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Strategic capital investment decision-making: A role for emergent analysis tools? A study of practice in large UK manufacturing companies

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Abstract

The complexity surrounding strategic capital investments present challenges to managers charged with evaluating these projects. In particular over-reliance on financial appraisal tools is thought to bias decision-makers against undertaking strategic projects that are crucial to the development of business capability and innovation. In response to this concern, several emergent analysis tools have been advanced as means to integrate strategic and financial analyses of capital investment projects. This paper examines the use of both conventional financial analysis tools and selected emergent analysis approaches in the capital investment decision-making of large UK manufacturing companies.

The findings update previous studies on the use of financial analysis tools, but also examine how their use varies between strategic and non-strategic investment projects and the extent to which emergent analysis tools are impacting decision-making practice. Little evidence emerges of integration between strategic and financial analysis approaches. Financial analysis techniques still dominate the appraisal of all categories of capital investment projects, while risk analysis approaches remain simplistic, even for complex strategic projects. Despite their noted potential for informing strategic investment decisions, the emergent analysis tools barely register in practice. The appraisal of capital projects seems to reflect a 'simple is best' philosophy and a commitment to the role of

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intuition and judgement in assessing how the strategic dimensions of capital investments connect with their financial outcomes.

Keywords: Strategic capital investment; Decision-making; Financial analysis; Risk analysis; UK manufacturing companies

1. Introduction

Capital investment projects may be relatively 'operational' in nature or have a more 'strategic' focus. 'Strategic' projects are substantial investments that involve high levels of risk, produce hard-to-quantify (or intangible) outcomes, and have a significant long-term impact on corporate performance. Typical examples include company acquisitions and mergers, the introduction of major new product lines, the installation of new manufacturing processes, the introduction of advanced manufacturing and business technologies, and substantial shifts in production capability (Mintzberg et al., 1976; Butler et al., 1991; Accola, 1994; Slagmulder et al., 1995; Van Cauwenbergh et al., 1996; Slagmulder, 1997).

The complexity and uncertainty surrounding strategic capital investment projects present particular challenges to management accountants charged with their evaluation (Butler et al., 1991; Slagmulder et al., 1995; Slagmulder, 1997; Abdel-Kader and Dugdale, 1998; Dempsey, 2003). Notably, it has been suggested that over-reliance on financial appraisal tools may bias decision-makers against strategic investment projects (Ashford et al., 1988; Cheung, 1993; Phelan, 1997) thus reducing their uptake and impeding the development of business innovation and capability.

Empirical surveys have reported a good deal about capital investment decision-making practice in general. Yet, despite the importance of strategic investments, little specific attention has been given to developments in how these complex and uncertain projects are assessed. This paper explores this issue, reporting the results of an investigation into the strategic investment decision-making practices of large UK manufacturing companies.

Section 2 reviews the existing literature on the evaluation of capital investments in general and strategic investments in particular. Section 3 outlines the method employed for this study. Section 4 reports the results and is followed by a discussion and conclusions in Section 5.

2. Current understandings of capital investment decision-making practice

Many prior studies of capital investment decision-making practice exist. However, a review of this literature reveals inconsistent findings, little direct comparison between strategic and non-strategic project evaluation and little investigation of the use of emergent analysis techniques for strategic investment appraisal. The following literature summary highlights the inconsistencies and gaps that signalled the need for the current study.

2.1. Conventional investment analysis techniques

Practice in regard to the use of capital investment financial analysis techniques has been well investigated (see, for example, the following UK studies: Pike and Wolfe, 1988; Pike, 1988; Ho and Pike, 1991, 1992; Lefley, 1994; Pike, 1996; Abdel-Kader and Dugdale, 1998; Arnold and Hatzopoulos, 2000). The use of 'conventional' investment appraisal techniques (payback [PB], return on assets or investment [ROA or ROI], internal rate of return [IRR] and net present value [NPV]), and risk analysis approaches (e.g. sensitivity analysis; adjustment of the payback period or discount rate), have been examined in almost all of these prior studies.

The research findings are inconsistent, however. It is difficult to determine the extent to which these inconsistencies may be an artefact of the different populations, sample sizes and questions used in the various empirical studies (Pike, 1996; Arnold and Hatzopoulos, 2000). While comparisons must be interpreted with caution for this reason, the evidence we seems to paint a confusing picture of capital investment analysis practice. For example, Lefley's (1994) study of large UK manufacturing firms reported that the most popular investment appraisal technique was the payback technique (used by 94% of the companies while only 69% used either IRR or NPV). Lefley's findings appeared to indicate a decline in the use of the sophisticated methods and suggested that the payback method was the most popular means of assessing risk in advanced manufacturing technology investments—a 'strategic' type of investment (71% use). In contrast, Pike (1996), Abdel-Kader and Dugdale (1998), and Arnold and Hatzopoulos (2000)[1] reported sensitivity analysis as the most widely used technique for dealing with investment project risk.

Pike (1996) and Abdel-Kader and Dugdale (1998) found that most companies use more than one financial analysis technique in investment appraisal. Although they noted widespread use of the discounted cashflow (DCF) techniques NPV and IRR, with the latter used more than the former, Abdel-Kader and Dugdale (1998, p. 273) pointed out that practitioners attributed the highest importance to relatively unsophisticated methods:

> "With the exception of discounted payback, all the measures of financial performance were seen as important, with the unsophisticated methods (payback and ROI) rating marginally more important than the sophisticated, DCF, methods."

On the other hand, Arnold and Hatzopoulos (2000) found that practitioners placed greatest emphasis on the discounting techniques (NPV and IRR) with NPV rated higher than IRR (97% of large firms used NPV; 84% used IRR; 66% used payback).

These findings from key prior studies present us with contradictions, inconsistencies and an overall lack of clarity. Also, they have often overlooked the limitations of

[1] It must be noted that the samples for these recent UK surveys are inconsistent, a problem that besets any attempt to compare past empirical studies. Pike (1996) surveyed the largest (according to market capitalization) UK quoted companies, while Abdel-Kader and Dugdale (1998) sampled large UK manufacturing companies using the FAME database and Arnold and Hatzopoulos (2000) selected large, medium and small UK companies (based on capital employed) from the *Times 1000*.

conventional financial analysis tools for supporting strategic investment decisions in particular.

