Choice of discount rate and agency cost minimisation in capital budgeting: Analytical review and modelling approaches

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DECLARATION

I, Arun Anton, declare that the DBA thesis entitled "Discount rate estimation and agency cost minimisation in capital budgeting: Analytical review and modelling approaches" is no more than 65,000 words in length including quotes and exclusive of tables, figures, appendices, bibliography and footnotes. This thesis contains no material that has been submitted previously, in whole or part, for the award of any other academic degree or diploma. Except where otherwise indicated, this thesis is my own work.

Signature [redacted] Date: 02 August 2019

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Arun V Anton

Revised with examiners comments.

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ABSTRACT

Research background and objectives

Capital budgeting is a crucial business function and most large firms use Discounted Cash Flow (DCF) methods, particularly the Net Present Value (NPV) method which takes into account the time value of money, for evaluating investment projects. Hence, the discount rate plays a major role in the choice of capital investments, and both the selection and appropriate use of a suitable discount rate are critical to sound capital budgeting.

Extensive evidence from the literature indicates that agency problems exist in capital budgeting decisions, both when choosing and when using a discount rate for this process. Managers as agents can manipulate the choice of the discount rate to maximise their own benefits. This creates an agency problem that has impacts on efficient capital investment decisions. Most firms believe that using project-specific discount rates may open up incentives for managerial opportunistic behaviour and hence they prefer firm-wide single discount rates that might moderate the managerial bias. In other words, most firms use their company-wide Weighted Average Cost of Capital (WACC) to evaluate all of their capital projects. However, company-wide WACC is not a correct approach, in that it may lead to the selection of high-risk, unprofitable projects and hence to inefficient allocation of resources.

This creates a need for a systematic and verifiable method to establish project-specific discount rates. If possible, the determination of these project-specific discount rates should be tied to outside market forces that are not under the control of the manager. But the selection of suitable project-specific discount rates alone may not completely minimise agency costs, as managers' can manipulate capital budgeting decisions to maximise their benefits. Hence, an appropriate capital budgeting framework that can further minimise agency costs and maximise company value is required.

The main aims of the study are to develop a process to select appropriate project-specific discount rates that minimise agency costs and to develop a better capital budgeting framework to further minimise agency costs in capital budgeting. Such

a framework should provide management incentives to achieve efficient capital budgeting outcomes leading to enhanced company value

Project-specific discount rates

The project-specific discount rate method proposed in this study is based on project debt capacity, which is usually determined by external banking and financial institutions, thus limiting managers' ability to influence the discount rate. Debt capacity is the maximum amount of new debt that can be used to finance an investment project without affecting the credit rating of the firm. Thus, the debt capacity determines the amount of debt the project can support.

This approach is based on the fact that projects with higher project risk have lower debt capacities and require greater equity funding, while projects with lower project risk have higher debt capacities and require less equity capital. The project debt capacity is used in this study to determine the appropriate debt and equity weights for financing a specific project, to estimate the Weighted Average Cost of Capital (WACC) for that project that is used as the discount rate.

The real life case study of Wal-Mart was used to estimate the project-specific discount rate based on debt capacity and highlight the benefits and implications. The case study uses two projects to illustrate how the project's debt capacity method generates the project-specific discount rates, one with a lower WACC estimate for the less risky project A, one with a higher WACC for riskier project B. These project-specific discount rates were used in the investment evaluation process to select the most viable project, and the results were compared with those of applying the firm-wide discount rate to evaluate these projects. It was evident that using a firm-wide single discount rate would result in the selection of the risky unprofitable project B, whereas using project-specific discount rates would result in the selection of project A. This shows that project-specific discount rates are appropriate for project evaluation, leading to efficient capital allocation.

Capital budgeting optimisation model

The proposed financial model is a capital budgeting optimisation model within a principal-agent game and incentive mechanism framework, to further minimise

agency costs and maximise company value. The model shows how the managers can select the right set of investment projects that maximise NPV and hence enhance company value.

The model was applied to the World Airways hypothetical case study to operationalise the design of incentive mechanisms within principal-agent game framework to mitigate agency problems. The model results were compared with the base model - that is, before incorporating incentive wages - and the outcome shows a significant improvement in NPV value. The model is also sufficiently flexible that the existing constraints can be replaced by alternative objective functions. Hence, it is useful for decision makers and represents a contribution to contemporary capital budgeting practices and literature.

Conclusions

The project-specific discount rate approach proposed in this study is an appropriate method that generates different discount rates for diverse capital investment projects with different risks, and provides little discretion to managers. The incentive based optimisation model, together with project-specific discount rate method, can be applied to resolve the underlying agency problems that arise from principal-agent relationships in capital budgeting. This will result in a better allocation of capital resources and improve corporate governance, leading to maximised shareholder value.

The accuracy of a capital budgeting model relies heavily on the estimates used in the model, particularly the discount rate, project cash flows and life span. This study also highlights that accounting quality, internal controls and auditing are important disciplines, which provide insights for decision makers.

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AAS	Australian Accounting Standard
AASB	Australian Accounting Standard Board
AC	Agency Costs
ARR	Accounting Rate of Return
ASIC	The Australian Securities and Investments Commission
ASC	Accounting Standards Codification
ASX	The Australian Securities Exchange
ATO	Asset Turnover
BPH	Bonus Plan Hypotheses
CAPM	Capital Asset Pricing Model
CAR	Capital Adequacy Ratio
CFF	Cash Flow from Financing activities
CFI	Cash Flow from Investing activities
CFO	Cash Flow from Operating activities
CGT	Cooperative Game Theory
DCF	Discounted Cash Flow
DCH	Debt Covenant Hypotheses
DEA	Data Environment Analysis
DER	Debt/Equity Ratio
DGM	Dividend Growth Model
DPS	Dividend Per Share
ECF	Equity Cash Flow
ERM	Enterprise Risk Management
ETA	Earning to Total Asset
FASB	Financial Accounting Standard Board
FCF	Free Cash Flow
FIFO	First-In-First-Out
FRC	The Financial Reporting Council
GAAP	Generally Accepted Accounting Principles

GDP	Gross Domestic Product
GFC	Global Financial Crisis
GRI	Global Reporting Initiative
HR	Hurdle Rate
IAS	International Accounting Standards
IASB	International Accounting Standard Board
IFRIC	International Financial Reporting Interpretations Committee
IFAC	International Federation of Accountants
IFRS	International Financial Reporting Standards
IR	Integrated Reporting
IRR	Internal Rate of Return
LIFO	Last-In-First-Out
LCA	Life-cycle Cost Analysis
LHS	Left-Hand Side
LP	Linear Programming
LR	Loans Ratio
NCGT	Non-Cooperative Game Theory
NCI	Net Cash Inflow
NIM	Net Interest Margin
NLP	Non-Linear Programming
NPV	Net Present Value
NWC	Net Working Capital
OCC	Opportunity Cost of Capital
OECD	Organisation for Economic Co-operation and Development
PAT	Positive Accounting Theory
PCH	Political Cost Hypotheses
PI	Profitability Index
P&L	Profit and Loss
PV	Present Value
QCP	Quadratically Constrained Programming

QP	Quadratic Programming
RBA	The Reserve Bank of Australia
RHS	Right-Hand Side
ROA	Return on Assets
ROE	Return on Equity
ROI	Return on Investment
RRR	Required Rate of Return
SFAS	Statement of Financial Accounting Standards
WACC	Weighted Average Cost of Capital

CHAPTER 1: INTRODUCTION

1.1. Background of the study

The key investment policy decision of an organisation is the capital budgeting decision. Capital budgeting techniques assist organization to analyse prospective long-term business opportunities systematically in order to choose the appropriate set of projects that enhance the value of the organisation. The most popular technique applied to appraise capital budgeting is the Discounted Cash Flow (DCF) method, in which the discount rate plays a major role (IFAC, 2013). Thus, an accurate estimation of the discount rate is critical for efficient capital budgeting and optimisation models. This, in turn, has a significant impact on stakeholders' interests, including shareholder value, sound corporate governance and best accounting practices. Extensive evidence from the literature suggests that managerial biases might affect the correct choice of discount rate for capital budgeting. In other words, managers as agents can manipulate the choice of the discount rate applied in capital budgeting to maximise benefits for themselves, ignoring the owners' interest in maximising company wealth. This creates an agency problem that has an impact on efficient capital investment decisions.

DCF analysis and the maximisation of Net Present Value (NPV) are well researched areas. Most of the efforts involving DCF are focused on the estimation of future cash flows. However, the impact of an appropriate discount rate on NPV has not been researched in-depth. Some studies have attempted to highlight issues related to the cost of capital estimation method, which is a critical element of capital investment decision making (Pratt & Grabowski, 2014; Ogier et al., 2004; Barnes & Lopez, 2006; Brown et al., 2012; Da et al., 2012). According to Murray (1997) and Jagannathan (2016), the discount rate is usually selected in an arbitrary fashion and little is known about what factors determine the rate.

Within this context, the central theme of this current research is to address the following research questions:

- Is the choice of an appropriate discount rate in the principal-agency game environment researched in-depth or addressed adequately, to minimise agency costs?

- Are appropriate methods and models available to estimate the suitable discount rate for capital budgeting?
- Are the estimation and application of a suitable discount rate for capital budgeting, as well as the associated accounting issues, clearly illustrated in the literature?
- How can we develop a financial model to mitigate agency problems that is formalised within the principal-agent game and mechanism design framework and solved as an optimisation problem?
- How can we integrate all the issues relating to discount rate, agency costs, accounting quality, game theory and optimisation models in an integrated model?

Guided by these questions, this study comprises two major components. First, the selection of project specific discount rate based on debt capacity in order to minimising agency costs that arise from principal-agent game and accounting quality are investigated. Second, this study developed a capital budgeting optimisation model within principal-agent game and incentive mechanism framework to further minimise agency costs and maximise company value. This will help in the selection of the right set of projects.

Adopting the appropriate accounting methods from the available alternative methods, such as the historical cost method, current costing, creative accounting, and conservative accounting, is important for estimating the discount rate and cash flows of projects in capital budgeting exercises. This study has reviewed these alternatives and proposes the right accounting methods with sufficient justifications and demonstrations of the reasons for the choices.

Accordingly, this study presents an integrated analysis of capital budgeting, discount rate and associated disciplines, such as agency problems, principal-agent game, accounting principles and practices, corporate governance and risk management.

1.2. Capital budgeting and strategic decision making

According to Dean (1951) capital budgeting became a topic of discussion between academics and practitioners during the early 1950s (Dean, 1951). The key aim of capital budgeting is to invest capital resources efficiently in long-term

capital projects in order to maximise shareholder wealth (Kalyebara & Islam, 2014). In other words, capital budgeting decisions implicate the long-term commitment of an organisation's resources in capital investments, which play an important role in influencing the success of the company. The commitment of investment to a chosen project can be massive and usually irreversible. Strategic capital budgeting decisions can either influence the organisation's future market position in its current product portfolios or permit it to expand into new product sets in the future (Pachamanova & Fabozzi, 2010). Capital projects may require an increase in investment in working capital, such as inventory, cash and accounts receivable. Working capital is the net current assets required for regular operations that support an organisation's long-term investments. Moreover, assets-in-place should be financed with more debt finance (Myers, 1977)

There are many techniques applied to evaluate capital projects. These can be divided into two basic groups. The first group ignore the time value of money by disregarding the fact that a dollar received or paid today is worth more than a dollar received or paid in the future. The payback period and accounting rate of return techniques are belongs to this group. The second group make use of the time value of money concept in the analysis, and are the most popular investment appraisal methods. Also known as discounted cash flow (DCF) methods, which includes NPV and Internal Rate of Return (IRR) methods. Generally, NPV is the only method that is consistent and maximises the owners' wealth under the most general circumstances (Dayananda et al., 2002). This means that long-term capital projects are appraised by converting the future net cash flows to the present value by applying a suitable project specific discount rate. The initial investment value is deducted from the discounted future value of estimated inflow to obtain the NPV.

1.3. Capital budgeting and discount rate

Brealey et al. (2014) state that capital budgeting as the process of evaluating and selecting long-term investments consistent with an organisation's goal of maximising its value. As stated in the previous section, the most popular methodology used to evaluate capital projects is the DCF technique, particularly the NPV method. Hence, the discount rate plays a major role in project

evaluation. The discount rate is one of the greatest sensitive elements in capital budgeting and it has a significant impact on shareholder value, sound corporate governance and accounting theory and practices. A small misjudgement in the discount rate choice will normally have very significant consequences than an error in a single stream of the cash flow (Murray, 1997). Selecting a suitable discount rate is very crucial for several reasons. First, if too low a discount rate is selected, financially unprofitable and socially inefficient projects could be accepted; on the contrary, if too high a discount rate is selected, profitable efficient projects could fail to clear the hurdle of acceptability. Second, what is at stake in the choice of a discount rate is not just the acceptance or rejection of specific projects, but also the allocation of resources between the public and private sectors of the economy (Jones, 2000).

The choice of a low discount rate implicitly indicates that analysts set a high value on future economic activities. However, the choice of a high discount rate denotes that future economic activities are much less valued in the present value context. In other words, a high discount rate gives us a very myopic view of the future. The choice of a zero discount rate will direct future benefits to be of the same value as they are today. In other words, the future value equals the present value.

Evidence from the literature suggests that agency problems exist in capital budgeting decisions, particularly when choosing a discount rate for investment decisions. As already indicated, managers may choose an arbitrary discount rate to get projects approved to gain managerial benefits (Jagannathan et al., 2016; Stein, 1989; Martin, 2008). This creates agency problems and hence, leads to inefficient capital budgeting decisions and weak accounting practices.

1.4. Capital budgeting and accounting practices

Financial accounting reports, particularly pertaining to financial performance (profit and loss) and financial position (the balance sheet) are crucial inputs for an investment evaluation process and estimation of suitable discount rate. Higher quality accounting enriches investment efficiency by minimising information asymmetry between managers and shareholders and outside investors (Biddle & Hilary, 2006). Hence, financial accounting reports are compelled to be prepared in accordance with the US Generally Accepted Accounting Practices (GAAP) and

approved accounting standards in order to maintain the qualitative characteristics of financial reports, such as understandability, relevance, reliability and comparability (Gaffikin, 2008). Bushman et al. (2004) stated that financial accounting information is influenced by other factors, such as the quality of audit, the competency of the financial analysts, the accounting methods adopted by the legal regime in the country, industry competitiveness, political influence over business activities, and the level of education of the investors and managers. Hence, accounting methodology and practices have a significant impact on capital budgeting decisions.

Although GAAP and accounting standards are developed to ensure the reliability and consistency of financial accounting statements, in practice, a wide range of methods could be applied selectively and could mislead users and analysts. For example, income can be measured by using a fair value accounting method or a historic value accounting method (Scott, 2015); inventory can be valued using First-In-First-Out (FIFO) or Last-In-Last-Out (LIFO) methods; and non-current assets can be depreciated by using straight line methods or reducing balance methods. These different methods could provide different values. Therefore, choosing the right accounting methods in a consistent manner is critical for efficient capital budgeting decisions. New accounting standards are always being developed to close the above gaps. For example, International Finance Reporting Standards (IFRS) 15/ AASB 15, a new standard on recognising revenue, has been developed as applicable for accounting periods on or after January 2018 (Hardidge & Subramanian, 2017).

1.5. Capital budgeting and the principal-agent game

An agency problem occurs with the separation of ownership and control of a firm, when managers work for their own best interests not for those of the owners (Petty et al., 2009). According to Samuelson and Marks (2015), the principal-agent game occurs when a principal, with limited information, relies on a self-interested agent to take action on the principal's behalf, based on the belief that the agent has more information. Generally, owners (principals) delegate firms' capital budgeting decision making tasks to managers (agents). The owners' objectives are to maximise their firm's wealth, whereas the managers general

interest is to maximise their interest. This conflict in interest between managers and owners creates agency problems, requiring owners to provide various incentives, at a cost, so their managers make decisions that maximise the owners' wealth. Renz (2007) defined agency costs as the costs incurred by a firm to encourage managers (agents) to make decisions that maximise company value, instead of maximising their own interests. These agency costs can be grouped into two categories: bonding costs and monitoring costs, usually denoted as the carrot and stick approach. Bonding costs are incentives, such as bonus shares, periodic bonus payments, personal staff, provision of accommodation, or various paid club memberships. Monitoring costs include legal fees for suitable employment contracts, audit costs (both internal and external) to make sure that managers' decisions are made in accordance with firm's policies, and regulations that are designed to maximise shareholder value. These costs are incurred in order to encourage managers to make accurate decisions to maximise shareholder value.

Another, more effective, solution to minimise agency costs is to impose sound control systems, particularly by implementing a post-audit process and to link the accuracy of estimates to the compensation of managers who initiated the projects (Brigham & Ehrhardt, 2005).

The mitigation of agency costs diminishes the chances of management misappropriating the organisation's scare capital resources, thus increasing cash flows that all stakeholders, including shareholders, can share in different forms. Minimisation of agency costs is also a great indicator of efficient financial management, which increases the NPV, and therefore increases the value of the firm (Tian & Twite, 2011).

1.6. Agency theory, contract theory and mechanism design

As discussed previously, when a business is owned by one person and managed by another (the agent), an agency relationship results from the separation of ownership and control (Gul, 2007). This agency relationship is defined as "a construct under which one or more persons (the principal/s) engage another person (the agent) to perform services on their behalf, which involves delegating some decision-making authority to the agent" (Jensen & Meckling, 1976).

In theory, a firm is made up of two types of contracts, implicit and explicit, in order to cover every business activity. An employment contract between a manager (agent) and a firm (principal), initiated to outline expected productivity, is an example for an explicit contract. Implicit contracts are unwritten and cover matters that are expected of agents. It is expected that agents should not be negligent and always act in the interests of the owner. However, in practice it is very difficult to include every implicit activity in the contract. Therefore, this is referred to as the theory of incomplete contracts (Gul, 2007, Aghion and Bolton, 1992 and Hart & Moore, 1988)). The enforcement and monitoring of these explicit and implicit contracts become more challenging when there is an agency problem.

The principal expects agents to perform to the best of their ability, maximising the firm's wealth by selecting the right set of projects for long-term investments. However, in practice, the principal often has inadequate information about the business and is never certain about how agents have contributed to the success of the firm. In other words, information asymmetry exists, with the agents having more information about the business than the principal. Another problem is moral hazard. This might include work aversion, shirking, extravagant investments (e.g. encouraging 'pet' projects and building empires), or illegal activities, such as consuming perks, plush offices and insider trading. On the other hand, the principal is only interested in financial returns on investments.

Another divergence between principal and agents is risk preference. Generally, there are different risk preferences between the principal and agents (Beatty & Zajac, 1994). Principals can diversify their investments across multiple companies, and hence they can be assumed to have a risk-neutral preference for a particular firm's actions. On the other hand, agents are more likely to prefer risk aversion in their decisions, in order to minimise risks in relation to their personal wealth. This might increase the opportunity costs for the principal.

The divergence of interests between principal and agent and information asymmetry make it difficult for the principal to enforce and monitor contracts. In other words, these agency problems can lead to loss of efficiency and sub-optimisation in the firm. One way to mitigate incomplete information in the principal-agent relationship is to design an incentive contract that can motivate

managers to maximise shareholder value (Samuelson & Marks, 2015; McGuigan et al., 2014).

Based on agency theory, two devices are available for the principal to reduce or eliminate agency problems. First, they can use incentive contracts to limit divergent preferences and hence reduce agency costs. Second, the principal can invest in systems, including accounting systems, designed to monitor the agents' actions. The incentive contracts and monitoring devices are described as corporate governance mechanisms that protect the shareholders' rights and maximise the value of the company. Together these devices represent a 'mechanism design' and issues can be resolved using game theory and optimisation methods.

1.7. Capital budgeting, accounting and corporate governance

Corporate governance principles and capital budgeting principles are both aimed at sound corporate financial management to improve firm performance, maximise firm value and define the overall responsibility of the organisation towards its stakeholders, including shareholders (Allen et al., 2009, Banks, 2004; Seitz & Ellison, 2005). Efficient capital budgeting and accounting strategies that incorporate elements of good corporate governance practices are crucial for an organisation's success and survival. Corporate governance comprises formal and informal institutions, laws, regulations and rules. These regulate the stewardship of a company to comply with external systems so that the company achieves not only its financial goals, but also its environmental and social goals (Clarke & Rama, 2008; Manzoni & Islam, 2009). In this context, corporate governance has a vital role in guiding an organisation to comply with the established legal, cultural and institutional procedures.

One accounting and financial management principle is that agency problems affect capital budgeting efficiency, as stated previously. Good accounting and financial management practices and good corporate governance play major roles in mitigating or minimising agency problems through their incentives and controlling instruments. Internal governance instruments cover both financial and non-financial policies, such as board governance functions, managerial incentive

plans, capital structure/leverage, dividend growth policy, and risk management practices (Nuryanah & Islam, 2015).

