EVA can be accomplished through a concept called the Service Profit Chain where employee satisfaction is linked to employee loyalty and service quality, which in turn is linked to customer satisfaction and customer loyalty, and finally this leads to increased revenue and profitability. |       |
### Article #53

**Executive Summary**

- Proves using a theoretical model that NPV and MVA, where MVA is defined as the present value of a future stream of EVAs, are equivalent under any assumptions on the depreciation schedule and final sale of depreciated equipment.
- The rising popularity of EVA is puzzling given the theoretical equivalence of NPV and MVA.

### Article #54

**Executive Summary**

- EVA should be used in appraising capital investments in new manufacturing capacity, since EVA is a value-based planning method that is closely associated with the potential of shareholder wealth creation.
- Illustrates the use of EVA in manufacturing by working through two examples of investments in manufacturing capacity. Each investment project spans multiple periods and the after-tax cash flows in future periods are converted into EVAs. The future stream of EVAs is discounted back to the present.

### Article #55

**Executive Summary**

- Stern-Stewart (inventor of EVA) executives have not met with much success in selling the EVA concept in Asia, although there are some pockets of forward-looking companies that are more focused on creating shareholder value.
- This lack of interest in EVA is particularly true of Old Asia firms rather than New Asia firms. Old Asia represents conglomerates with antiquated business cultures and is typically characterized by crony capitalism. It is the Old Asia companies often found in countries such as Philippines, Malaysia, Thailand and Indonesia that are most resistant to concepts like EVA.
- Old Asia companies must start to adopt the value-oriented business practices of the more forward-looking New Asia companies otherwise they will be left behind in the quest for global capital.
### Article #56  Practitioner EVA  Score

**Executive Summary**

- EVA is a poor indicator of stock performance and explains only a fraction of the variability in stock returns.
- This is based on regressing stock returns against 1-year prior EVAs for various samples of companies from the S&P 500 and DJIA indices. The reason for the lag is to test the hypothesis that growth in EVA shows up as an improvement in stock returns after one year. Results show there is either a very weak or no relationship between EVA and total stock return.

### Article #57  Academic EVA  Score

**Executive Summary**

- Adopting EVA has a profound and positive impact on the R&D function as R&D is now treated as strategic capital rather than expensed.
- Under an EVA framework, those R&D projects that have the most potential for increasing EVA are given priority, and therefore EVA influences the very ideas generated by the R&D function.
- The power of EVA lies in the fact that a single system can positively affect so many issues facing R&D management.

### Article #58  Academic EVA  Score

**Executive Summary**

- Mixed results are obtained when comparing the performance of large companies that have adopted EVA to those that haven’t.
- Empirical study of Fortune 500 companies from 1997 to 1998 finds that EVA users were ahead of non-EVA users in profits as a percentage of revenues, assets and stockholders equity.
- However Non-EVA users were ahead of EVA users in the following measures:
  - 1998 EPS
  - 1997-to-1998 EPS change
  - 1988-1998 EPS growth rate
- EVA is expected to become less popular in its use as an instrument to measure value creation.
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<th>Article #59</th>
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| Executive Summary | - Stern-Stewart (inventor of EVA), recommends that clients engaged in acquisitions appraise the deal from EVA perspective.  
- Clients should also involve a consulting firm paid on a fixed-fee basis in addition to the investment banker because such firms, including Stern-Stewart, have no vested interest in whether the deal is made or not, unlike the investment banker who gets paid only if the deal is struck. |       |

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<th>Article #60</th>
<th>Academic EVA</th>
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| Executive Summary | - This empirical study demonstrates that EVA contains useful information over and above that contained in EPS (Earnings Per Share) in forecasting future earnings of a company.  
- Analysts however do not appear to fully incorporate this incremental information provided by EVA in their forecasts of future earnings.  
- An explanation for this behavior could be that analysts may not be fully familiar with EVA since this is a relatively new measure of performance, particularly given that the period of this study was 1989 to 1996. |       |

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<th>Article #61</th>
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| Executive Summary | - Employees of a company whose stock has hit zero, and their equity has become worthless, may be kept motivated by putting them on a bonus plan that is tied to EVA.  
- Although investors do not like giving out cash bonuses before the IPO because of the need to conserve cash during the growth phase of a company, an EVA bonus plan is seen as a good solution since it encourages cash-generating activities that increase shareholder value |       |
### Article #62

**Executive Summary**

- The bull market in stocks during the 1982 to 1999 period where the Dow Jones Industrial Average grew about 15% a year, an unusually high appreciation, was partly due to the fact that stocks were severely undervalued in the late ‘70s and early ‘80s, where the amount of undervaluation is measured relative to the intrinsic EVA value of the stock.