2.2. Shortcomings of traditional investment appraisal methods

Although DCF analyses have long been considered the most effective technique for evaluating investment alternatives[2], writers have attacked DCF techniques for their theoretical and implementation problems in practical business contexts. As already noted, financial project appraisals, particularly those involving DCF models, tend to be biased towards short-term, less strategic investments whose benefits are most easily quantified. Also, the rationality of such financial analyses is compromised where techniques are improperly applied, cash flows are inaccurately estimated, hurdle-rates are inappropriate, or important non-quantifiable project attributes are omitted (Kaplan, 1986; Dugdale and Jones, 1995; Adler, 2000). Critics of conventional investment appraisal methods further argue that DCF analysis is an inadequate and incomplete means of securing a 'rational' decision process in regard to strategic investments, because it fails to capture 'intangible' project attributes and ignores the value of future flexibility embedded within some strategic projects(Pike et al., 1989; Slagmulder et al., 1995; Carr and Tomkins, 1996, 1998; Dempsey, 2003; Brookfield, 1995; Busby and Pitts, 1997).

In light of these shortcomings of conventional financial analyses, it has been argued that strategic investment projects should not be justified solely on their capacity to create economic value for the firm. Rather, a complementary evaluation of their contribution to competitive strategy is required (Butler et al., 1991; Carr et al., 1994; Chen, 1995; Putterill et al., 1996; Abdel-Kader and Dugdale, 1998; Adler, 2000). Product quality, fit with business strategy and improved competitive position are amongst those factors identified as important influences on strategic investment decision-making (Pike et al., 1989). Yet, these hard-to-quantify benefits from strategic investments remain difficult to evaluate using conventional financial techniques, suggesting that strategic investment decision-making may require a different approach (Butler et al., 1991; Van Cauwenbergh et al., 1996; Covin et al., 2001).

Empirical studies (e.g. Butler et al., 1991; Slagmulder and Bruggeman, 1992; Carr et al., 1994; Slagmulder et al., 1995; Van Cauwenbergh et al., 1996) suggest that a 'subjective' decision-making approach is often evident in practice, with strategic factors forming a crucial part of the decision-making input. Butler et al. (1991, p. 402) noted:

> "In making decisions on strategic investments, quantifiable financial performance factors (whether measured by discounted cash flow techniques, payback period, or impact on sale and profits) were viewed as of secondary importance by most respondents… product quality, fit with business strategy and improving the competitive position of the firm were the most important factors considered by all informants."

[2] The past decade has seen the emergence of three popular techniques for measuring value creation—the equity spread model, the shareholder value approach, and the economic value-added model. For all their differences in implementation, each approach is fundamentally based on the DCF model.

Some researchers (e.g. Carr et al., 1994; Van Cauwenbergh et al., 1996) have pointed out that formal financial and risk analysis techniques in fact have remarkably little impact on strategic investment decisions. Conversely, others have suggested that the greatest reliance is placed on financial analyses, whether the investment project is strategic or non-strategic in nature (Abdel-Kader and Dugdale, 1998). This study will explore this issue with regard to strategic investment decisions, in part by exploring managers' use of emergent tools that claim to support the integration of strategic and financial analysis.

2.3. Integrating strategic and financial analysis

Numerous calls have been made for a more sophisticated approach to supporting strategic investment project appraisal by integrating strategic and financial considerations (Slagmulder et al., 1995; Lefley, 1996; Putterill et al., 1996; Shank and Govindarajan, 1993; Shank, 1996; Adler, 2000). To this end, various analysis tools, which combine quantitative and qualitative factors, have been linked with strategic capital investment decision-making. Five key tools, all at the forefront of recent strategic analysis developments, are included in the current study and outlined below.

2.3.1. The balanced scorecard

Kaplan and Norton (1992) devised the popular 'balanced scorecard' as a set of measures that link financial measures of performance with non-financial measures (focused on customers, internal business processes, and innovation and learning), to give managers an integrated framework for managing and evaluating their businesses. Kaplan and Norton (2001) advocated the balanced scorecard as a strategic management and decision-making tool, leading others to suggest that a balanced scorecard approach could be usefully applied to strategic investment decision-making (Milis and Mercken, 2003; Lyons et al., 2003). Few researchers have explored its use in capital investment practice, however.

2.3.2. Real options analysis

As noted, traditional financial analysis tools such as NPV do not explicitly incorporate the value of project flexibility (Copeland and Howe, 2002). The DCF model assumes a static environment where *all* capital investment decisions are reversible without penalty—an assumption that may not hold in a competitive environment. Real options analysis has been proposed as a means of addressing this limitation of the DCF model. Derived from the financial option-pricing model (Black and Scholes, 1973; Cox et al., 1979), real options analysis recognises that the flexibility (options) inherent in some capital projects has value. For example, options to expand, defer, downsize or abandon a major capital investment project have value because they allow a firm to respond to strategic and competitive opportunities rather than remaining locked into a fixed course of action (Cornel, 1993; Busby and Pitts, 1997, 1998; Trigeorgis, 1988, 1993, 1997, 1999; Copeland, 2001; MacDougall and Pike, 2003). Conversely, projects without this flexibility have a relatively lower value to the firm.

While real options analysis has been widely advocated for strategic capital investment appraisal (Trigeorgis, 1988, 1997, 1999; Cheung, 1993; Dixit and Pindyck, 1994;

Benaroch and Kauffman, 1999; Anderson, 2000), empirical evidence of its uptake remains thin (MacDougall and Pike, 2003) and the findings to date are inconsistent. On the one hand, it has been suggested that few practitioners understand or use the real options approach (Busby and Pitts, 1997; Howell and Jägle, 1997; Bowman and Moskowitz, 2001), but other studies note that some companies have begun to draw on it in their strategic investment analyses (Coy, 1999; Trigeorgis, 1999). This study will contribute new empirical evidence by examining the extent to which real options analysis is applied to those investment projects where it is expected to be of greatest utility—i.e. strategic projects.

2.3.3. Value chain analysis

Value chain analysis is advanced as a useful tool to help businesses identify their strategically important value-creating activities and develop appropriate competitive strategies (Porter, 1985; Shank and Govindarajan, 1992; Hoque, 2001). As such, it has the potential to inform strategic capital investment decision-making (see Shank, 1996; Carr and Tomkins, 1996). While Carr and Tomkins (1996) examined the relative use of value chain analysis in UK and West German companies, little research has been done since then to examine its use in UK companies.

2.3.4. Benchmarking

Benchmarking has been defined as "a search for industry best practices that lead to superior performance" (Hoque, 2001, p. 184). Benchmarking is considered a useful tool in assisting organisations to (among other things) "promote competitive awareness…link operational tactics to corporate vision and strategy … [and] trigger major step changes in business performance" (Hoque, 2001, p. 185)—all areas which are integral to strategic capital investment.

