Abstract

As the strategic importance of information technology (IT) has increased, the decision of where and when to allocate resources to IT programs has become more risky and more difficult. Executives are tempted by the opportunities for strategic impact, but struggle with the massive expenditures and uncertainties involved. Evaluating the opportunity afforded by a system and judging its strategic impact ex ante have proven difficult, and even when analyses are performed well, they are frequently done on an ad hoc basis. IT does confer advantage under appropriate conditions; and equally important, even when it fails to confer advantage, it still may prove crucial. Both concepts -- competitive advantage and strategic necessity -- confound traditional financial analysis. We offer seven principles on which to base an evaluation of a strategic IT venture. The principles range from making the investment decision, through managing risk, to preparing for unanticipated upside and downside implications. Since we have not performed a statistically validating study, these principles are expressed as hypotheses.

1. Introduction

1.1. The IT Casino

New technologies and technology-driven opportunities are being developed and presented to managers at an ever-accelerating rate. Chances to join networks, forge electronic linkages with customers and suppliers, and develop and implement new systems architectures require careful consideration and analysis. The stakes and the possible returns are enormous.

In September 1988, AMR Corporation, parent company of American Airlines, announced that it would consider bids for selling off its highly regarded Sabre system, in use in over 14,000 travel agencies. Wall Street put a value on the system of $1.5 billion. At the time, AMR's market value was $2.9 billion, indicating Sabre's value in the 12 years since its introduction had grown to exceed AMR's core airline business.1 And yet when American was first considering the $40 million start-up cost of the system, the decision to develop was not easy to justify [45]. AMR's chief competitor, United Airlines, had decided against wider distribution of its own travel agent reservation system that was in use on a small scale. A full roll-out of United's Apollo system came several months after Sabre's introduction. The market share held by Apollo has continued to lag, and is now 29%, compared to Sabre's 40% [41],[48].

The downside can be substantial as well. Chemical Bank and a Chemical and AT&T joint venture abandoned their disappointing electronic home banking product, Pronto, in December 1988, and were estimated to have written off $70 million in assets associated with the system [21]. Despite aggressive promotion and technological excellence, Pronto attracted only 10,000 subscribers in six years, well short of expectations and below the level necessary to break-even.

Strategic systems initiatives such as these carry immense risk yet may offer commensurate reward. They are difficult to undertake, and the decision to develop is rarely obvious in advance. Sabre's ultimate value was not readily apparent in the mid-1970s and the investment decision was neither obvious nor easy. Difficulty in justifying an investment that now seems indisputable should not be surprising. User adoption, future benefits, and competitive impact are difficult to forecast. And the system itself may so radically alter the industry that prior assumptions are invalidated.2 We have found that strategic IT programs often lack formal economic justification. We disagree however that an act of faith is necessary to

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1 The reason for Sabre's value is profitability and prospects for growth. Pre-tax income in 1985 from Sabre was $143 million on sales of $336 million. In 1987, Sabre revenues were $400 million, or 5.5% of AMR's operating revenues, but its $248 million profit accounted for 54% of AMR's operating income [34],[5].

2 For instance, the proportion of plane tickets issued by travel agents doubled to 70% after the introduction of reservation systems.
justify strategic technology investments. Principles exist, and many of the novel techniques used to justify today's highly visible and successful systems are rational.

1.2. Plan for the Paper

This paper proposes principles for evaluating and selecting IT opportunities in which to invest. Our hypotheses are based on empirical studies, and on theoretical work on the timing of investments and the valuation of options. The second section of this paper will describe the general problem of making technology investment decisions. Companies are no longer able to justify investments in advanced technology solely on the basis of cost-savings and tangible returns on investment. At the same time, these projects are considered essential for firms to maintain their competitive position. The third section examines the difficulties specific to strategic IT decisions that executives face. In the fourth section, we detail intangible benefits of IT that should be considered when making the investment decision. Often these benefits appear serendipitously midway into the project. In the fifth section, lessons from strategic IT successes are developed. In our studies, non-traditional justification methods generally appear more appropriate for making strategic IT commitments. The sixth section proposes seven working hypotheses for guiding the evaluation of an IT investment. These principles range from identifying upside and downside implications, to managing multiple forms of risk that are inherent in strategic IT venture. The final section suggests directions for future research.