In the corporate governance settings, accounting measures the business activities of an organisation in monetary terms. The role of accounting is to recognize and record the economic events of an entity, and then report the record of financial activities to interested parties (Weygandt et al., 2010). This practice represents a direct input to corporate control mechanisms, designed to discipline managers/agents to guide resources towards efficient projects and to prevent them from expropriating the wealth of investors. Therefore, accurate accounting information promotes efficient corporate governance (Bushman & Smith, 2001).

One of the important functions of accounting and financial management is the making of sound capital budgeting decisions for long-term investments. Accounting and financial management requires a thorough understanding, analysis and interpretation of three key financial statements: profit and loss accounts (financial performance), balance sheets (financial position) and cash flow statements. Lee et al. (2009) stated that accounting and financial management is also about effective control of and accountability for all funds, property and company assets to ensure that they are safeguarded and used effectively to fulfil authorised goals. Therefore, sound accounting and financial management policies strengthen the efficiency and effectiveness of capital budgeting decision making, corporate governance and consequently the mitigation of agency costs (Kalyebara & Islam, 2014).

1.8. Capital budgeting and risk management

Risk and uncertainty are part and parcel of operating a business (Day, 2009; Gilman et al., 2011). Risk can be defined in several ways, according to discipline area. The definition of the Australian and New Zealand Standard for Risk Management (AS/NZS 4360, 2004) is the chance of something happening that will have an impact (either a loss or gain) on objectives. The main objective of capital budgeting is to maximise the firm's wealth and minimise the total risk to the firm. Brealey et al. (2014) stated that, in any investments, there is no return without risk and therefore risk must be considered in any capital budgeting decisions.

Generally, risk can be grouped into two categories: systematic risk, which is not diversifiable and can affect the whole economy; and unsystematic risk, which is diversifiable and is company or project specific. Capital budgeting should consider the systematic risk and account for it in an appraisal process by way of such initiatives as sensitivity analysis, or an increased discount rate to compensate for the risk (Kalyebara & Islam, 2014). According to Day (2009), risk management involves recognizing the source of risk, describing the risk, analysing and understanding the relative importance of the risk, mitigating and controlling it, accepting or rejecting the uncontrollable risk, putting a price on risk and monitoring in the normal course of business operations.

According to Brealey et al. (2014), capital budgeting must take into account various risks due to the uncertainty of future activities, such as cash flow fluctuation risks that prevent the achievement of expected net cash flow from capital investments, movements in interest rates and the cost of capital (the discount rate), which would impact on capital budgeting decisions. Organisational risks can be identified and analysed in many ways, including financial ratio analysis, scenario analysis, and sensitivity analysis. Applying ratios in financial analysis highlights the main sources of risk or weakness in an organisation (Ross et al., 2011). Financial ratios provide useful information about a company's current and past financial performance and financial position, which are used to compare not only with the company's financial status but also with other companies in the same industry.

1.9. Limitations of existing literature and practices

Proper analysis of capital investment projects requires an understanding of how to determine the appropriate discount rate for a project. It is less well understood how to determine discount rates under asymmetric information, hence the question remains unaddressed.

Managerial bias and agency cost issues relating to the discount rate estimation are not adequately discussed in the literature. Also the issues such as fair value accounting, historic value accounting, and choosing appropriate depreciation methods that are critical for correct income estimation, are not specifically addressed in the literature.

A review of the existing literature reveals that studies on accounting reporting and its benefits for capital budgeting, corporate governance, risk management and company value, have found different and somewhat conflicting results. Moreover, no existing study comprehensively incorporates new theoretical and conceptual developments such as agency theory, game theory, mechanism design and optimisation models that impact the selection of an appropriate discount rate and hence efficient capital budgeting.

The gaps and limitations in the existing literature as discussed above, justify this research with its focus on developing an improved method for estimating the suitable discount rate for efficient capital budgeting decisions. The research also centres on developing an integrated optimisation model within principal-agent game framework that can be used to resolve the underlying information asymmetry and agency problems that impact on the choice of discount rate, efficient capital budgeting and overall organisational efficiency.

1.10. Aim of the research

The general aim of this research is to empirically estimate the project specific discount rate that can be adopted for capital budgeting and minimise agency costs. The estimated project specific discount rate is validated based on other available estimates and in comparison with other commonly used discount rates, such as firm-wide WACC. The proposed project debt capacity based project specific discount rate method was tested by using a case study. An optimisation model within principal-agent game and the mechanism design framework is also incorporated into this research in order to address the need to further minimise agency costs and generate sound capital budgeting decisions.

The specific aims of the research are to address questions regarding the choice of discount rate and mitigation of agency costs that impact on shareholder wealth, which are explored through the following ways:

- A review of the concepts and associated issues relating to discount rates in capital budgeting, and particularly in the context of accounting practice, agency theory and game theory.
- An examination of the complexities of choosing a suitable discount rate.

- A discussion of the limitations of the dominant methodology adopted in accounting practice.
- The development of a guide and capital budgeting model to assist in the process of deriving a suitable discount rate for investment projects that are consistent with accounting practice.
- Choice of a suitable discount rate for the projects selected as case studies, using the new model in comparison with existing methods.
- The development of a new capital budgeting optimisation game theory model within the mechanism design framework that mitigates the issues of asymmetric information and agency problems in order to maximise firm wealth.

The concepts and issues discussed in this study will assist articulate and explain the complexities of choosing and applying an appropriate discount rate and developing a joint optimisation model for capital budgeting, as well as set the agenda for further research into this topic.

1.11. Research methodology and approach

This research adopted two case studies to test and illustrate the study outcome. While the maximisation of NPV is a well-researched area, the area of appropriate discount rate choice in an agency conflict environment has not been researched in-depth. A descriptive research method guided the case study approach, as the study involved in-depth descriptions of the evaluated organisations. The strategic importance of the study lies in its estimation of a suitable discount rate for capital budgeting and the development of a new framework for optimisation game theory modelling, considering their impact on NPV and efficient capital investment decisions. The real life case study of the United States of America (US) company, Wal-Mart was used to estimate the project specific Weighted Average Cost of Capital (WACC) for the discount rate model. The hypothetical case study of the US-based World Airways was used to develop the new capital budgeting optimisation model within the principal-agent game and mechanism design framework, to address the issue of mitigating agency costs and support sound capital investment decisions. The actual investment decisions created using the

proposed optimisation model will offer significant advantage over currently available models and methods.

Microsoft Excel spread-sheets were used to develop the model for estimating a suitable discount rate and Microsoft Excel Solver was used to test and run the capital budgeting optimisation model.

1.12. Contribution to knowledge and significance of the study

The existing literature has limitations in terms of guiding the determination of a suitable discount rate for capital budgeting and optimisation of shareholder wealth. This study addresses these limitations and makes an appropriate contribution to the literature as described below:

- The study offers a critical review of the concepts and associated issues of discount rate choice for capital budgeting.
- Discount rate estimation requires various parameters and coefficients that are calculated from appropriate accounting methods to minimise agency costs. These are not adequately discussed in the current literature, but are important for this research. Hence, this study makes a sufficient contribution to the accounting and finance literature.
- This study investigates accounting issues, agency problems, and principal-agent game in the estimation of discount rates. It also incorporates the correct discount rate in an optimisation model for investment planning decision making. Hence, this research makes an additional contribution to contemporary accounting.
- Integration of agency cost issues, game theory, accounting issues, and optimisation modelling contribute to the literature on the theory and practice of capital budgeting.
- In this research, the agency problems that impact on the correct choice of discount rate are formalised within the game theory and mechanism design framework and solved as an optimisation problem. Thus, this study makes a new contribution to the accounting and finance literature.
- To the best of the researcher's knowledge, beside the research findings of Martin & Titman (2008), this is one of the primary studies to address debt

capacity and accounting issues that affect the discount rate estimation and capital budgeting from an academic perspective.

- The concepts and issues discussed in the study will assist articulate and explain most of the difficulties of choosing suitable discount rates for capital budgeting for the selection of an efficient set of projects and establish an agenda for further research on this topic.

This research makes significant practical contributions, as follows:

- It assists to enhance the standard of capital investment appraisal practices in accounting and finance and improves efficiency and risk management in capital budgeting.
- It creates an important capital budgeting model for efficient investment planning, which reduces the risk of financial mismanagement.
- The proposed discount rate estimation method could provide more reliable capital budgeting decision making tools for accountants, managers, policy makers and the investment appraisal community.
- The agency problems formalised within the game theory and mechanism design framework enhance the quality of management decisions and hence the adoption of these tools by accounting practitioners and other professionals.

1.13. Outline of the research

The study comprises seven chapters. This first chapter has introduced the main objective of the research and the research questions. It has also briefly discussed major areas of the study, including discount rate, capital budgeting, accounting quality, agency theory, and game theory. This chapter has also highlighted the research methodology and contributions of the study.

Chapter 2 provides a critical review of the existing literature on the relevant areas of the study, which include capital budgeting, discount rate estimation and application, agency conflict, game theory, accounting methods and mechanism design. This chapter also identifies the limitations of the current literature.

Chapter 3 presents the conceptual framework and theoretical foundation for developing the financial models, the research methodology, and background of the two nominated case studies.

Chapter 4 discusses the concepts and issues of discount rate estimation and its effect on capital budgeting. It also discusses the development of new methods and a model to estimate the project debt capacity based project specific discount rate using the Wal-Mart case study, and analyses the impacts of an estimated discount rate. This chapter also discusses the implications and benefits of proposed project specific discount rate model, accounting quality, and the principal-agent game.

Chapter 5 provides a discussion on the development of a financial optimisation game theory model for mechanism design in capital budgeting, with the integration of principal-agent game and agency costs. The World Airways case study is used to illustrate the effects of the model, as well as the implications and benefits of the model.

Chapter 6 presents the major findings and the implications of results on the issues investigated in Chapters 4 and 5.

Chapter 7 concludes the study by providing a summary of the research questions and issues, major findings, and discusses the theoretical and practical implications of the study for the body of literature and professional practices. This final chapter also highlights the contributions of this study to the body of knowledge, the limitations of the research and an agenda for possible further research into this topic.

1.14. Conclusion

This chapter has introduced the research gaps and questions, background, motivation and the objective of the study. Particularly being highlighted are the two main research questions: firstly, how to estimate suitable discount rates for capital budgeting considering minimisation of agency costs, principal-agent game, and accounting quality; and secondly, to what extent can the integrated mechanism design model can align the interests of shareholders and managers, leading to sound capital budgeting decisions, good corporate governance, and

enhance company value. Moreover, this chapter has discussed the concepts and dominating issues regarding a suitable discount rate and its significance. It has also highlighted the need for the proposed model, incorporating agency problems and quality accounting, to assist in estimating the appropriate discount rate for efficient capital investment decision making. This chapter has also introduced a capital budgeting optimisation game theory model for mechanism design in capital budgeting to resolve agency problems. This model can be used as a reliable tool for investment decisions. Also highlighted were the research methodology and the contributions to the literature and practices in the fields of contemporary accounting and finance.

CHAPTER 2: LITERATURE REVIEW

2.1. Introduction

This chapter essentially evaluate the current literature on capital budgeting and related discipline areas. This includes capital budgeting theory and methods, discount rate concepts and applications, WACC, corporate governance, risk management, agency theory, game theory, theory of mechanism design and accounting theory and practice. Moreover, the gaps in the literature are identified based on the arguments and existing methods and models in the current studies on discount rate, agency theory, game theory, mechanism design, risk management, corporate governance and accounting practices in an integrated way.

The reminder of the chapter is structured as follows. Section 2.2 examines capital budgeting and its importance for the efficient investment decisions of an organisation. Section 2.3 provides an outline of capital budgeting methods and highlights the benefits of the DCF methods, particularly the NPV method. Section 2.4 discusses capital budgeting and accounting practices. Section 2.5 discusses discount rates and illustrates concepts and associated issues. Section 2.6 discusses risk management. Section 2.7 discusses the role of corporate governance in capital budgeting. Section 2.8 discusses the relationship between agency theory and capital budgeting. Section 2.9 highlights the benefits of the application of game theory and mechanism design in capital budgeting. Section 2.10 provides a summary of the literature. Section 2.11 summarises the shortcomings of the current literature and the motivation for conducting this study. Section 2.12 concludes the overall discussion in this chapter.

2.2. Capital budgeting

Capital budgeting evaluations are vital as they could impact the firm in the long-term (Aggarwal, 1993). An organisation growth profoundly be contingent on investments in capital investments, for instance, plant and machinery, that turn out future net revenue (Ross, et al., 2011; Shapiro, 2005). According to International Federation of Accountants (IFAC) (2013), investment evaluation refers to the appraisal of decisions made by an organisation about its allocation of resources to investments of a significant size. Firms need to obtain and assign

large capital for long-term investments, thus making their capital investment decisions crucial, which means they require vigilant planning and implementation (Brealey et al., 2014; Peirson et al., 2012).

Figure 2.1 below indicates how capital budgeting is connected to the goals of a firm, its strategic decisions, DCF and the discount rate.

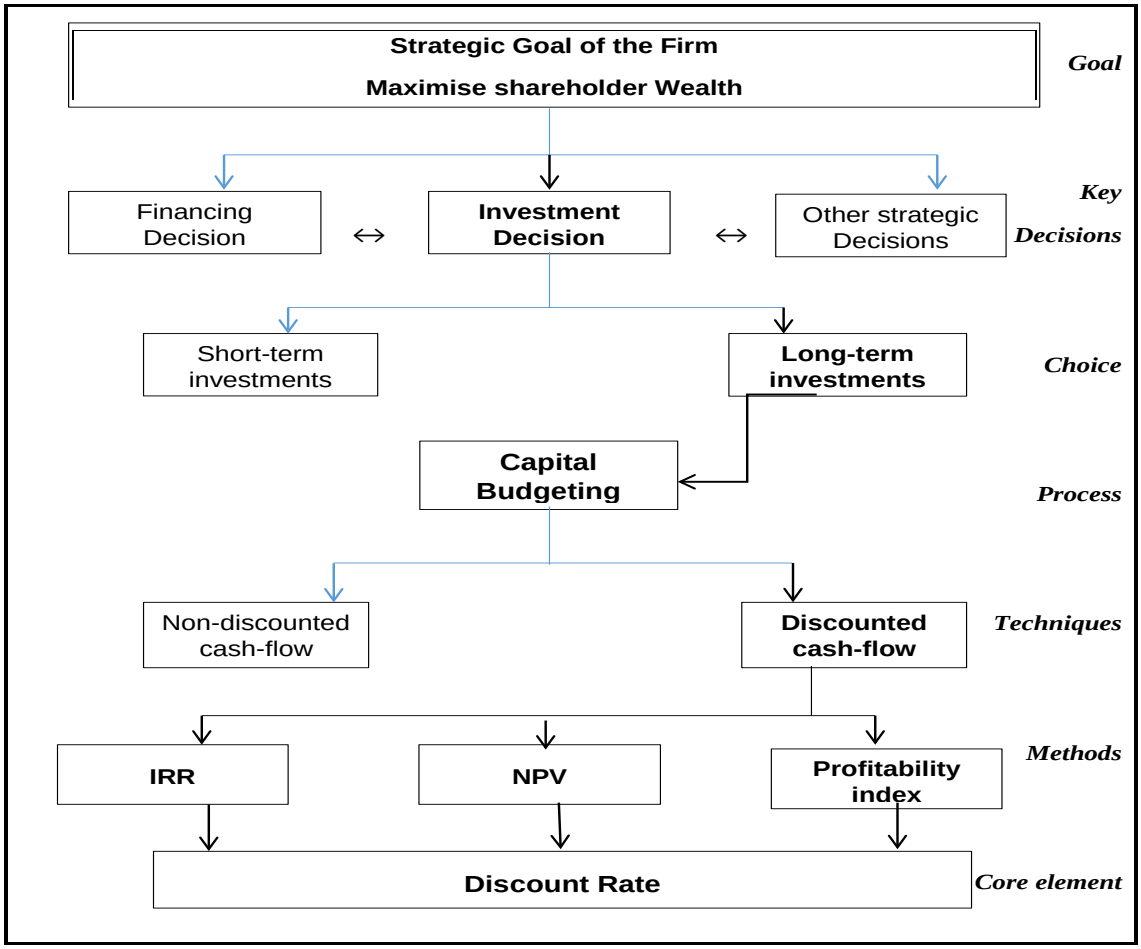

Figure 2.1: Strategic decisions of firms, capital budgeting, DCF and discount rate

Capital budgeting decisions are made by a firm to allocate its capital resources in the most efficient manner for long-term investment activities. This is designed to ensure that the total future cash inflows exceed the initial investments, the cash outflows, maximising shareholder wealth and other stakeholder interests (Kalyebara & Islam, 2014). An incorrect decision could be catastrophic for the continuous existence of an organisation. The procurement of undesirable long-term capital assets could result in an unwarranted capital allocation and intense operational costs for an organisation (Aggarwal, 1993). According to Jagannathan et al. (2016), allocation of capital is a critical business function, but

it is not well understood. An inaccurate forecast of any capital projects could have severe effects. Haka (2006) stated that investment decision making emphases on the capital employed and apply a range of financial devices such as the time horizon, risks associated with project and market, time value of money, the WACC, option values, value chain analysis, simulations, and game theories. However, such investment decisions remain depend on people's commercial experience and perception.

2.2.1. Capital investment decisions

Capital budgeting is the evaluation section of accounting and financial management that institutes benchmarks for investing in long-term capital projects (Clark et al., 1989). Such projects commonly include the following:

- The acquisition of new non-current assets: This may be a straight forward decision to buy or not to buy, or it may involve a choice between several items of equipment that will serve the same general purpose.
- Replacement of existing equipment: The choice to carry on with current facilities or to upgrade them.
- New or improved products: Add another product to an existing product line or improve/modify the existing product to increase its marketability. This usually requires new equipment, increased working capital and other additional outlays.
- Lease or buy: Leasing is an alternative to outright purchase of new assets.
- Cost reduction: Future benefits in the form of reduced operating expenses. This has to be compared with the capital investment necessary to automate processes or other cost reduction programs.
- Expansion: Creation of new production facilities, sales outlets, service centres etc.
- Regulatory: Some investments are essential by state and federal government conventions. These obligatory investments generally include attaining standards for workplace safety and environment.

The decisions made regarding the above types of projects are vital for most companies for the following reasons (Clark et al., 1989):

- These projects are normally somewhat large expenditure of funds.

- The funds are generally obliged for long term. Furthermore, capital investment decisions are difficult or very costly to reverse.
- Capital investment decisions usually have a significant impact on whether or not a firm achieves its most important financial objectives.
- The decision to replace existing capital assets or to abandon previously accepted investment projects determines a company's future course of development.
- Working capital requirement is closely related to the size and utilisation of fixed assets.

2.2.2. Category of investment projects

Capital projects are generally categorized into various types based on their impact on the investment decision procedure. There are three categories of projects commonly used, such as independent, mutually exclusive and contingent projects (Dayananda et al., 2002).

Independent projects: Cash flows of these projects are unrelated and hence endorsement or refusal of one project does not influences on other project's investment decision. For example, presume an organisation has unlimited funding and management needs to invest in following three projects, (1) construct a new parking ramp at its head office; (2) procure a trivial competitor; and (3) increase production volume to one of its plants. As each project's cash flow is not linked, decision take on one of these three projects will have no influence on others two projects.

Mutually exclusive projects: These projects cannot be carried out simultaneously, in other words, the approval of one project obstructs the approval of the other project. For example, a vehicle assembling organisation has option to locate its factory in location A, B or C. If location C is nominated, the options of location A and B are ruled out. These projects can be appraised individually and the firm can select the project that yields the highest NPV. It is crucial to identify mutually exclusive options early for a rational vetting of investments (Dayananda et al., 2002).

Contingent projects: Investment decision of a project is reliant on the investment decision of other related project or projects. Generally, contingent projects situations arise in two types mandatory and optional. An example of the **mandatory** contingent project is when a public electricity firm builds a power plant, and it is essential to invest in appropriate pollution control apparatus to comply with the statutory environmental standards. Thus the investment to curb pollution is a mandatory contingent project. In these mandatory situations, suggested process is to consider all the relevant projects as one investment for appraisal. An example for the **optional** contingent project, suppose a company invest in a computer for non-business market with an element that allows the company to include an exclusive gaming system as an optional bundle. Although the gaming system is an optional add-on to the computer, it is a contingent project. In these conditions, the optional contingent project need to be appraised discretely and the decision should be made on its own merits. Further, contingent projects can be **complementary** or **substitute**. For instance, an approval to establish a chemist shop and a doctors' surgery in the same building or close to each other may be complementary. The cash flow of one could enhanced the existence of the other. When the acceptance of a project leads to the rejection of the other project is referred as substitute project. For example, in the purchase of both a Chinese restaurant and a Thai restaurant, the rejection of one will certainly increase the cash flow of the other as they are considered intimate substitute businesses.