Since its origins in the Xerox Corporation in the late 1980s (Camp, 1989), benchmarking has become widely used as "one of the more popular of management fashions" (Mayle et al., 2002, p. 212). Its potential application to strategic capital investment lies in its ability to direct attention outside the firm towards competitors, the 'best in class' firms and innovation (Putterill et al., 1996). Yet, despite its widespread popularity as a strategic analysis tool, the role of benchmarking in strategic investment appraisal has yet to be examined.

2.3.5. Technology roadmapping

Technology roadmapping is emerging as an approach at the cutting edge of strategic decision-making developments. It is described as "a process that contributes … to the definition of technology strategy by displaying the interaction between products and technologies over time" (Groenveld, 1997, p. 48) by using charts and graphs to reveal the links between technology and business needs.

A key aim of technology roadmapping is to look both within and beyond the firm to ensure that the right capabilities are in place, at the right time, to achieve strategic objectives (McCarthy, 2003). It, therefore, has clear potential for application to strategic investment decision-making, as Miller and O'Leary (forthcoming) note:

> "Technology roadmap can be used to ensure that investments in assets such as new fabrication processes, products and factory layouts, made by different sub-units of the firm, are coordinated with one another and with investments in enabling and related technologies made by other firms…. The requirement that investments be consistent with a technology roadmap means that proponents of individual investments have to ensure that their proposals synchronize and fit with related investments taking place within and beyond the firm in a manner that enhances value."

While Miller and O'Leary (forthcoming) documented extensive use of technology roadmaps in their Intel Corporation case study, published surveys of capital investment decision-making practice have yet to examine the wider use of technology roadmapping. Its inclusion in this study serves to explore the uptake of a very new approach to strategic investment appraisal.

2.4. Exploring strategic investment decision-making: research questions

The preceding discussion has revealed two key issues in regard to the analysis of strategic investment decisions. First, conventional financial and risk appraisal methods appear to remain widely used (even for complex, strategic investment decisions), despite their acknowledged limitations. Second, although approaches have been proposed to integrate financial appraisal with the more strategic analysis of investments, the extent of their uptake in practice is not well known.

The study reported in this paper aimed to explore these two issues and update current knowledge on strategic investment analysis in practice. The research questions addressed in the study were shaped by the gaps identified in extant literature and can be broadly categorised as follows:

- Are conventional analysis techniques employed similarly in the analysis of strategic and non-strategic (operational) capital investment projects, and which techniques are used?
- What non-financial (strategic) criteria are considered important in the evaluation of strategic investment projects?
- Are recently developed analysis tools (i.e. those that aim to integrate strategic and financial analyses) being employed to evaluate strategic investment projects?
- Do practitioners perceive real benefits in the use of strategic analysis tools?

Section 3 outlines the research method used before moving to the findings.

3. Research method

The research evidence was collected in two ways. First, a survey was conducted using a mailed questionnaire. Respondents were asked to indicate whether they would be willing to participate in a follow-up interview—eight such interviews were then conducted.

3.1. Survey questionnaire

The questionnaire was four pages in length.[3] Most questions required respondents to assign a score on a five-point Likert scale. Where appropriate, questions were adopted from previous surveys of capital investment practice (in particular Pike, 1988, 1996; Abdel-Kader and Dugdale, 1998; Arnold and Hatzopoulos, 2000) to facilitate comparison with prior studies.

Sampling followed the approach taken by Abdel-Kader and Dugdale (1998), selecting only the largest UK manufacturing companies on the assumption that these firms make substantial capital investment expenditures and could be expected to undertake strategic investment projects. This sample selection, while appropriate for exploring our key research questions, does preclude any useful examination of organisational size effects related to the use of various investment appraisal approaches (c.f. Arnold and Hatzopoulos, 2000).

The sample comprised 320 companies selected from eight different manufacturing groups in the *Financial Analysis Made Easy* (FAME)[4] database using the standard industrial classification (SIC), UK-code-1992 (industry codes of two digits) as shown in Fig. 1. The selected companies satisfied the following criteria: (1) minimum turnover of £100 million for the year ended 2001, (2) minimum of 1000 employees for the year 2001, and (3) minimum total assets of £50 million for the year 2001.

On 29th November 2002, questionnaires were sent to the financial directors of these 320 companies on the basis that financial directors are most likely to be involved in evaluating investment projects (Chen, 1995; Arnold and Hatzopoulos, 2000; Graham and Harvey, 2001).

A covering letter attached to each questionnaire served as an introduction to the purpose of the survey and assured the confidentiality of the information supplied by each respondent. A follow-up fax was sent to non-respondents on 12th December 2002 and further reminders were sent out on 17th December. By the end of January 2003, 132 questionnaires had been received, giving a response rate of 41.25%. The sample size dropped from 320 to 271 because 49 questionnaires were returned unanswered.[5] So, 83 usable questionnaires were included in the analysis giving a net usable response rate of 30.63% (83 completed questionnaires/271 potential respondents). This response rate is comparable with that achieved in prior similar surveys (e.g. Lefley, 1994; Chen, 1995; Slagmulder et al., 1995; Abdel-Kader and Dugdale, 1998; Arnold and Hatzopoulos, 2000).

Most of the respondents were financial directors (86%) or financial controllers (8%), with the remainder (6%) being financial analysts, heads of treasury, heads of strategy, or

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[3] Copies of the questionnaire are available from the authors on request.

[4] The FAME database is a computerised service provided by *CD-ROM Publishing Co. Ltd* (London) and *Jordan & Sons Ltd* (Bristol). The database identifies companies by criteria such as industry, geographical area, turnover and number of employees and provides monthly updated information.

[5] Eighteen questionnaires were returned from the Post Office as undelivered. Seven questionnaires were returned because the named finance director had left the company. Twenty-four further questionnaires were returned because the company policy was not to respond to surveys, or because the recipient did not have time to complete it.

Manufacturing sub-sector	Industry code	Number of companies selected
Manufacture of motors vehicles, trailers and semi- trailers	44	21
Manufacture of radio, television, and communication equipments and apparatus	32	31
Manufacture of computer and related products	72	51
Manufacture of electrical machinery	31, 33	56
Manufacture of chemicals and chemical products	24	55
Manufacture of wood, rubber and plastic products	20, 25	27
Manufacture of food products, and beverage	15, 16	46
Extraction of crude petroleum and natural gas, mining of metal, uranium and other mining	11, 12, 13, 14	33

Fig. 1. Questionnaire survey sample.

heads of corporate development. Most respondents had an accounting and finance background (92.8%), while others had a background in engineering/science (4.8%) or social science (2.4%). The annual turnover ranges of the responding companies are shown in Fig. 2.

