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THE EVOLUTION OF THE APPLICATION OF CAPITAL BUDGETING TECHNIQUES IN ENTERPRISES

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ABSTRACT

This study examines the evolution of the application of capital budgeting techniques. Previous studies mostly used cross-sectional inquiry to understand capital budgeting practices in firms. Only a few researchers have undertaken longitudinal studies to generalise the findings of individual cross-sectional studies to the wider population and to identify emerging trends in the use of capital budgeting techniques (CBTs). This longitudinal study surveys 78 studies of capital budgeting practices across firms in India, South Africa, the United Kingdom (UK) and the United States of America (USA) for the period 1966 to 2016. The findings show that six capital budgeting techniques, namely net present value (NPV), internal rate of return (IRR), payback period (PBP), accounting rate of return (ARR), return on investment (ROI) and real option valuation (ROV), are the most popular methods used for evaluating capital investment. Of these techniques, ROV is the least used; a general lack of familiarity with this technique and its complexity are the reasons most commonly cited for not using it. Another method used less than the first four techniques is ROI. However, this technique is of growing significance mainly in the UK, followed by the USA, South Africa, and India. Firms in the USA and UK have increased their use of IRR as a primary method for evaluating capital projects and have retained PBP as an ancillary technique to strengthen the information available when evaluating capital projects. Firms in India and South Africa are increasingly excluding both PBP and ARR methods and are increasingly using NPV for evaluating capital investments. Although this development is in line with the theory, it limits the scope of information available when evaluating capital projects.

JEL Classification: G31, G32

Keywords: Capital budgeting techniques, trends in capital budgeting techniques, investment appraisal, longitudinal analysis

1. INTRODUCTION

This paper examines the evolution of the application of capital budgeting techniques (CBTs) in selected developing countries (South Africa and India) and developed countries (United Kingdom and United States of America) in recent decades. The period under review is 1966 to 2016. Previous researchers, such as Sangster (1993) and Pike (1996), used longitudinal studies to generalise the findings of individual cross-sectional studies to the wider population and to identify emerging trends in the use of capital budgeting techniques. However, recent innovations in capital budgeting practices have resulted in the development and use of new techniques, such as real option valuation (ROV) methods. ROV was proposed by Myers (1977) and further developed for use in capital budgeting by authors such as Luehrman (1995) and Merton (1998). Other capital budgeting techniques are modified internal rate of return, discounted payback period, Monte Carlo simulations and Economic Value Added (EVA), to mention a few (Kengatharan, 2016; Rigopoulos, 2014). The continuing developments in CBTs make it important to undertake current research regarding present practices to be able to identify trends in the use of CBTs.

Most of the previous studies (Andrews & Butler, 1986; Arnold & Hatzopoulos, 2000; Correia & Cramer, 2008; Hall & Millard, 2010; Kester & Robbins, 2011) in both developed and developing countries researched CBT practices using cross-sectional techniques. As a result, there is an information gap on how CBT preferences have evolved over the last five decades, and to what extent their evolution is aligned with the relevant theoretical developments. It is also unclear whether firms in developed and developing countries have preferences for using different CBTs. Although Kester et al. (1999) and Ekeha (2011) compared CBT practices in some developing and developed countries, their findings cannot be generalised to a wider population, mainly because their studies are cross-sectional and therefore do not reflect longitudinal trends in CBT preferences. The existing literature on the use of CBTs by firms in developed and developing countries does not provide adequate information regarding three key areas. First, the evolution of CBTs in these countries is not clearly understood. Second, the capital budgeting processes are not clearly defined. Lastly, anticipated future trends in CBT remain undefined.

The significance of understanding how CBTs are used is articulated by Pike (1988), Ben-David, Graham and Harvey (2007) and Kengatharan (2016), who concur that the use of advanced techniques, such as discounted cash flow (DCF), leads to increased capital investment and subsequently to enhanced earnings in the long term. The current study contributes to the capital budgeting literature by investigating whether firms are using capital budgeting techniques that have been found to enhance capital investment, which ultimately leads to increased earnings and the promotion of growth in firms. Using integrative reasoning, it remains unknown whether the evolution (or non-evolution) of firms' CBT preferences in developing countries dissuades capital investment, thereby effectively limiting growth. In the same vein, it remains unknown whether the evolution of CBTs used by firms in developed countries promotes investments in capital projects, thereby effectively promoting growth. This study endeavours to fill the information gap in CBT theory and practice by describing CBT preferences in developed and developing countries and how the use of those CBTs has evolved. Lastly, the anticipated future trends of capital budgeting practices in both developed and developing countries are provided.

The results of this study will contribute to the knowledge of academics and practitioners by providing insights into the evolution of capital budgeting techniques. Academics will be able to revise educational curricula accordingly and concentrate more on theoretically sound techniques that have received little or no attention in practice thus far. Practitioners who seek to outperform their peers (pursuant of an investment's alpha) may use this study to identify theoretically robust techniques that are seldom used in industry so that they can implement CBTs that increase earnings and promote growth.

The remainder of the paper is structured as follows: Section 2 presents the literature review regarding the use of capital budgeting techniques; Section 3 outlines the research methodology; Section 4 discusses the results and Section 5 provides the conclusion and recommendations for further research.

2. LITERATURE REVIEW

In today's business environment making sound capital budgeting decisions is a critical factor for survival and success (Bukvic, 2016; Hayward, Caldwell, Steen, Gow, & Liesch, 2017). Due to the competitive nature of business, companies increasingly find themselves faced with many (and sometimes competing) capital investment choices. Making optimal choices is essential for businesses to remain competitive. To this end, firms often use capital budgeting techniques (CBTs) to objectively identify which investment projects are worth pursuing (Cooper, Morgan, Redman, & Smith, 2001; Correia, 2012; Neelakantam, 2015).

Although there are numerous CBTs, these techniques can be divided into three categories, namely non-DCF (non-discounted cash flow), DCF (discounted cash flow) and alternative methods. What distinguishes the three CBT categories is the extent to which each conforms to two concepts: the time value of money and business uncertainty. Non-DCF methods do not include either of these two concepts, and DCF methods only incorporate the time value of money concept, whereas alternative methods incorporate both the time value of money and business uncertainty concepts. It is therefore evident that there has been a steady theoretical development in CBTs, but it remains unclear whether there are any emerging trends in the application of these methods by firms in practice. It is also not yet evident whether the capital budgeting processes of firms in developing and developed countries are similar or different and whether practices are gradually converging. The next section explores the evolution of capital budgeting practices in developing and developed countries to seek answers to these questions.

2.1 Capital budgeting techniques in developed countries

Ever since Hastie (1974) reasoned that prudent capital investment appraisals should not focus on the use of one specific CBT there has been a proliferation of new capital budgeting techniques. This study adopted a timeline approach and reviewed developments in CBT preferences by firms in developed and developing countries over a period of 50 years, namely 1966 to 2016. Table 1 summarises the literature review's key findings.

Table 1: Capital budgeting techniques in developed countries

| Author(s) | Year | Country | Popular Method(s) (%) |
|--|-------------------|-----------------|---|
| Klammer | 1969 ¹ | USA | DCF (57%), PBP (12%), |
| Baker & Beardsley | 1972 | USA | PBP (65%), ARR (55%), IRR (47%), NPV (44%) |
| Fremgen | 1973 | USA | DCF (76%), PBP (14%), |
| Petry | 1975 | USA | IRR (61%), PBP (58%), NPV (33%) |
| Gitman & Forrester | 1977 | USA | IRR (53%), NPV (10%), PBP (9%) |
| Schall, Sundem, & Geijsbeek, | 1978 | USA | PBP (74%), IRR (65%), ARR (58%), NPV (56%) |
| Oblak & Helm | 1980 | USA | IRR (60%), NPV (14%), ARR (14%), PBP (10%), ROI (2%) |
| Stanley & Block | 1984 | USA | IRR (65%), NPV (16%), ARR (11%), PBP (5%) |
| Mills | 1988 | UK | PBP (78%), IRR (68%), NPV (51%), ARR (44%) |
| Block | 1990 ² | USA | PBP (43%), IRR (28%), NPV (28%), ARR (18%), ROI (16%) |
| Drury, Braund, & Tayles | 1993 | UK | PBP (86%), IRR (80%), |
| Drury & Tayles | 1996 | UK | PBP (86%), IRR (80%), |
| Chadwell-Hatfield, Bernard, Philip, & Allen. | 1997 | USA | NPV (84%), IRR (70%), |
| Kester <i>et al.</i> | 1999 | Australia | IRR (96%), NPV (96%), PBP (93%) |
| Arnold & Hatzopoulos | 2000 | UK | IRR (81%), NPV (80%), |
| Graham & Harvey | 2001 | USA | IRR (76%), NPV (75%) |
| Ryan & Ryan | 2002 | USA | NPV (96%), IRR (92%), |
| Brounen, De Jong, & Koedijk | 2004 | UK | PBP (67%), NPV (47%), |
| | | France | PBP (50%), NPV (42%), |
| | | Germany | PBP (51%), NPV (44%), |
| | | The Netherlands | NPV (70%), PBP (65%) |
| Liljeblom & Vaihekoski | 2004 | Finland | IRR (82%), PBP (77%), NPV (62%), ARR (23%), |
| Hermes, Smid, & Yao | 2007 | Netherlands | NPV (89%), ARR (2%) |
| Truong, Partington, & Peat | 2008 | Australia | NPV (94%), PBP (91%), IRR (80%) |
| Holmén & Pramborg | 2009 | Sweden | PBP (57%), NPV (48%), ARR (38%), IRR (34%) |
| Bennouna, Meredith, & Marchant. | 2010 | Canada | NPV (58%), IRR (42%) |
| Daunfeldt & Hartwig | 2014 | Sweden | NPV (61%), IRR (30%) |