2. The Technology Investment Decision Problem

Companies concede that they can no longer justify leading-edge automation projects in their factories, the development of large-scale systems architectures, or communications networks for their distribution organizations solely on the basis of return on investment. The direct cost savings and higher production rates that once paid back IT investments in a short time are insufficient to offset the price of many of today's technology projects. Apprehensively, managers are using broad strategic considerations such as enhanced quality, better customer service, and keeping up with the competition, to justify technology investments. Clearly, executives are considering alternative justification methods, and questioning the use of DCF analysis. Unfortunately, principles for making IT investment decisions are not yet available.

In this section we review evidence that managers struggle to evaluate technology investments. We review the strategic systems literature, and identify shortcomings in current approaches to justifying strategic IT initiatives. For instance, the impassioned support of a "champion" [3], or convincing top management of less visible benefits of strategic systems [37] may not be suitable for some of today's board-level decisions on $100 million IT infrastructure investments [22].

2.1. Evidence

Recent studies have shown that executives are troubled by their firms' technology investment decisions. A 1988 survey of technology managers in U.K. banks found that 80 percent of the respondents feel technology has fallen short of their expectations, and more than half confirm that systems investments are not generating the anticipated improvements in productivity [51]. IT applications have grown beyond supporting efficiency improvements, and increasingly improve effectiveness, and enable strategic aims to be reached.

In the areas of effectiveness and strategy, performance and return on an IT investment can no longer be quantified so easily. Instead, executives struggle to weigh intangible benefits and strategic impact against the often imposing hardware and development costs.

In a 1986 survey of how technology investments are justified in sixty-seven Fortune 500 companies, 77.0% of respondent firms felt they will soon be making additional IT investments. However, 89.5% have great difficulty quantifying the intangible benefits of proposed systems, and another 61.2% find that the uncertainty of benefits makes justification methods hard to apply [2]. Clearly, executives are confronting challenging IT investment decisions, yet few appear to be well served by existing investment justification models.

2.2. Discounted Cash Flow Analysis

Discounted cash flow analysis (DCF), the most widely-taught model for investment justification, applies a simple criterion to investment decision making: those projects that have a positive net present value (NPV) -- i.e., the present value of the after-tax cash inflows exceeds the present value of the after-tax cash outflow -- should be undertaken, otherwise they

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3 "Justifying organization-spanning networks whose benefits are uncertain ... is in part an act of faith." [46] Investment in technology is "an act of faith, a belief that the future will be as promising as the present." [24]

4 National Westminster Bank has committed the staggering sum of £3 billion [8].
should be rejected. Future cash flows are discounted at the appropriate cost of capital to make them comparable to today's costs.

A broad debate is unfolding on the use of DCF methods for directing investment spending. Managers recognize that many of today's large-scale technology investments -- flexible manufacturing systems and integrated accounting processing systems in banks -- are not easily justified on a cost-reduction basis [44],[27]. These critics of DCF methods feel that an over-reliance on discounting techniques has inhibited capital investment in American businesses, reduced research budgets, and harmed the competitiveness of U.S. industry [24].

Discounting's defenders reply that DCF analysis is based on sound theoretical principles [39]. Rather than biasing against long-term investments, they contend DCF is an objective framework for comparing the relative merits of investments with different cash flows [6].

We feel that the evaluation of strategic IT programs is fraught with complexity that is not well-handled by DCF analysis. The debate over the use of DCF analysis for technology investments obscures the current misunderstanding of how IT can provide strategic value.

2.3. The Vanishing Status Quo

The problem of the vanishing status quo is real and prevalent. As management often neglects in its analysis of IT opportunities, the alternative to investment and development is rarely a continuation of existing industry conditions. Technological innovations have continually reshaped industry structures since the industrial revolution began in Britain in the eighteenth century [33]. IT simply increases the pace of change. Floor trading on London's stock market disappeared days after its Big Bang series of market reforms took effect in 1986 [14]. Activity moved to a screen dealing system that was better equipped to handle the demands of modern securities trading.