The possibility of non-response bias was examined by comparing the 83 responding companies to the total sample in regard to their turnover, number of employees and total assets. The results of parametric independent *t*-tests indicate that there is no statistically significant difference between the means of the responding companies and the total sample in terms of turnover (*P*-value $=0.651$), total assets (*P*-value $=0.414$) and number of employees (*P*-value $=0.587$).[6]

To further examine the possibility of non-response bias, answers to survey questions from respondents who replied without follow-up reminder (62 companies) were compared with answers from respondents who replied only after the reminder (21 respondents). There was no significant difference between the two groups of answers.[7] These results also suggest that more respondents would not have changed the results of the study.

3.2. Follow-up interviews

The purpose of the eight follow-up interviews was to explore questionnaire responses in greater depth and to seek elaboration on respondents' perceptions of their strategic investment decision-making experiences. The interviews were conducted during July–September 2003—seven by telephone and one face-to-face according to the respondents' preferences—and lasted for 15–25 min. The interviewees included Group Finance

[6] Further details of these statistical tests are available from the authors on request.

[7] For example, the non-parametric Mann–Whitney test for the 'importance of NPV' question, 'adjustment of forecast cash flows to allow for risk' question and 'use of benchmarking' question gave *P*-values of 0.832, 0.550, and 0.477, respectively.

Turnover range	% of responding companies
< £100 million	6.0%*
£100 million - £499 million	50.6%
£500 million - £999 million	16.9%
£1 billion - £5 billion	16.9%
£6 billion - £10 billion	2.4%
> £10billion	7.2%

Fig. 2. Annual turnover ranges of responding companies.

Directors of companies within the extraction/mining, chemical, motor vehicles, electrical machinery and beverage industries.

The interviews were semi-structured in nature. A list of open-ended questions was prepared to facilitate consistency and each interviewee was provided with the interview schedule in advance. These were utilised with a considerable degree of flexibility, however. If an interviewee showed interest in a specific issue and wished to discuss it further, he or she was encouraged to do so.

Section 4 presents the key findings of the survey and the supplementary interviews.

4. Survey and interview findings

4.1. Types of strategic investment projects

Respondents were asked to specify the types of strategic investment projects they had launched in the last 5 years (see Fig. 3). A guiding definition of 'strategic investments' was provided in the questionnaire as follows:

> "The term *strategic investments* refers to capital spending to protect, enhance or alter a firm's competitive capabilities, e.g. introducing major new product lines, installing new manufacturing processes, acquisitions or mergers. Such investments may be distinguished from routine asset replacement decisions."

Respondents were allowed to make their own judgements as to whether their capital investments were 'strategic', since it is the *perception* that a project is strategic that matters to the choice of analysis approach and this perception may vary across different contexts.

Increases in production capacity, company acquisitions and the introduction of electronically integrated operations emerged as the most common strategic investments, undertaken by more than half of the companies.

4.2. Financial analysis

The main conventional techniques for evaluating investment projects are the payback rule (PB), accounting rate of return (ARR), net present value (NPV), and internal rate of

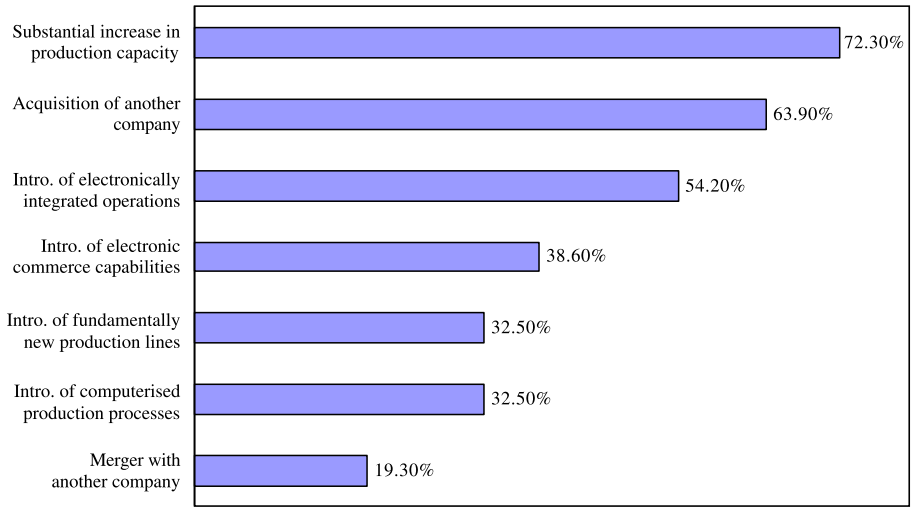


Fig. 3. Types of strategic investment projects.

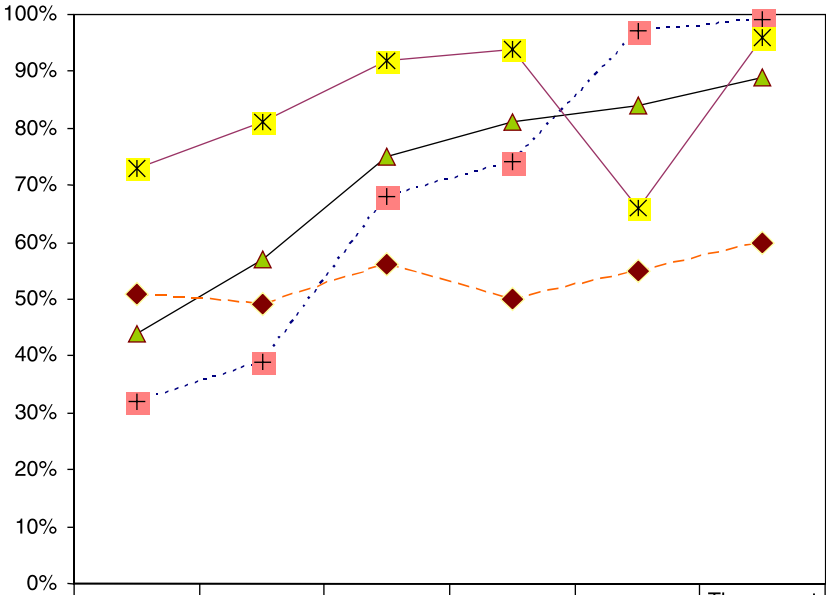
return (IRR). Fig. 4 presents the survey results on the level of use of these financial analysis techniques for strategic and non-strategic investments. Fig. 5 shows how the overall use of analysis techniques compares to usage levels reported in two recent UK studies by Pike (1996) and Arnold and Hatzopoulos (2000).