- The reasons for this undervaluation were:
  - Investors tend to discount real earnings of firms using nominal rather than real rates and nominal rates were high in the late 70s/early 80s because of the high rate of inflation at that time.
  - Investors often neglect to take into account the positive impact on equity valuation arising from inflation’s erosion of the value of fixed liabilities in real terms.

- The primary conclusion of undervaluation is based on an empirical study that tests for the correlation between the undervaluation amount, which is the EVA-based intrinsic value minus the stock price, against the rate of inflation in late 70s/early 80s.

### Article #63

**Executive Summary**

- Most of what is taught in the classroom on corporate finance is not relevant to the CFO in her job, e.g.,
  - Lot stress is paid to NPV analysis in the classroom, but getting NPV analysis right is not the most important thing in the real world where achieving capital efficiency is key.
  - What drives Total Return to Stockholders (TRS) is also very important to practitioners. Yet all of the metrics, such as EPS, EPS growth, EVA, and EVA changes, are poor predictors of stock returns.

- Rather than focusing on EPS, EVA, etc., finance teaching should focus on developing theories and models for Expectations Based Management (EBM), since stock price moves primarily on whether the firm is performing above or below analyst expectations.
### Article #64: Practitioner EVA

**Executive Summary**
- EVA should be used in appraising IT investment decisions since IT should be held just as accountable for wealth creation as other business units. Capital for IT spending isn’t cost-free.
- However, using EVA in the IT organization cannot succeed if it is employed autonomously.

### Article #65: Practitioner EVA

**Executive Summary**
- Armstrong Industries, a multibillion dollar manufacturer of home products, concluded that EVA is a better measure of value creation than traditional accounting measures such as ROE and EBIT. This caused Armstrong to switch to EVA-based financial accounting.
- EVA helped Armstrong stand out in the competition for global capital.

### Article #66: Academic EVA

**Executive Summary**
- An empirical study of EVA bonus systems using data on 117 managers in a large international company finds that managers on EVA bonus plans do perform better but only if they understand EVA. However, EVA understanding is not always high.
- Performance increases detected in the study could also be due to an increased consistency in the evaluation-reward system rather than due to EVA.
- There are big differences in EVA-based performance between different parts of the company.
<table>
<thead>
<tr>
<th>Article #67</th>
<th>Practitioner EVA</th>
<th>Score</th>
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</table>
| Executive Summary | • The US Postal Service terminated its EVA-based bonus system because it kept giving managers bonuses while the performance of the postal service declined.  
• The US Postal Service concluded that the EVA system was flawed.  
• The postal service said that the EVA program was misunderstood and hard to explain. |

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<tr>
<th>Article #68</th>
<th>Practitioner EVA</th>
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</table>
| Executive Summary | • Compares the performance of 16 major pharmaceutical companies on various measures and ratios including EVA, MVA, EPS, P/E, growth, gross margin, R&D to sales, price to sales, P/E to growth, and market capitalization.  
• Includes both EVA and MVA (present value of a future stream of EVAs) in the comparative assessment of companies. Both measures are included because while EVA measures the company’s historical performance, MVA provides a look into its future prospects.  
• No single metric tells the whole story, so a host of metrics including those for intangible assets such as knowledge capital and brand strength must be looked at to determine the best strategies for competing. |

<table>
<thead>
<tr>
<th>Article #69</th>
<th>Practitioner EVA</th>
<th>Score</th>
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</table>
| Executive Summary | • Companies in New Zealand generally perform poorly in terms of creating shareholder wealth compared to their international counterparts. In 2001, the top 35 companies in the New Zealand Stock Exchange destroyed 10% of their Market Value Added (MVA).The picture however improves for mid-size companies.  
• One problem appears to be that managers in New Zealand tend to treat shareholder funds as though they were “free”.  
• Companies in New Zealand are thus encouraged to adopt EVA principles in order to have a closer alignment of management and shareholder interests. |
### Article #70
**Practitioner EVA Score**

**Executive Summary**
- Despite what EVA critics have claimed, EVA cannot be responsible for motivating managers to inflate the return from IT projects.
- Since a manager’s own incentive pay is tied to achieving EVA results, it is impossible for EVA to be the cause of dysfunctional behavior such as managers inflating returns on IT investment.
- If EVA is negative for the company in one year, there is no bonus for anyone.