Executives making IT investment decisions must acknowledge the near-certainty that technology-induced change will alter the structure of their industry. Continuation of the status quo, as the alternative to a proposed IT program, is a glaringly naive assumption. Barwise et al. identify misstating the base case -- what will happen if the project is not carried out -- as a primary flaw in most companies' investment decision-making [1]. They recommend spending more time considering the

5 A related criterion, internal rate of return (IRR) or marginal efficiency of investment, is defined as the discounting rate that renders the NPV equal to zero. While the IRR and DCF criteria tend to be in agreement on most investment projects, for certain patterns of returns their results will differ.

likely outcome of not making an investment; the company's position is likely to deteriorate, rivals will act, and market share and margins of firms that fail to respond will fall.

2.4. Strategic Systems

The strategic systems literature has focused on innovation champions and winning the support of the CEO as methods for gaining acceptance of hard-to-justify IT projects. Identifying opportunities and threats, and analyzing the financial consequences of competitive advantage and strategic necessity, have received less attention than they deserve. IT affects more aspects of company's value chains and has become a critical enabler of many business strategies. For instance, IT has:

- Formed distribution channels, reaching out to the organization's customers: McKesson Economost, AMR's Sabre, and BZW TRADE are examples [12],[16].
- Enabled tight linkages with suppliers. GM and Hewlett-Packard have extensive EDI programs with vendors.
- Spawned powerful cooperative partnerships: MAC, a shared network of ATMs managed by Philadelphia National Bank [15], and the "virtual" merger of SAS and Texas Air by linking their reservation systems and combining their flight codes

In spite of the attention that several of these successful IT initiatives have received, managers have trouble evaluating the initial opportunities to use technology strategically, and have difficulty making investment decisions when these opportunities arise. The CFO of a Fortune 500 company said "in today's environment we don't think the numbers really tell the story -- many investments are required for survival or to stay ahead of the competition." [44] Clearly, the decisions of where and when to allocate resources to technology programs have simply become far more risky and difficult.

2.5. Evaluating Strategic IT

Our goal in developing IT investment principles is to review the determinants of a strategic system's value, and use them as a basis for making investment decisions. Few companies that have spent heavily to create a competitive advantage through IT have been rewarded. However, those firms that fail to respond to competitive requirements, and assume the continuation of a comfortable status quo, consistently find themselves in deteriorating positions.

3. Strategic IT Investment Analysis: Sources of Difficulty

Unfamiliar risks and difficulties confront executives deciding on strategic IT programs. Many firms pursue competitive advantage, but
few systems actually provide it. A number of hard-to-quantify parameters have a strong bearing on a system's strategic impact, but these factors are often overlooked in the investment analysis. Our studies indicate executives must consider the following factors in the evaluation of strategic IT programs.

3.1. Replicability and Competitor Response

In general, IT capabilities are easily copied, and the benefits of an innovation -- eg., lower production costs, enhanced customer service -- are not held exclusively by the innovating firm. The technology itself, however, is rarely a source of advantage. Instead, IT is an enabling other resources controlled by the firm to be exploited for advantage [9]. Lacking patent protection, genuine first-mover benefits, or a truly sustainable edge, managers are not justified in forecasting competitive benefits from a system. The ability to readily duplicate IT capabilities means that any advantage conferred will most likely erode. In addition, since opportunities to apply technology are usually open to all competitors, rejecting a technology program leaves it available to other players.

3.2. Misapplication of Financial Models

In practice, many firms misapply discounted cash flow models to IT investments. Surveys of current capital investment practice indicate that [30],[24],[42]:

- Benefits that are not easily measurable tend to be ignored and hence set to zero. -- The advantages of better quality, greater flexibility, lower throughput times, and experience with new technology are additional, but rarely quantified IT benefits.

- Financial analyses focus too narrowly on labor and materials savings, i.e., cost displacement is emphasized over new products and enhancements to existing offerings.

- To compensate for high perceived risk, rate of return hurdles are set at arbitrarily high levels. -- True cost of capital is far lower than that generally applied in deciding on new investment projects.

- High hurdle rates set in order to compensate for risk have no theoretical justification and have a discouraging effect on technology investment.

Poor application of DCF techniques to risky, long-term, or strategic programs is capable of misleading managers, and misleading firms in their use of IT innovations.

3.3. Industry Restructuring and Environmental Hazard

More dramatically, the status quo can change because of IT's ability to fundamentally restructure an industry. By creating new communication links and enabling coordination of businesses, IT brings about fundamental change:

- More recently, the sweeping deregulation and restructuring of the London securities markets in 1986 was accomplished in large part by the introduction of a screen-based dealing system. The improved market efficiency however has had disastrous effects on member firm profitability, causing losses that several years earlier would have wiped out the capital of most firms [14].