Figs. 4 and 5 reveal that NPV is the most used analysis technique for both strategic and non-strategic projects, while ARR is much less utilised across the board (consistent with Pike (1996) and Arnold and Hatzopoulos (2000)). The payback approach (PB) ranks second to NPV for non-strategic investments, with IRR ranking third, but this order is reversed for strategic projects. This suggests that managers are favouring DCF techniques (NPV and IRR) above less sophisticated approaches (e.g. PB) when it comes to more complex strategic projects. Several Group Finance Directors commented in interview on their preference for the 'value' focus of NPV, for example:

Technique	For non-strategic projects		For strategic projects		Difference in means (non-strategic v. strategic projects)	*P*-value
	Mean Score	Std Dev.	Mean Score	Std Dev.		
Net present value	3.6829	1.2754	3.9759	1.1367	0.2969	0.139
Payback	3.4268	1.1550	3.6098	1.1413	0.2073	0.257
Internal rate of return	3.3293	1.3058	3.7073	1.2813	0.3780	0.065
Accounting rate of return	1.9867	0.9371	2.2667	1.1547	0.2800	0.179

Response scale for technique use: 1= never; 2 = rarely; 3 = often; 4 = mostly; 5 = always

Fig. 4. Use of financial analysis techniques (non-strategic vs. strategic projects).



	1975/a *	1980/a	1986/a	1992/a	1997/b *	The current survey
NPV	32%	39%	68%	74%	97%	99%
IRR	44%	57%	75%	81%	84%	89%
PB	73%	81%	92%	94%	66%	96%
ARR	51%	49%	56%	50%	55%	60%

* a = Pike (1996); b = Arnold & Hatzopoulos (2000)

Fig. 5. Financial analysis techniques used to evaluate capital investment projects in large UK companies (1975–2002).

> "I prefer NPV over IRR because it is a more usable concept. NPV allows us to measure the total additional shareholder value we expect to generate from the project."
>
> "We believe it [NPV] to be the most rigorous evaluation of the project ability to add value to the shareholders."

The survey results also indicate that the use of multiple techniques is expanding; 98% of respondents used more than one financial analysis technique when evaluating investment projects and 88% used three or more techniques. This result is consistent with recent UK studies (e.g. Arnold and Hatzopoulos, 2000).

Despite its theoretical inferiority, the payback method is still widely employed as a primary or secondary evaluation technique—98% of respondents use PB when evaluating strategic investment projects and 96% use it when evaluating non-strategic projects. These results are consistent with previous findings (Carr and Tomkins, 1996; Abdel-Kader and

Dugdale, 1998; Pike, 1988, 1996). The payback technique's focus on liquidity is seen to be its main attraction, as evidenced in these interview comments:

> "We use a number of different formats. We would use a NPV and IRR calculation, but we also use cash payback as being probably our principle one that allows us to assess how quickly we are going to get a cash return back on our investment and how long before it starts to generate cash for the business."

> "Basically, we use payback method and we are looking for a 3 year payback period. When it is an acquisition we focus more on discounted cash flow techniques."

The calculation of mean 'scores' for the degree of use of each technique (Fig. 4) allowed the use of *T*-test statistics to examine the difference in technique usage for strategic vs. non-strategic investment projects. No statistically significant difference was found in the mean technique usage scores for the two types of investment projects (see Fig. 4). Hence, it can be concluded that the responding companies' use of these four well-established financial analysis techniques is independent of the nature of project being evaluated (strategic or non-strategic). This conclusion supports the view of Abdel-Kader and Dugdale (1998), who examined the financial appraisal of one category of strategic investment projects—those concerned with advanced manufacturing technology (AMT). They observed that *"a package of financial return indicators is employed by most companies in appraising investment opportunities—whether investing in AMT or in more conventional projects"* (Abdel-Kader and Dugdale, 1998, p. 273). This study suggests that the same undifferentiated approach to selecting financial analysis tools applies across a wide range of strategic (and non-strategic) investment decisions.

4.3. Risk analysis

Previous studies have investigated the use of various approaches to risk analysis in capital investment decision-making, although have not differentiated between strategic and non-strategic projects. Our study asked respondents to indicate how frequently they used the techniques identified in Pike (1996) and Arnold and Hatzopoulos (2000)—the main recent UK comparator studies—when evaluating strategic and non-strategic investment projects. Three further risk analysis techniques (adjusting the discount rate; adjusting forecast cash flows; and use of computer simulation) were also included, since they had featured in Abdel-Kader and Dugdale's (1998) study of investment in advanced manufacturing technology. Full results and descriptive statistics for risk analysis technique usage, as identified in the current study, are presented in Fig. 6. The overall levels of use for each technique, and comparisons with earlier studies, are presented in Fig. 7.

Rankings (according to mean usage scores) of techniques were broadly similar for both types of investment projects. The least used techniques across the board were computer simulation and beta (CAPM) analysis, confirming Abdel-Kader and Dugdale's (1998) observation that these theoretically preferred methods are perceived as less useful, even for high risk strategic projects, despite their apparent 'scientific' rigour. Sensitivity analysis emerged as the most widely employed technique for assessing the risk of both

	Non-strategic investment projects		Strategic investment projects		Difference in mean scores	*P*-value
	Mean Score	Std. Deviation	Mean Score	Std. Deviation		
Adjust required payback period to allow for risk	2.2892	1.06531	2.6867	1.25841	0.3976	.029
Adjust required return on investment to allow for risk	2.5181	1.11925	3.1084	1.24951	0.5904	.002
Adjust discount rate to allow for risk	2.6747	1.21081	3.0723	1.21759	0.3976	.036
Adjust forecast cash flows to allow for risk	2.8193	1.27015	3.2169	1.33479	0.3976	.051
Probability analysis	2.4337	1.17071	2.6867	1.18864	0.2530	.169
Computer simulation	1.8434	0.90368	2.0000	1.07067	0.1566	.310
Beta analysis (Capital asset pricing model)	1.7108	1.04216	1.7590	1.04287	0.0482	.766
Sensitivity /scenario analysis	3.1928	1.31091	3.4699	1.11899	0.2771	.145

Response scale for technique use: 1= never; 2 = rarely; 3 = often; 4 = mostly; 5 = always

Fig. 6. Use of risk analysis techniques (non-strategic vs. strategic investment projects).