¹ Cited in Klammer (1972)

| Author(s) | Year | Country | Popular Method(s) (%) |
|----------------------------------|------|-------------------------|------------------------------------|
| Horn, Kjærland, Molnár, & Steen. | 2015 | Sweden, Norway, Denmark | NPV (74 %), PBP (66 %), IRR (51 %) |

Source: Author's review of the literature

2. Cited in Block (1997)

The following can be deduced from Table 1 regarding CBT practices in developed countries:

- firms use multiple CBTs;
- NPV, IRR and PBP are the most popular CBTs;
- the adoption of alternative CBTs is very low and slow;
- in spite of widespread criticism, non-DCF techniques are still used and many firms combine both DCF and non-DCF techniques when making capital budgeting decisions; and
- DCF techniques have been accepted and more widely applied faster than alternative CBTs have been accepted and applied thus far.

2.2 Capital budgeting techniques in developing countries

Compared to developed countries there were relatively few studies on CBTs in developing countries during the period studied. Table 2 summarises the literature review findings regarding the use of CBTs in developing economies.

Table 2: Capital budgeting techniques in developing countries

| Author(s) | Year | Country | Popular Method(s) (%) |
|-----------|------|---------|---|
| Porwal | 1976 | India | ARR (85%), PBP (70%), IRR (10%), NPV (8%), |
| Dhankhar | 1995 | India | PBP (35%), ARR (33%), IRR (16%), NPV (15%), |

| | | | |
|--|------|---|--|
| <i>Cherukuri</i> | 1996 | India, Hong Kong, Malaysia & Singapore | IRR (51%), PBP (38%), NPV (30%), ARR (19%) |
| <i>Jain & Kumar</i> | 1998 | India | PBP (61%), NPV (45%) |
| <i>Kester et al.</i> | 1999 | Indonesia, Malaysia | NPV (83%), IRR (78%), PBP (50%), ARR (20%) |
| | | Philippines | IRR (87%), PBP (72%), NPV (67%), ARR (41%) |
| <i>Hermes, Smid, & Yao</i> | 2007 | Chinese firms | NPV (89%), PBP (84%) |
| <i>Verma, Gupta, & Batra.</i> | 2009 | 30 Indian firms | IRR (57%), NPV (50%), PBP (37%) |
| <i>Maquieira, Preve, & Sarria-Allende.</i> | 2012 | Argentina, Brazil, Chile, Colombia, Ecuador, Peru, Uruguay, Venezuela | NPV (72%), IRR (70%), PBP (62%), ARR (15%) |
| <i>Mendes-Da-Silva & Saito</i> | 2014 | Brazil | NPV (81%), IRR (74%), PBP (61%), ARR (20%) |
| <i>Mbabazize & Daniel</i> | 2015 | 30 Rwandan companies | IRR (25%), PBP (25%) |

Source: Author's review of the literature

From Table 2 it can be inferred that in developing economies:

- firms use multiple CBTs;
- NPV and IRR are the most popular CBTs;
- the use of alternative CBTs is low;
- there is a significant use of non-DCF methods; and
- firms combine DCF and non-DCF methods when making capital budgeting decisions.

2.3 Capital budgeting techniques in South Africa

There are several studies on the use of CBTs in South Africa. Table 3 summarises the key findings regarding CBTs in South Africa.

Table 3: Capital budgeting techniques in South Africa

| Author(s) | Year | Sample | Popular Method(s) (%) |
|------------------|------|-------------------------|--|
| Andrews & Butler | 1986 | 500 mining companies | IRR (45%), PBP (27%), ARR (15%) |
| Hall | 2000 | 65 JSE listed companies | ROI (34%), IRR (33%), PBP (17%), NPV (17%) |

| | | | |
|-----------------------|------|-----------------------------------|--|
| Gilbert | 2003 | South African manufacturing firms | PBP (79%), ROI (72%), IRR (48%) |
| Du Toit & Pienaar | 2005 | 524 JSE listed companies | IRR (37 %), NPV (27%), ARR (11%) |
| Correia & Cramer | 2008 | JSE listed companies | NPV (82%), IRR (82%), PBP (56%) |
| Brijlal & Quesada | 2009 | South Africa | PBP (38%), NPV (36%), IRR (28%), ARR (22%) |
| Hall & Millard | 2010 | 41 JSE listed companies | ROI (33%), NPV (29%), IRR (24%) |
| Maroyi & Van der Poll | 2012 | Mining companies | NPV (69%) IRR (46%), PBP (23%) |
| Hall & Mutshutshu | 2013 | Selected parastatals | NPV (25%), IRR (17%), ROI (17%), PBP (17%) |

Source: Author's review of the literature

Based on Table 3 the following observations may be made regarding CBT preferences in South Africa:

- firms use multiple methods when evaluating capital investments;
- DCF methods (particularly NPV and IRR) are the most popular CBTs;
- firms combine both DCF and non-DCF techniques when making capital budgeting decisions;
- alternative techniques in capital budgeting are not popular; and
- ROI is a relatively important CBT technique.

2.4 Alternative methods in capital budgeting

Alternative methods provide valuable additions to the above-mentioned CBTs, such as DCF methods (McDonald, 2006). However, according to (Rigopoulos 2014), they are not often used in practice. Table 4 summarises the literature review's key findings relating to the use of ROV. There are few studies on the use of other alternative capital budgeting methods, such as Monte Carlo simulations, game theory, decision trees, the Capital Asset Pricing Model (CAPM) and Economic Value Added (EVA).

The reason for the non-use of alternative methods does not appear to be a lack of familiarity. These methods have been extensively discussed in the literature (Hull, 2014; McDonald, 2006; Verbeeten, 2006). Studies by Verbeeten (2006) assessed the role of alternative methods in capital budgeting and found that the use of, for

example ROV techniques encourages decision makers to think broadly and to incorporate the flexibility embedded in future project investment decisions. Further, Verbeeten (2006) argues that any costs emanating from the time and effort spent in applying alternative methods in capital budgeting can easily be offset by returns arising from improved investment decisions. However, Horn et al. (2015) argue that the complexity of alternative CBTs is their main drawback. It is assumed that practitioners prefer simple CBTs, instead of the computationally intensive alternative methods. This is line with Cheng, Kite and Raditke's (1994) study, which found that practitioners prefer methods that are convenient and understandable. This study's findings confirm that practitioners prefer to use DCF and non-DCF methods, which are relatively easy to formulate, compute and interpret to a wide range of stakeholders, comprised of individuals with varying financial skills and knowledge.