- The Chicago Mercantile Exchange (CME) and Reuters are progressing in a joint venture, Globex, to facilitate computer-assisted, off-hours trading in futures contracts [7]. Available world-wide on 173,000 Reuters terminals, Globex could radically alter the market's liquidity, and the role of floor brokers and other intermediaries that have had a long-standing presence in Chicago's derivative markets.

Anticipating the environment at the time of the investment decision is difficult and perilous. While predicting the future is always subject to error, technological advances make even the most expert forecast unreliable.

3.4. Long Lead Times

Information technology investments have long lead times. Before a full roll-out, an IT project typically passes through many phases of development, which include coding, testing, modification, training, and limited implementation with close monitoring. Fourth generation languages and CASE tools can shorten the timetable, but in most cases a strategic IT program will have a substantial lag between acceptance of the investment proposal, and the eventual time when benefits can be gauged. The effect of this delay is to introduce added uncertainty into assumptions made about market conditions and competitors.

In general, the future environment is highly uncertain at the time of the investment decision, and simply bounding the range of future cash flows may be extremely difficult even for experts. To have correctly projected Sabre's value would have required accurate predictions of the airline industry's growth under deregulation, the adoption rate of travel agents, and American's competitors' response to paying a booking fee to a competitor. Even extensive scenario evaluation would not have yielded the full range of future environments to be considered in making the strategic commitment to Sabre.

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3.5. Management and Organizational Barriers

Several barriers handicap management in properly evaluating strategic IT ventures. The size of the commitments is intimidating. NatWest Bank recently commit itself to the first part of a £3 billion program to replace its entire IT infrastructure [8]. In addition, as the number of risks and environmental uncertainties grows, IT decisions will not get safer or easier. As a result, paralysis can occur. Managements may have the misplaced belief that a technological panacea lies around the corner, obviating their need to act now. Promising new technologies may threaten a company's existing products are often neglected. Also, it is simply difficult to deviate from existing practice. There is an observed incapacity of incumbents and leading firms to respond to challenges of start-up firms that apply new technologies and innovations that represent generational change rather than incremental change [25].

4. Strategic IT Investment Analysis: Sources of Opportunity

Several benefits of IT are often overlooked and not fully valued in traditional investment decision models. To maintain precision, financial analysis assigns zero for the value of intangible benefits. Our studies indicate that less visible factors can significantly enhance the realized value of IT projects.

4.1. Divisibility and Expandability

IT provides the ability to expand scale easily, and generally at little incremental cost. Systems can be designed to have flexible and readily increased capacity, and are usually highly leverageable. There are few technical restrictions, and low incremental costs for sending more bits to travel agents, hooking up another customer into an order entry system, or selling CASE tools to other industry players.

IT has the capability to enhance a company's offerings and the convenience to its customers by expanding geographical reach or extending the hours of business. These enhancements can reach new segments of demand, and enable the business to grow in ways unforeseeable at the time of the investment decision.

4.2. Marketing In-house Systems

IT cost centers can become profit venture for firms that invest early. A number of systems that were developed as in-house projects received a favorable internal response, and were expanded in scale and offered as a third-party service, or on a licensing basis, resulting in generous returns on the incremental selling expense.

- First Boston is now licensing its proprietary systems development technologies -- CASE tools -- and its advanced global trading and clearance systems to competitors [20].
- Mellon Bank developed sophisticated, large-capacity transaction and account processing systems in the early-1970s. Mellon quickly became a leading provider of processing and other correspondent banking services to small banks [47].
- SNCF, France's national rail body, recently purchased a license to use Sabre software from American Airlines for $160 million [50].

Clearly, the possibility of packaging and selling internally-developed IT services and applications creates an opportunity for additional value from an IT investment.

4.3. Timing Value

Timing value is often overlooked when evaluating IT investments. Technology offers management a choice of when to adopt an innovation. The ability to choose when to implement a system is valuable, and there are several approaches to the optimal timing of a technology implementation.