<table>
<thead>
<tr>
<th>Article #71</th>
<th>Academic EVA Score</th>
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<tbody>
<tr>
<td><strong>Executive Summary</strong></td>
<td>E-commerce firms that use EVA to appraise their investments made in on-line selling, e.g., in providing a superior shopping experience on their web site and advertising to generate traffic to the web site, experience superior firm performance and increased shareholder value.</td>
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<td>This is based on an empirical study of 67 firms on the value of the firm’s web site and advertising measured in terms of EVA.</td>
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<td></td>
<td>It is legitimate to use EVA to measure the value created by e-tailing projects such as web site enhancements and advertising to generate traffic, since EVA is recognized as an effective tool for measuring wealth created by companies.</td>
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</tbody>
</table>
### Article #72 | Academic EVA | Score
---|---|---
Executive Summary | - Many companies are pursuing a “growth at all costs” strategy. However, as the case of Enron demonstrates, a single-minded pursuit of growth can actually end up destroying shareholder value.  
- Empirical study using Compustat data from 1990 to 2000 explores the link between growth and EVA and also between EVA and Jensen’s Alpha, a measure of shareholder value, shows that:  
  o Maximizing growth does not maximize EVA or Jensen’s Alpha.  
  o Companies with moderate growth in sales and earnings actually show the highest rates of value creation for shareholders.  
- Management must abandon the habit of blindly increasing company size and move from a “growth now, profitability later” to a “profitable growth now” strategy. |  

### Article #73 | Practitioner EVA | Score
---|---|---
Executive Summary | - Temasek is a government holding company in Singapore which owns 80 companies, including major companies like Singapore Telecommunications.  
- Chris Matten has just been put in charge of shareholder value management at Temasek because of his background in EVA. Matten installed EVA in National Australia Bank when he was their controller.  
- Matten expects to bring EVA principles to Temasek. He says that he sees his job more as an evangelist rather than an enforcer. |  

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<tr>
<th>Article #74</th>
<th>Academic EVA</th>
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| Executive Summary | • EVA is not a useful construct in either a world where the Efficient Market Hypothesis (EMH) holds or in a non-EMH world.  
  o In an EMH world, a +ve EVA, where returns from an asset exceed the cost of capital, simply cannot be observed on a consistent basis. Any +ve EVA would at best be a random and statistically non-significant phenomenon.  
  o In a non-EMH world, the Capital Asset Pricing Model (CAPM) does not hold. However, computing EVA involves using the Weighted Average Cost of Capital (WACC), which uses the CAPM-derived beta value for the firm for computing its cost of equity. Hence, there is a dependence on the CAPM built into the EVA construct.  
  • In addition, information on earnings, and EVA is a measure of earnings albeit of economic profits, is becoming less relevant in stock valuation. | |

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<tr>
<th>Article #75</th>
<th>Academic EVA</th>
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| Executive Summary | • EVA is a useful and legitimate construct regardless of EMH assumptions. The notions of market efficiency and economic rents or profits must not be confused. The EMH only asserts that all public information is discounted in the stock price and investors cannot use public information to make an abnormal return on a consistent basis, but the EMH does not say that companies cannot realize economic rents or profits.  
  • These economic rents or abnormal profits are driven to zero through competition only when an industry reaches a state of long-run equilibrium. However, industries are typically in a state of flux rather than at a static long-run equilibrium point. Therefore, it is possible for specific companies to enjoy economic rents or +ve EVA for an extended length of time.  
  • Finally, the CAPM does not necessarily depend on the EMH. The CAPM assumes efficient portfolios, which is not the same thing as the EMH. | |
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<tr>
<th>Article #76</th>
<th>Academic EVA</th>
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| Executive Summary | - Managers lack an effective framework for analyzing the performance of supply chains because supply chains consist of many interdependent firms and it is difficult to measure the contribution of each firm to the performance of the whole supply chain.  
- EVA and Activity Based Costing (ABC) can be combined to effectively analyze the performance of multi-firm supply chain environments.  
- EVA and ABC can further be integrated into a Balanced Scorecard framework to correct the bias towards financial measures that EVA and ABC models might have. A broader Balanced Scorecard approach would allow the integration of non-financial measures. |       |