Table 4: Use of real options in capital budgeting techniques

| Author (Year) | Sample information | Use of real options |
|--|---|--|
| Busby & Pitts (1997) | Selected firms in the FTSE 100 index | 0% |
| Geddes (1999) | Selected UK and Irish companies | 2% |
| Graham & Harvey (2001) | Selected US firms | 27% |
| Rigby (2001) | Firms in North America, Europe, Asia, Africa and South America | 10% globally of which 7% in North America. |
| Triantis & Borison (2001) | 34 selected US companies | 66% of companies have adopted only a conceptual approach |
| Vollrath (2001) | Selected German firms | 3% |
| Ryan & Ryan (2002) | US Fortune 1000 companies | 11% |
| Siddle & Rigby (2002) | Firms from over 20 countries in North America, Europe, Asia, Africa and South America | 9% |
| Sandahl & Sjögren (2003) | Selected Swedish companies | 0% |
| Brounen, De Jong, & Koedijk. (2004) | Firms in the UK, Germany, France and the Netherlands | 29% in the UK, 34% in the Netherlands, 44% in Germany and 53% in France. |
| Block (2007) | US Fortune 1000 companies | 14.3% |
| Baker, Dutta, & Saadi (2011) | Canadian firms | 17% |
| Singh, Jain & Yadav (2012) | Selected firms in India | 50% |
| Hanaeda & Serita (2014) | Selected firms in Japan | 1% |
| Horn, Kjærland, Molnár, & Steen (2015) | Selected firms in Sweden, Norway and Denmark | 6% |

Source: Adapted from Horn et al. (2015)

Most studies on CBTs were contemporary cross-sectional surveys of techniques used in industry. A problem arises when one tries to generalise the outcomes of

these cross-sectional studies to a wider population to identify how CBT preferences have evolved over time. Sangster (1993) attempted to generalise CBT practices in UK firms. According to Sangster (1993) any generalisation regarding changing attitudes among firms concerning the use of CBTs is weakened by varying survey populations, questions and analysis methods. Pike (1996) heeded this caution and attempted a panel survey of the same UK firms at approximately five-year intervals between 1975 and 1992 using similar questions and analysis methods. He found that, in spite of his surveying the same respondents, there were still differences because some firms had closed, restructured and/or changed their management during the 17-year study period. Changes in survey response rates or sample sizes as a result of company closures, restructuring and management changes are also mentioned by Rigopoulos (2014), who argues that firms are not static, so it is not surprising that management attitudes towards different CBTs change over time. Rigopoulos (2014) states that, even when CBT preferences are surveyed in the same firms and in the same market but at different points in time, responses regarding CBT preferences may still be affected by various behavioural and market factors. Kengatharan (2016) therefore advocates the use of longitudinal analysis to understand the evolution of CBT preferences.

3. RESEARCH DESIGN AND METHODS

Longitudinal analysis research designs have frequently been used in finance research. Early studies, such as that by Rappaport (1979), used longitudinal analysis to understand CBT trends. Miller and Friesen (1984) applied a longitudinal analysis to investigate the corporate life cycle. More recently, Rashid, Noor, Matsuki, AbRahman and Omar (2016) used longitudinal analysis to study the relationship between a firm's financial abilities and earnings management. Longitudinal studies comprise three main variants, namely panel surveys, cohort surveys and trend analysis surveys. These three variants of longitudinal studies are extensively discussed by Edwards (2000) and Creswell (2012). As with every research methodology, longitudinal research designs require a unique set of conditions. Studies by Sangster (1993), Pike (1996) and Rigopoulos (2014) concur that in longitudinal studies it is vital that cross-sectional data is drawn from similar samples to permit comparisons. This study follows Sangster's (1993) approach by using a

trend analysis as a strategy of inquiry. Pike (1996) used a panel study approach, while the research by Mukherjee (1987), Correia (2012) and Kengatharan (2016) was based on extensive qualitative literature review methods. In theory, panel studies can produce relatively robust longitudinal results, compared to trend analysis and cohort studies (Creswell, 2012). In practice, these three methods produce similar results, as long as the CBT trend data are drawn from similar samples that permit comparison. Rigopoulos's (2014) study demonstrates the processes involved in ensuring that the data available for analysis is similar. The data similarity does not imply that exactly the same firms must be surveyed, because firms are not static. Preferences for a particular CBT are not influenced only by internal factors, such as a change in management, management behavioural attitudes, or other firm characteristics, such as size. External factors, such as price stability, also affect CBT choices. Thus, trend analysis was deemed to be a suitable research methodology for gaining an understanding of the evolution of CBTs, as it incorporates the variability of both internal and external factors.

Unlike panel and cohort studies, trend analysis survey respondents may be either different or the same. However, it is important that these respondents are drawn from the same population. In order to satisfy this key requirement the current study identified CBT practices from cross-sectional surveys of firms in selected countries. The populations identified were firms in the UK and USA (developed countries) and India and South Africa (developing countries). Studies on CBT practices in the UK and USA were independently analysed to understand the development of capital budgeting practices in developed countries. Similarly, cross-sectional studies of CBT preferences in India and South African firms were surveyed and analysed independently to understand the evolution of CBT preferences in developing countries. This segregation of populations by country is important because trend analysis survey designs involve identifying a population and examining changes within that population over time (Creswell, 2012).

A comprehensive search was conducted on the University of Pretoria's online databases, including sources such as SA ePublications, Emerald, Google Scholar, Proquest, Science Direct and EbscoHost, to locate studies on capital budgeting practices in various countries. The study's search parameters included CBTs, capital

budgeting practices, capital budgeting methods and other closely related parameters.

The present study purposively sampled the UK, USA, India and South Africa because there are many studies that discuss capital budgeting preferences in these four countries.

For a prior study to be included in this research it had to meet the following criteria:

- focus on firms assumed to have value maximisation as their goal;
- present a cross-sectional survey of CBTs in use at the time when the study was undertaken; and
- it was not allowed to be more than 50 years old as at December 2016.

There is no limit on the number of studies that can be integrated in a longitudinal (trend analysis) survey. Statistical power is enhanced when larger, rather than smaller, sample sizes are analysed.

This study extracted quantitative information pertaining to CBT preferences used by firms in the four countries sampled. Table 5 summarises the number of studies included in the current study.

Table 5: Number of studies on capital budgeting practices

| Country | Number of studies | As a percentage of the present study |
|---------|-------------------|--------------------------------------|
| India | 17 | 22% |
| SA | 16 | 20% |
| UK | 20 | 26% |
| USA | 25 | 32% |
| | 78 | 100% |

Table 5 shows that studies on CBT preferences are more common in developed countries. Of the 78 studies surveyed, 32% analyse capital budgeting preferences in the USA, followed by 26% in the UK, 22% in India and 20% South Africa. In the USA studies on CBT preferences started in 1970 and the most recent surveys were published in 2006. Similarly, in the UK early studies began in 1973, while the most recent studies were conducted in 2006. By contrast, studies exploring CBT

preferences in India and South Africa (developing countries) are topical thus far. In both instances the most recent studies were published in 2016. Early studies are recorded in the early 1970s as in USA and UK.

3.1 Data analysis

Data pertaining to the various CBTs and rates of usage across time were collected from published studies. This study applied non-parametric methods, specifically the Mann-Kendall (MK) test and the Mann-Whitney test, to analyse the trend analysis data. The use of these statistical techniques in trend analysis is discussed below. The Mann-Kendall test was selected to assess if there is a monotonic upward/downward trend of the various CBTs found in practice. A monotonic upward/downward trend in a particular CBT suggests that the use of the CBT in question consistently increases/decreases over time.

To understand whether CBT practices in developing countries are different to CBT practices in developed countries, this study employed the Mann-Whitney test. The Mann-Whitney test does not make any distributional assumptions about CBT preferences data nor does it require the preferences of the four independent groups (countries) to be the same sample size. The Mann-Whitney test was used to evaluate whether the different CBT preferences tended to be higher (or lower) in developed countries (the UK or USA) than in developing countries (India or South Africa).

3.2 Assessing and demonstrating the quality and rigour of the research design

Generally, longitudinal survey data is skewed by missing data, data outliers and the degree of normalcy of the data. The strategies used to mitigate the potential negative impact of these three factors on the validity of the present study's results are discussed below.

The Mann-Kendall test and the Mann-Whitney test allow for missing data when analysing trends.

This study discarded data outliers thereby omitting them from the data analysis. The quartile range approach and transformations were used to fence the data and

identify outliers falling outside the lower limit and upper limit boundaries. The boundaries were defined as follows:

- Upper limit: third quartile + (1.5 x interquartile range)
- Lower limit: first quartile - (1.5 x interquartile range).

Previous studies, such as those by Daunfeldt and Hartwig (2014), used regression analysis to understand developments in the use of CBTs over time as well as the factors that affected CBT usage. Regression analysis assumes that data will follow a normal distribution. However, the CBT preferences identified from the literature did not follow a normal distribution.