For instance, Lee modeled the returns that an investment project generates as a stochastic process, and analyzes the value of the timing option -- the ability to defer the project--contained in many technology investments [38]. Using options valuation, he derives the optimal deferral policy and calculates a trigger-point value, the value of the project, which when reached, should trigger its implementation.

4.4. Flexibility and Option Value

Although difficult to account for in traditional financial frameworks, quicker response to customer orders, greater customer satisfaction, and enhanced service quality are aspects of IT programs that affect market share and growth, and thus require explicit consideration in making an investment decision. Fine and Freund note that there is scarce "knowledge and experience in evaluating investments that enhance flexibility." [19] They derive the added economic value provided by flexible production capacity when demand is stochastic, and note that this added value is rarely considered in investment decisions. Harrigan points out that flexibility -- by enabling firms to overcome exit barriers in declining industries and unprofitable market segments -- has strategic benefits [23].

5. Lessons from IT Successes

5.1. IT Investment Decision Cases

In spite of the obstacles to accurately evaluating IT programs and making sound IT investment decisions, it can be done. We examined five strategic systems investments
made with sound, rational methods [17]. These
price of these investments ranged from $2
million to $100 million. The companies justified
strategic technology investments by viewing IT
as a source of change, and a tool for strategic
positioning; i.e., several of the systems invest-
ments formed a platform for reaching a number
of strategic goals. Measuring IT ventures solely
on the basis of fallible estimates of future cash
flows was recognized to be misleading.

The analyses these firms conducted prior
to the launch of their IT ventures made use of
traditional capital investment methodologies, but
return on investment was never the primary
criterion. They used evaluation methods that
are rational, but not quantitative.

5.2. Strategy and Systems Decisions

As technology increases its strategic role,
companies are making the evaluation of IT
opportunities look more like the company's
strategic planning process. Managers base
strategic planning on the application of a
number of different models and paradigms.
Lederer and Sethi report that 'organizations
generally apply one of a number of methodolog-
ies in order to perform strategic IS planning'
and may "select features of the alternative
methodologies and in effect combine them to
arrive at decisions" [36]. Brealey and Myers
refer to strategic planning as "capital budgeting
on a grand scale" [6]. The 'grandness' is
accomplished by taking explicit consideration of the
factors and strategic dimensions not in-
cluded in a standard NPV analysis.

5.3. Managing the Risks of
Strategic IT Investments

The companies examined recognized that
risk may come in forms with which management
is unfamiliar. The first companies to switch
over to automated payroll processing faced
technical risk -- there was uncertainty whether
the technology was capable of supporting the
payroll processing needs. On the other hand,
the development of electronic securities markets
occurring today presents entirely different types
of risk. Environmental hazard arises; the IT
project can so radically change the environment and
business practices that forecasts are grossly
unreliable estimates of what the response and
the future environment will be. As a result, ex-
ante financial valuation cannot be precise, and
alternative principles for evaluating IT inves-
tments are necessary. Hypothesis 4 treats these
risks and ways they can be actively managed.

6. Hypotheses

H1. It may not be beneficial to use DCF
\textit{techniques for IT investments whose
impact is sufficiently uncertain.}

When investment values are not calculable,
ordinal ranking may still be possible and is
quite useful. As noted, estimating future cash
flows resulting from a strategic IT investment
is complex and subject to significant error. An
alternative is to perform decision tree analysis.
Identifying branches that characterize scenarios
-- i.e., rapid or slow customer adoption, and
limited or wide-spread competitor duplication--
is often easier than valuing future cash flows.
When properly structured, decision tree analysis
can frequently establish a value ordering of
outcomes even when precise valuations are not
available. It also surfaces assumptions, and lays
out the arguments for the viability of an IT
program. In some cases the eventual realiza-
tions of individual parameters may be irrelevant
to the decision; the ranking may not be af-
ected within wide ranges of parameter values.

H2. Thresholds established by sensitivity
analysis be used as trigger points
for fine tuning a project once it is
initiated.

Sensitivity analysis is simply a procedure for
calculating the consequences of mis-estimating
parameters in a decision model. Sensitivity
analysis is used to:
\begin{itemize}
\item Determine accuracy required for input data
\item Establish control ranges for changes in input
parameters and constants over which the
present solution remains optimal.
\end{itemize}

An IT program, like any investment, should
be subjected to sensitivity analysis. This is not
new. However, an investment that relies on a
particular adoption rate by users or a certain
completion date in order to be viable should be
tested for its robustness to mis-estimation.
Furthermore, the sequential development of
many systems allows them to be shut down at
substantial saving when prospects no longer
appear favorable, or scaled up if conditions
improve.