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<tr>
<th>Article #77</th>
<th>Practitioner EVA</th>
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| Executive Summary | - Residual Income Models (RIM), which is the same concept as EVA, are better than Discounted Cash Flow (DCF) models because DCF accounting simply cannot take into account forms of value that aren’t reflected in cash flows.  
- The problem with RIM or EVA models is that you still have to develop accurate estimates of future income. |       |

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<tr>
<th>Article #78</th>
<th>Practitioner EVA</th>
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| Executive Summary | - A business is like a big train with the CEO as the engineer who sits in the cab looking at various gauges and dials such as speed, temperature, and pressure; and he controls the train with the controls at his disposal such as the brakes and levers. Using this train metaphor for a business, the question is – What if the gauges don’t give you the right readings and the controls are not the right ones to control the train?  
- EVA is a “gold standard” measurement that does show the right picture about the business as they tell shareholders whether they are getting their money’s worth.  
- The caveat that CEOs have to be aware of as they steer the business (their train) is that the controls that work for a “people intensive” business like Microsoft may not work for a capital intensive business like Intel. |       |
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<tr>
<th>Article #79</th>
<th>Practitioner EVA Score</th>
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</table>
| Executive Summary | - An analysis of the public restaurant businesses in the US shows that franchisors create more value and perform better financially than their non-franchise competitors.  
- EVA and MVA were used as two key metrics in comparing franchisors to non-franchisors. |

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<tr>
<th>Article #80</th>
<th>Academic RO Score</th>
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| Executive Summary | - RO is a more powerful valuation and decision-making model under uncertainty than NPV.  
- In NPV decision-tree analysis, all future scenarios and their probabilities are laid out upfront. RO on the other hand allows management to tailor its strategy as new information comes to light.  
- The NPV model does not capture the flexibility that managers have in making decisions when faced with multiple projects that depend on each other. |

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<tr>
<th>Article #81</th>
<th>Academic RO Score</th>
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| Executive Summary | - Applies Real Options Analysis to two software development projects: 1) developing a Java application server, and 2) making a software product XML compatible. Both Java and XML are unstable and evolving technologies, hence these projects carry a good deal of risk.  
- Analyzing these software development projects which typically comprise a 1st stage of prototype development followed by a 2nd stage of full software development from an RO framework allows the correct modeling of the flexibility that management has in either proceeding with or abandoning the 2nd stage of the project depending on the conditions that exist after the completion of the first stage.  
- Static NPV analysis cannot model this flexibility and therefore undervalues these risky projects and would recommend against them. |
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<thead>
<tr>
<th>Article #82</th>
<th>Academic RO</th>
<th>Score</th>
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| Executive Summary | • RO has been applied in diverse areas including bio-tech, manufacturing, natural resources, R&D, and strategy.  
• RO is expected to become vitally important for strategic decision-making  
• There are however a number of problems with the RO methodology including limitations in using a Geometric Brownian Motion (GBM) process for valuing the underlying real asset, non-tradability of the real asset, appropriateness of the risk-free rate as the discount rate, the non-discrete nature of the “exercise” price for real options, and the lack of information on the amount and timing of “dividends”. | |

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<tr>
<th>Article #83</th>
<th>Academic RO</th>
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| Executive Summary | • RO is the proper way of valuing risky projects with managerial flexibility since NPV undervalues this flexibility.  
• Shows in an analysis of a scenario where there is an option to abandon a project part-way, only RO accurately accounts for the value of this option.  
• Develops a simpler way for valuing projects from an RO standpoint which would be easier to apply for those who are accustomed to using the NPV model.  
• Shows that if a properly weighted average of the NPV discount rate and the risk-free rate is used, then the RO and NPV approaches lead to the same results. | |
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<tr>
<th>Article #84</th>
<th>Academic RO</th>
<th>Score</th>
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| Executive Summary | - While previous theory on using RO in IT projects had focused on the valuation of these investments, this article enhances the existing theory of applying RO by taking a risk management rather than simply a valuation of given options approach.  
- The enhanced methodology shows how an investment can be optimally configured from a risk standpoint by embedding in it various kinds of real options such as a defer option.  
- A potential investment in an Internet Sales Channel is used as an example to demonstrate the use of this approach of proactively embedding real options in an investment to optimally configure risk. | |