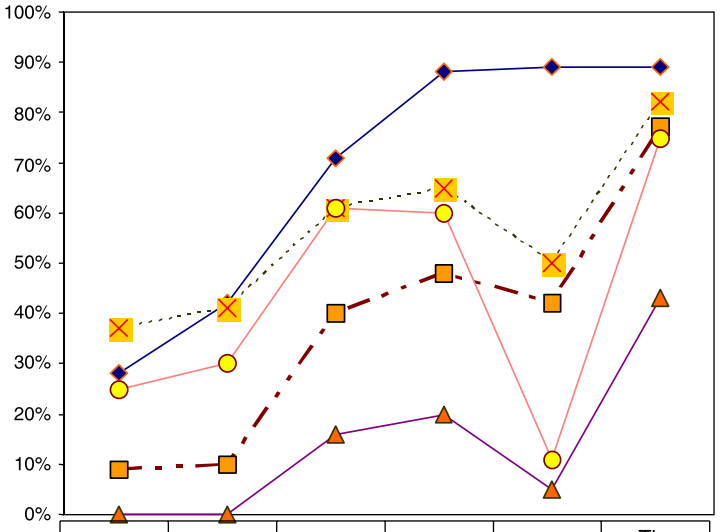
strategic and non-strategic investment projects, continuing a trend evident in previous UK studies (Pike, 1988, 1996; Ho and Pike, 1991; Arnold and Hatzopoulos, 2000).

The use of risk analysis techniques generally showed no significant variation across the eight manufacturing sub-sectors included in the sample. The one exception was sensitivity/scenario analysis, which was most used by firms in the extraction/mining sector and least used by firms in the computer manufacturing sector, perhaps reflecting perceptions that this method has particular utility for projects in higher risk industries.[8] It is often suggested that the popularity of sensitivity/scenario analysis derives from its perceived simplicity and intuitive appeal, a view supported by this respondent's interview comment:

> "We use simple sensitivity/scenario analysis. We look at different cases—we do an up-side, down-side type of risk analysis." (Group Finance Director)

Fig. 6 shows that the mean usage scores for some of the risk analysis techniques were significantly higher for strategic investment projects. These techniques were: adjusting the payback period; adjusting the required return on investment; adjusting the discount rate; and adjusting forecast cash flows (with *P*-values of 0.029, 0.002, 0.036 and 0.051, respectively). This seems consistent with the expectation that strategic projects are perceived as higher risk, therefore warranting greater attention to risk analysis. However, these four risk analysis techniques could be considered the least sophisticated of those included in the survey. The mean usage scores for the more sophisticated risk analysis

[8] A Kruskal–Wallis one-way ANOVA test of manufacturing sub-sector contingency effects resulted in a *P*-value of 0.04 for sensitivity/scenario analysis.



	1975/a *	1980/a	1986/a	1992/a	1997/b *	The current survey
Sensitivity/Scenario Analysis	28%	42%	71%	88%	89%	89%
Raise the Required Rate of Return	37%	41%	61%	65%	50%	82%
Probability Analysis	9%	10%	40%	48%	42%	77%
Shorten Payback Period	25%	30%	61%	60%	11%	75%
Beta Analysis	0%	0%	16%	20%	5%	43%

* a = Pike (1996); b = Arnold & Hatzopoulos (2000)

Fig. 7. Risk analysis techniques used to evaluate capital investment projects in large UK companies (1975–2002).

techniques (probability analysis, computer simulation, beta analysis and sensitivity/scenario analysis) were *not* significantly different for strategic and non-strategic projects. This is surprising, since we might expect complex, strategic investment projects to call for greater use of sophisticated risk analysis methods. This expectation finds no support in the survey results. Although the use of *some* risk analysis methods is higher for strategic projects, there is no evidence that more sophisticated methods are supplanting intuitive and simple approaches to analysing strategic project risk.

Fig. 7 illustrates the overall trends in the usage of risk analysis techniques within large UK companies.[9] The most widely used risk technique, sensitivity/scenario analysis, has

[9] Note that only those techniques surveyed by Pike (1996) and Arnold and Hatzopoulos (2000) are included in this longitudinal comparison.

dominated since the 1980s, although strong upward trends in the use of adjusted required rates of return, shortened payback periods and probability analysis can also be observed. Beta analysis continues to lag significantly behind. Although the current study suggests a substantial increase in the use of beta analysis over the past decade, interviews with respondents revealed little enthusiasm for this sophisticated, 'scientific' analysis tool—for example:

> "Beta estimation is a tool in the textbooks but it is not something you'd necessarily use from a business perspective." (Group Finance Director)

Interestingly, where Arnold and Hatzopoulos (2000) suggested a curtailing in technique use from the upward trends noted by Pike (1996), this current study supports the usage trends that Pike had identified. The use of shortened payback periods is a striking example of this. Pike had noted a 25–60% increase in the use of this technique from 1975 to 1992, but Arnold and Hatzopoulos claimed that it had fallen back to 11% use in 1997. The current study reveals usage rates of 75% for this technique, leaving the 1997 study results apparently out of line with the observed longer-term trend.

Persistent themes to emerge from the follow-up interviews were the intractability of risk, particularly for strategic investment projects, and the need to accept risk-taking as an inherent part of being innovative and responsive to customer and market opportunities:

> "Clearly with every investment you are taking a risk and it does not matter how much intelligence or research you do, you never totally eliminate the risk. All you do is seek to understand the risk better. You can do a year of work on it with a hundred people; you don't take the risk away. Our industry is all about taking risk." (Vice President, Corporate Finance)

> "If you want to prepare to make an investment by collecting all the information you might want and being 100% happy with the integrity of that information, you might considerably minimise the risk, but it's likely that you'll miss the opportunity because you spend so much time gathering the information." (Group Finance Director)

While increasing use is being made of the 'scientific' tools available to support risk management for strategic investment projects, an important role clearly remains for the 'art' of judgement by the decision-maker in deciding which risks are palatable and what degree of risk can be accepted. The limitations of available analysis techniques in resolving these challenges are well recognised.

4.4. Non-financial/strategic investment criteria

It has been widely noted that the strategic benefits of capital investment projects often depend on the competitive positioning afforded by increased efficiency, quality, innovation and customer satisfaction (Porter, 1985, 1996; Butler et al., 1991; Chen, 1995; Shank, 1996; Abdel-Kader and Dugdale, 1998, 2001). These strategic outcomes are not always amenable to traditional financial expression and analysis, however. An aim of this study was to identify the key strategic factors that impinge on investment

decision-making and to explore the use of analysis techniques that have been designed explicitly to incorporate strategic project outcomes.

Respondents were asked to evaluate the importance of 10 strategic project criteria using a five-point Likert scale. Fig. 8 shows the percentage responses for each point on the scale and an overall mean score for the importance of each factor.