2.2.3. The capital budgeting process

The capital budgeting process usually embark with goals and strategic plan of an organisation. Strategic planning convert the organisation's corporate goals into specific policies and guidelines. Generally, the company's strategic objectives translate into business plans at divisional level. Business plans usually have one to two year time period and offer a comprehensive account of targets for respective division to achieve throughout the planning cycle. Capital budgeting support these business plans by detailing the resource management in order to accomplish the planned targets. There are numerous consecutive phases in the capital budgeting practice. The usual capital investment proposal stages of a large organisation are presented in the synopsised diagram in Figure 2.2 below.

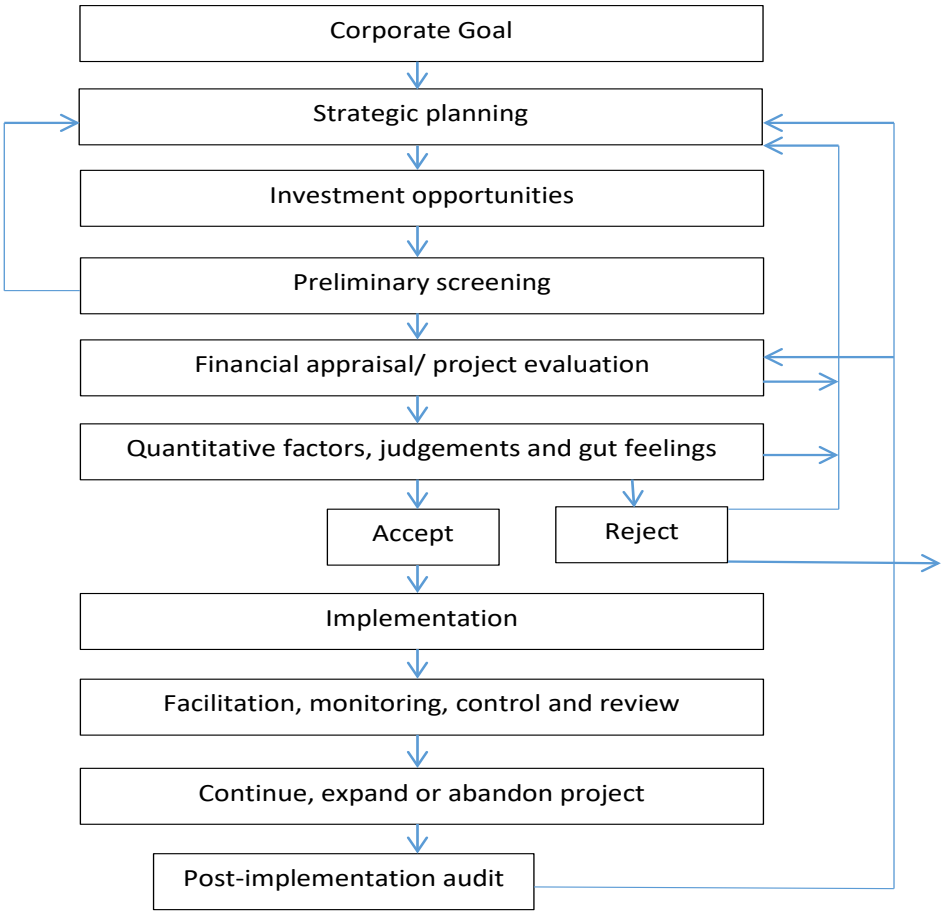

Figure 2.2: The capital budgeting phases

Source: Dayananda et al., 2002

The recognition of investment opportunities and initiation of proposals of projects are vital stages in the capital budgeting phases. The nominated investment projects must go through an initial vetting process to eliminate unviable proposals. Projects that traverse the initial vetting stage turn out to be contenders for thorough project evaluation. As the project succeeds the evaluation test, it requires further appraisal based on relevant qualitative aspects, such as societal impact, environmental impact, government policies, and legal and regulatory issues. The project accept/reject decisions are made based on financial and qualitative assessments. Once the project is accepted, it must then be implemented by management. Review of the performance of already executed projects are referred as a post implementation audit. It is an important step in capital investment as it can provide very useful feedback for future project evaluation. Post-implementation audits furthermore assist as incentives for

managers to consider rigorous capital investment decisions (Dayananda et al., 2002).

2.3. Capital budgeting methods

In practice, diverse capital budgeting decision tools are frequently used by firms to appraise their capital investment projects. Numerous surveys undertaken during the last two decades have shown a growing application and inclination for the DCF technique to appraise capital projects (Arnold & Hatzopoulos, 2000; Graham & Harvey 2002; Haka, 2007; Vesty et al., 2013). According to Vesty et al. (2016), both NPV and IRR techniques remain supreme, along with payback and Accounting Rate of Return, as highlighted in Table 2.1 below.

Table 2.1: Most commonly used capital appraisal tools

Appraisal tools	Vestly, Oliver & Brooks (2013)	Truong, Partington & Peat (2008)	Hermes, Smid & Yao (2007)		Graham & Harvey (2002)	Ryan & Ryan (2002)	Pike (1996)
			Netherland	China			
Net present value (NPV)	76.80%	94%	89%	49%	75%	96%	74%
Internal Rate Of Return (IRR)	55%	80%	74%	89%	75%	92%	81%
Payback Period	58%	91%	79%	84%	57%	74%	94%
Accounting Rate of Return (ARR)	58%	57%	2%	9%	na	34%	50%

Source: Vesty, G., Brooks, A. & Oliver, J. (2016), p.23.

The majority of firms apply more than one technique, normally at least two, which is why the total responses presented in the table above are more than 100%. These survey results also included other techniques/tools, specifically real options, the Monte Carlo simulation, sensitivity analysis, Economic Value Added, Cost-Benefit Analysis, decision trees and Life-Cycle Analysis.

Of the most popular techniques used (i.e. NPV, IRR, payback and ARR), the first two methods are often referred to as DCF methods, as projected cash flows are discounted at the suitable discount rate. Despite the progress of these DCF methods, the payback method, including the discounted payback period method, appears to be a surviving technique yet used by a great number of firms (Graham & Harvey, 2002; Jackson, 2010; Vesty et al., 2013).

These four methods do not necessarily direct to the similar accept or refuse decisions. The role of the discount rate in NPV and IRR methods are to reflect the time value of money and thus are very relevant to the central argument of this thesis. Commonly used methods are discussed below.

2.3.1. Net Present Value (NPV)

The NPV of a capital project is the contribution it makes to the wealth of an organisation. It is calculated by discounting all the inflows and outflows of a project to the present value by using a discount rate and summing up these DCFs and termed as the NPV of a project. The project would be accepted if the NPV is positive as this represents an immediate increase in the company's wealth. The project would be rejected if the NPV is negative. For competing projects (i.e. mutually exclusive projects), the greatest NPV project essentially selected. Peirson et al. (2012) stated that if other things remain constant, the market value of shares in a firm should increase by the same amount as the NPV of the project implemented.

The NPV of an investment project can be indicated in formulation as the present value of all the net cash flows, after deducting all cash outflows from cash inflows, relate with the project. The typical NPV equation shown beneath:

$$NPV = \sum_{t=0}^{n} NCF_t \ \frac{1}{(1+r)^t} \qquad (2.1)$$

where:

$\mathrm{NCF_t}$ = net cash flow in period t, where t=1,2,3,….n

r = discount rate

n = estimated life of project.

It should be noted from the above formula that the present value of a project be contingent on three factors: the time horizon; the occurrence of net cash flows (cash inflows – cash outflows) over each period; and the discount rate (cost of capital). The first two factors are very much dependent on the project that is being evaluated. But the discount rate is a choice parameter, generally selected in an arbitrary fashion with no true understanding of its function or composition (Murray, 1997).

2.3.2. Internal Rate of Return (IRR)

The rate of return on investment of an asset is defined as its IRR. This is calculated by obtaining the discount rate that results in the present value of future net cash flows being equal to the cost of the investment (Bishop et al., 2004). In other words, it is the discount rate at which NPV of a project is zero. The IRR technique is similar to the NPV concept. However, in the IRR calculation, instead of discounting the cash flows at a fixed discount rate, or a Required Rate of Return (RRR), as in the case of a NPV calculation, the IRR for the project is calculated and compared to the RRR. This is usually known as the Hurdle Rate (HR), to determine the acceptability of the project.

The RRR is the same as the discount rate used in the NPV approach. If the IRR is greater than the RRR (IRR > RRR), the project is accepted. If the IRR is lower than the RRR (IRR < RRR), the project is rejected. For mutually exclusive projects, the project with the highest IRR, which also has to be above the RRR, should be accepted. The IRR method is consistent with a company's goal of maximising its shareholder value. The disadvantages of this method are that it assumes that net cash flows are re-invested at a rate of return equal to the IRR and when the cash flows are not conventional, it gives more than one IRR. Furthermore, it assumes the same opportunity cost for all the cash flows (Brealey et al., 2014). Sometimes IRRs do not exist and IRR method can lead to erroneous investment decisions. The IRR equation can be shown as follows:

$$\sum_{t=0}^{n} NCF_t \frac{1}{(1+IRR)^t} = 0 \qquad (2.2)$$

where:

NCF_t = net cash flow in period t, where t=1,2,3,….n

IRR = discount rate

n = estimated life of a project.

2.3.3. Profitability Index (PI or benefit-cost ratio)

The profitability index (PI) uses a similar method to NPV nevertheless is articulated in dissimilar metrics. The NPV uses cash flows while the PI uses an index. The PI is calculated using the future total sum of net cash flows divided by

the original investment. The decision rule of this method is to accept all the projects if the PI is greater than one. This means that when the PI is higher than one the net cash flow of the project is higher than the initial investment, which means the project is NPV positive, hence it will increase shareholder value. The main shortcoming of this technique is that it may be misleading when dealing with two mutually exclusive projects. Project A may have a higher NPV and project B may have a higher PI. In this circumstance, the general recommendation is to rely on the NPV outcome as it is a well-regarded method (Brealey et al., 2014).

2.3.4. Payback method

The payback method is also very commonly used instruments for appraising capital projects. It is commonly referred as payback period which is the number of periods entailed to return the initial investment out of post-tax pre-interest cash flows. With this method, if a project's payback period is below the required threshold then the project is accepted. This method does offer certain insights into a project's risk and liquidity; quicker the cash recouped the lessor the project risk. The major weakness of this method is, there is no economic justification that links the payback period to maximisation of shareholder value. If an organisation has several mutually exclusive projects, they are selected based on their payback rank; that is, project that has shortest payback period is chosen first. The major limitation of this technique is that it disregards the cash flows after the payback period. Hence, a good project with richer cash flows in later years may get rejected. Other weaknesses of this technique are: it disregards the time value of money, and cut-off rate (payback period) is arbitrarily determined.

Some companies use a discounted payback period, which is a refinement of the payback period for risk assessment (Levary & Seitz, 1990). The computation of this method is identical to the ordinary payback calculation apart from that the future cash flows are discounted by the appropriate discount rate (Parring et al., 2009). The key benefit of the discounted payback method is that it illustrate the period taken for a project to reach a point where NPV is zero. Thus, selected projects under this method are NPV positive. Nevertheless, this method also disregards all cash flows after the payback period that is determined arbitrarily. It also implicitly assumes that risk is increasing over time, that is, the projects with

longer payback period are higher risk projects. This is not necessarily correct for economic risk.

2.3.5. Accounting Rate of Return (ARR) or Return On Investment (ROI)

There are many ways to calculate ROI. The most popular method is the ratio of average annual profit before interest and tax (PBIT) to the average net investment (i.e. net of depreciation). Some use initial investment as a denominator instead of the average net investment. ROI is compared with a RRR or cut-off rate to determine acceptability of a project. There are two fundamental problems in this method (Peirson et al., 2012; Bishop et al., 2004). Firstly, it is calculated using accounting earnings rather than cash flows and is open to accounting manipulation. The other major problem is that it disregards the time value of earnings, like the ordinary payback period. This method ranks projects with the similar capital cost, life and total earnings equally, although the pattern of a project's earning streams may be dissimilar. Further, if projects with the same capital costs and total earnings have diverse lives, the ROI will inevitably prefer projects with shorter lives. Furthermore, this method ignores the risk component, and the cut-off rate used is arbitrarily determined.

2.4. Capital budgeting and accounting practice

Many stakeholders make their important business decisions based on accounting statements, particularly financial position (balance sheets) and financial performance (profit and loss accounts) statements. Future cash flow statements for capital investment appraisal decisions are generally estimated by using the firm's financial reports. When a firm applies for a loan, one of the inputs used by the lending institution to evaluate the company's position is its balance sheets that shows its capacity to meet its future financial obligations and its risk level. In other words, the traditional accounting balance sheet is the established tool for reporting various related historic measures (Lee, 1994). Hence the rate of interest charged for the loan is heavily influenced by the financial statements. The interest rate is one of the inputs in the WACC to ascertain the discount rate that is applied to discount the future cash flow to calculate the NPV. Hence accounting practices have an influence on the discount rate, cash flow measurement and capital investment decisions.

According to Scott (2015) earning management is the choice by accounting policy managers to attain their particular objective. Furthermore, research in accounting statements has founded that earning management activities play a role in conveying accounting information. Generally, periodic financial statements include financial performance (profit and loss accounts), financial position (balance sheets) and cash flow statements. Professional accounting bodies require all entities to prepare these financial statements in accordance with the GAAP and approved accounting standards. Some GAAP principles and accounting standards are comprehensive and give a range of options; hence, when preparing financial reports, managers can select accounting policies to meet their specific purposes and benefits. Thus, the accounting practice that a company implements impacts financial reporting numbers. More importantly, it impacts projected future cash flows, and hence, capital investment decisions. This accounting practice would also weaken corporate governance and create agency problems. In these instances, financial statements numbers are unreliable and irrelevant to the users of financial statement, including shareholders and other stakeholders. Thus the expected cash flows and the estimated discount rate are not prudent for making sound capital budgeting decisions (Kalyebara & Islam, 2014).

2.4.1. Accounting and cash flow

The present value model is commonly used in economics and finance and has had a considerable impact on accounting over the years (Scott, 2015). As already stated, financial accounting statements are expected to be prepared in accordance with GAAP and relevant accounting standards, in order to maintain reliability and consistency. Hence, for the NPV to measure the wealth impact of an activity, the fundamental principle of consistency must be adhered to. The cash flows must be defined in a manner totally consistent with the RRR (discount rate) definition; if they are not, the NPV will be an erroneous investment appraisal technique (Bishop et al., 2004). This will lead to sub-optimal or inferior capital investment decisions. The estimation of the cost of capital appropriate to non-financial assets and liabilities for financial statements, needs an awareness of the pertinent accounting standards and fair value framework comprehended within ASC 820 (US), and fair value measurement (Pratt, 2014).

Precise and reliable cash flow forecasts are unequivocally crucial for capital budgeting analysis. Responsibility of maintaining the accuracy of cash flow forecasts lies with managers. All the forecasted cash flows must be after tax values. Depreciation is not considered as cash flow; however, depreciation have cash flow implications as generally tax laws allow depreciation as a deductable item in computing taxable income. Both the straight line and reducing balance depreciation methods yield the similar value of depreciation deductions over the life of the depreciated asset. In practice, the reducing balance method is preferred as it accelerates the allowable depreciation deduction for tax purposes.

2.4.2. Accounting quality and capital budgeting

Existing studies advocate that better quality financial statements should increase investment value by reducing information asymmetries that leads to moral hazard and adverse selection (Lambert et al., 2007; Busman & Smith, 2001; Healy & Palepa, 2001). According to Biddle and Hilary (2006), organisations with better quality financial statements reveal greater investment value and lower investment-cash flow sensitivity. Moreover, Biddle et al. (2009) defined financial reporting quality as the meticulousness that conveys information to the equity investors about the operations of an organisation, in particular its expected cash flows. Consistent with this definition, the US Financial Accounting Standards Board Statement of Financial Accounting Concepts No.1 (1978) states that an objective of financial reporting is to notify current and prospective investors when forming sensible investment decisions and in evaluating the expected cash flows of the firm. Quality financial statement assists to alleviate information conflicts that eventually hinder investment effectiveness. The outcome of the study by Biddle et al. (2009) confirmed this idea and also revealed that organisations with better quality of financial statements are unlikely to vary their projected value of investment.

2.5. The discount rate

The discount rate, the RRR, the HR, cost of capital, opportunity cost of capital (OCC) and WACC are used interchangeably in many studies (Ross, 2011; Brealey, 2014; Pratt, 2014). According to Pratt's (2014) definition, the discount rate is the estimated rate of return sourced to convert projected future payments

or receipts (economic income) into a current cash value as of a precise valuation date (present value). The discount rate represents the total expected rate of return that an investor entails from the investment. In theory, the discount rate is the expected rate of return from the suitable alternative option for the project being considered. It is akin to the concept of opportunity cost because this is the opportunity rate of return (Bandy, 2011). The OCC is project-specific and reflects both the project's business risk and financial risk.

2.5.1. Concept of discount rate

Discount rate is the price or cost of time. Discounting is a method in which this cost is calculated over a specific time horizon (Kula, 1997). Murray (1997) stated that the philosopher John Locke claimed that people had an intrinsic preference for appreciating enjoyment now rather than in the future. Locke was mainly fascinated for its application to ethical and spiritual conduct perspective, however, economists are involved with economic and financial present and future values perspectives (Murray, 1997). Most economists and members of other disciplines agree that individuals always prefer an amount of consumption today rather than at some future date. There are two generally accepted reasons for discounting the future occurrence: **time preference** and **opportunity cost**. Essentially, the time value of money is more important than any other concepts used in finance, which is commonly referred as the DCF analysis (Brigham & Ehrhardt, 2014).

The discounting concept is crucial to economics, as it converts all future costs and benefits occurring at various time into the common currency of the equivalent present dollar. Hence, the estimation of a suitable discount rate is very vital issues in economics (Weitzman, 2012). A minor change in discount rates can cause a significant variance in the discounted present value of future cash flows.

The opportunity costs concept for discounting occurs due to the notion of the time value of money. This arises from the reality that a dollar collected today provides more value than a dollar collected in the future (Brealey et al., 2014). Assume an interest rate of r% and the dollar received today is invested. This dollar will yield a total sum of 1+r dollar in twelve months' time. After twelve months, the original dollar will increase by r% in order to account for the lost opportunity of the foregone return. In other words, receiving $(1+r %) in twelve months' time can be

worth $1 today. Where costs and benefits occur at different points of time it will be necessary to discount them to some common time period before they can be realistically compared. Therefore, the estimation of a suitable discount rate, with which future net benefits are to be discounted, has occupied a major part of the discussion on capital budgeting.

2.5.2. Weighted Average Cost of Capital (WACC)

The WACC is the rate of return earned from investments that equal to the return expected by the suppliers of funds and also equal to the expected return from alternate investment options with equal risk (Seitz & Ellison, 2005; Clark et al., 1989). This required rate is the average of the required returns from the various sources, weighted according to the proportion of the total capital raised from each source. The capital structure typically contains debt and equity components. The cost of debt is the borrowing rate on the commercial market. The cost of equity is the RRR expected by the shareholders. Organisations usually determine the cost of equity using the Capital Asset Pricing Model (Meier & Tarhan, 2007). According to Brealy et al. (2014), WACC is the opportunity cost of the capital for investment in assets of an organisation, and thus the suitable discount rate for the projects with average risks. Cost of capital is recognised as the proper measure of the discount rate (Pratt & Grabowski, 2010).

Although majority of organisations use WACC as their discount rates, they generally enhance it to suitable rate to evaluate projects. Most organisations apply discount rates with premiums that is significantly higher than their cost of capital (Jagannathan et al., 2016). The added high premiums are exposed to great levels of idiosyncratic risk and compelled to hold large cash. These organisations are financially strong and they await for worthwhile investment opportunities in the future.

The standard textbook rule states that an investment project value estimated based on expected cash flows of the project and the applied risk adjusted discount rate. Nevertheless, in practice evidence suggests that most organisations apply only a single discount rate to evaluate all their projects. (Graham & Harvey, 2001). This behaviour is labelled by Kruger (2015) as the “WACC fallacy”. The WACC fallacy is the absence of project-specific risks, which

is critical for making sound investment decisions between diverse projects. This leads to overvaluing the riskier projects and under estimating the value of safer projects, which leads to reduction in a firm's value, as its capital is not being used optimally. Thus, regardless of whether a firm has based its decision on NPV or IRR, the application of a single discount rate could lead to an inefficient investment policy.

The CAPM captures some of the dimensions of fundamental risk. According to Kruger (2015), although organisations generally utilise CAPM betas, they do not usually vary them based on project's risk. Graham and Harvey's (2001) survey evidence shows that organisations usually apply a company-wide risk premium rather than a project-specific one to appraise new investment projects.