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<tr>
<th>Article #85</th>
<th>Academic RO</th>
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| Executive Summary | - Applies an RO model to estimate the cost of regulatory constraints in the telecommunications industry.  
- The cost of regulatory constraints is modeled as removing the options that telecommunication service providers have to delay, limit or abandon service. Removal of these options has a cost as it lessens the value of the investment for the service provider when viewed from an RO perspective. | |

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<tr>
<th>Article #86</th>
<th>Academic RO</th>
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| Executive Summary | - RO was successfully applied to a major infrastructure project in Japan, the Minami Alps forest road construction project.  
- RO was preferred to traditional NPV analysis in this case because the probabilities for various states of nature and outcomes and their associated risk premiums are subject to serious estimation error in NPV analysis. Furthermore, the NPV discount rate assumes that all future years have the same risk  
- The problem in RO of the lack of data on the market value of the real asset is addressed in this case by using historical data from similar public infrastructure projects. | |
### Executive Summary

- Just like the real options model has been used in making appraisals about economic capital such as plant and machinery, real options thinking can also be gainfully applied in valuing “natural capital”, i.e., the environment.

- If we were to apply the real options approach to rain forests as an example, we would choose to preserve the rain forests, i.e., keep open the option of harvesting the trees later if the option value of preserving the forests was greater than the immediate value of the lumber obtained from cutting down the trees now.

- If we take a real options perspective to our natural capital, then learning about the environment acquires a good deal of significance. The real options model is really all about acquiring more information, i.e., learning, so that a more informed decision can be taken at a later point.
  - A real options approach thus argues for national policies to educate society about the environment and the benefits of preserving it.
### Appendix A.4  Article Scores

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<thead>
<tr>
<th>No.</th>
<th>Q</th>
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<th>Article Ratings</th>
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<tbody>
<tr>
<td>4</td>
<td>2Q'95</td>
<td>Rubel, C. (1995) ‘Create value – or else’, <em>Marketing News</em>, Vol. 29, No. 9, p. 17.</td>
<td>E P 0 1 1 1 1 1 1</td>
</tr>
<tr>
<td>6</td>
<td>4Q'95</td>
<td>Spinner, K. (1995) ‘Signed and sealed – But can EVA deliver?’, <em>CFO</em>, Vol. 11, No. 11, pp. 93-95.</td>
<td>E P 0 1 2 2 1 1</td>
</tr>
<tr>
<td>No.</td>
<td>Q</td>
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<tr>
<td>19</td>
<td>3Q'97</td>
<td>Fortune (1997) ‘Debate: Duking it out over EVA’, Fortune, Vol. 136, No. 3, p. 232.</td>
<td>E P 0 0 0 0 0 0 1</td>
</tr>
<tr>
<td>20</td>
<td>3Q'97</td>
<td>The Economist (1997) ‘A star to sail by?’, <em>The Economist</em>, Vol. 344, No. 8028, pp. 53-55.</td>
<td>E P 1 1 1 1 1 1 1</td>
</tr>
<tr>
<td>21</td>
<td>3Q'97</td>
<td>Christinat, D. (1997) EVA training. <em>CFO</em>, Vol. 13, No. 8, p. 18.</td>
<td>E P -1 0 0 0 0 0 1</td>
</tr>
<tr>
<td>22</td>
<td>3Q'97</td>
<td>Segal, R. (1997) ‘Pursuing value and market share’, <em>The Voice of Food Service Distribution</em>, Vol. 33, No. 8, p. 35.</td>
<td>E P 0 3 0 0 1 1</td>
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### Appendix A.4  Article Scores (continued)