Klammer (1972) analysed developments in CBT preferences between 1959 and 1970. No statistical techniques were applied to test the significance of these results. Instead, Klammer (1972) relied on year-on-year CBT preference comparisons to reach a conclusion regarding the increased use of DCF methods and decreased use of non-DCF methods. Further studies (Cooper et al., 2001; Pike, 1996; Sangster, 1993) adopted a similar year-on-year comparison approach, although they analysed larger samples. Sangster (1993) and Pike (1996) both analysed five studies between 1975 and 1989 and between 1975 and 1996 respectively. Cooper et al. (2001) analysed ten studies between 1959 and 1990.

While the year-on-year comparison approach does provide insights into how CBT preferences developed, it is challenging to make unbiased generalisations when the sample size is large and there is an uneven and inconsistent trend line. The present study therefore used the Mann-Kendall test to assess the evolution of CBT preferences objectively.

The next section discusses the empirical analysis and results.

4. RESULTS AND DISCUSSION

Numerous CBTs are described in the theory and applied in practice, but only six techniques are frequently used in appraising capital investments. Table 6

summarises the number of times the most frequently used CBTs were applied by the firms studied.

Table 6: Capital budgeting techniques in use

| Country | Number of studies | NPV | IRR | PBP | ROI | ARR | ROV |
|---------|-------------------|-----------|-----------|-----------|-----------|-----------|-----------|
| India | 17 | 17 | 17 | 17 | 6 | 14 | 2 |
| SA | 16 | 16 | 16 | 16 | 8 | 13 | 2 |
| UK | 20 | 20 | 20 | 20 | 13 | 16 | 4 |
| USA | 25 | 28 | 28 | 28 | 11 | 23 | 6 |
| | 78 | 78 | 78 | 78 | 38 | 66 | 14 |

There is widespread use of DCF and non-DCF methods to evaluate capital investment decisions in developed and developing countries. However, the use of alternative methods is low, despite their strong theoretical grounding. All of the studies reviewed reflected the use of NPV, IRR and PBP. The use of ARR is reported in 85% of the studies, followed by ROI at 49% and ROV at 18%. The ROI and ROV methods were excluded from this study because there were too few data points to allow further analysis using the Mann-Kendall and Mann-Whitney tests.

4.1 Trend analysis of capital budgeting technique preferences

4.1.1 Capital budgeting techniques in developed countries

Firms in the UK

Figure 1 shows CBT preference trends in the UK. (More detailed information is provided in Appendix A - Panel A.1: UK). Preferences shown in red are adjusted for the outlier effect. The use of DCF methods, such as NPV and IRR, is increasing in UK firms. By comparison preferences for non-DCF methods, such as PBP and ARR, have remained fairly stable, as represented by the trend line in the two lower quadrants of Figure 1 below. This development (the increased use of DCF methods) is supported by current theoretical principles.

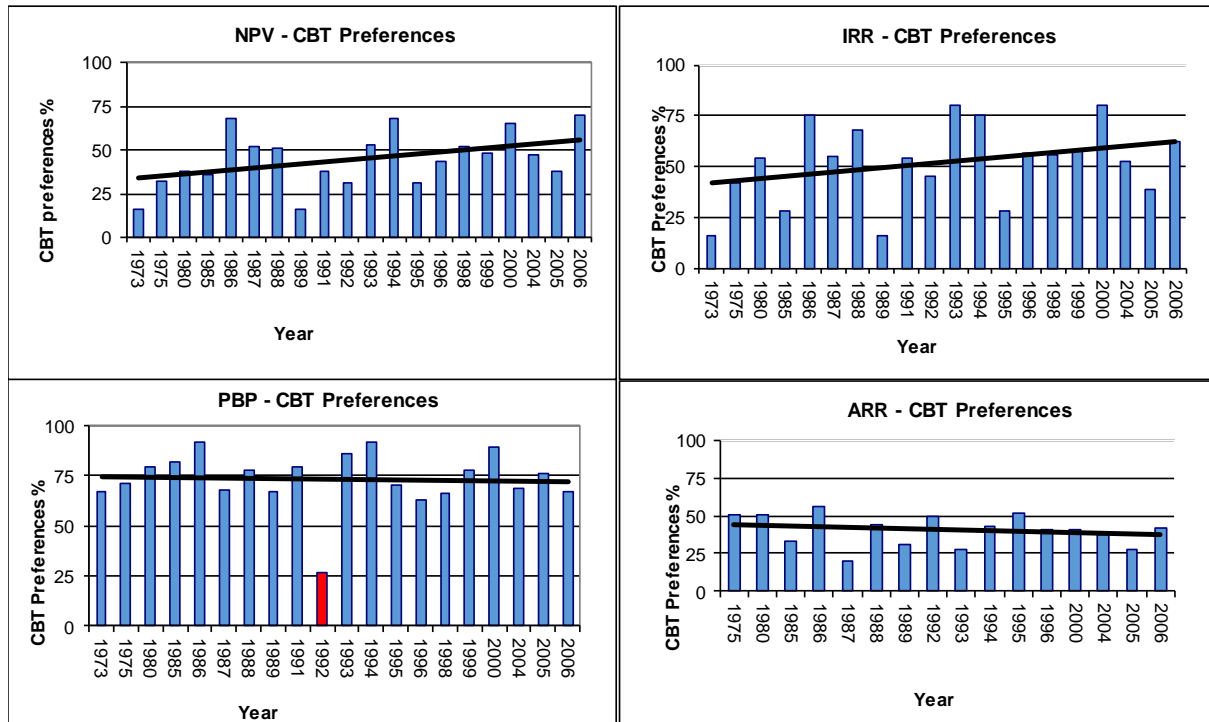


Figure 1: Trends in UK capital budgeting techniques

Regarding non-DCF methods, early studies (Carsberg & Hope, 1976; Pike, 1983; Westwick & Shoet, 1976) on CBTs reported higher preferences (with an average of 50%) for the ARR method, compared to recent studies (Alkaraan & Northcott, 2006; Block, 2005), which found less usage of ARR (with an average of 35%). Further analysis on this trend is presented below to assess whether the decreased use of the ARR technique in the UK is significant. The preference for the PBP technique appears to be stable, fluctuating around a mean use level of 74%. The Mann-Kendall test was used to evaluate whether these trends are significant.

Regarding the use of DCF methods, the trend line suggests significant increases in the preference for the NPV and IRR techniques. These findings corroborate those of other studies (Drury et al., 1993; Kengatharan, 2016; Mukherjee, 1988): UK firms have changed their CBT preferences from the use of non-DCF methods to DCF methods. An important debate topic is whether the increased use of DCF methods is gradually leading to the phasing out of non-DCF methods in evaluating capital investments. The findings of this study suggest that non-DCF methods are retained and increasingly being used as ancillary methods for evaluating capital investments.

Firms in the USA

As in the UK, firms in the USA have increased their usage of NPV and IRR, in line with textbook recommendations regarding CBTs (Bierman & Smidt, 2014; Brealey, Myers, Allen, & Mohanty, 2012; Carsberg & Hope, 1976; Porwal, 1976; Purohit, Lall, & Panda, 1994). The preference for PBP is increasing in the USA, unlike the UK, where it was observed to be relatively stable. The literature attributes the continued preference for the PBP technique to its simplicity, especially when assessing the liquidity risk of a project. Risk management tools, such as PBP, are likely to continue to play a key role in guiding corporate decision making in a business environment that is becoming increasingly volatile due to changes in both qualitative factors (climate, technology, wars, migration) and quantitative factors (sales revenue, term structure of interest rates). The decreased use of ARR can arguably be attributed, in part, to the increased prominence of private equity firms. This reasoning emanates firstly from Mukherjee's (1988) assertion that the ARR is mostly used in publicly listed companies. Secondly, recent findings by Kersley and Koutsoukis (2016) show that there has been an increase in private equity firms and a decline in the number of public companies in the USA. Therefore, the apparent declining preference for ARR in the USA may be due to the decrease of publicly listed firms.