2.5.3. Capital Asset Pricing Model (CAPM)

In a stock market context, the CAPM defines the cost of equity capital as the expected rate of return for a share in a specific stock market. CAPM affirms that the expected return on a security is corresponding to the risk-free rate plus a comparative risk premium (Brigham & Ehrhardt, 2014; Peirson et al., 2012). According to Bishop et al. (2004), the CAPM is a relatively straightforward model and is particularly appealing because of its consistency with the intuitive notion that assets are priced in order that their expected return is equivalent to the risk-free rate of return plus a risk premium. Usually, CAPM is expressed as shown below:

Cost of equity capital = risk-free rate + risk premium

The pre-tax risk-free rate is the total of interest income and the relevant capital appreciation that an individual investor would expect to earn on a riskless asset of equivalent duration to the investment under consideration, such as a government bond. The risk premium is the extra return that shareholders would normally look for from an investment that has an equal risk to all the stock market securities. Relative risk is the beta coefficient, which refers to non-diversifiable risk that arises principally within the economy and which cannot be removed by diversification within a portfolio of investments. Generally, The CAPM model mathematical formula is shown below:

$$Ke = Rf + \beta(Rm - Rf)$$

where:

Rf = the pre-tax risk-free rate

Rm = return on a portfolio of all securities in the market

$Rm - Rf$ = risk premium required to invest in equities

β = relative risk of an equity/ security (beta coefficient)

Estimates of historic beta for most listed companies are available in Australia and most other countries. Estimates of the market return (Rm) are also published periodically. Government bond rates (Rf) are available on a daily basis via public media.

Based on the Fama and French (1993) three-factor model, the market, size, and value-growth factors, a five-factor asset pricing model that adds profitability and investment factors have been tested by Fama and French (2015). Similar to the three-factor model, the five-factor model is also an empirical asset-pricing model that is designed to attain noticeable patterns in average returns. According to Fama & French (2016), empirical asset pricing models can be assessed only on empirical strength. An empirical q-factor model developed by Hou et al. (2014), comprising four-factors such as the market, a size, an investment, and a profitability, mainly reiterates the cross section of average stock returns

As this section has discussed the risk component, it is appropriate to discuss risk analysis in the following section.

2.6. Risk management and capital budgeting

The phrase ‘risk’ is generally imply expose to the likelihood of a loss or injury. Generally, in finance and accounting, the phrase risk is used to refer to the chance of losing money or earning less than anticipated (Dayananda et al., 2002; Seitz et al., 2005). Agrawal (2009) defined risk management as a human activity that incorporates identification of risk, assessment of risk, development of strategies to manage risk and the alleviation of risk using organisational resources. Further, risk management is defined as the method that guide organisations recognize, evaluate and take action on all risks, with an aim to

enhance the probability of success and decreasing the prospect of failure (Institute of Risk Management, 2002). Risks can occur from internal or external factors pertaining to an organisation and such risks comprise the following categories (Hussin & Islam, 2017):

- financial risks: interest rate, foreign exchange, commodity price, equity price, credit and liquidity risks;
- operational risks: distribution, technological interruptions or regulations;
- strategic risks: relate to competition, demand and industry transformations; and
- hazard risks: relate to natural incidents, the environment, suppliers, safety of employees, current contracts, products and services.

Capital budgeting can involve various risks due to uncertainty about the future, comprise the cash flow fluctuations, failure to earn the anticipated cash flows, interest rates instabilities and the discount rate, which could impact on investment evaluation decisions (Brealey et al., 2014; Ross et al., 2011). Generally, the risk analysis of a project is very tricky as every project is unique and the risk contribution of a project to the total risk of a company is challenging to quantify. A variety of risks can impact the capital budgeting process, namely, corporate risk, country and global risk, stand-alone risk, competitive risk, market risk, project-specific risk and industry specific risk.

Appropriate methods of dealing with risk are essential for successful capital budgeting. Risk can be integrated into capital budgeting appraisal in several methods. The most commonly used quantitative methods in capital budgeting are risk-adjusted discount rate, the certainty equivalent, sensitivity analysis, break-even analysis and simulation (Seitz et al., 2005). Also a New Estimator of Expected Return (NEER) model developed by Stein (1996) to set hurdle rates. However, the simplest risk analysis is qualitative and subjective, that is, management using some element of judgement.

2.7. Capital budgeting and corporate governance

Corporate governance has emerged again as one of the crucial business issues of the early twenty-first century (Banks, 2004). According to the Australian Securities Exchange (2017) definition, corporate governance practice employed

by management to guide and manage organisations to maximise the company value. Firms adopt good corporate governance for the benefit of all the relevant stakeholders, such as directors, managers, employees, investors, creditors, and diverse industry groups (Bank, 2004). This is very similar to the goal of capital budgeting decisions, which is to maximise the NPV of an organisation in order to benefit all its stakeholders. Pursuit for corporate value is the primary force in a rational economic world, and the allocation of capital and other corporate resources must proceed as efficiently as possible. Thus, efficient capital budgeting decisions improve good corporate governance.

Good corporate governance benefits all segment of organisation, to name a few, it help to access a better flow of funds, improved access to funds at lower interest rate, enhanced credit ratings, better reputation and deliver more business opportunities. All of these benefits lead to cheaper cost of funds, it may stimulate higher share price and decrease agency costs (Kalyebara & Islam, 2014). Cheaper borrowing costs would have a direct impact on the discount rate, as this component forms part of the WACC, and hence improves the NPV and shareholder value.

2.7.1. Regulatory impacts on capital budgeting

Regulations play a vital role in persuading capital investment evaluation around the world. Proposed projects that have the imminent possibility to damage the nature including decay the environment and harm human health is steadily scrutinised by all stakeholders. At the broad level, accounting is impacted by compliance with accounting standards and the promotion for integrated reporting (IR) and compliance with sustainability-related assurance standards and guidelines provided by the Global Reporting Initiative (GRI, G3 indicators) (Vesty et al., 2013). The legal aspects of sustainability related activities in Australia covered by the Corporations Act 2001, which requires organisations to include details of breaches of environmental laws and licences in their annual reports. Moreover, it requires capital investment providers to disclose the level of consideration of labour standards, environmental, social and ethical issues in investment appraisal decision-making.

Usually, stock exchange guidelines and listing rules set minimum standards for corporate governance expectations and associated sustainability-related practices (Vesty et al., 2013). Sustainability issues introduced in Australia via Principle 7 of the ASX Corporate Governance Council Principles and Recommendations. According to this code, organisations must be able to assess the materiality of sustainability-related impacts on their businesses and control them satisfactorily.

2.8. Capital budgeting and agency theory

Agency theory has become one of the crucial theoretical paradigms in accounting over the last three decades (Lambert, 2007). The agency relationship is characterised as a contract under which one person (the principal), or more, engages another person (the agent) to perform services on the principal's behalf, which involves delegating some decision making authority to the agent (Jensen & Meckling, 1976). This delegation creates two problems for the management decision process. Firstly, the goal of the principal and agent may not converge, as managers/agents generally act to maximise their interest rather than the interests of the company. Secondly, the agent has more information about the business than the principal does, which known as information asymmetry (Gul, 2007). Generally, information asymmetries classified into two types such as adverse selection and moral hazard. Adverse selection means that one or more party has an information advantage over other parties in a business transaction. Moral hazard occurs when one or more party in a contract observes their actions in fulfilment of that contract though other parties focus on their own benefits (Scott, 2015).

Agency theory plays a vital role in the positive accounting theory (Gaffikin, 2008). According to Jensen and Meckling (1976), shareholders (owners) should be aware that their managers/agents will make optimal decisions only if appropriate incentives are provided.

Managerial bias might also affect the allocation of capital. Manager optimism and myopia might explain why firms screen projects using discount rates that are higher than the cost of financial capital (Jagannathan et al., 2016). One possibility is that firms use high discount rates to guard against overly optimistic cash flow

forecasts. Managers may overstate their cash flow forecasts due to a psychological bias or as a strategic response to organisational incentives. Another possibility is that myopic managers might inflate the discount rate to forgo profitable long-term investment opportunities in order to reduce current expenditure and increase current earnings. Stein (1989) and Martin (2008) suggest that the use of a single discount rate as an alternative to project-specific discount rates to evaluate projects may have influenced by managerial incentives to obtain approval for projects. Such incentives could lead managers to manipulative behaviour by inflating the expected cash flows and understating project risks and thus choose a lower discount rate.

2.8.1. Agency theory and agency cost

As discussed previously, agency theory centres on the segregation of ownership from control (Kim et al., 2009). Usually, managers make all operational, and important strategic decisions on behalf of owners/shareholders. Human beings are self-interested and wealth maximisers by nature (Kalyebara & Islam, 2014). Hence, it is reasonable to expect that managers are often focused on maximising their own benefits/wealth, although they are employed to maximise shareholder wealth. This will create significant agency costs to the firm. Agency theory evolved from this context, with managers maximising their own benefits at the expense of shareholder's value via excessive self-remuneration, making decisions that focus on short-term performance rather than long-term growth, and averting long-term risky projects (Psaros, 2009; Marino & Matsusaka, 2005). Hence rising agency costs and impact on capital investment decisions.

Capital budgeting often involves huge investments, which induce managers to influence decisions towards maximise their own benefits at the expense of owners. Therefore, organisations required to spend money to mitigate agency costs. Agency costs may be stated as the aggregate of the owners' monitoring costs, managers' bonding costs and the residual loss" (Jensen & Meckling, 1976). Agency costs also include the spend on several incentives, such as bonus payments, share ownership, and pay increases, to attract managers to perform fairly to maximise shareholders' wealth instead of their own short-term benefits.

Firms also develop various policies and controls to monitor management to ensure they act appropriately.

2.8.2. Implications of agency theory for accounting

According to Gaffikin (2008) agency theory deemed as a vital part of the Positive Accounting Theory (PAT). PAT endeavours to foresee such actions as the choices of accounting policies that managers will choose to maximise either their own benefits or the interest of their shareholders, and how managers would react to the proposal of new accounting standards (Kalyebara & Islam, 2014). PAT has three hypotheses: the Bonus Plan Hypotheses (BPH), the Debt Covenant Hypotheses (DCH) and the Political Cost Hypotheses (PCH). In the first two hypotheses, the reported earnings moved to the current period in order to enhance the bonus payable and minimise the likelihood of failing to meet interest and principal payments when they become due. In the PCH case, reported earnings may be moved to a future period to suspend political costs (Scott, 2015).

An insinuation of agency theory is that net income can play a role in motivating and monitoring manager performance (Scott, 2015). The basic reason why accounting policies affect manager and firm welfare is information asymmetry. A manager uses his/her effort to run the firm on the owner's behalf, but the owner usually does not observe this effort. Knowing this reality, the manager may be tempted to shirk. The owner might offer the manager a share of reported net income to control this moral hazard and to motivate the manager to work harder. However, this also means that the manager has a personal interest in how net income is measured (Scott, 2015). A contract based on share price as a second performance measure, in addition to net income, would be more efficient and help reduce agency costs significantly. In effect, net income and share price together reflect a manager's effort better than a single variable alone (Scott, 2015).

The capability of net income to achieve enhance performance of a manager depends on its sensitivity and exactness as a measure of the payoff from the effort of the manager. Net income competes with other performance measures, such as share price. If accountants can improve the precision and sensitivity needed for a good performance measure, they may expect to see an increase in the role of net income in manager compensation plans (Scott, 2015). Controlling

earning management through accounting practices (e.g. GAAP), accountants can restore a manager's incentive to work harder, thereby increasing payoffs to owners.

2.9. Game theory and agency problems

According to Perloff (2012), game theory formally defines games and predicts their outcome based on the rules of the game, the information that players have and other factors. Furthermore, the World Bank Policy Research Working Paper 4072 (2006) defines game theory as the study of the mathematical modeling of decision makers' strategic behaviour in conditions where decisions of one player may influence the other players. Further, the basic assumption of game theory is that decision makers are rational and intelligent players. Thus, as pursuing well-defined objectives, players consider other players' rationality and, accordingly, form expectations on their behaviour. There are two major categories of game theory, non-cooperative game theory (NCGT) and cooperative game theory (CGT). The key difference between the two is that NCGT models in conditions where players can observe only their own strategic objectives and hence binding agreements amongst the players are not possible. On the other hand, CGT centered mostly on agreements to share cooperative gains.

Generally, principal-agent models represent game situations in the form of incentive compatibility problems, commonly between principal and agents. In this concept, Salanie (2005) stated that the parties are involved in strategic interactions to find the most optimal payoff that they can accept in a rational and intelligent way. A game includes a number of players, a set of strategies for each player, and a payoff that quantitatively designates the outcome for each player in terms of the amount they win or lose (Barron, 2013). Furthermore, a game is any competition between players in which strategic behaviour plays a major role. Perloff (2012) defined strategic behaviour as a set of actions a player chooses to enhance the benefits, in view of the likely actions of other players.

Standard game theory assumes very strong player abilities to understand the strategic situation and to calculate their best strategies. However, based on experimental evidence using new game theoretic modelling principles, individual behaviour can impact the theoretically predicted outcome (Montet & Serra, 2003).

Moreover, Montet and Serra (2003) stated that recent developments in game theory are progressing in the direction of behavioural game theory, as this can represent the real world more accurately than traditional CGT. CGT based on the principles of behavioural game theory (altruism, bounded rationality, reciprocity) can provide a more realistic framework for achieving cooperation among agents. The new game theoretic modelling principles of Montet and Serra (2003) are based on experimental evidence. Game theory, particularly CGT, can be integrated with recent developments in welfare economics, such as the capability approach, and the role of ethics.

2.9.1. Game theory and mechanism design

As indicated above, traditional game theory assumes self-enforcing cooperation among agents and it models this perfectly. However, there are many situations when self-enforcing cooperation is not possible and external regulations and mechanisms or institution buildings are needed to achieve cooperation. In that context, the mathematics of traditional CGT needs to be modified to model different systems, such as mechanism design and optimal contracts.

Since the 1950s, game theory and mechanism design have emerged as important apparatus to model, analyse and solve decentralised design problems involving multiple autonomous parties that interact strategically (Arifa & Islam 2017). The theory of mechanism design is a concept of microeconomics that specifies the extent to which economic decisions are made as the function of the information that is known by individuals (Mas-Colell et al., 1995). Mechanism theory focuses on designing systems that satisfy certain preferred objectives, assuming that the parties interacting through the systems will act strategically and may possess private information that is pertinent to their decisions. Myerson (1989) stated that, in the formation of the economic problem, one of the fundamental insights in the theory of mechanism design is that incentive constraints should be considered equally with resource constraints. Furthermore, Monte and Serra (2003) stated that the concept designs games whose equilibria are desirable to all agents, which is incentive compatible, in efficient and effective ways. This mechanism would encourage all agents to participate in the contract

and reveal more information to planners, in line with the revelation principles (McGuigan et al., 2014).

2.10. Summary of the literature review findings

Table 2.2 below presents a summary of an assessment of existing literature on capital budgeting and discount rates.

Table 2.2: Summary of literature review findings

	Authors	Year	Origin	Summary
1	Freeland & Rosenblatt	1978	UK	When lending is allowed, an objective function of maximising the present value is equivalent to maximising the horizon value (net benefits arising close to the beginning of the projects). Thus, the problem of finding the right discount factor can be eliminated by maximising the horizon value. The decision regarding what discount factor should be used beyond the horizon must be made external to the model.
2	Pike	1983	UK	DCF analyses and methods endorsed in capital budgeting literature are used by larger organisations. This paper highlights significant progress in areas such as inflation, HR DCF methods, risk analysis and post-implementation audits.
3	Ross	1986	US	The DCF method is widely used, in particular the IRR method. At the same time, several organisations continue to apply a simple payback method. The study establish that WACC is as widely used as discount rate.
4	Haka	1987	US	Organisational and environmental characteristics influence the effectiveness of using more sophisticated capital budgeting financial tools, DCF. Positive relationships between the DCF effectiveness and foreseeable environments, the use of long-term reward systems, and the degree of decentralisation of the capital budgeting practice are demonstrated.
5	Pike	1988	UK	The use of DCF techniques in capital budgeting significantly increased during the period between 1975 and 1986. Also, firm performance was enhanced during this period.
6	Stein	1989	US	The paper develops a model of inefficient managerial behaviour misleading the market about firm value; managers abandon worthy investments to increase current earnings. The model is beneficial in gaging evidence that has been offered in the 'myopia' debate. It also yields unique effects regarding company structure and the parameters of integration.
7	Woods	1991	Australia	The paper argues that when the Equivalent Annuity (EA) and Constant Chain of Replacement (CCR) approaches of DCF analysis are used for ranking mutually exclusive projects of unequal

				lives, the correct discount rate to use is the real risk-free rate. None of the references consulted for this paper handle the matter adequately or correctly.
8	Fama & French	1999	US	The study estimates the IRR earned by non-financial organisations on the original market values of their shares, and the cost of their investments. The return on investment is an estimation of the whole organisation cost of capital. The estimate shows that the real return on costs is larger compared to the real cost of capital, so overall, corporate investment appears to be profitable.
9	Arnold & Hatzopoulos	2000	UK	The field study survey of ten Central and Eastern European (CEE) countries found that the cost of capital estimate and the application of a CAPM are persuaded typically by organisation size and culture, and code of ethics. One of the interesting findings is that a worthy project selected based on DCF analysis may be refused by top management for various other reasons, for example, ethical and moral concerns, limitation of financial resources, strategic fit, confidence in the analysts and reliability of data source.
10	Graham & Harvey	2001	US	A survey of 392 CFOs showed that large organisations rely greatly on NPV techniques and small organisations are more likely to utilise the payback criterion. The survey results showed that the diffusion process in large firms was nearly complete.
11	Graham & Harvey	2002	US	DCF method is the favoured capital budgeting method. The most popular method is the IRR and then NPV. Most firms utilise NPV to appraise new projects. Payback methods are also widely used in capital investment evaluation.
12	Moosa	2002	Australia	The report considers the choice between the ten-year and the five-year bond yields as the risk-free rate applied to calculate the cost of capital. The paper suggests two sets of considerations: theoretical and econometric. The econometric consideration shows no preference for any of the two series. However, the theoretical considerations lead to preference for the ten-year bond yield.
13	Fama & French	2004	US	CAPM proffers commanding and instinctively fair forecasts about how to measure risk and the correlation between risk and projected return. The empirical issues of CAPM may reflect theoretical flaws, the outcome of various assumptions. Nonetheless they could be influenced by implementation problems of valid tests of the model.
14	Marino & Matsusaka	2005	US	The study shows that the manager favours spending more than the owner. Manager has greater information about project returns than the owner. The owner decides level delegation to manger re decision making. Delegation provide opportunity for the manager to overspend, however when the owner try to influence in the decision, then the manager may distort his

				proposal to make the project look better than it is, resulting in an inefficient capital allocation.
15	Biddle & Hilary	2006	US	The study confirms that better quality accounting boosts investment efficacy by minimising information asymmetry that leads to moral hazard and adverse selection between managers and outside suppliers of capital. This upshot would be severer in economies where capital is mainly accessible through arm's length transactions.
16	Fernandez	2007	US	The study endorses ten valuation methods such as equity cash flow, free cash flow, adjusted present value, risk adjusted free cash flow and equity cash flow, risk free rate adjusted free cash flow and equity cash flow, economic profit and EVA. These techniques constantly give the same value. This outcome is consistent as all the techniques analysed the same realism under the same assumptions; they varied only in the cash flows or parameters taken as the basis for the valuation.
17	Meier & Tarhan	2007	US	Survey of 127 companies. The key study outcomes reveal that there is a HR linked dilemma, in that organisations used HRs higher than cost of capital. The findings also showed that the firms surveyed were not consistent with cash flow aspect of their investment decisions.
18	Apreda	2008	Argentina	Study raises the issue of the extent to which conservative practice delivers reliable information or misrepresents the value anticipated from any impartial estimation of cost of capital. Governance risk should not be ignored any longer, and be included in cost of capital.
19	Martin	2008	US	The study suggests a useful technique for estimating the cost of capital that yields diverse discount rates for capital projects with various risks. This method minimise the agency costs that occur from managerial discretion when choosing the discount rates. The suggested method utilise the market information such as firm-wide costs of debt and equity, hence minimising managerial bias, and provides a sensible and notionally correct project-specific discount rates.
20	Truong et al.	2008	Australia	A survey reveals that projects are typically being appraised by applying NPV method, however other techniques, particularly the payback method is also used by companies. Generally, project cash flow forecast are based on three to ten years and single WACC is applied as the discount rate. Largely companies apply a single discount rate for all the projects. Generally CAPM is used to calculate cost of equity.
21	Biddle et al.	2009	US	Greater quality of financial statements typically linked with lower investment organisations that are cash rich and unlevered, and also associated with higher investment organisations that are cash constrained and highly levered. Further, organisations with high quality financial statements incline to invest less when total investment is high, and invest more when the total investment level is

				low. Moreover, better quality financial reporting organisations remain steady from expected investment levels and reveal less sensitivity to fluctuations in economic conditions. The findings propose that investment accompanying quality financial reporting mechanism mitigate moral hazard and adverse selection that hinder effective investment.
22	Bennouna et al.	2010	Canada	A survey finding of 88 large Canadian companies indicates that 83% of firms continue to use DCF and the remaining 17% use other methods. The majority of firms use NPV and IRR methods among those using DCF. Also 8% of firms use real options.
23	Da et al.	2012	US	Research outcome defend the continual application of the CAPM by organisations despite the growing evidence contrary to it based on the range of stock returns. The paper argues that the empirical evidence opposing the CAPM does not nullify its use for estimating the cost of capital for capital budgeting decisions. It also offers empirical backing for the claims by providing a technique for estimating project CAPM betas and project returns of organisations.
24	Brunzell et al.	2013	Sweden	Study of five Nordic countries found that the use of the NPV and the supremacy of the capital budgeting are associated with the nature of organisations. Also found backing for much higher HRs than influenced by economic theory. The premium is positively correlated to managerial short-term pressure although weakly and negatively but strongly correlated to the level of efficiency of the organisation's capital budgeting.
25	Vesty et al.	2013	Australia	The survey findings show that impacts linked with sustainability appear to effect on the firm's investment decision making processes. Vital sustainability associated matters considered in capital appraisal comprise effects of office health & safety compliance, health and wellbeing of employees, the effect on brand and reputation, and the cost of clean-up and remediation.
26	Andor et al.	2015	Hungary	The survey results from company executives in ten CEE countries indicate that capital budgeting methods seem to be influenced typically by the size of organisations and international culture, and though not greatly by insider ownership..
27	Kruger et al	2015	US	Evidence of survey proposes that many organisations apply a company-wide WACC as discount rate to appraise projects, a behaviour labelled the "WACC fallacy", or failure to consider project-specific risks. The occurrence of the WACC fallacy suggests that organisations be inclined to favour higher investment for sections that hold a higher industry beta than the core section of the organisation.
28	Vesty et al.	2015	Australia	Case study based research on sustainability and investment decisions provides evidence that there is very limited research involving accounting models and related business decisions. Also

				establish evidence of the usual role of accounting and the pertinent cash flow data for decisions. However, more and more non-cash flow data and values plays a very significant role in the decision making process.
29	Jagannathan et al.	2016	US	Presents reliable evidence with operational constraints, prominent organisations to apply high discount rates that almost double the firms' cost of capital. A survey found that organisations with ample accessibility of capital with limited qualified management usually sacrifice profitable projects for anticipated better investment opportunities that provide greater benefits. Moreover, organisations seem to escalation discount rates to justify idiosyncratic risk.
30	Bamberg & Krapp	2018	Germany	Study shows that investment decisions analysis emphasising on mechanisms can encourage managers to reveal their knowledge truthfully. In a one-period framework, knowledge generally implies the profit ratio and in a multi-period context, knowledge denotes to the cash flow or the NPV. If the manager fails to comprehend the mechanism, truthful reporting cannot be guaranteed.