These survey results suggest (unsurprisingly) that non-financial/strategic criteria are of particular significance in strategic investment decision-making. Consistency with corporate strategy was the stand-out issue of importance—not surprisingly, since respondents are commenting on investment decisions they consider to be strategic in nature. Requirements of customers, the quality and reliability of outputs, keeping up with competition, the ability to expand in the future, and obtaining greater manufacturing flexibility ranked 2nd to 6th most important, respectively, and were deemed 'important' or 'very important' by the majority of respondents.

Improved company image, reduced lead-times, reduced inventory levels and experience with new technology were rated at lower than average importance. Two Group Finance Directors suggested that those 'strategic' factors considered most important perhaps had the most direct link to financial outcomes:

> "Keeping up with competition… will have financial benefits. You do it because it will generate extra returns. Quality and reliability are all financial indicators, really. Expansion is important again because it will be assessed based on your work capacity and how quickly you can sell it [production]. So it leads towards financial areas."

> "Production enhancement, improving competitive advantage and growth opportunities—all of those are important where they are relevant. I do believe that all of the things ultimately translate into financial terms, which could be quantified.

	% of respondents selecting each category of importance					Mean Score (out of 5)
	(1) Not Important	(2) Below Average Importance	(3) Average Importance	(4) Important	(5) Very Important	
Consistency with corporate strategy	0.0%	0.0%	7.2%	41.0%	51.8%	4.4458
Improved company image	7.2%	36.1%	38.6%	14.5%	3.6%	2.7108
Requirements of customers	4.8%	1.2%	12.1%	50.6%	31.3%	4.0241
Keeping up with competition	6.0%	3.6%	22.9%	51.8%	15.7%	3.6747
Obtaining greater manufacturing flexibility	9.6%	8.4%	26.5%	49.4%	6.1%	3.3373
The ability to expand inthe future	1.2%	12.1%	30.1%	49.4%	7.2%	3.4940
Quality and reliability of outputs	3.6%	2.4%	28.9%	50.6%	14.5%	3.6988
Reduced lead-times	10.8%	12.1%	47.0%	21.7%	8.4%	3.0482
Reduced inventory levels	12.0%	16.9%	41.0%	25.3%	4.8%	2.9398
Experience with new technology	13.3%	27.7%	36.1%	21.7%	1.2%	2.6988

Fig. 8. The importance of non-financial factors related to strategic investment projects.

> We include these into the qualitative considerations, but ultimately any investment will have to meet financial criteria."

Another Group Finance Director gave short shrift to the notion that 'strategic' investment projects might have benefits beyond financial returns, stating:

> "Financial evaluation is critical in both strategic and non-strategic investments. As far as we're concerned, there is no such thing as a strategic investment that doesn't have a financial aspect to it."

For these Finance Directors, 'strategic benefits' cannot necessarily be viewed as a category beyond and outside 'financial benefits', a perspective somewhat at odds with the academic call for 'non-financial strategic benefits' to be better considered in investment appraisals. Indeed, these respondents seemed to regard qualitative/strategic project outcomes as significant only where they are considered essential to the continued operation of the business. A Corporate Finance Head of a large pharmaceutical firm further illustrated this point by saying:

> "Quality and safety are very important for us because ultimately we can't sell any of our products unless we have the approval of the relevant authority. Manufacturing reliability and manufacturing flexibility are very important for us because we are supplying drugs to customers."

Another Group Finance Director made a similar observation in regard to the legislative and societal requirements of business:

> "Sometimes we have to make investments due to environmental considerations, which is important to preserve the business and to maintain credibility and reputation… We'll do those projects even if they do not have a financial return."

Notwithstanding these 'compulsory' types of strategic investment, these investment decision-makers appeared to perceive qualitative, 'strategic' factors as directly related to the 'scientific' financial analysis of strategic investment projects. In practice, they strive to achieve a balanced evaluation across these elements:

> "Overall, I think you have to use a balance of the two categories [strategic and financial]. I would never say I would only do something because the numbers make sense. But equally, I'd never say I would only do something because it is strategic. You have to use a balance between strategy and finance—it's not about the extremes, it's about moving around in between, in the middle."

Section 4.5 considers the extent to which this need to find a balance 'in the middle' has led decision-makers to employ those recently developed decision-tools that aim to integrate strategic and financial analysis.

4.5. Strategic appraisal methods

The survey respondents were asked to indicate their use of the five recently developed analysis approaches (identified in Section 2.3) for the evaluation of strategic capital

Strategic Investment Analysis Approach	(1) Not Important	(2) Below Average Importance	(3) Average Importance	(4) Important	(5) Very Important	Mean Score (out of 5)
Coordination with investment decisions of other firms (i.e. using technology roadmaps)	54.2%	25.3%	13.3%	3.6%	3.6%	1.77
Real options approach	56.6%	22.9%	16.9%	3.6%	-	1.67
Balanced scorecard	12.0%	49.4%	20.5%	13.3%	4.8%	2.49
Benchmarking	4.8%	7.2%	49.4%	27.7%	10.8%	3.32
Value chain analysis	9.6%	48.2%	22.9%	15.7%	3.6%	2.55

Fig. 9. Perceived importance of strategic investment analysis approaches.

projects. Fig. 9 shows the percentage responses for each point on the scale and an overall mean score for the perceived importance of each analysis method.

The results reveal considerable variability in the use and perceived importance of these techniques. Benchmarking was most widely used, rated as 'of average importance' or 'important' by 87% of respondents. This result is perhaps not surprising because benchmarking is now well established and has been applied in many world-class companies (Hoque, 2001). However, its application to strategic capital investment analysis had not been identified previously.

Other analysis approaches fared less well. Value chain analysis and the balanced scorecard were the next most used approaches, but their mean 'perceived importance' scores fell below the 'average importance' score of 3. Although authors such as Milis and Mercken (2003) and Lyons et al. (2003) have suggested that the balanced scorecard provides an integrated evaluation framework that could inform strategic investment analysis, the results of this study reveal limited uptake of this idea in practice. Future studies could usefully explore whether the balanced scorecard, now well established for performance management purposes, makes inroads into strategic capital investment analysis. Similarly, despite the arguments by Shank (1996) and Carr and Tomkins (1996) that strategic capital investments should be informed by value chain analysis, this approach seems slow to take hold in practice. Carr and Tomkins (1996) noted UK companies had a long way to go to match (generally more successful) West German companies' use of value chain analysis, so would likely be disappointed by the results of this recent study. Again, future studies could usefully monitor whether UK companies begin to draw more on value chain analysis in their strategic investment decision-making.

Technology roadmapping approaches[10] and real options analysis were considered least important by respondents in this study; more than 50% of respondents rated these approaches 'not important' at all and the real options approach failed to garner even one respondent who considered it 'very important' (see Fig. 9).