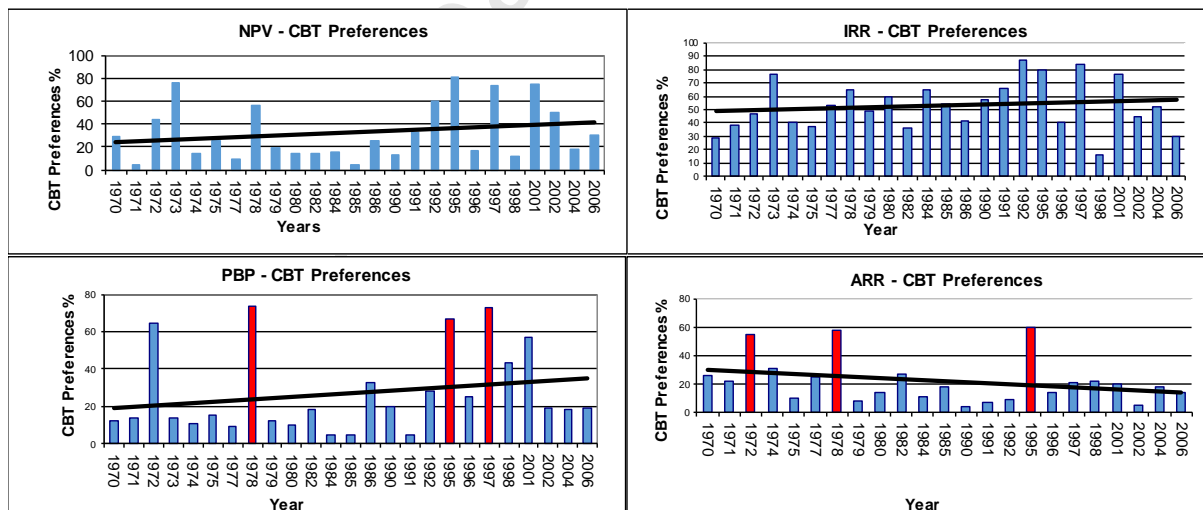


Figure 2: Trends in US capital budgeting techniques

Figure 2 (more detailed information is provided in Appendix A - Panel A.2: USA) shows an increased use of NPV, IRR and PBP, thereby indicating that these are the

main techniques used for evaluating capital budgeting decisions in the USA. However, the use of ARR is decreasing.

Significance of the capital budgeting techniques in developed countries

Table 7 summarises the Mann-Kendall trend test results and indicates how CBT preferences have developed in the UK and USA over the last five decades. First, the ARR technique is diminishing in significance, both in the UK and USA. However, the use of PBP and IRR has increased in the USA. UK firms have significantly increased their use of NPV, whereas the use of NPV has remained fairly stable in the USA.

Using the strength of Tau factors, this study shows that UK firms are significantly increasing their use of NPV, followed closely by IRR and then PBP. Firms in the USA are rapidly and significantly increasing their use of PBP, followed by IRR.

Table 7: Capital budgeting trends in developed countries

| Country | Metric | NPV | IRR | PBP | ARR |
|---------|--------------------------|------------------------|----------------|----------------|----------------|
| UK | Tau | 0.3750 | 0.3714 | 0.1714 | -0.3333 |
| UK | Tau critical @ 0.05 | 0.1544 | 0.1544 | 0.1544 | 0.1544 |
| UK | Coefficient of Variation | 0.4044 | 0.4079 | 0.3779 | 0.2834 |
| UK | Trend | Sig.Increasing | Sig.Increasing | Sig.Increasing | Sig.Decreasing |
| USA | Tau | 0.0265 | 0.4052 | 0.4248 | -0.5294 |
| USA | Tau critical @ 0.05 | 0.1140 | 0.1140 | 0.1140 | 0.1470 |
| USA | Coefficient of Variation | 0.7229 | 0.2920 | 1.0067 | 0.7019 |
| USA | Trend | Stable/No Trend Exists | Sig.Increasing | Sig.Increasing | Sig.Decreasing |

4.1.2 Capital budgeting techniques in developing countries

Firms in India

In India, regarding non-DCF techniques, the use of both PBP and ARR is decreasing. The decrease is more pronounced in ARR than in PBP. Regarding DCF preferences, the use of NPV is increasing, whereas the use of IRR is stable. Figure 3 (more detailed information is provided in Appendix A - Panel A.3: India) shows the trends of CBT preferences in India. By increasing their use of DCF methods, firms in India are aligning their practices with the theory, which discourages the use of non-DCF methods and supports the use of DCF methods, particularly NPV.

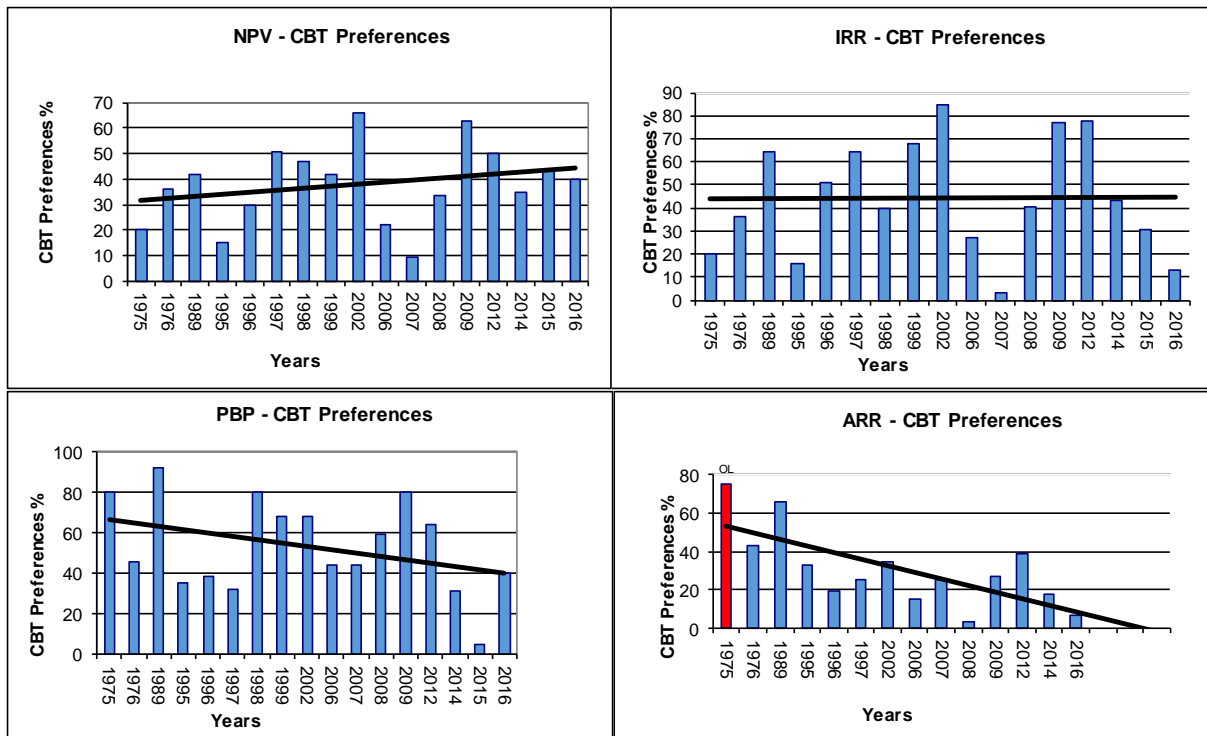


Figure 3: Trends in Indian capital budgeting techniques

Firms in South Africa

Capital budgeting practices in South African firms are similar to those in India. There has been a decrease in the use of PBP and ARR, but an increase in the use of NPV, as shown in Figure 4 (more detailed information is provided in Appendix A - Panel A.4: South Africa). Further analysis of the use of DCF methods reveals that South African firms are increasingly using NPV and decreasingly using IRR. This development is in line with the theory, which discourages the use of IRR and advocates the use of the NPV technique.