2.11. Limitations of the current literature and the motivation for this study

Proper analysis of capital investment projects requires an understanding of how to estimate the suitable discount rate for a project. The literature is either silent on this matter or inadequate, hence the need to address this issue remains.

The major limitations in the existing literature are summarised as follows:

- Although most of the DCF attempt to estimate future cash flows, the discount rate is typically chosen in an arbitrary manner, without understanding its function. Generally, there is no proper guide or standard suggested to estimate suitable discount rates.
- Accounting issues relating to the discount rate estimation, such as fair value accounting vs historic value accounting, are not addressed in the literature. Yet this is critical for correct income estimation (Scott, 2015).
- General flaws in the estimation and the application of the cost of capital still exist. Some examples are: using an organisation's cost of capital to appraise a risky project; misidentifying historical rates of return for the expected rate of return; using today's risk premium for future projects; using the book value of capital structure instead of the forecasted market

value; using the same WACC for different diversified business projects; using a discount rate in real value to a net cash flow projection in nominal terms; and a discount rate that is estimated after tax to a pre-tax net cash flow (Pratt & Grabowski, 2014).

- The discount rates applied in capital budgeting practice are static, remaining the same for the entire life of the project, but no consideration is given to future market conditions and the time-varying nature of risk. Although many organisations admit the fluctuating nature of risk with time, they prefer to use a single discount rate in their project appraisal process and there is no proper explanation available in the literature for this fixed discount rate behaviour. According to Truong et al. (2008), it might be that it is deemed very challenging to reliably estimate time variant in discount rates.
- No comprehensive study exists that incorporates the new theoretical and conceptual developments, such as using agency theory, game theory and optimisation models, to determine the appropriate discount rate.
- Cash flows are forecast based on assumptions and historic data and are not always accurate (Dayananda et al., 2002).
- Common assumption is that the projected net cash flows will be realised throughout the lifespan of the project but this has proved to be incorrect in most cases (Dayananda et al., 2002).
- Investment decisions are made based on NPV outcomes, which are based on the accounting numbers. However behavioural, qualitative information and non-financial matters are generally ignored (Vesty et al., 2015).
- The existing literature on accounting, pertaining to studies on accounting reporting and its benefits for capital budgeting, corporate governance, risk management and company value, has revealed different and somewhat conflicting results. Moreover, there is no mechanism design model that can be used to analyse the relationship between accounting practices, capital budgeting, corporate governance, risk management and company value in an integrated way (Kalyebara & Islam, 2014).

The limitations of the existing literature justified the need for further study into developing improved methods and models for deriving a suitable discount rate,

mitigating agency costs and refining efficient capital budgeting processes. The limitations also provided the motivation for developing a new integrated mechanism design model within game theory as an optimisation problem that can be used to analyse the research issues. Such a model can also be used to resolve the underlying information asymmetry and agency problems that affect the right choice of discount rate and efficient capital budgeting decisions. Moreover, the research sought to advance accounting theory and applications that are key to improving the quality of information required for efficient capital budgeting decision making. These improved approaches will not only help to close the gap in the current literature, but also provide practical benefits to many critical sectors of the economy and major industries.

2.12. Conclusion

The literature review indicated that there is a substantial integration gap between capital budgeting, accounting practices, agency issues, corporate governance and risk management. The choice of a suitable discount rate has occupied a significant part of the discussion on capital budgeting. However, no satisfactory methodology and model for deriving appropriate discount rates has been suggested to date.

While WACC and CAPM methodologies are widely used to derive discount rates in many countries, they ignore some economic factors, both internal and external, for example; agency costs, accounting methods and related issues, project-specific risks, uncertainty, inflation, taxation, capital markets, and future economic changes. These issues affect accurate decision making.

Agency conflicts and basic accounting concept issues, particularly income and cash flow measurement, historic costs and fair value, are not adequately addressed in the literature. Accountants have laboured long and hard to find a solution to these basic concepts, but with relatively little success (Scott, 2015).

This research aims to resolve the literature limitations and gaps discussed in this chapter. The concepts and issues raised here are addressed in the next chapters, which vindicate and articulate certain difficulties of choosing appropriate discount rates for capital budgeting and suggest appropriate models for estimating the discount rate. Moreover, addresses the mitigation of agency costs within the

game theory and integrated mechanism design framework, and solved as an optimisation problem. This research also sets the agenda for further research on this topic.

CHAPTER 3: CONCEPTUAL FRAMEWORK AND THE METHODOLOGY

3.1. Introduction

This chapter discusses the conceptual framework of this study, created for the development of a discount rate estimation and a game theory based multi-objective optimisation model. The framework is formed on a game theoretic mechanism design approach. It was developed to address the main research questions: *how to estimate a suitable discount rate for capital budgeting, considering agency problems and accounting issues; and to what extent the model can represent an optimal contract design to align the interests of shareholders and managers, leading to rigorous capital budgeting decisions, good corporate governance, and enhance company value?*

In this way, this study forms an integrated analysis of capital budgeting, discount rate and associated issues, such as agency problems, the principal-agent game, accounting principles and practices, risk management and corporate governance that impacts on the application of a suitable discount rate for capital budgeting.

As specified in the research questions, this study comprises two major components: firstly, the estimation of a suitable discount rate for private organisations and the effect of agency problems and accounting measurement and issues are examined. Secondly, the optimisation principal-agent game model within mechanism design framework is investigated. In order to compare and justify the selected methodology, this chapter discusses contemporary issues and contemporary approach in accounting research (Wolk et al., 2008), various forms of research methods (Ryan et al., 2002), different forms of optimisation models, including capital budgeting optimisation models (Ragsdale, 2018), game theory (Perloff, 2012), and mechanism design concepts.

These issues are then analysed and a new financial model for discount rate estimation and an optimisation model for mitigating agency problems within the game theory and mechanism design framework are proposed. This study employs two case studies using secondary data from the relevant companies in order to simulate the model. Furthermore, to analyse and test the model, this

study uses Microsoft Excel and Solver software for solving the optimisation problem.

The rest of this chapter is organised as follows. Section 3.2 describes the conceptual framework relate to this study. Section 3.3 examines various research methods and the method applied in this study. Section 3.4 investigates the theoretical foundation for developing the financial model. Section 3.5 discusses new directions in accounting research. Section 3.6 presents the emerging dominating issues in accounting measurement methods. Section 3.7 discusses accounting information and the choice of discount rate and Section 3.8 discusses the discount rate estimation model. Section 3.9 discusses an overview of game theory, its classifications and the types of contract design and their effects in controlling principal/agent game. Section 3.10 discusses the mechanism design framework for mitigating agency problems and provides the characteristics and structure of the new financial optimisation model within the game theoretic framework. Section 3.11 discusses the case study background, research data and the tools, including the computer program applied in this study. Section 3.12 summarises the chapter.

3.2. Conceptual framework

Capital budgeting is a fundamental role of company financial management and it involves concurrent decisions of investment, financing, working capital and dividend (Brealey et al., 2014; Ross et al., 2011). Investment decisions focus on what investments a firm should make and financing decisions focus on how a firm should pay for their investments. Working capital decisions centre on ensuring the organisation's proficiency to payout its short-term liabilities when required to be paid. Working capital denotes to the net current assets or the liquidity of the firm, usually determined by subtracting total current liability from the total current assets. The higher working capital ratio indicate the greater ability of the firm in meeting its current liabilities. Dividend decisions are usually made after taking into consideration the financing of positive NPV projects using internal funds as the cheapest option, rather than debt and equity. Thus, good financial management of a company must accomplish good financing decisions, good

investment decisions, good working capital decisions and good dividend decisions.

The split of ownership and control in an organisation may create agency costs between shareholders (principals) and managers (agents), caused by asymmetric information when managers possess more unobserved information than shareholders (Jensen & Meckling, 1976). Although many governance mechanisms are available to mitigate principal-agent problems, an incentive compatible contract is the most prominent mechanism to mitigate agency problems and minimise agency costs (Zingales, 2008).

As discussed previously, this study aims to investigate two elements in capital budgeting that sustain sound investment decisions. Firstly, the estimation of a suitable discount rate for capital budgeting decisions that accounts for agency costs, accounting quality and the selection of the right set of projects for capital investment. Secondly, to investigate specifically the extent to which capital budgeting optimisation methods lead to good corporate governance, efficient allocation of resources and enhance company value. This is done within the framework of mechanism design and game theory. The relevant frameworks relating to these two elements are discussed in the next sub-sections 3.2.1 and 3.2.2.

3.2.1. Capital budgeting and a discount rate framework

The most popular capital budgeting method uses NPV to evaluate the estimated financial outcome of potential projects. Hence a key aspect of the capital budgeting procedure is the estimation of cash flows related to the proposed projects and the right choice of discount rate (Dayananda et al., 2002). Consequently, the discount rate plays a critical role in DCF techniques, leading to efficient capital budgeting decisions. DCF techniques, together with a suitable discount rate, help management to systematically analyse and select the right set of projects to provide potential business opportunities and maximise shareholder wealth.

The discount rate sets the standard for investment decisions that create more value for the firm than financing decisions. Managers are human beings and are subject to opportunistic behaviour and, as such, they are not always the perfect

servants of shareholders. Thus, firms should consider corporate governance rules and procedures together with suitable incentives to ensure that pertinent managers work towards increasing company value (Brealey et al., 2014). Furthermore, mitigating agency problems, robust accounting practices, risk management and good corporate governance are the most common factors for capital budgeting to attain the corporate goal of maximising shareholder wealth. Good corporate governance institutes controls over business transactions, while risk management ensures that every business transaction complies with established limits (Kalyebara & Islam, 2014). Robust accounting practices ensure that business transactions are recorded and reported according to approved accounting standards and GAAP, and mitigating agency costs reduces the total cost to the firm and increases shareholder wealth.

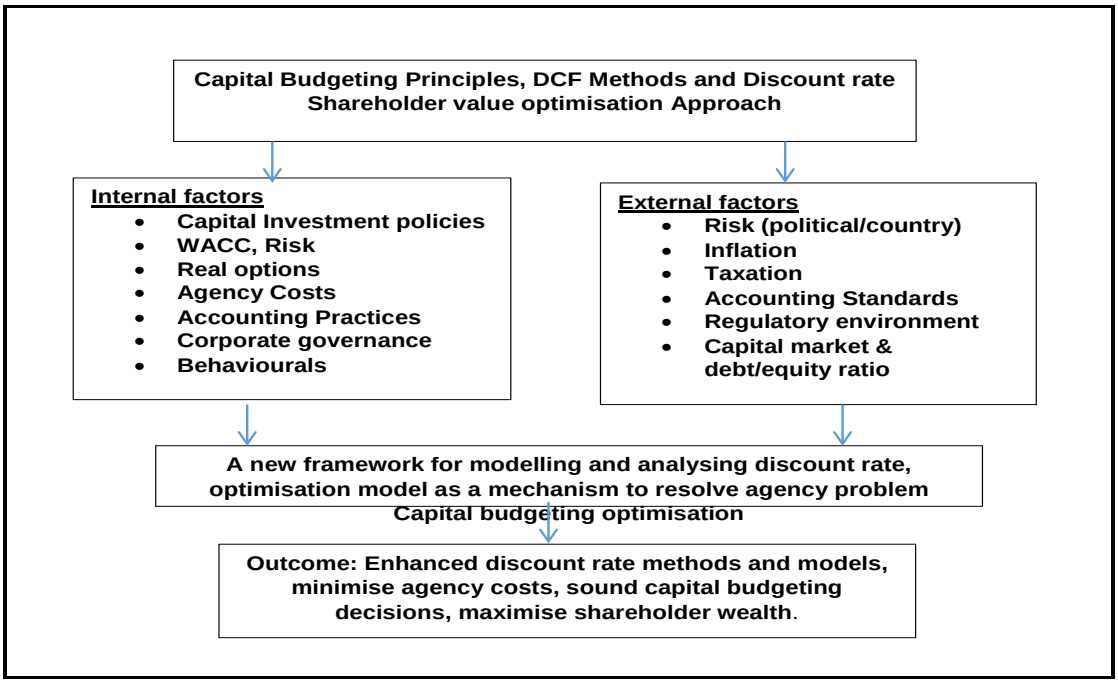

Figure 3.1: Conceptual Framework – Elements of capital budgeting and discount rates

Figure 3.1 illustrates that efficient capital budgeting is linked with many common factors. Most important among these factors are DCF methods, suitable discount rates, good corporate governance, risk management, mitigation of agency costs, good accounting practices, and optimisation game theory model for mechanism design in capital budgeting. Generally, DCF methods are preferred to non-DCF methods to evaluate projects and hence, the discount rate plays a major role in

project selection decisions. As discussed in Chapter 2, the two most commonly used DCF methods are the NPV and the IRR. Although both NPV and IRR methods have pros and cons, ideally, the NPV method for project appraisal is reliable than IRR (Dayananda et al., 2002). The NPV method discounts all the cash flows of future project to the present value in order to determine the net gain or loss to the organisation from the capital investment.

As noted previously, risk in finance is defined as the chance of losing money or receiving less than expected (Seitz & Ellison, 2005). In practice, cash flows forecast are mainly estimated by such things as assumptions, interpretation, and local markets, hence, inevitably there is scope for inaccuracy in cash flow projections. There are several means in which risk can be assimilated into the NPV calculation and capital budgeting decision process, including risk-adjusted discount rates, the certainty equivalent, sensitivity analysis, break-even analysis and simulation.

In the principal-agent game setting, shareholders/principals expect management/ agents to perform to the best of their abilities in maximising company wealth by selecting the right set of projects for long-term investments. However, in practice, shareholders often have inadequate information about the business and may not be certain as to how managers have influenced to the achievement of the organisation. In other words, as discussed in Chapter 2, there may be a degree of information asymmetry, with the agent having more information about the business than the principal (Gul, 2007). Within the context of this asymmetry, managers might arbitrarily choose the discount rate to pick an inefficient set of projects in order to maximise their own interests, creating agency costs.

Financial statements are widely used by internal and external users for various analyses, including the estimation of suitable discount rates and cash flow forecasts for investment evaluation. Therefore, the quality of accounting practices becomes more important, particularly as compliance with approved accounting standards is essential for all public listed companies. Criticism of accounting has encouraged accounting standard-setters globally to establish standards that enhance the quality of accounting information in terms of understandability, relevance, reliability, comparability and consistency. These standards improve

the decision making process (Warfield et al., 2008; Weygandt et al., 2010). Accordingly, there has been a move to International Financial Reporting Standards (IFRS) and a conjunction between IFRS and country specific local standards has taken place in many countries, including Australia.

Internal control is represented by a set of accounting and administrative controls and practices that help make sure that approved and suitable decisions are made in an organisation. This process is aimed to deliver sensible reassurance that an organisation will attain its objectives in terms of effectiveness and efficiency of operations, accuracy and reliability of financial reporting. Internal control also helps safeguard firms' assets and improve accountability for actions and compliance with appropriate laws and regulations (Maher et al., 2012; Horngren et al., 2014; Wilford, 2016). Therefore, internal control offers management with sensible assurance that the organisation's assets are safeguarded and their accounting information is of a high quality and reliable.

As discussed in Chapter 2, agency problems arise due to information asymmetry and game theory has been developed as a mechanism to optimise actions and decisions to maximise both parties' interests. Therefore, a game theoretic approach is appropriate for developing a model within a mechanism design framework and to solve optimisation problems for efficient capital budgeting decisions and accounting practices. Mechanism design linked to the conceptual framework is discussed in the next section.

3.2.2. Optimisation agent-principal game

The second part of the key objective of this study was to develop an optimisation model incorporating a game theoretic approach. This would mitigate agency costs arising from asymmetric information in principal and agent relationships within capital budgeting practices. The research aim was to investigate the relationship between incentive contracts and capital budgeting decision making processes, thus addressing an identified gap in the current literature (Kunz, 2018; Marino & Matsusaka, 2005).

The conceptual framework of this research is provided in Figure 3.2. This shows that sound capital budgeting decisions are linked with many factors, most importantly, the mechanism design incorporating a joint optimisation model,

accounting quality, accounting regulations and standards, agency theory, game theory, contract theory, risk management and corporate governance.

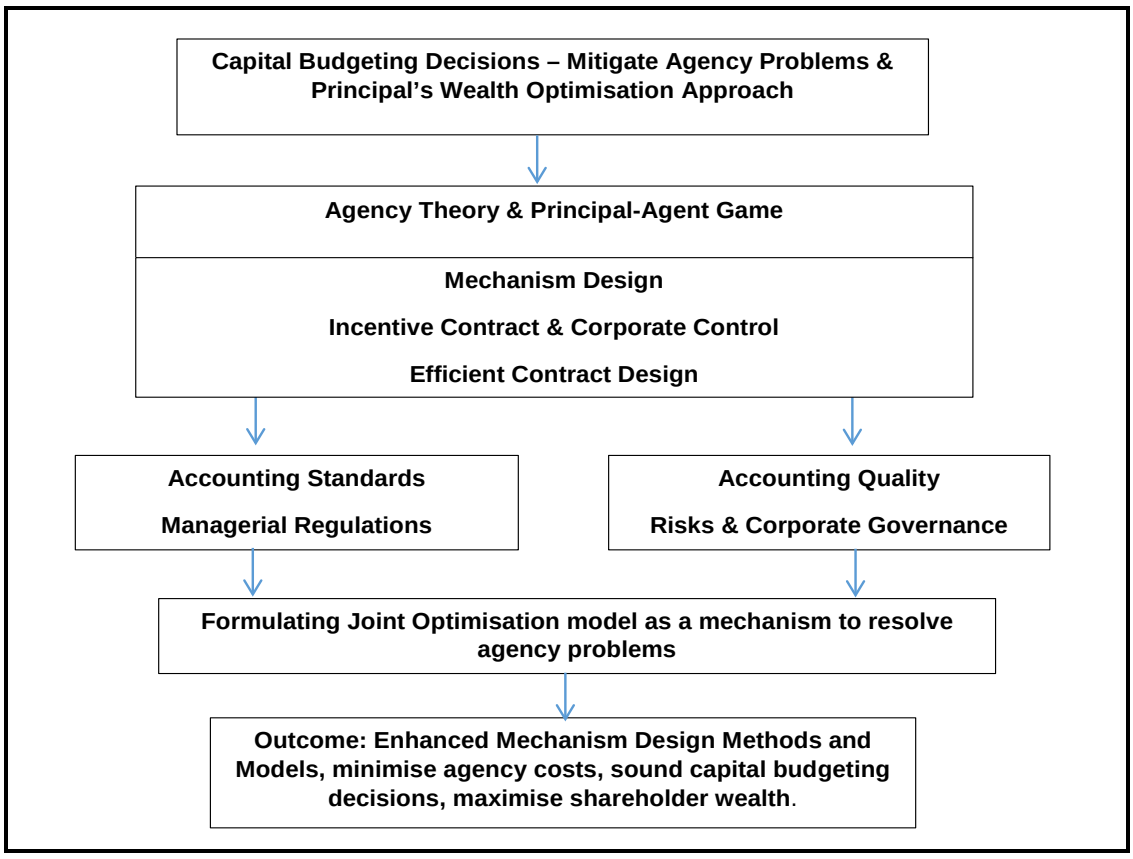

Figure 3.2: Conceptual framework - Optimisation game theoretic model for mechanism design in capital budgeting

The optimisation model was developed based on quantitative applications and tested using case study data. Creswell (2014) described quantitative approaches as including established data, defined questions, performance related data, censuses, attitudes and observations, statistical analysis and interpretation. The data used to conduct this research comprised the majority of the above characteristics and, as such, justified the inclusion of quantitative methods in the research. Quantitative research encompasses the collection and analysis of data quantification with a focus on testing theories, including a logical relationship between theory and research (Bryman & Bell, 2015).