[10] The strategic benefits of technology roadmapping are most strongly associated with its contribution to inter-firm co-ordination. For this reason, respondents were prompted to indicate the importance placed on "coordination with investment decisions of other firms through the use of industry level data/technology roadmaps".

Overall, these findings suggest that the five recently developed analysis tools considered here have made little impact on strategic investment decision-making practice, despite the growing academic call for the use of such techniques to inform strategic investment decisions.

The follow-up interviews suggest that managers may perceive these techniques as practically and conceptually difficult to apply. In the case of real options approaches, perhaps one of the most advocated tools for application to strategic investment analysis, interviewees made the following remarks:

> "The Real Options Approach is an academic exercise rather than something that is real for businesses." (Group Finance Director)
>
> "I think the capabilities of people to understand what they are doing with options are very limited. In other words, they think it is theoretically the correct thing to do, but practically it is not feasible in my business." (Group Finance Director)
>
> "The real options approach is something we could look at, but in fact we are not using it. I am aware of other companies who are using real options but we are not." (Corporate Finance Head)
>
> "Real options analysis has never really been applied because there are two issues. One is to get enough reliable data to put into the model. The second is, will people really understand what the model means, or is it just a black box approach to come up with an answer?" (Corporate Development Manager)

While it has been noted previously that formal real options analysis is little used in practice (Busby and Pitts, 1997; MacDougall and Pike, 2003), some commentators have suggested that the use of differentiated hurdle/discount rates for different project types may be a surrogate for real options analysis, since it can reflect an acknowledgement that some projects have greater flexibility (i.e. higher options value) and therefore are intuitively less risky (Stark, 1990; Busby and Pitts, 1997). While the findings of this study confirm that higher discount rates are often set for strategic investment projects[11], it seems ambitious to interpret this as any practical engagement with real options analysis. Rather, the interview quotes and survey results suggest that real options analysis has a long way to go to establish a meaningful place in practice.

Real options analysis is not alone in this regard. The results of this study have revealed that few of the most mooted strategic analysis approaches have made substantive inroads into investment appraisal practice. One Group Finance Director offers an insight into why it is that the 'science' of evaluative technique is unlikely to ever supersede the 'art' of strategic decision-making:

> "Intuition and judgment are absolutely essential. You can't just take academic calculations and sit down and look at them and say they make sense…. These decisions aren't based on hard calculations—you have got to have a view of your

[11] About 26% of respondents indicated that they used a higher discount/hurdle rate for strategic investment projects than they did for non-strategic projects.

company when you're talking to the people in it. So, intuition and experience are extremely important."

5. Conclusion

This 2002/2003 study has confirmed the findings of previous studies by Pike (1996) and Arnold and Hatzopoulos (2000) in that the use of all financial analysis techniques is increasing with time, with the greatest growth in the use of DCF analysis techniques and almost universal use of multiple techniques. However, the counter-intuitive finding of this study is that the choice and use of analysis techniques appear to be independent of the type of project being evaluated. That is, there is no significant difference between the use of techniques for analysing strategic and non-strategic projects, despite the very different natures and complexities of these projects. While Abdel-Kader and Dugdale (1998) observed a similar lack of differentiation in the use of financial analysis techniques for advanced manufacturing technology (AMT) investments and non-AMT investments, this study extends these findings across a much broader range of strategic investment decisions.

In regard to the use of risk analysis techniques, some of the relatively simple methods are drawn on more often for strategic projects. This seems to suggest that strategic projects are perceived as requiring greater attention to risk issues, although there is little evidence that more sophisticated techniques are supplanting simple methods of strategic project risk analysis. For example, while the current study confirms the Abdel-Kader and Dugdale (1998) finding that sensitivity/scenario analysis is the most widely used technique for both strategic and non-strategic projects, in contrast it finds no significant increase in the use of this technique for strategic investment projects. The same is true for probability analysis, computer simulation and beta analysis—all considered sophisticated approaches, yet apparently no more used for strategic investment analysis than they are for routine, non-strategic investments. The issue of how risk is perceived and evaluated for strategic investments warrants further investigation in future studies.

Interestingly, the findings of this 2002/03 study appear to contradict those of the most recent UK study (Arnold and Hatzopoulos, 2000) when it comes to trends in the use of risk analysis techniques. Our study supported Pike's (1996) finding that the use of the main risk analysis techniques in large UK companies is increasing over time, rather than Arnold and Hatzopoulous' view that use of techniques other than sensitivity analysis is falling away. However, even for strategic projects there is little uptake of the theoretically preferred techniques of computer simulation and beta analysis. Simple is perhaps still considered best when it comes to risk analysis and the interview evidence suggested that risk evaluation may be perceived as a question of judgement rather than of formal analysis.

While it was unsurprising to find that non-financial criteria were generally considered important for strategic projects, the interview evidence suggested that those 'strategic criteria' considered most important are those perceived as most closely linked to financial outcomes. This suggests that the dichotomy between 'financial' and 'qualitative/strategic' investment criteria may be perceived as less real in practice than is suggested in our

textbooks and that these two dimensions of capital projects are more readily linked than we might expect. This issue warrants further investigation in future research.

A key focus of this study was the use of emergent analysis tools for evaluating strategic capital investment projects. Benchmarking was the only one of five examined techniques to be widely applied to strategic capital investment analysis in UK manufacturing companies. The uptake of technology roadmapping and real options analysis appear particularly poor, despite academic endorsements of their potential to improve strategic investment decision-making (Miller and O'Leary, forthcoming; Dixit and Pindyck, 1994; Busby and Pitts, 1998). Technology roadmapping is a very recent entrant into the capital investment analysis domain, so its contribution may remain to be followed up in future studies. But, with only around 20% of respondents considering it *important* or of *average importance*, real options analysis, one of the most sophisticated and widely promoted techniques for analysing complex strategic projects, appears to have been 'abandoned' and has largely 'vanished' from practice, as suggested in the recent Bain study (IOMA's Report on Financial Analysis, 2003).

Criticisms still surround the use of financial analysis techniques to evaluate strategic projects and the call to adopt more 'strategic' appraisal approaches continues. Yet, this study provides little empirical evidence of integration and balance between strategic and financial analysis approaches. Financial analysis techniques still dominate the appraisal of all categories of capital investment projects, while risk analysis approaches remain relatively simplistic even for complex strategic projects. The emergent analysis tools included in this survey register very little impact on practice. The appraisal of capital projects seems to reflect a 'simple is best' philosophy and a commitment to the role of intuition and judgement in assessing how the strategic dimensions of capital investments connect with their financial outcomes.

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