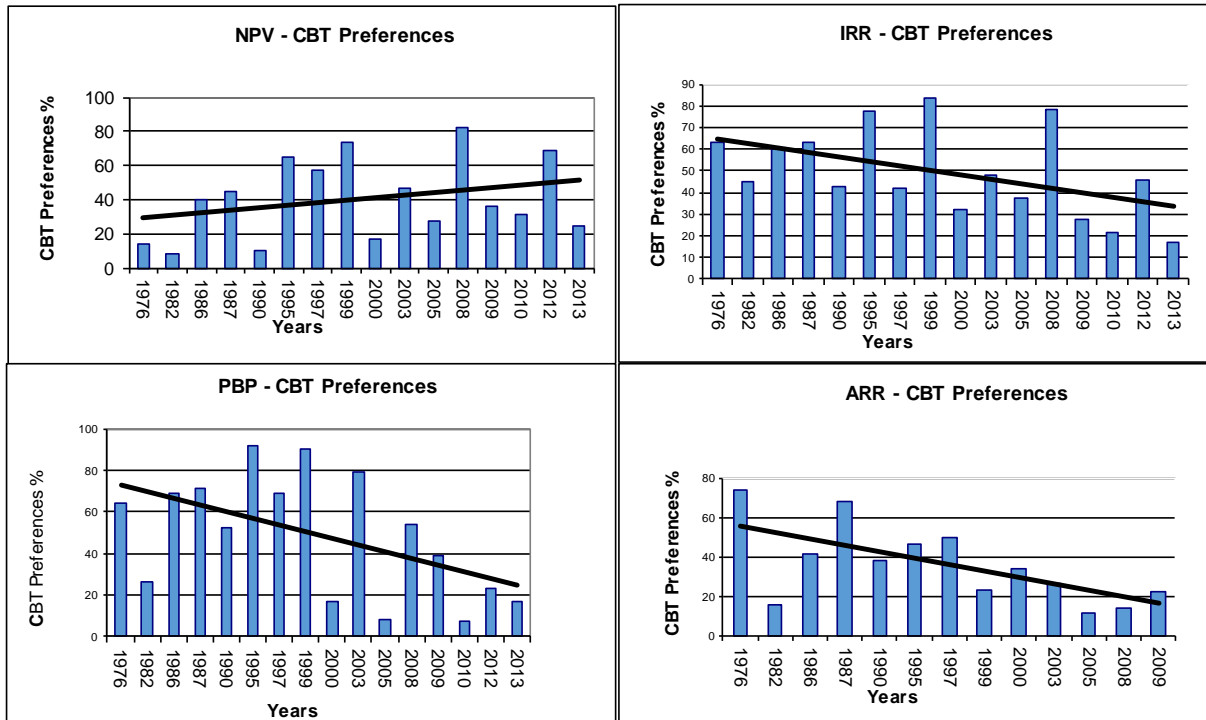


Figure 4: Trends in South African capital budgeting techniques

Significance of the capital budgeting trends in developing countries

Regarding their use of non-DCF methods, firms in India and South Africa are conforming to the theoretical principles, which discourage the use of non-DCF methods. There has been a significant decrease in the use of both PBP and ARR by South African and Indian firms. However, firms in the USA and UK have only decreased their use of ARR. The use of PBP in developed countries is increasing significantly, even though the theory advises that non-DCF methods should not be used. While the theory supports the increased use of NPV compared to other CBTs, firms in India and South Africa increasingly use only NPV, thereby inadvertently limiting the scope of information available for evaluating capital projects. Table 8 shows the significance of CBT preference trends.

Table 8: Capital budgeting trends in developing countries

| Country | Metric | NPV | IRR | PBP | ARR |
|--------------|--------------------------|-----------------|-----------------|----------------|----------------|
| India | Tau | 0.0571 | 0.0667 | -0.2667 | -0.3810 |
| India | Tau critical @ 0.05 | 0.1544 | 0.1544 | 0.1544 | 0.1815 |
| India | Coefficient of Variation | 0.4432 | 0.5209 | 0.3520 | 0.7395 |
| India | Trend | Stable/No Trend | Stable/No Trend | Sig.Decreasing | Sig.Decreasing |
| South Africa | Tau | 0.3167 | -0.3917 | -0.3833 | -0.3167 |
| South Africa | Tau critical @ 0.05 | 0.1544 | 0.1544 | 0.1544 | 0.1794 |
| South Africa | Coefficient of Variation | 0.5807 | 0.3728 | 0.5694 | 0.7236 |
| South Africa | Trend | Sig.Increasing | Sig.Decreasing | Sig.Decreasing | Sig.Decreasing |

Although firms in India and in South Africa have significantly decreased their use of non-DCF methods, their use of DCF methods diverges. South African firms are increasingly using NPV and significantly decreasing their use of IRR. Use of NPV rather than IRR techniques is supported by the theoretical principles discussed in various studies (Bierman & Smidt, 2014; Kengatharan, 2016; Lander & Pettengill, 2007; Verbeeten, 2006), especially when appraising mutually exclusive capital projects. NPV theoretically possesses robust discount rate (re-investment rate) assumptions and it also provides explicit shareholder value-enhancing criteria. Continued CBT preference trends in South Africa, *ceteris paribus*, result in the use of NPV as the main technique. Although the use of NPV is encouraged, South African firms, unlike firms in the UK and USA, rely on limited information to evaluate investment projects. By comparison, not only have UK firms increased their use of NPV, but they have also increased their use of IRR and PBP, thus broadening the scope of information available for decision making. Notwithstanding their significantly decreased use of non-DCF methods, Indian firms still do not use DCF methods to a significant degree. Perhaps firms in India are gradually evolving towards a reliance on both NPV and IRR.

4.2 Capital budgeting technique tendencies in developed and developing countries

Firms in the UK and USA are increasing their use of DCF methods, particularly the IRR and PBP techniques, whereas firms in India and South Africa are increasing their use of the NPV method. Although the theory advocates using NPV over IRR, using a single CBT may disadvantage firms in developing economies, because doing so would reduce the scope and breadth of information available for decision making purposes. There is a high likelihood that firms using limited information may make

sub-optimal capital investment decisions, which may have a negative impact on their operations and in turn on their growth and profitability.

Use of the ARR and PBP techniques is decreasing significantly in both South African and Indian firms, whereas in UK and US firms only the use of ARR is decreasing significantly. Use of the PBP method is significantly increasing in UK and US firms. Firms in developed countries have thus not excluded the use of all non-DCF methods, but they are increasingly using the PBP technique when evaluating capital investment decisions. These developments imply that firms in developed countries have not only increased their use of DCF techniques, but they also continue to use non-DCF techniques, particularly the PBP method. By contrast, firms in developing countries, specifically India and South Africa, have decreased their use of non-DCF methods in favour of the theoretically superior NPV technique.

The results of the Mann-Whitney test are summarised in Table 9.

Table 9: P-values for the comparison of capital budgeting technique preferences across countries

| | | South Africa | | | | India | | | |
|-----|-----|--------------|------|---------|---------|-------|-------|----------|---------|
| | | NPV | IRR | PBP | ARR | NPV | IRR | PBP | ARR |
| UK | NPV | 0.638 | | | | 0.181 | | | |
| | IRR | | 0.78 | | | | 0.332 | | |
| | PBP | | | 0.018** | | | | 0.05** | |
| | ARR | | | | 0.2 | | | | 0.037** |
| USA | NPV | 0.228 | | | | 0.308 | | | |
| | IRR | | 0.52 | | | | 0.178 | | |
| | PBP | | | 0.053* | | | | 0.005*** | |
| | ARR | | | | 0.048** | | | | 0.231 |

NB: if the p-value is greater than the significance level, alpha, one cannot reject the null hypothesis that there is no difference between the use of that CBT in the two countries being compared. The starred p-values are significant at a 1% (***), 5% (**) and 10% (*) significance level.

4.2.1 Firms in South Africa

In South African firms the use of NPV is increasing and that of IRR is decreasing, but there is no significant difference between the use of these techniques by firms in South Africa or firms in the UK and USA. However, there is a difference between the

level of use of the PBP method in South African firms and that of UK firms. There is also a difference between the level of use of the ARR method by firms in South Africa and firms in the USA.

The p-value of 0.018 (<0.05 , which is the significance level) for PBP use in the UK and South Africa shows that there is a significant difference between the use of the PBP method by firms in these two countries. Further analysis of the summary statistics and the Mann-Whitney test results regarding the use of the PBP in the UK and South Africa yields the results set out in Table 10.

Table 10: Mann-Whitney test results for UK and South African firms' use of PBP

| Variable | Minimum | Maximum | Mean | Median |
|------------|---------|---------|------|--------|
| UK_PBP (%) | 27 | 92 | 74 | 78 |
| SA_PBP (%) | 7 | 92 | 49 | 54 |

Mann-Whitney test / Two-tailed test:

| | |
|----------------------|---------|
| U | 259.500 |
| p-value (two-tailed) | 0.018 |
| Alpha | 0.05 |

In essence, UK firms tend to use the PBP method more than South African firms. The current study found a significantly higher use of PBP in UK firms than in South African firms. This study did not find significant differences between the use of other techniques, such as NPV, IRR and ARR, by South African or UK firms.