The principal-agent game, commonly referred to as the agency problem, is usually prevalent in all modern companies and corporations, and mechanism design can provide a solution to mitigate this problem (Samuelson & Marks, 2015;

McGuigan et al., 2014). In accounting, mechanism models have been developed in several areas, such as a principal-agent model applied to the design of performance measures (Kanodia, 2014); an incentive compatibility model for resolving agency problems in cost accounting (Demski, 2008); and an agency model for management accounting (Lambert, 2007). However, no mechanism design model has been identified in the current accounting literature that can be used to analyse capital budgeting decision making, and related accounting quality issues, risk management and achievement of good corporate governance within the principal-agent game framework. Hence, the integrated mechanism design model developed in this study represents a theoretical advancement in resolving agency problems that impact on capital budgeting decisions. This will help improve the corporate governance of firms. This integrated mechanism model was developed using a joint optimisation framework and makes a valuable contribution to the accounting and finance literature and accounting practices.

The next section discusses the various research techniques and methods used in this study.

3.3. Research design

Research design is usually defined based on the need of the study and is generally categorised by numerous parameters, including kind of research, purpose, duration, scope and environment. According to Cooper and Schindler (2014), major research designs are classified as exploratory, descriptive and causal. Kumar (2005) categorised research designs as either descriptive, correlational, explanatory or exploratory. However, these designs could be grouped together based on their characteristics. According to other scholars, research can be categorised into four groups, based on its purpose: exploratory, descriptive, analytical and predictive (Sekeran, 1992; Ryan et al., 2002; Islam & Mak, 2006). These research categories are discussed in the following sections.

3.3.1. Exploratory research

Exploratory research is implemented where there is limited current knowledge concerning the research problem and little, if any, preceding studies have focused on the research problem. Exploratory research focusses on collecting evidence and directing potential studies rather than providing specific answers to a

problem. Such research may choose the mode of case studies, observations and historical analysis (Islam & Mak, 2006). This study encompasses an exploratory element, as very limited work has been carried out on capital budgeting that incorporates agency theory, game theory, accounting theory and practices.

3.3.2. Descriptive research

A descriptive study is conducted to find specific information and define the relevant aspects of the research problem from an individual, societal, organisational, industry, or other perspective (Islam & Mak, 2006). A descriptive study uses statistical techniques to analyse quantitative data and aims to answer questions of what, who, when, and where, hence often it is known as statistical research. In this type of research, the researcher has only a little control on the dependent variables and thus there is a little requirement for internal validity (Ryan et al., 2002). This study also involves descriptive research, as capital budgeting and choice of discount rate require significant quantitative analysis.

3.3.3. Analytical research

Analytical research focusses at comprehending the research issues, recognizing and measuring any underlying relationships among diverse variables, and answering questions with solutions. Therefore, analytical research continues on from descriptive research and drives further than the simple description of the research issue. This study embraces an analytical component as a critical element of the capital budgeting decision process.

3.3.4. Predictive research

Predictive research is more sophisticated than the above research types. It focusses at predicting the possibility of an outcome occurring by using gathered empirical evidence, developed theories and formulated and tested hypotheses (Islam & Mak, 2006). This thesis encompasses a predictive component in way of forecasting and analysing firms' efficient allocation of resources/investments to appropriate sets of capital projects.

Consequently, the research methods used in this study comprises a combination of all four types of research as discussed above.

3.3.5. Case study research

Generally, case study methodology is applied in social science research and typically limited to a single unit of analysis, such as a company, a project, a country or any specific single unit (Smith, 2017). Case studies focus on a few problems that are critical to acknowledging the significance of the area or event under study and secure the majority of the details via application of multiple sources of data. This method use approximations when an in-depth and longitudinal investigation is required (Feagin et al., 1991). Internal and external factors are important inputs for case study research and they need to be taken into consideration to capture their impact on the desired objective (Ryan et al., 2002).

Case studies may be descriptive, explanatory or exploratory. Descriptive case studies require a descriptive theory to be established prior to the study. Explanatory cases are frequently applied to find an underlying relationship in a real life context, and exploratory case studies are usually used in social science research (Stake, 1995).

3.3.6. The research approach of this study

Quantitative research encompasses the collection and analyses of quantified data, which has a focus on testing theories that include a logical relationship between the theory and research (Bryman & Bell, 2015). The key aim of this research was to, firstly, estimate a suitable discount rate for capital budgeting, taking into consideration agency costs and accounting issues, and secondly, to develop a joint optimisation model incorporating a game theoretic approach. This could then be used to mitigate the agency problems that arise from asymmetric information between principals and agents.

The maximisation of NPV is a well-researched area in capital budgeting. However, the impact of interdisciplinary research that incorporates a choice of suitable discount rate, accounting methods and practices, agency theory, game theory and a mechanism design framework for optimal capital budgeting has not been researched in-depth. Hence, this thesis selected the case study methodology as appropriate for exploring the effect of integrated disciplines in

both the case studies: Wal-Mart and World Airways. Moreover, a descriptive research method was adopted in these two case studies, with evaluation of in-depth descriptions of the organisations, the conditions and the need for the cases, descriptions of the people involved, and in general, society and its cultural norms, morals, and motives.

3.4. Theoretical foundations for developing the financial model

The financial model developed in this study is primarily based on the theoretical foundations of accounting and principal-agent game theory within the capital budgeting and mechanism design framework. These are discussed in the following sub-sections.

3.4.1. Accounting foundations and governance role

This study proposes an accounting-based financial model that was developed using accounting principles and practices. It also examines their significance of those principles and practices for good corporate governance. Reliable accounting information is vital for designing an optimal contract mechanism that can mitigate agency problems, ensure sound corporate governance and, in turn, provide better company performance and increase shareholder wealth (Bushman & Smith, 2003). Risk management is another important element in helping to achieve reliable accounting information.

Accounting information makes a significant contribution to achieving good corporate governance practices. Nevertheless, since accounting information is produced by accounting systems, the numbers produced may contain accounting inaccuracies that managers cannot control, or possible earnings management as dictated by agency theory that can impact on contract efficiency (Scott, 2015). Thus, it is essential for managers to evaluate and improve the quality of accounting information.

The most efficient form of corporate governance for a specific organisation depends on various factors, including its legal and institutional environment, its available technology, and the magnitude of competition in the industry (Scott, 2015). Efficient contracting is a significant component of efficient corporate

governance. Financial accounting can contribute to efficient contracting and efficient corporate governance, as key contracts depend on accounting variables.

Empirical research has reported evidence of both efficient contracting and opportunistic managerial behaviour existing in the real world of accounting, which represent a failure of corporate governance. However, evidence of efficient contracting suggests that it is possible to align manager interests with principal/owner interests via incentive control mechanisms that ultimately lead to maximising firm wealth (Scott, 2015).

3.4.2. Risk management

There is growing evidence that agency costs could lead to significant company risks (Bernado et al., 2001; Seits & Ellison, 2005). Currently, there is a shift from focusing on the prevention of fraud to prevention of overly risky bad management. One way of mitigating management acting in its own interests is to make a portion of its compensation dependent on the company's profits. When managers have a larger stake in the company's equity, the incentives for management and shareholders become better aligned. In other words, managers become shareholders (Daelen et al., 2010).

In contrast, an outrageous compensation system does show that bonuses also have a downside and are even considered as one of the underlying problems that contributed to the global financial crisis, as these bonuses provide management with incentives to engage in practices that increase the company's risks. Incentives can tempt management to take huge risks, even to engage in fraudulent behaviour, if it drives up reported corporate income and thereby secures tremendous pay increases for managers (Daelen et al., 2010). Hence, designing an optimal incentive contract to mitigate these types of risk is critical in risk management and accounting practices.

In some cases, hedging can be used to monitor and motivate managers in order to mitigate agency costs (Brealey et al., 2014). Risk is an integral part of many capital investment decisions. Managers seek to measure, control, and consider the selection of capital projects. Risks can be viewed from many perspectives, such as a single project perspective, company portfolio perspective, and a diversified-shareholder perspective (Levary & Seitz, 1990). In this study, risk is

considered from the total project risk perspective. The proposed discount rate estimation model considers project-specific risks rather than firm-wide risks. The adopted mechanism design model in this study incorporates risk management in various aspects. Generally, the final outcome of managing different types of risk in an organisation is to fulfil the company objective of maximising NPV (Kalyebara & Islam, 2014).

The next section examines the new directions in accounting research that impact the research methods used in this study.

3.5. New directions in accounting research

New directions in accounting research have influenced the capital investment decisions. According to Wolk et al. (2004), one new direction in accounting research focuses on the decision model approach that justifies the move from purely normative research towards normative deductive research. The model focuses on relevant information that is required for making decisions rather than on the users of accounting information dictating what they need. Value has been added to accounting research through the decision model approach, as well as the capital market approach, behavioural approach, agency theory, game theory, contract theory and critical accounting issues (Wolk et al, 2004). The decision model approach is similar to accounting standards approach in terms of the issues and concerns, but without the politics of regulatory processes.

The search for basic accounting concepts and the underlying truth on which the practice of accounting must be based, has been seen as a mode to enhance accounting practice by minimising irregularities in the adoption of accounting policies within organisations. This would also enable accounting for new reporting challenges to be deducted from basic principles instead of developing in an ad hoc and inconsistent manner (Scott, 2015). After major company failures in the US, particularly Enron and WorldCom, accounting research activities have shifted to another level. Scott (2015) argued that accounting standard setters moved quickly to restore public confidence, by tightening the rules and developing new standards to improve the quality of accounting statements.

Scott (2015) stated that there are two complementary means in which the role of accounting research can be assessed. The primary one is to consider its effects on accounting practices, which fundamentally means that investors must be supplied with relevant information to assistance them form sound investment decisions. Moreover, the theory has been exposed to wide empirical testing, which has founded that, typically investors use financial accounting information significantly as the theory predicted. The second view of the role of research is as a means of improving understanding of the accounting environment. For instance, fundamental research into models of conflict resolution, in particular agency theory models that include executive compensation plans to motivate and control managers, has improved the understanding of managers' interests in financial reporting, accounting policy choice and the motives to manipulate reported net income and profitability.

Moreover, it is vital to realise that there is a social aspect to integrity and independence, in addition to such things as rules, and audit clearance and certification. Hence, the ethical behaviour of managers, accountants and auditors is also necessary for restoring and maintaining public confidence in financial reporting. In the case of the US company collapses, for example, many accountants were engaged in, or at best knew concerning the various reporting irregularities (Scott, 2015). Ethical behaviour means that managers, accountants and auditors should behave with integrity and independence in considering the public interest in front of employer and client interests.

3.6. Emerging dominant issues in accounting: Accounting measurement methods

There are two measurement bases available that are recognised by accounting bodies, including the International Accounting Standards Board (IASB). The first is cost-based, referred to as historical cost. The second is value-based, commonly referred to as current value or market fair value. According to the IASB definition, historical cost is the amount of cash or cash equivalents paid or the fair value of the consideration given to acquire them at the time of their acquisition. Value based measurement broadly reflects the fair value.

The measurement method selected for assets and liabilities has obvious impacts for the value of income and expenses reported in financial reports, as changes in assets and liabilities affect the reported income, expense and equity. Historical cost is the primary basis of accounting methods, particularly for asset and liability classes that are key elements for reporting financial position (the balance sheet), such as capital assets, inventories and long-term debts. Generally, asset value can be written down if assets are impaired based on an impairment test, also called the ceiling test. Accounting standard (IFRS) also allow capital assets to be written up over cost if their value has increased.

Standard setters have moved towards current value as an alternative to historic cost accounting, arguing that fair value based accounting reports provide more reliable information about managerial stewardship. However, in practice, a mixed measurement system is often in place, as both historical cost and current value methods have pros and cons (Scott, 2015).

The current value method can be grouped into two categories. The first is **value-in-use**, such as the present value of future cash flows. The second is **fair value**, likewise called exit price or opportunity cost. **Net realisable value** and **settlement value** are also included in the value-based measurement category. Nevertheless, generally, current value terminology is used instead of these classification (Scott, 2015). According to the model presented by Allen and Carletti (2008), historical cost accounting is socially preferred to fair value accounting, since it avoids the possibility of financial contagion between the industries when they hold similar assets in common. Additional details are provided in Appendix I.

3.7. Accounting information and choice of discount rate

Accounting information helps managers make sound business decisions, particularly capital investment decisions. Consequently, it plays an important role in an organisation's strategic decisions. Moreover, accounting information influence on organisation's economic performance, corporate governance policies and share price.

Liquidity risk can be a significant contributor to the cost of capital, referred to as the discount rate, particularly in times of severe market downturns. Acharya and

Pedersen (2005) defined liquidity risk as the uncertainty about the buying or selling cost of securities and extended the CAPM model to establish the conditions under which cost of capital increases for firms with high liquidity risk. Quality and credible financial statements increases the value of organisation specific public information and hence helps reduce information asymmetry, resulting in share price of a company being less sensitive to changes in market instability. In other words, quality financial reporting helps to reduce the liquidity risk and consequently reduces the adverse effects of liquidity risk on the cost of capital (Scott, 2015).

Estimating an appropriate discount rate for capital budgeting decision making is very challenging task for many firms, as diverse types of cash flow require different discount rates. Moreover, the risk level of projects and firms, various interest rates, inflation and regulatory and social elements further complicate the determination of suitable discount rates. These issues are discussed in the next sections.

3.7.1. Cash flow and discount rate

The DCF method is normally applied to estimate the present value by discounting the projected cash flows of an investment using the risk adjusted discount rate (Ho & Lee, 2004; Ross et al., 2011). Thus, cash flows and the discount rate are the essential inputs for the DCF method that determine the NPV of investment projects. However, both of these inputs are estimates based on sustainable assumptions using past experience and expectations. Hence, accurate estimation of cash flows and the discount rate are critical for sound and efficient capital investment decisions. In particular, a slight variation in discount rate estimation could lead to a substantial impact on NPV, to incorrect selection of projects, and reduction in shareholder wealth.

Investment project cash flows can be discounted by applying equity cost of capital, debt cost of capital or a combination of both equity and debt. Generally, equity and debt are used to fund the projects; hence, free cash flows generated from operations of the relevant projects are discounted by WACC. Table 3.1 specifies the various forms of cash flow and suitable discount rates relevant to each category of cash flow when undertaking NPV calculation.

Table 3.1: Cash flow types and relevant discount rates

Cash flows	Suitable discount rate
Free cash flow (FCF)	WACC combination of equity and debt (*K)*
Equity cash flow (ECF)	Required rate on equity (*Ke*)
Debt cash flow (DCF)	Required rate on debt (*Kd*)

Source: Fernandez 2007 (slightly altered)

3.7.2. The WACC

A firm's WACC, *k*, is computed as a weighted average of the cost of debt capital, *kd, and cost of equity capital, ke,* using the weights determined by the value of debt and equity in the capital structure. Accordingly, the WACC (*k*) formula can be exhibited as follows:

$$K = kd(1-t)\frac{D}{(D+E)} + ke\frac{E}{(D+E)} \qquad (3.1)$$

where:

K = WACC

kd = cost of debt

ke = cost of equity

t = rate of corporate tax

D = market value of debt

E = market value of equity

The debt component reflects the weighted cost of debt, (*D / (D+E)*) *kd* and is multiplied by (1 – *t*) in order to incorporate the tax saving that is typically allowed as tax deductable expenses for debt financing in many countries, including Australia.

It clearly shows that the cost of capital is determined by the cost of debt capital, the cost of equity capital and the debt/equity ratio. These determining components are generally affected by several factors, including the size of the company, availability of international capital, international diversification, and exposure to foreign exchange and country risks (Moosa, 2002).

3.7.3. The cost of debt capital

The cost of debt capital is typically estimated using the risk free rate and the risk premium as indicated below:

$$kd = i + p \quad (3.2)$$

where:

i = risk free rate

p = risk premium

The risk premium is determined by the quality of the borrower, where quality is an inverse function of the risk of default. The cost of debt capital can vary from country to country based on the variation in risk free rate and/or risk premium. These variations generally occur due to a number of factors that change the supply and demand of funds available for loan and influence the level of interest rate. Some of the major factors are listed below (Brealey, 2014; Ogier, 2004):

- State of the economy, booming and slump.
- Inflation.
- Monetary policy.
- Tax laws.
- Demographic factors.

The risk premium is to protect the debt providers from the risk of default by the borrower. Generally, this risk differs among countries based on economic conditions, relationships between firms and debt providers (e.g. banks), government and regulatory intervention, and the degree of financial leverage. Countries with stable economic conditions tend to have lower risk premium (Moosa, 2002). These factors are considered in the discount rate estimation model in Chapter 4.

3.7.4. The cost of equity capital

The cost of equity capital, *ke*, is the expected rate of return on a firm's stock in the equity market, based on the opportunity cost of forgoing investment in other

stocks with the same risk (Pratt et al., 2014). In addition to business risk, the debt/equity ratio also impacts the cost of capital as the level of financial leverage impacts the risk of equity.

The cost of equity capital can be calculated by using the price/earnings (P/E) ratio to a given stream of income. The P/E ratio echoes the stock price of a firm relation to its performance. The higher the P/E ratio, the higher the stock price and, hence, the lower the cost of equity capital. The most popular way to estimate the cost of equity capital is by applying the CAPM (Brealey et al., 2014; Bishop et al., 2004). The CAPM formula to determine the equity cost of capital is as follows:

$$ke = i + \beta(km - i) \qquad (3.3)$$

where:

i = risk free rate

km = market rate of return

The market is represented by a stock price index, and

β = beta of the stock, measuring the correlation between the stock price and the market risk.

3.7.5. The debt/equity ratio – Capital structure

Selecting the capital structure denotes the selection of a debt/equity ratio. Generally, debt is useful for a firm as interest expenses are tax deductable. However, high level debt creates the impression that the firm is financially at risk, which increases the cost of equity. Firms usually aim for an optimal debt/equity ratio that minimises the cost of capital and thus maximises its value.

The following three characteristics impact the capital structure: stability of cash-flow; credit risk; and access to retained earnings.

Organisations that have stable cash flows are able to borrow more loans as they have enough cash available to pay the interest without defaulting. Some firms diversify their business across countries to attain more stability of cash flows. Thus, globally diversified firms generally tend to have stable cash flows, more debt intensive capital structures and higher debt/equity ratios. Similarly, firms with

less credit risk tend to have more debt intensive capital structures. In contrast, firms that are more profitable can finance their investments use the retained earnings, and hence form equity intensive capital structures.

3.7.6. WACC combined equations

The WACC equation developed by combining the above equations (3.1), (3.2), and (3.3) is as follows:

$$k = (i + p)(1 - t)\frac{D}{(D+E)} + \frac{E}{(D+E)}[i + \beta(\mathrm{km} - \mathrm{i})] \qquad (3.4)$$

This WACC depends on the debt/equity ratio, the risk premium, the tax rate, the beta, the market rate of return and the risk free rate. The risk free rate is a critical element as it affects the cost of capital via more than one channel. Thus, any slight error in the risk free rate calculation will lead to a considerable impact on the cost of capital, leading to a major distortion.

The next section discusses the WACC estimation model to determine a suitable discount rate for project appraisal.

3.7.7. Discount rate and accounting issues

In the WACC model, different variables are adopted to estimate the numerical value of the suitable discount rate (Brent 1990). As discussed in previous sections, a firm's WACC, *k*, is estimated using the weights of the cost of debt capital, *kd,* and equity capital*, ke.* The weights are determined by the ratios of debt and equity values in the capital structure of the balance sheet. Hence, accurate accounting reporting on an organisation's debt and equity is vital for correct estimation of a suitable discount rate.

The major accounting issue that needs to be highlighted here is the accounting measurement. As already discussed, two measurement methods are generally used in accounting reporting: historical cost and current value. The historical costs method is based on actual transaction values that can be evidenced and verified, thus not exposed to dispute. However, it does not indicate the true market value and hence must be supplemented by additional rules to ensure that the carrying value of the asset that appears in the balance sheet, does not exceed the future economic benefits that the entity expects to derive from the asset. On

the other hand, market value reflects the recoverable amount of an asset. Hence, weights to calculate the WACC must be measured at market value.