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<th>Article Ratings</th>
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</thead>
<tbody>
<tr>
<td>32</td>
<td>2Q'98</td>
<td>McDonald, L. (1998a) The EVA way. *Best’s Review/ Property-Casualty Insurance Edition 1998; 99:63-64.</td>
<td>E P 0 0 0 0 0 1</td>
</tr>
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<td>33</td>
<td>2Q'98</td>
<td>Vames, S. (1998) Value added or just a Croc? Chemical Week 1998;160:20-20.</td>
<td>E P -3 -2 -3 -3 -3 1</td>
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<tr>
<td>36</td>
<td>2Q'98</td>
<td>Logistics and Management Distribution Report (1998) ‘Up front’, Vol. 37, No. 4, pp. 3-5.</td>
<td>E P -3 -2 -3 -2 -2 1</td>
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</table>
### Appendix A.4  Article Scores (continued)

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<tr>
<td>49</td>
<td>1Q'00</td>
<td>Business India Intelligence (2000) ‘Paying for value’, <em>Business India Intelligence</em>, January Issue, pp. 4-5.</td>
<td>E 2 P 2 T 3 R 3 R 2 R 3 R 1 W 1</td>
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<tr>
<td>51</td>
<td>1Q'00</td>
<td>Pfeiffer, T. (2000) ‘Good news and bad news for the implementation of shareholder-value concepts in decentralized organizations’, <em>Schmalenbach Business Review</em>, Vol. 52, No. 1, pp. 68-91.</td>
<td>E 1 A 1 T 1 R 1 R 1 R 1 R 0.5 W 1</td>
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<tr>
<td>56</td>
<td>1Q'00</td>
<td>Farslo, F., Degel, J. and Degner, J. (2000) ‘Economic value added (EVA) and stock returns’, Financialiser, Vol. 7, No. 1-4, pp. 115-118.</td>
<td>E P -3 -3 -3 -3 -3 1</td>
</tr>
<tr>
<td>57</td>
<td>1Q'02</td>
<td>Hatfield, G.R. (2002) ‘R&amp;D in an EVA world’, Research Technology Management, January-February Issue, pp. 41-47.</td>
<td>E A 2 1 2 2 1 0.5</td>
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<tr>
<td>59</td>
<td>1Q'02</td>
<td>Fugazy, D. (2002) ‘Martin Ellis, senior vice president, Stern Stewart &amp; Co.’, Buyouts, Vol. 15, No. 3, p. 1.</td>
<td>E P 0 0 0 0 0 1</td>
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<tr>
<td>No.</td>
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<td>Article</td>
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<tr>
<td>64</td>
<td>3Q'02</td>
<td>Berry, J. (2002a) ‘Turning a profit on IT’, <em>Computerworld</em>, Vol. 36, No. 36, p 39.</td>
<td>E P 1 0 1 1 0 1</td>
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<tr>
<td>68</td>
<td>3Q'02</td>
<td>Trombetta, W. (2002) ‘Industry audit and companies of the year’, <em>Pharmaceutical Executive</em>, Vol. 22, No. 9, pp. 72-84.</td>
<td>E P 0 0 0 0 0 1</td>
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<tr>
<td>70</td>
<td>4Q'02</td>
<td>Berry, J. (2002b) ‘EVA as fact not fiction’, <em>Computerworld</em>, Vol. 36, No. 41, p. 51.</td>
<td>E P 1 0 0 0 0 1</td>
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</table>
# Appendix A.4  Article Scores (continued)

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<tr>
<td>77</td>
<td>2Q’05</td>
<td>Sanford, J. (2005) ‘RIM’s shot’, <em>Canadian Business</em>, Vol. 78, No. 12, pp. 63-64.</td>
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<td>79</td>
<td>2Q’05</td>
<td>Rennick, R. (2005) ‘Franchising creates value’, <em>Franchising World</em>, Vol. 37, No. 5, p. 6.</td>
<td>E P</td>
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<tr>
<td>87</td>
<td>1Q’05</td>
<td>Gough, S. (2005) ‘Rethinking the natural capital metaphor: Implications for education and learning’, Environmental Education Research, Vol. 11, No. 1, pp. 95-114.</td>
<td>R</td>
<td>A</td>
<td>2 1 1 1 1 0.5</td>
</tr>
</tbody>
</table>

Q – Quarter
M – Methodology, E – EVA, R – RO
T – Type, P – Practitioner, A – Academic
W – Journal Weight