The p-value of 0.05 (<0.10) means that there is a difference between the use of PBP by US firms and South African firms, although this difference is not statistically highly significant. The summary statistics are provided in Table 11.

Table 11: Mann-Whitney test results for US and South African firms' use of PBP

| Variable | Minimum | Maximum | Mean | Median |
|-------------|---------|---------|------|--------|
| USA_PBP (%) | 5 | 78 | 31 | 18 |
| SA_PBP (%) | 7 | 92 | 49 | 54 |

Mann-Whitney test / Two-tailed test:

| | |
|----------------------|-------|
| U | 155 |
| p-value (two-tailed) | 0.053 |

Despite the fact that there has been a significant increase in the use of PBP in the USA and a significant decrease in the use of PBP in South Africa, firms in South Africa still use PBP more than US firms. Perhaps the observed trend, where the use of PBP is increasing in the USA and decreasing in South Africa, indicates that firms in both countries are adjusting towards a moderate use of the technique.

As noted above, South African firms also use the ARR method more than US firms, as indicated by the summary statistics in Table 12.

Table 12: Mann-Whitney test results for US and South African firms' use of ARR

| Variable | Minimum | Maximum | Mean | Median |
|-------------|---------|---------|------|--------|
| USA_ARR (%) | 4 | 60 | 24 | 20 |
| SA_ARR (%) | 11 | 74 | 36 | 34 |

Mann-Whitney test / Two-tailed test:

| | |
|----------------------|-------|
| U | 98 |
| p-value (two-tailed) | 0.048 |

South African firms use ARR more than US firms. However, the use of non-DCF methods, especially ARR, is not well supported by theoretical principles.

4.2.2 Firms in India

The use of DCF methods (NPV and IRR) in Indian firms does not differ from the use of DCF methods in the UK. However, UK firms display a higher use of non-DCF

methods than Indian firms. The use of PBP in India and the UK is summarised in Table 13.

Table 13: Mann-Whitney test results for Indian and UK firms' use of PBP

| Variable | Minimum | Maximum | Mean | Median |
|---------------|---------|---------|------|--------|
| UK_PBP (%) | 27 | 92 | 74 | 78 |
| India_PBP (%) | 4 | 92 | 53 | 46 |

Mann-Whitney test / Two-tailed test:

| | |
|----------------------|-------|
| U | 245 |
| p-value (two-tailed) | 0.052 |

Based on Table 10, one can state that UK firms use PBP more than Indian firms. Similarly, UK firms' use of ARR is higher than the use of ARR in Indian firms. The summary statistics are provided in Table 14.

Table 14: Mann-Whitney test results for Indian and UK firms' use of ARR

| Variable | Minimum | Maximum | Mean | Median |
|---------------|---------|---------|------|--------|
| UK_ARR (%) | 28 | 56 | 42 | 43 |
| India_ARR (%) | 3 | 75 | 31 | 26 |

Mann-Whitney test / Two-tailed test:

| | |
|-----------------------|---------|
| U | 171.500 |
| p-value (tTwo-tailed) | 0.037 |

While firms in India are conforming to theoretical principles, which advocate the increased use of DCF methods, there is a likelihood that excessive dependence on DCF methods may limit the scope of information available for decision making.

Although Indian firms underuse all non-DCF methods compared to UK firms, they do use the PBP method more than US firms. Regarding the use of ARR, there is little difference between firms in the USA and firms in India. The summary statistics for the use of PBP in the USA and India are presented in Table 15.

Table 15: Mann-Whitney test results for Indian and US firms' use of ARR

| Variable | Minimum | Maximum | Mean | Median |
|---------------|---------|---------|------|--------|
| USA_PBP (%) | 5 | 78 | 31 | 19 |
| India_PBP (%) | 4 | 92 | 53 | 46 |

Mann-Whitney test / Two-tailed test:

| | |
|----------------------|-------|
| U | 120 |
| p-value (two-tailed) | 0.005 |

Since the p-value 0.005 (<0.05) for PBP use in India is significantly higher than that of the USA, this implies that Indian firms prefer to use PBP more than US firms.

In summary, Indian and South African firms are similar in two respects. First, there is no significant difference between their use of NPV and IRR and that of firms in developed countries. Second, they use PBP less than UK firms, but they use this technique more than US firms.

4.3 Anticipated trends in capital budgeting technique preferences

The results of this study suggest that developments regarding the use of CBTs vary by country. Firms in the USA, UK, India and South Africa have evolved uniquely in the ways in which they align practice with the theory.

Based on the trend lines in Figure 3 (see Section 4.1.2), UK firms are likely to continue to use multiple CBTs for appraising investment projects. It may be expected that IRR and NPV will continue to be the primary techniques used by UK firms when evaluating capital investments. The PBP and ARR techniques are likely to remain widely in use as ancillary methods.

Firms in the USA may be expected to increase their use of DCF methods, but may continue to place a higher emphasis on IRR methods over NPV methods. PBP is also expected to remain a relevant tool for assessing capital projects. However, the use of ARR is expected to diminish in significance, in line with the theory, which

discourages the use of DCF methods. The increased use of IRR is expected to crowd out other CBTs. This may be due to the fact that IRR is mainly used in private equity firms, which are beginning to dominate in the USA.

South African firms may be expected to increase their use of NPV. The increased use of NPV will largely be associated with the decreased use of PBP and ARR methods, which will then be relegated to the role of secondary CBTs. NPV users are likely to continue to first use PBP as an additional CBT to increase the information available for investment decisions. As the decreased use of ARR is more pronounced than that of PBP, it is expected that ARR will become a secondary choice.

Indian firms show a decreased use of non-DCF methods, but it is expected that the use of DCF methods will remain stable. Firms in India may be expected to alternate between using IRR and NPV.

5. CONCLUSIONS AND RECOMMENDATIONS

This study analysed the use of CBTs in the USA, UK, India and South Africa, based on surveys published from 1966 to 2016. Cross-sectional survey data must be drawn from the same population to achieve effective survey comparisons. A longitudinal analysis of the developments in CBTs was undertaken to identify CBT evolution trends. Despite the limitations of longitudinal studies, such studies remain useful to practitioners and academics for comparing past survey results and to infer long term trends.

Although a number of CBTs are detailed in the theory, only selected techniques are commonly used in practice. The most widely used techniques identified in this study are non-DCF methods (ARR and PBP) and DCF methods (IRR and NPV). Alternative methods are the least preferred and used CBTs, probably due to their complexity and the shortage of human capital with the required skills and knowledge to apply them. Although ROI is the second least preferred technique used in the period under review, it is of growing significance in the UK followed by the USA, South Africa and India. More research is needed to understand the use of real option techniques in capital budgeting by firms in both developed and developing countries. Similarly, studies on the use of other theoretically robust techniques (such as CAPM,

EVA, modified internal rate of return, discounted payback period and decision trees) in capital budgeting remains sparse.

Firms in developed countries, using the USA and UK as samples, are increasingly using DCF methods (in particular IRR and NPV) rather than non-DCF methods (such as ARR and PBP) in making capital investment decisions. The increased use of DCF methods is congruent with finance theory, which stresses the need to incorporate the time value of money in financial decision making. Similarly, firms in developing countries, using South Africa and India as samples, are increasingly using DCF methods (in particular the NPV method) rather than non-DCF methods (such as ARR and PBP) in making capital investment decisions. While there is limited information regarding the use of alternative CBT methods, it is possible to say that there has been a general increase in the use of DCF methods in both developed and developing countries. However, the use of non-DCF methods varies. Firms in developing countries have significantly decreased their use of non-DCF methods (PBP and ARR). By contrast, firms in the USA and UK have decreased only their use of ARR. The preference for PBP increased significantly both in UK and US firms.

The combination of the increased use of DCF techniques and decreased use of non-DCF methods in firms in developing countries, suggest that firms in developing countries are evolving towards a greater reliance on DCF methods. The use of CBTs is thus evolving from less effective (or less sophisticated) non-DCF practices into superior DCF practices, as recommended in finance theory. In developed countries there is an increased use of DCF methods (IRR and NPV) and varied use of non-DCF methods. The increased use of DCF methods, in the light of the varied use of non-DCF methods, suggests that DCF methods are becoming the primary CBTs for assessing capital investment projects, with non-DCF methods assuming a secondary role. Where there are mutually exclusive projects non-DCF methods may be useful for ranking potential projects when making capital budgeting decisions.