Moreover, accounting professional bodies have moved towards current value instead of historic cost accounting, arguing that fair value based accounting reports provide more reliable information (Scott, 2015).

3.8. Discount rate estimation model

As noted in Chapter 2, according to Pratt and Grabowski (2014), cost of capital is the appropriate measure of the discount rate. One of the major tools that is widely adopted to estimate the discount rate is the WACC model. In practice, WACC is used by a majority of companies to estimate the discount rate (Jegannathan et al., 2016). Many firms commonly use WACC to obtain the discount rate to evaluate their investment projects since it is simple and easy to estimate (Pratt & Grabowski, 2014).

This study adopted the WACC to estimate the suitable discount rate for capital budgeting using the following combined equation model, as shown in the previous section.

$$k = (i + p)(1 - t)\frac{D}{(D+E)} + \frac{E}{(D+E)}[i + \beta(\mathrm{km} - \mathrm{i})] \qquad (3.5)$$

where:

k = WACC

i = risk free rate

km = market rate of return

β = beta of the stock

D = debt

E = equity

t = company tax rate

p = risk premium.

The following six-column table shown in Table 3.2 is the easiest step by step method commonly used as the basis of calculating the WACC.

Table 3.2: WACC Table

Source of capital	Funds at market value	Weights	Cost of capital before tax	Cost of capital after tax	WACC
Ordinary shares (equity)	5,000	42%	10%	10%	4.2%
Preference shares	2,500	21%	15%	15%	3.1%
Debentures (debt)	2,000	17%	25%	17.5%	2.9%
Bank loan (debt)	1,500	13%	15%	10.5%	1.3%
Bonds (debt)	1,000	8%	30%	21%	1.8%
Total	**12,000**	**100%**			**13.3%**

***Note**: The numbers provided are not real and are for illustration purposes only. A corporate tax rate of 30% is assumed.*

The above example shows a WACC estimation of 13.3%. A real life calculation is more complex than this for many reasons, particularly because of complexities with the debt components, as many firms have a variety of debts in their capital structure.

This model was used as a base to build a new improved model to calculate suitable discount rate, which is discussed in Chapter 4. In this model, different variables are adopted to estimate the numerical value of the suitable discount rate (Brent, 1990). In addition to the usual WACC components, such as cost of debt, cost of equity, and debt/equity ratio, the proposed new discount rate model will consider several types of risk. For example, bank risk, foreign exchange risk and country risk. It will also consider interest rates, OCC, project life, the nature of mutually exclusive projects, inflation, taxation, agency costs, sensitivity analysis and accounting methods and policies.

Moreover, together with the development of the discount rate estimation model, project-specific risks, the impact of accounting principles and issues, agency theory and principal-agent game are also discussed in Chapter 4. This will lead

to a discussion of the optimisation game theory model for mechanism design in capital budgeting in Chapter 5.

The next section discusses the framework of mechanism design applied in this study.

3.9. Game theory in capital budgeting

A game theory model involves the interaction between two or more players and has many practical applications (Scott, 2015). It predicts the outcome of games based on the rules of the game and the information available to the players.

Game theory can be classified into two groups: non-cooperative game and cooperative game, and their applications in capital budgeting are discussed in the following sections.

3.9.1. Non-cooperative game

In a non-cooperative game, there is no binding agreement between the players. This is evident in a principal-agent game in capital budgeting when the owner/principal desires all relevant and reliable information about projects to make appropriate capital investment decisions and the manager/agent does not wish to reveal information about the projects under evaluation. Both parties are aware of the other's strategies and possible reactions. In this case, the manager has the choice of two strategies, either make an honest effort or behave opportunistically to maximise his/her benefits. The owner can choose to either accept or reject the project. Table 3.3 shows the utility payoffs of each player, with hypothetical values used for illustration purposes.

Table 3.3: Capital budgeting decision payoff

		Manager	
		Honest Effort	**Opportunistic**
Owner	**Accept**	100, 60	40, 100
	Reject	50, 15	50, 40

The strategy pair chosen in this scenario will not be ‘reject’/‘honest effort’ or ‘accept’/‘opportunistic’ due to the fact that each player has complete information about the other and knows their respective strategies and payoffs. Furthermore, if the manager chooses to be ‘opportunistic’, the owner would not choose to ‘accept’ as the owner would receive a higher utility with ‘reject’. Also, if the manager chooses to put in ‘honest effort’, the owner would not choose to ‘reject’, as the owner would receive higher utility with ‘accept’. Thus, in this case, ‘reject’/‘opportunistic’ is the strategy pair likely to be chosen, although the ‘accept’/‘honest effort’ pair would provide each player higher utility. This is because given the other player’s strategy, each player is content with their decision. This outcome is generally referred to as a Nash equilibrium (Scott, 2015).

The aim of this study is to convert this situation into a cooperative game environment in order to align both the principal’s and agents’ interests and thereby maximise company wealth.

3.9.2. Cooperative game

The main strategy in capital budgeting is to convert the non-cooperative game into a cooperative game, a situation in which there is a binding agreement between players. This would then motivate a rational manager to act on behalf of shareholders. Under this arrangement, the greater effort exerted by the manager, the greater the possibility of a higher payoff, and vice versa. In order to achieve this, the owner must design an incentive contract and monitoring to control moral hazard that arises in principal-agent game (Gul, 2007). The types of contract design are discussed in the next section.

3.9.2.1 Incentive contract to control agency problems

The commonly used contract design methods and their effects in controlling agency problems within a principal-agent game are discussed below (adapted from Scott, 2015).

Hire the manager and accommodate shirking: Obviously this is not a preferred option as this will not maximise the owners’ interests and would ultimately

increase agency costs. Hence owners usually adopt other techniques to maximise their interests.

Direct monitoring: Under such a contract, a manager will receive his/her normal wage if he/she puts in more effort, and will receive a reduced wage if he/she puts in less effort. However, implementation of such a contract is not practical as it is hard to measure the effort of managers due to information asymmetry. The manager knows his/her effort level, of which the owner may have no knowledge. This type of contract is referred to as a first-best contract, as the owner gains the maximum utility and the manager gains the reservation utility for participation.

Indirect monitoring: This type of contract involves the issue of performance-based pay versus fixed pay. Under performance-based pay, payoffs are based on the manager's efforts, whereas under the fixed pay system, payoffs stay the same irrespective of the actions taken by the manager. Implementation of performance-based pay is not practical in many countries, including Australia, as financially penalising the manager based on action taken is against the law. Most contracts are based on fixed wages to comply with legal requirements, hence the implementation of a performance-based pay system is not practical.

Rent the firm to the manager: This arrangement is usually called internalising the manager's decision problem. Under this arrangement, the manager provides the owner with an agreed fixed rental payment. Thus, there is no need for the owner to monitor the manager's actions, as he/she receives a fixed percentage of the potential payoffs and the manager's responsibility is to perform better to increase his/her benefits. This arrangement may create more opportunity for managerial opportunistic behaviour, leading to high agency costs due to information asymmetry. Hence it is an inefficient option.

A share of the payoff to the manager: Under this arrangement, a percentage of the payoff is provided to the manager to motivate him/her to put in more effort and thus increase the owner's interests. This is also known as incentive compatibility. This option would help minimise agency costs and share the risk between owner and manager. Generally, the measure of performance can be an accounting outcome, net income and/or share price. Thus this arrangement imposes a heavy responsibility on the quality of accounting reports. This type of

contract is referred to as the second-best contract and it is the most efficient contract to mitigate agency problems. It is discussed further in the next section.

3.9.2.2 Incentive problem and efficient contracting

Incentive problems occur when parties to financial contracts cannot easily observe the obligations as agreed upon in those contracts, generally referred to as incomplete contracts (Froot, 1995). There are two ways in which incentive problems impact investment policy. Firstly, in the absence of incentives attached to projects, managers can use high discount rates above traditional levels to calculate NPV in order to choose projects that increase their interest. This may lead to **under investment**. Secondly, under an information asymmetric condition, when managers are not compensated according to company value but their wages and reputations grow with the size of projects, this might lead to **over investment**. This might be particularly severe when firms have large amounts of free cash flow. Thus the correct design of efficient incentive contract mechanisms is crucial for a firm's investment policy to maximise shareholder value.

Empirical research has reported evidence of both efficient contracting and opportunistic managerial behaviour the real world of accounting. This represents a failure of corporate governance. However, evidence of efficient contracting suggests that it is possible to align managers' interests with owners' interests via incentive control mechanisms that ultimately lead to maximising firm wealth (Scott, 2015). This is discussed in detail in Chapter 5.

3.10. Mechanism design and a game theoretic framework for mitigating agency problems

The key approach to develop the model in this study is the game theory based within mechanism design to mitigate agency problems. Research studies indicates that game theory has been identified as an effective tool to make strategic decisions in organisations and settle the payoffs of effective decisions (Allen et al., 2013; Cachon & Netessine, 2006). Game theory has been defined as a strategic tool that can be used in a competitive environment and it includes several partners whose actions and decisions affect one another and who are working towards their own interests (Samuelson & Marks, 2015). Many studies

have embraced game theoretic approaches and reached solutions for productions such as information asymmetry, coordination among partners, revenue sharing strategies and the like (Lei et al., 2015; Fiestras-Janeiro et al., 2011; Zhao et al., 2010; Arshinder et al., 2008).

Agency problems arise due to information asymmetry between principals and agents whose actions and decisions affect one another. In this settings game theory plays a key role as an effective tool to optimise those actions and decisions to maximise both parties' interests. Hence, developing a game theoretic based model is highly appropriate within a mechanism design framework and solve as an optimisation problem for efficient capital budgeting decisions and accounting practices.

Several control mechanisms can be imposed to align the interests of shareholders and managers to mitigate agency problems, including mechanisms such as payment by efforts, payment by results, direct monitoring, efficiency wages and bonding. Some scholars have claimed that results based payment is the most optimal device to motivate managers by making them fully responsible for the consequences for their actions (Scott, 2015; Molho, 2001).

Game theory, particularly the CGT, can be integrated more with recent developments in welfare economics, such as the capability approach, the role of ethics, etc. It should be noted that agency theory has its detractors, such as Fama (1980), who stated that the value of a manager's human capital will be affected by the quality of management provided. In other words, if a manager changes jobs, the salary that manager can obtain will depend on previously observed work. The discipline of the labour market depends firstly on the quality of the manager's work being observable, and secondly on the manager being submitted to the discipline of the labour market (Seits & Ellison, 2005).

In summary, in a principal-agent game relationship it is important that the principal develops relevant mechanisms to force the agent to exert an optimal level of effort and reveal any private information truthfully to the principal. This will maximise both parties' interests.

The next section discusses the techniques used to determine the optimal solution to make sound capital budgeting decisions.

3.10.1. Mathematical programming and capital budgeting optimisation

Several methods can be used to obtain optimal solutions for a problem and to enhance the efficiency of decision making processes in a firm. The most commonly applied techniques are linear (and non-linear) programming optimisation, stochastic programming, Monte Carlo simulation, expert systems, the Markov decision process, Data Environment Analysis (DEA), neural networks, and the analytic hierarchy process. However, the optimisation or mathematical programming is considered an advanced analytical technique to obtain the optimal way of allocating limited resources in order to attain the objectives of an individual or a business (Ragsdale, 2018). In practice, the optimisation method is widely applied in business to maximise profits or minimise costs, particularly in capital budgeting to maximise the NPV of investment projects.

Capital budgeting involves evaluating a portfolio of projects, which simultaneously satisfy all constraints on the problem setting, and selecting the right set of projects to maximise the aggregate NPV and increase firm wealth. Mathematical models are powerful in that they are optimisation techniques and can be used to provide an accurate representation for virtually any real life problem setting, particularly in facilitating the decision making process in capital budgeting (Clark, 1989). The typical basic expression of the capital rationing problem, applying the linear programming model that incorporates the objective function and constraints, is shown as follows:

Optimisation model–The capital rationing problem (Source: Clark, 1989)

$$maximise\ NPV = \sum_{j=1}^{N} b_j x_j \tag{3.6}$$

subject to:

$$\sum_{j=1}^{N} c_{jt} x_j \ \leq k_t \quad t = 1, 2, \ldots\ldots\ldots, T \tag{3.7}$$

$$x_j \ \leq 1 \tag{3.8}$$

This is to show an upper limit for each project; that is, it is required that each project have a maximum value of 1 or that is accepted 100%.

$$x_j \geq 0 \qquad (3.9)$$

This is to show each project is non-negative, where:

b_j= NPV of project *j* over its useful life

$$b_j = \sum_{t=0}^{T} NCF_t \frac{1}{(1+r)^t}$$

where:

NCF_t = net cash flow in period *t*, where t =1, 2, 3,,….n

r = the discount rate = WACC is used as the discount rate

n = the project's estimated life.

x_j = percent of project *j* that is accepted

c_{jt} = cash outflow required by project *j* in year *t*

k_t = budget availability in year *t*

N = the number of projects under evaluation

This formulation merely states that a firm should select the set of projects that maximises the NPV without violating any of the budget constraints. Major variables of the model are various investment projects that are earmarked for selection.

This capital budgeting modelling principle, together with the mechanism design and principal-agent game theory (discussed in the next section), are used to develop the joint optimisation game theory model based mechanism for the capital budgeting case study, as discussed later in Chapter 5.

3.10.2. A new financial model for mechanism design

An optimisation model is incorporated into this research as a mechanism in order to resolve the issues of asymmetric information and agency problems. The model

illustrates incentive contracts between managers and shareholders that align the interests of both parties, and thus reduce agency costs and generate sound capital budgeting decisions. A linear programming model for capital budgeting was used for this task. Linear programming is a very powerful instrument that can be used in many business conditions (Ragsdale, 2015). The model allows for flexibility in estimating the target value for the decision variables, which is a significant features in decision making, especially for capital budgeting decisions. NPV is usually considered as a proxy for measuring shareholder value. World Airways was selected as the case study used to examine the effects/benefits of the model, discussed in chapter 5.

The objective functions of the proposed new model are to specify the maximisation of the NPV and minimise agency costs. Relevant constraints were determined from areas such as the discount rate, accounting methods and regulations, corporate governance, and agency costs. The suitable discount rate principle, which will be discussed in Chapter 4, was adopted in the optimisation model. Also adopted were accounting constraints related to the system that accommodates the objective of financial reporting for decision making and ensures correct accounting practices. The agency cost constraints represent the incentives contract among the stakeholders of the company, to ensure that the essential mechanisms for reaching good corporate governance and long-term financial sustainability are in place. The corporate governance constraints relate to the management's policies. These protect all stakeholders for the long-term optimal allocation of the company's resources to maximise the financial outcome and to optimally manage the diversified risks.

3.11. Case study and data sources

As stated in Section 3.3, the selected case study approach had elements of all four types of research method as it involved a detailed description of the organisations being appraised.

Two case studies were used in this study. Firstly, the Wal-Mart case study was used to develop a project-specific discount rate model, which is discussed in Chapter 4. This is a US-based company and all the required data were provided in Seitz and Ellison (2005). Secondly, the hypothetical World Airways case study

analysed by Levary and Seitz (1990) was used to develop a new capital budgeting optimisation model, incorporating the principal-agent game, agency costs and accounting issues within the mechanism design framework. This is discussed in Chapter 5. The proposed optimisation model will offer significant advantages over manually generated solutions.

3.11.1. Tools

As indicated earlier, Microsoft Excel spreadsheets were used in this study to estimate the discount rate, using WACC as a base model and Microsoft Excel Solver to resolve the optimisation problem model developed within the game theoretic mechanism design framework. Excel Solver is user friendly and it allows the inputting of several objectives and constraints into the program without any difficulties (Ragsdale, 2018).

3.11.2. Data collection

Data for different subjective and objective variables and parameters were required to estimate the discount rate and to develop the joint optimisation model to resolve agency problems. These data were obtained from published sources, mainly from the case study firms, Wal-Mart and World Airways. The data collected cover a five-year period. Other necessary data such as interest rates, tax rates and other relevant accounting and regulatory environments were obtained from various institutions, including the Reserve Bank of Australia (RBA), World Bank and other agencies. Some data that were not available from public sources were calculated and simulated based on reasonable assumptions from previous studies and historical data.

3.12. Conclusion

This chapter has presented the conceptual framework incorporating all the relevant factors for addressing the research problem. The strategic importance of this conceptual framework relates, firstly, to the development of a model to estimate a suitable discount rate for capital budgeting, incorporating agency problems and accounting practices. Secondly, the framework was designed to develop an optimisation game theory model within a mechanism design framework for efficient capital budgeting. As discussed, the interrelationships

between capital budgeting, DCF, discount rate, risk, agency costs, game theory, accounting quality and optimal shareholder value, became the basis of the conceptual framework.

This chapter has discussed the methodology used for estimation of a suitable discount rate and its importance for DCF estimation, which determines the NPV of capital investment projects. It has also examined the impact of accounting information, game theory, agency theory and information asymmetry on discount rate estimation. The development of a joint optimisation game theory model within a mechanism design framework for capital budgeting was also discussed.

Contemporary focusses in accounting research and accounting measurement have been examined, as well as their influence on capital investment decisions and research methodologies. These were then related to the selected case studies, with a discussion on the proposed use of Excel spreadsheets to estimate WACC-based discount rates for the Wal-Mart case study and Excel Solver for optimising multi-objectives and constraints in the World Airways case study.

The discussions in this chapter, together with those in Chapter 1 and Chapter 2, postulate the basis for the development and justification of both models: the discount rate estimation (discussed in the next Chapter 4); and the joint optimisation game theory model for mechanism design in capital budgeting (discussed in Chapter 5).

CHAPTER 4: CHOICE OF A SUITABLE DISCOUNT RATE FOR CAPITAL BUDGETING

4.1. Introduction

The aim of this chapter is to propose a suitable discount rate selection method that reflects the project-specific risks for capital budgeting in private sector firms. In this way, an appropriately estimated discount rate that is tailored to the risks of investment projects will lead to better allocation of a firm's capital, and sound investment decisions would maximise company wealth. The chapter also discusses the importance of accounting quality and agency problems, within the principal-agent game framework in discount rate estimation and capital project selections.

Estimating a suitable discount rate is complex in finance and accounting and very little is known about factors that determine the discount rates that firms use in capital budgeting (Jagannathan et al., 2016). Addressing the lack of information about such a key variable, this study presents an informed and defensible position regarding the discount rate issues built on the research findings of Martin & Titman (2008).

Accounting statements are widely used by internal and external users for various analyses, including capital budgeting and, more specifically, discount rate estimation. Therefore, the quality of accounting practices become more important for efficient capital budgeting. This is particularly important when complying with approved accounting standards and applying correct accounting methods, which ultimately could improve the capital budgeting decision making process (Warfield et al., 2008; Weygandt et al., 2010).

As discussed in the previous chapter, principals expect managers to choose appropriate discount rates for selecting the right set of profitable projects for long-term investments. However, in some instances, managers may arbitrarily choose discount rates to select an unprofitable set of projects in order to maximise their own interests. This creates agency costs (Gul, 2007). In such settings, the application of principal-agent game in capital budgeting to investigate agency problems is a worthy exercise (Mueller & Trost, 2018).

The remaining sections of this chapter discuss capital budgeting and discount rate concepts and issues. These issues relate to the interdisciplinary impacts of accounting methods, agency theory, game theory, risk management and corporate governance. The chapter also investigates the WACC-based discount rate, risk factors, corporate tax, inflation, CAPM and related issues, as well as the importance of accounting quality and principal-agent game. These issues are then analysed and an appropriate method developed for estimating project-specific discount rates using the Wal-Mart case study. These various discount rates are then applied to the two projects provided in the case study to analyse the outcome. Finally, this chapter discusses the implications and benefits of the WACC-based discount rate, accounting quality and game theory and highlights their potential applications and limitations.

4.2. Capital budgeting and the discount rate

One of the most important functions in accounting and finance is the evaluation of capital expenditures. The decisions involving these activities are known as capital budgeting decisions (Pachamanova & Fabozzi, 2010). Capital allocation is a crucial business function and most large firms use DCF methods, which take into account the time value of money. Among DCF techniques, the NPV method is more popular for evaluating investment projects, as this approach properly considers the time value of money and opportunity cost of investments, and sets against the risks of the particular investment project in hand (Jagannathan et al., 2016; Vesty et al., 2015; Truong et al., 2008; Ogier et al., 2004). The NPV analysis discounts the cash flows of future years to make them equivalent to those in the current year. Hence, the discount rate plays a major role in the choice of capital investments, and accurate estimation of the required return is therefore critical to sound capital budgeting (Levary & Seitz, 1990). According to Modigliani and Miller (1958), investment decisions are based on a risk adjusted or certainty equivalent yield with the market rate of interest.