While an IT project may be worth undertak-
ing on the basis of present information, if a
parameter value falls below an indicated thresh-
hold, it signals the project no longer has a
positive value and abandonment ought to be
considered. Knowing these threshold values in
advance gives management the ability to make
sequential decisions, and cut losses as early as
possible in foundering project.

In addition to testing for the attractiveness
of a project when one input parameter is varied
at a time, it is also valuable to consider scena-
rios, \textit{different} but consistent combinations of
variables. One reason for creating plausible
scenarios is that inputs themselves may not be
independent. For instance, the cost of provid-
ing third-party processing may be related to the
size of the market. If demand rises it may be
possible to charge less and thus attract more
business. Also critical to assess in scenario
analysis are possible unspecified variables, or
\textit{unknown unknowns}.
H3. Advantage results from unique assets and resources of the implementing firm.

The theoretical underpinnings for this hypothesis are fundamental economic laws. If technology increases margins, we expect entrants and copying by existing players. Moreover, as Teece has demonstrated, there are limited barriers to copying -- a "weak appropriability regime" -- advantages will be competed away [49]. Unless patents or trade secrets offer protection, most IT capabilities are likely to have weak appropriability.

IT will likely have an asymmetric impact on different players. IT innovations will make some assets singularly more valuable. Since firms in the same industry often operate with different portfolios of assets, an IT capability, even when universally implemented, can take two firms with equivalent profitability and radically affect their margins and position in the industry [9].

As a result, those players that develop or acquire the requisite co-specialized assets before IT hikes their value will be advantaged. With access to co-specialized assets, a firm may be able to derive advantage that is not readily available to its competitors who lack these assets. Two examples are:

- In the drug distribution business, market share was the co-specialized asset whose value was greatly enhanced by the automation of the ordering and distribution function. Such as McKesson's Economation of the ordering and distribution function.

- In third party processing, Provident Bank had developed resources in-house that enabled them to win a large contract to handle Shearson's processing for its response to Merrill Lynch's Cash Management Account. In subsequent contracts, Provident enjoyed economies of scale and experience that drove their costs even lower.

If a fundamental impact of an IT innovation is to raise the value of a set of co-specialized assets, then one of the key decision criteria in considering a strategic IT venture will be which of these assets to buy and when to buy them.

H4. Several types of risk exist and can be actively managed to reduce the overall project risk.

A number of forms of risks arise in undertaking strategic IT programs. In contrast to modern securities analysis, which makes a number of assumptions and treats risk by calculating a single beta value of investment risk relative to the market, companies IT investments have several dimensions of risk. As IT projects have become bigger and more complex, there are more ways they can fail. These risks need to be recognized and managed. In some cases, the risk can be hedged, through out-sourcing and joint development, or by investing sequentially had scaling the project up or down as uncertainties become resolved. Components of IT risk include:

- Technical risk. The systems are not feasible with the current technology.
- Project risk. The IT capability that a firm seeks to develop is too large, too complex, or overwhelms the staff's technical skills. It may be possible to bring in outside help, such as consultants or independent software developers to reduce this risk.
- Financial risk. Estimates of payoffs may be incorrect, costs can run over estimates, or benefits and revenues may fail to reach targets. Sensitivity analysis and good management control can bound this risk.
- Functionality risk. The firm may get the design or implementation right but fail to realize the anticipated benefits.
- Environmental and systemic risk. The IT program so dramatically shifts the environment that the advantages expected from it vanish. The source of the risk is unanticipated response from competitors, or regulatory bodies, or changes brought about by the system itself.

H5. Technology investments may have option and timing value, and unexpected upside benefits.

Options theory can improve the evaluation of strategic IT investments. Similar to a call option, IT ventures frequently have upside value. Several authors have pointed out that a technology investment can result in a residual value that is similar to a financial option that ends up "in the money." [41] For instance, an R&D investment may position the firm to move quickly into a new technology at a later time. Other sources of option value from an IT program derive from the ability to scale up or down an IT capability in response to demand.
and the ability to achieve scope advantages through a system that is capable of extension beyond its originally intended application. For instance, a bank that develops a corporate account management system, and may later use it to support trust department operations.