Numerous studies have shown that practitioners' use of CBTs is increasingly aligned with finance theory, with a shift towards greater use of DCF methods than non-DCF methods. However, there are still unexplained differences between the theory and practice.

There are four main recommendations for future research. First, more research is required to explore the continuing importance of IRR over NPV. Moreover, there is a need to validate the assertion that the use of IRR is prevalent in private equity firms. Second, there are few studies that explore the use of advanced alternative CBTs, such as real options, Monte Carlo simulation, EVA and modified internal rate of return in capital budgeting. Third, the literature emphasises issues relating to the selection phases of the capital budgeting process, but future research could focus on the control phases of capital investment.

Fourth, the findings of this study suggest that firms are increasingly using DCF methods. It is not sufficient to conclude that firms are simply adhering to theoretical principles. There should be a visible notable performance difference when firms choose to embrace certain methods over others, justifying the relevance of the adopted CBTs. Therefore, there is a need to explore the impact of adopting (or not adopting) DCF methods on firms' performance. Further research is needed to ascertain the relative performance of companies that have adopted DCF methods compared to companies that use non-DCF methods.

Other recommended future areas of research are CBT practices in high-risk business environments and sectors, such as technology companies. Suggestions for studying the use of CBTs by firms operating in high risk business environments include countries such as Zimbabwe and Syria.

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APPENDIX A

Table 9: The development in capital budgeting techniques

Panel A.1: UK

| Year | Author (s) | NPV (%) | IRR (%) | PBP (%) | ARR (%) |
|------|---|---------|---------|---------|---------|
| 2006 | Alkaraan & Northcott | 70 | 62 | 67 | 42 |
| 2005 | Block | 38 | 39 | 76 | 28 |
| 2004 | Brounen, De Jong & Koedijk | 47 | 53 | 69 | 38 |
| 2000 | Arnold & Hatzopoulos | 65 | 80 | 89 | 41 |
| 1999 | Geddes | 48 | 58 | 78 | |
| 1998 | Sekwat | 52 | 56 | 66 | |
| 1996 | Drury and Tayles | 43 | 57 | 63 | 41 |
| 1995 | Ballantine, Galliers, & Stray | 31 | 28 | 70 | 52 |
| 1994 | Wilkes, Samuels, & Greenfield (published 1996) | 68 | 75 | 92 | 43 |
| 1993 | Drury, Braund, & Taylesl | 53 | 80 | 86 | 28 |
| 1992 | Pike (published 1996) | 31 | 45 | 27 | 50 |
| 1991 | Klammer, Koch & Wilner | 38 | 54 | 79 | |
| 1989 | Sangster (published 1993) | 16 | 16 | 67 | 31 |
| 1988 | Mills | 51 | 68 | 78 | 44 |
| 1987 | Mills & Herbert | 52 | 55 | 68 | 20 |
| 1986 | Pike (published 1996) | 68 | 75 | 92 | 56 |
| 1985 | McIntyre & Coulthurst | 36 | 28 | 82 | 33 |
| 1980 | Pike (published 1996) | 38 | 54 | 79 | 51 |
| 1975 | Pike (published 1996) | 32 | 42 | 71 | 51 |
| 1973 | Carsberg & Hope (published 1976) | 16 | 16 | 67 | |

Panel A.2: USA

| Year | Author (s) | NPV (%) | IRR (%) | PBP (%) | ARR (%) |
|------|--|---------|---------|---------|---------|
| 2006 | Danielson & Scott | 30 | 30 | 19 | 14 |
| 2004 | Hogaboam & Shook | 18 | 52 | 18 | 18 |
| 2002 | Ryan & Ryan | 50 | 45 | 19 | 5 |
| 2001 | Graham & Harvey | 75 | 76 | 57 | 20 |
| 1998 | Block (published in 2005) | 12 | 16 | 43 | 22 |
| 1997 | Burns & Walker (published in 2009) | 73 | 84 | 73 | 21 |
| 1996 | Shao & Shao | 17 | 40 | 25 | 14 |
| 1995 | Traham & Gitman | 81 | 80 | 67 | 60 |
| 1992 | Bierman (published in 1993) | 60 | 87 | 28 | 9 |
| 1991 | Ken & Cherukuri | 33 | 66 | 5 | 7 |
| 1990 | Cooper, Morgan, Redman, & Smith (published in 2001) | 13 | 57 | 20 | 4 |

| | | | | | |
|------|--|----|----|----|----|
| 1986 | Ross | 25 | 42 | 33 | |
| 1985 | Cabbage & Redmond | 5 | 54 | 5 | 18 |
| 1984 | Stanley & Block | 16 | 65 | 5 | 11 |
| 1982 | Kelly & Philippatos | 14 | 36 | 18 | 27 |
| 1980 | Oblak & Helm | 14 | 60 | 10 | 14 |
| 1979 | Kim & Farragher (published in 1981) | 19 | 49 | 12 | 8 |
| 1978 | Schall, Sundam, & Geijsbeek | 56 | 65 | 74 | 58 |
| 1977 | Gitman & Forrester | 10 | 53 | 9 | 25 |
| 1975 | Kim & Farragher (published in 1981) | 26 | 37 | 15 | 10 |
| 1974 | Petty, Scott, & Bird (published in 1975) | 15 | 41 | 11 | 31 |
| 1973 | Fremgen | 76 | 76 | 14 | |
| 1972 | Baker & Beardsley | 44 | 47 | 65 | 55 |
| 1971 | Fremgen (published in 1973) | 4 | 38 | 14 | 22 |
| 1970 | Klammer (published in 1972) | 29 | 29 | 12 | 26 |

Panel A.3: India

| Year | Author (s) | NPV (%) | IRR (%) | PBP (%) | ARR (%) |
|------|------------------------|---------|---------|---------|---------|
| 2016 | Sharma | 40 | 13.3 | 40 | 6.7 |
| 2015 | Umair | 44 | 30 | 4 | |
| 2014 | Batra & Verma | 35 | 43 | 31 | 18 |
| 2012 | Singh, Jain, & Yadav. | 50 | 78 | 64 | 39 |
| 2009 | Verma, Gupta, & Batra | 63 | 77 | 80 | 27 |
| 2008 | Shah | 33 | 41 | 60 | 3.2 |
| 2007 | Gupta, Batra, & Sharma | 9 | 3 | 44 | 25 |
| 2006 | Irala | 22 | 27 | 44 | 15 |
| 2002 | Anand | 66 | 85 | 68 | 35 |
| 1999 | Parashar | 42 | 68 | 68 | |
| 1998 | Jain & Kumar | 47 | 40 | 80 | |
| 1997 | Bhattacharya | 51 | 64 | 32 | 25 |
| 1996 | Cherukuri | 30 | 51 | 38 | 19 |
| 1995 | Dhankar | 15 | 16 | 35 | 33 |
| 1989 | Pandey | 42 | 64 | 92 | 66 |
| 1976 | Porwal | 36 | 36 | 46 | 43 |
| 1975 | Chandra | 20 | 20 | 80 | 75 |

Source: Author's review of the literature

Panel A.4: South Africa

| Year | Author (s) | NPV (%) | IRR (%) | PBP (%) | ARR (%) |
|------|-----------------------|---------|---------|---------|---------|
| 2016 | Kedige | 83 | 62 | 58 | |
| 2013 | Hall & Mutshutshu | 25 | 17 | 17 | |
| 2012 | Maroyi & van der Poll | 69 | 46 | 23 | |
| 2010 | Hall & Millard | 31 | 21 | 7 | |
| 2009 | Brijlal & Quesada | 36 | 28 | 39 | 22 |
| 2008 | Correia & Cramer | 82 | 79 | 54 | 14 |
| 2005 | Du Toit & Pienaar | 27 | 37 | 8 | 11 |
| 2003 | Gilbert | 47 | 48 | 79 | 26 |
| 2000 | Hall | 17 | 32 | 17 | 34 |
| 2000 | Napier | 74 | 84 | 90 | 23 |
| 1997 | Matundu | 57 | 42 | 69 | 50 |
| 1995 | Coltman | 65 | 78 | 92 | 46 |
| 1990 | Parry & Firer | 10 | 43 | 52 | 38 |
| 1987 | Andrews & Firer | 45 | 63 | 71 | 68 |
| 1986 | Andrews & Butler | 40 | 60 | 69 | 41 |
| 1976 | Lambrechts | 14 | 63 | 64 | 74 |

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