IT developments give firms valuable options and provide a platform for enhancing the bundle of assets and resources that make up the firm. For instance:

Call Option. Firms can cobble together prototypes. The initial versions of Merrill's Cash Management and McKesson's Economost were initially rolled out as prototype versions [12],[13]. When market response permitted more precise and accurate estimation of their impact, these prototypes were replaced by full implementations.

Put Option. Leasing or subcontracting to gain an IT capability is a second alternative. If demand and benefits of the leased IT fail to justify it, the project is cut at minimal loss.

Timing choices are often available that can improve the value of an IT program. Brealey and Myers point out "the fact that a project has a positive NPV does not mean it is best undertaken now." Waiting may have benefits and result in a greater project value.

H6. Downside risk exists in rejected IT programs, which then may become strategic necessities through another firm's initiative

Since effective technology is generally widely adopted, firms reject IT programs because they are satisfied with the status quo. They should assess the position of ending up a follower in that technology. If a firm decides not to initiate the development of a system, competitors most likely will. Also, the unit of analysis for analyzing an IT program needs to be chosen carefully. If development of an IT capability appears un-economic, not developing while the rest of the industry does may be even less attractive.

Management need to decide on a clear metric for measuring a strategic IT program. The unit of analysis may not be clearly defined when an investment is intended to have a strategic impact. The desired strategic objectives could include increased market share, lower costs, new geographic reach, or business growth. The alternative to investment is unclear and hard to know in advance. It might be lower margins, or a necessary "catch-up" investment later. As a result, the decision to invest in a strategic system needs to be compared not to the status quo, but to the future environment assuming competitors develop it and users adopt it. Falling margins and vanishing market share are usually the true alternative to a strategic IT investment. The negative NPV of an IT program may be less negative than that of not doing it.

H7. Cooperation may be the dominant investment alternative under conditions of strategic necessity

Cooperation enables smaller and more specialized firms to counter scale weaknesses that they may face in developing and implementing strategic systems. If a strategic system relies on high volumes to be economic, the smaller players could be better off by initiating joint development efforts and providing a shared system. After Citibank, the dominant player in the New York retail banking market, rolled out its ATM network in the late-1970s, smaller institutions banded together and formed the New York Cash Exchange to offer equivalent ATM service on a cooperative basis. Other motivations for cooperating can be to:

Enhance scale advantages. Had Delta been allowed to merged its travel agent reservation system with Sabre, the combined system would control half of the market. Maintenance costs, marketing efforts, and the expense of any further enhancements would be spread over a wider user base.

Leverage existing assets. TRADE, BZW's system for stockbrokers to enter customers' buy and sell orders, has received enthusiastic adoption. In large part, the favorable reception came because the securities house had strong relations in place with the brokers, and the system did not try to bypass them, but was intended to enhance service to their customers [16].

Make up for resource deficiencies. SAS and Texas Air, two airlines with strong regional franchises in Europe and the U.S. respectively, decided to share flight codes and link their reservation systems. As a result, each will now serve as a feeder system for the other, enabling them to compete more effectively with larger carriers that cover both regions.

7. Conclusions and Directions for Future Research

Investing in strategic IT programs is a high stakes decision that carries enormous risk and large potential rewards. We have addressed the difficulties that management faces when making these investment decisions. How can the strategic impact of an IT opportunity be judged ex ante? What factors distinguish an IT program likely to generate competitive advantage? We feel that the success of an IT introduction depends on the company's existing strategic plan, and the assets and resources of the firm, which any IT venture should seek to leverage.

Given the degree of uncertainty in a strategic system's development and implementation,
and in the eventual environmental response, precise valuation methods, such as DCF, must fail. In light of the vast sums of money and high levels of corporate vulnerability associated with strategic IT programs, we sense that many of the existing methods are biased toward conservatism and risk-aversion. We have presented several procedures for evaluating IT investment programs, and have offered hypotheses and guidelines for making decisions to pursue strategic programs in IT. The credibility of these principles will be established through formalization and proofs, and through further empirical study. Due to the size of the commitments and the period of study required to determine the success of a large IT project, sample sizes will remain small. We feel that these early principles represent a significant improvement over methods generally in use.

References