A suitable discount rate for any capital project investment appraisal is the cost of capital for alternative investment projects of equivalent risk. Usually, the present value of each cash flow is calculated by using a discount rate that reflects the

weighted average cost of acquiring investment capital. This discount rate is often called the HR or minimum desired rate of return.

Most finance and accounting textbooks suggest that firms should evaluate capital projects using discount rates that reflect both debt capacity and the unique risks of the projects. Nevertheless, in practice, firms often use their firm-wide WACC to evaluate such projects, given the subjectivity involved in, and the difficulty of estimating, the individual project risk, and the potential for managerial bias and influence to distort the estimates (Martin & Titman, 2008). These are discussed further in later sections.

4.2.1. The WACC as the discount rate

Various methods can be adopted to determine the discount rate for capital budgeting. This includes cost of capital, cost of debt plus risk premium, cost of equity, WACC, current prime interest rate, and established rates based on similar projects carried out previously. However, economic theory suggests that the appropriate discount rate to use in capital budgeting is the firm's cost of capital, which is the opportunity cost of funds and generally referred to as the normal rate of return or the Hurdle Rate (HR) (Dayananda et al., 2002; Davidson et al., 1988). The Opportunity Cost of Capital (OCC) used for an investment is the income the owner could have earned if the funds were invested elsewhere. Thus, the term cost of capital means the minimum rate of return required by the owner of an asset to justify using the asset. Moreover, the appropriate cost of capital calculation should be based on the risk profile for the investment being analysed, not the cost of capital of the potential investor (Martin & Titman, 2008; Ogier et al., 2004).

Generally, firms measure the cost of capital by computing the cost of all of the liabilities and owners' equity on the balance sheet. This is the WACC that can be estimated by multiplying the cost of debt and cost of equity by their respective value needed by the firm. Cost of debt is usually the interest applicable to the debt in maturity, minus company tax, as interest expense is an allowable deduction, to arrive at the net income. Generally, cost of equity can be estimated using various methods, including current dividend yield, current dividend yield plus estimated growth, CAPM, cost of debt plus equity risk premium, market

return adjusted for risk, earnings/price ratio and an average of minimum returns expected by shareholders. However CAPM is the preferred method used by many firms to measure the cost of equity (Ogier et al., 2004; Bishop et al., 2004; Brealey et al., 2014).

Regulated capital markets could influence the cost of capital on borrowings by investors and firms to finance capital projects. Consequently, the cost of capital in capital markets impacts on the capital projects chosen by firms for investment (Kalyebara & Islam, 2014). When financial markets are in equilibrium, the RRR on assets can be determined from the cost of raising the funds used to acquire the assets (Davidson et al., 1988). Nevertheless, the cost of capital does not depend on the source of funds used to acquire those assets. It does depend on the risk characteristics of alternative investments; the risker the project, the higher the cost of capital.

4.2.2. Corporate tax and capital budgeting

Corporate taxes play an important role in the capital budgeting decisions of private sector firms. Since these firms are subject to corporate tax, after tax effects of the net cash flows must be determined for investment appraisal of projects under consideration. Furthermore, although depreciation is not a cash flow item, it is an allowable deduction for corporate tax calculation, thus it will reduce a firm's corporate tax payments and hence improve net cash flows. corporate tax is also an important element that must be considered when estimating the cost of debt. In other words, WACC must be developed on an after-tax basis. An example of calculating cost of debt after income tax is shown below.

$$K_d = K_{dbt}\,(1 - \ tax) \qquad (4.1)$$

where:

K_d = cost of debt after tax

K_{dbt} = cost of debt before tax, and

tax = firm's corporate tax rate.

4.2.3. Inflation and capital budgeting

Inflation is defined as the decline in the general purchasing power of the monetary unit (Horngren et al., 2014). As capital budgeting involves cash flows over several years, it is important to consider the impact of inflation in capital budgeting analysis. Inflation can be incorporated in a DCF analysis in two ways, using real value or using nominal value. A nominal value discount rate includes a premium for inflation, whereas a real value discount rate does not. Therefore, when undertaking capital budgeting analysis using a DCF method, one must use a combination of either a nominal discount rate with cash flows measured in nominal dollars, or a real value discount rate with cash flows measured in real dollar values. The example in Table 4.1 below illustrates the difference between a real value discount rate and a nominal value discount rate.

Table 4.1: Real and nominal discount rates

Risk free element	3%
The risk premium	5%
Real Discount Rate	**8%**
Inflation element	4%
Nominal Discount Rate	**12%**

Source: Hongren et al. (2014)

4.2.4. CAPM and capital budgeting

The CAPM is a good model for understanding the role of information in capital markets. Its assumption of diversified investors is consistent with many investment strategies (Scott, 2015). CAPM has some drawbacks and thus it has faced various criticisms. However, despite these concerns, it is widely used by many firms and analysts as an appropriate tool to estimate the cost of equity.

The risk premium, the beta, the market rate of return and the risk free rate are important elements to estimate the rate of return on equity using CAPM. The basic CAPM equation may be written as;

$$K_e = r_f + \beta(r_{m\_} r_f) \qquad (4.2)$$

where:

K_e = cost of equity

r_f = risk free rate

β = beta risk factor

r_m = expected market rate of return.

The risk free rate is a critical element as this affects cost of capital via more than one channel. Thus, any slight error in the estimation of the risk free rate will have a significant impact on the cost of capital, leading to a major distortion. The risk components generally reflect the economic risk, market risk and external risks faced by firms, such as country, political and exchange risks.

4.2.5. Risk management and capital budgeting

The recent financial scandals in the US brought internal control and risk management issues into the spotlight. These issues are currently high on the corporate agenda and have drawn the focus of academics, policymakers, lawmakers and practitioners (Daelen et al., 2010; Scott, 2015). Risk management is a very effective tool to encourage and protect firms' specific investments. In practice, forecast of cash flows are largely determined by assumptions, interpretation, local market etc., hence, there is inevitably scope for inaccuracy in the cash flow projections and hence impact on NPV outcome. There are various ways in which risk can be incorporated into the NPV computation and capital budgeting decision process, such as risk-adjusted discount rate, the certainty equivalent, sensitivity analysis, break-even analysis and simulation.

The history of risk management and accounting is a history of transparency, standardisation and attestation, which have been considered a means to reduce the risk of misappropriation of corporate funds, misstatement of financial reports, the risk of ineffective and inefficient controls and too risky strategies (Ven, 2010). In addition to standardising accounting practices, best practices in the form of business control frameworks, and rules and regulations, have prescribed and standardised internal control and risk management practices. Moreover, the need for independent attestation to assure the reliability of information has led to an increasing reliance on audits (Ven, 2010).

As indicated in Chapter 3, there has been a shift from focusing on the prevention of fraud to the prevention of overly risky management (Ven, 2010). There is growing evidence that agency costs, particularly in the form of too little capital investment by managers, are related to total firm risk (Bernado et al., 2001; Seits & Ellison, 2005). One way of mitigating the self-serving behaviour of managers is to make a portion of their compensation based on the company's profits. Daelen et al. (2010) argued that the incentives for managers and shareholders become well aligned when managers have a larger stake in the company's equity. In contrast, certain compensation systems show that bonuses have a downside, as they may provide management with incentives to engage in opportunistic behaviour that increase the company's risks. Bonuses can tempt managers to take huge risks, even engage in fraudulent behaviour, if those risks drive up reported corporate income and thereby secure tremendous pay increases for managers (Daelen et al., 2010). Hence, designing an optimal incentive contract to mitigate these types of risks becomes challenging in risk management and accounting practices.

Hedging is one risk management strategy aimed at minimising the financial volatilities of firms and thus helps to stabilise long-term profitability and expected cash flows. Most firms use derivatives for hedging, as hedging can reduce the total and systematic risk (Bartram et al., 2011). In some cases hedging can be used to monitor and motivate managers in order to mitigate agency costs (Brealey et al., 2014). According to Kaen (2005), hedging can effectively reduce agency costs and increase the market value of firms. Risk is an integral part of many capital investment decisions and hence managers seek to measure, control, and consider risk in the capital budgeting project selection process.

Although there are broad studies of, and empirical research into, risk management, a comprehensive integrated approach in accounting, business, finance, law and tax to risk management is essentially non-existent. The multidisciplinary approach of this study will bring insights into the overall influence of risk management on companies and on society as a whole, taking the corporate governance discussion to a higher level (Daelen et al., 2010). Moreover, the objective of modern organisations is that risk management is to be used not only to maximise shareholder wealth but also to ensure firms' survival

and continuity, and to recognise and support societal interests (Daelen et al., 2010)

4.2.6. Corporate governance and capital budgeting

Corporate governance is often described as a set of rules, guidance, structures and procedures by which a firm ensures that investors get an adequate return on their investment and managers do not misuse investors' funds (Kaen, 2005). The most efficient form of corporate governance for a particular firm depends on its legal and institutional environment, its technology, and the degree of competition in the industry (Scott, 2015). Good corporate governance practices ensure the achievement of economic benefits by making use of company resources more efficiently in areas of operating, investing and financing, thereby underpinning growth and increasing firm performance, leading to enhanced shareholder wealth (Brown & Caylor, 2009). Therefore, one of the most critical corporate governance principles is to ensure a positive return on investment. Efficient capital budgeting practices play a major role in achieving this task.

The three key components of capital budgeting that contain uncertainties around estimations are cash flow, project life and the discount rate. Thus, sensitivity analysis needs to be carried out on these three components to facilitate final capital investment decisions. In addition to sensitivity analysis, a range of techniques is frequently applied in practice to compensate for uncertainties in capital budgeting. The most sophisticated technique used is accounting for sustainability, which usually includes full cost accounting, LCA and costing, real options, multi-criteria analysis, decision trees and Monte Carlo simulations (Graham & Harvey, 2002; Vesty et al., 2015). These different approaches provide a more complete picture for capital budgeting decision makers and hence lead to good corporate governance.

One major concern in corporate governance is to find ways to solve or mitigate the opportunistic behaviour of managers that can have an impact on firm value. Thus, efficient contracting becomes important. Financial accounting can contribute to efficient contracting, as important contracts depend on accounting variables.

4.3. The importance of accounting quality for capital budgeting

Empirical studies advocate that higher financial reporting quality can improve investment efficiency. This is achieved by mitigating information asymmetries that give rise to conflicts such as moral hazard and adverse selection (Biddle et al., 2009; Lambert, 2007). WACC estimation substantially depends on accounting numbers, such as equity, various debt components, rate of returns, cash flow, tax, and depreciation. Therefore, the quality of accounting practices becomes more important and compliance with approved accounting standards is crucial for sound investment decisions.

4.3.1. Fair value accounting and historical cost accounting

Fair value accounting and historical cost accounting are relevant emerging issues in accounting that impact capital budgeting decisions. The definition of a fair value accounting measure is the price that would be received to sell an asset, or paid to transfer a liability, in an orderly transaction between market participants at the measurement date (IFRS 13). The assumption of an orderly transaction is important for fair value. This reflects an amount at which market participants would willingly exchange an item, rather than a liquidation or fire sale price that might be achieved in a forced sale if the vendor is under financial pressure. Although the IFRS does not prescribe the use of fair value, it establishes a hierarchy for the measurement of fair value when another standard prescribes or permits its use. According to Scott (2015), fair value is considered by many academics and practitioners to be more relevant than cost-based measures. However, the fair value measure has been criticised for several reasons that include social preference, lack of relevance to decision making and reliability problems.

4.3.2. Creative accounting, earnings management and responsibility accounting

Creative accounting practices can be defined as the steps used to play the financial numbers game. This includes the aggressive choice and application of accounting principles, fraudulent financial reporting, and any steps taken towards earnings management (Mulford & Comiskey, 2011). Deviations of reported statements of financial information from the actual business reality are defined as accounting distortions (Subramanyam & Wild, 2009). Hence, these accounting

deviations can be termed accounting risks, as they influence the quality of accounting information that play an essential role in business decision making. These distortions generally occur in an accrual accounting environment, in the form of incorrect applications of accounting standards, constraints in measurement and concepts, errors in estimation, and managerial bias referred to as earnings management activities.

Earnings management can be defined as the active manipulation of earnings towards a predetermined target set by management, thus leading to accounting distortions (Mulford & Comiskey, 2011; Zimmerman, 2011; Subramanyam & Wild, 2009). The major objective of managerial manipulation might be to increase manager incentives that are based on earnings. Changing accounting methods, estimates and/or policies are commonly related to revenue manipulations. Generally, revenue recognition, inventory valuation, provisions such as for bad debts, tax provisions, various accruals, and one-off charges (asset impairments, restructure etc.) are potentially exploited by managers for earnings management purposes. Therefore, firms need to be vigilant and put in place adequate control mechanisms to prevent the occurrence of earnings management. Such controls will help maintain accounting quality and hence sound capital budgeting decisions that lead to maximisation of shareholder wealth.

A responsibility accounting system is used to measure the operating results of sub-units within a firm, usually referred to as responsibility centres (Zimmerman, 2011). Generally, for responsibility accounting purposes, decision rights within a firm are grouped into three centres: cost, profit, and investment. Cost centres usually have decision rights over inputs for products and services. Thus these centres are evaluated based on cost minimisation for the set output or maximising output for budgeted costs. Profit centres have decision rights over input and pricing, that is expense and revenue. These centres are obviously evaluated by profits. Investment centres have all the decision rights, including the rights of cost centres and profit centres, and particularly on the value of capital invested by the centres. These centres are evaluated based on ROI and sometimes on residual income.

4.3.3. Accounting standard setting

The development of the discount rate, and the cost of capital applicable to assets and liabilities require an understanding of the relevant accounting standards and, specifically, the fair value framework contained in accounting standards and GAAP (Pratt & Grabowski, 2014). The fair values of assets and liabilities are potentially of greater interest to equity investors than historical costs since fair values provide the best available indication of future firm performance and investment returns. However, the unrealised gains and losses from adjusting the carrying values of assets and liabilities to current values, do not reflect managers' performance. Therefore accounting standard setters are required to play a moderator role between the investors and managers who have conflicting preferences (Scott, 2015).

Generally, accounting standards are developed based on rules or principles. Rules-based standards attempt to lay down rules in detail for application and how to account. In contrast, principles-based standards only lay down general principles, and rely on accountants' professional judgement to ensure that the application of the standards is not misleading. Rules-based standards use punishment as a powerful tool to prevent fraud. However, experience suggests that this is not always effective and the preferred option is to prevent misleading reporting before it emerges.

Professional accounting bodies have already introduced conceptual frameworks to encourage principles-based behaviour, through codes of professional conduct, discipline committees, and the process of standard setting. Hence, it appears that rules-based standards are not working and the world is moving towards principle-based standards (Scott, 2015).

4.3.4. The importance of ethical behaviour for accounting

Ethical behaviour by managers and accountants is also required to restore and maintain public confidence in financial reporting as numerous accountants were involved in various reporting irregularities at various situations (Scott, 2015). The prospects for survival and prosperity will be enhanced if accountants have a critical awareness of the longer-run impact of financial reporting on investors, managers, the economy and society.

As stated previously, one of the responses to the recent financial crisis and subsequent collapse of public confidence in financial reporting has been increased regulation, including new accounting standards. However, ethical behaviour by professionals is also required, since numerous accountants were directly or indirectly involved in the various reporting irregularities of the collapsed companies. It is also obvious that complying with GAAP alone is not sufficient to prevent financial reporting failures. Ethical behaviour means that managers and accounting professionals should do the right thing, they must behave with integrity and independence in placing the public interest ahead of other stakeholders, when these two interests conflict. This kind of social behaviour will lead to optimal capital investment decisions.

4.3.5. Agency theory and accounting

Agency theory, a branch of game theory, has been one of the most important theoretical paradigms in accounting in recent years. The primary feature of agency theory that has made it attractive to accounting researchers is that it allows to explicitly incorporate conflicts of interest, incentive problems, and mechanisms for controlling incentive problems into financial models (Lambert, 2007). This is an important feature, as most of the motivation for accounting has to do with the control of incentive problems. Lambert (2007) further stated that agency theory is used in accounting research to address the following two questions:

- How do features of information, accounting, and compensation systems affect incentive problems? and
- How does the existence of incentive problems affect the design and structure of information, accounting, and compensation systems?

The incentive and control mechanisms are the most effective features for efficient capital budgeting as they help the principal to mitigate conflicts of interest between shareholders and managers and work towards maximising firm wealth. Because of managerial opportunistic behaviour that lead to agency costs, firms set stringent rules and procedures that limit managerial flexibility. In order to implement this option, the principal needs to invest in various systems and control

designs to monitor the agent's actions. Investments in monitoring systems include information systems such as budgeting systems and accounting systems. This aspect is discussed further in the next section.

4.4. The principal-agent game in capital budgeting

When undertaking capital budgeting decisions in a firm, the owner/principal expects the managers/ agents to perform their best in order to maximise company wealth by selecting the right set of projects for long term investments. However, in practice, managers tend to work towards maximizing their interest when making capital budgeting decisions as contrast to the owner's interest of maximizing company wealth, which is referred as information asymmetry, where the agents have more information about the business than the principal (Gul, 2007 and Scott, 2015). This is also referred to as private information and unobservability (Molho, 2001).

Information asymmetry generates adverse selection and moral hazard and leads to undesirable outcomes. This creates a non-cooperative game environment, where the principal and agents move to divergent actions. For example, the principal can increase borrowings instead of using equity funds so that interest payments will reduce retained earnings, hence leaving little funding for managers. The principal can also pay more dividends to shareholders to reduce the retained earnings. On the other hand, as discussed previously, managers can choose inappropriate discount rates to select an unprofitable set of projects to maximise their own benefits. Managers also can misuse excess funds for empire-building purposes.

As indicated in Chapter 1, principals and agents may also have different risk preferences (Beatty & Zajac, 1994). Principals can diversify their investments across multiple projects, and hence they can be assumed to have a risk-neutral preference for the company's actions. On the other hand, the agents are most likely to prefer risk aversion in their decisions in order to minimise risks in relation to their personal interests. This might increase agency costs. These divergent actions create a game between principal/owner and agents/managers.

4.5. Discount rate selection

Generally, the value of an investment project depends on both its expected cash flows and the applied discount rate, which is a measure of risk. In practice, nevertheless, evidence shows that most firms use only a single discount rate to evaluate all their capital projects, a behaviour labelled the WACC fallacy, as discussed in Chapter 2. This represents the failure to account for project-specific risk, leading to inefficient capital budgeting decisions, particularly when a firm has to decide between distinct projects (Kruger et al., 2015).

4.5.1. Firm-wide discount rate

Investment projects can be funded by using equity capital only, debt only or a combination of both. Generally, projects are funded by a combination of both equity and debt and hence, free cash flows generated from the operations of relevant projects are discounted by WACC. One of the major tools that is widely adopted to estimate the discount rate is the WACC model which in practice is being used by a majority of companies to estimate the discount rate (Jegannathan et al., 2016 and Martin & Titman, 2008). Many firms commonly use because of its simplicity and ease of calculation (Pratt & Grabowski, 2014; Kalyebara & Islam 2014). Generally, government and government business organisations acquire funds for investments via special bond issues, and borrowings from financial institutions. Private sector organisations fund their investment projects through borrowings, issuing new shares, using invested funds and surplus free cash flows. Hence, the cost of capital should be a weighted average of the cost of funds from each of these sources.

In some cases, managers set discount rates that are too high when compared to the traditional WACC estimation. This usually occurs in large businesses where a high discount rate provides a form of capital rationing. Some firms use high discount rates as insurance against the uncertainty of future cash flow estimates. A high discount rate may also be used by senior managers to provide an incentive for divisional managers who undertake capital budgeting, to propose only those projects with very high returns (Langfield-Smith et al., 2003). Furthermore, in some circumstances, managers might apply higher or lower than the appropriate discount rate to choose projects that give positive cash flows in the early periods of the project's life, to maximise their short-term benefits. This can also protect

managers from poor corporate performance that could endanger their reputation and job security (Jagannathan et al., 2016), which aligns with managerial opportunistic behaviour as discussed in agency theory.

Although most of the literature on capital investment focuses on financial constraints to explain why firms forgo positive NPV projects by inflating discount rates above the WACC, research findings suggest that operational issues such as organisational and managerial bandwidth are more important for many firms (Jagannathan et al., 2016). In their study, Meier and Tarhan (2007) found that some firms appear not to adjust their discount rate with time frequency, while other firms use firm-wide discount rates even when they have multiple divisions or are evaluating risky projects. Both of these missteps might create under investment or over investment, which could potentially harm shareholder value. Hence, this study recommends the project-specific discount rate. This is discussed in the next section.

4.5.2. The proposed project-specific discount rate

The prevalence of the WACC fallacy among firms is consistent with managerial bounded rationality (Kruger, 2015). Thus, it should be emphasised that managers should discount a risky investment project using a project-specific risk adjusted discount rate and not the firm's cost of capital.

The project-specific discount rate is tailored to the risks of the investment project and would lead to an efficient allocation of the firm's capital and a better investment decision. Despite the benefits of applying a project-specific discount rate that reflects the project risk, for numerous reasons many firms use their company-wide WACC to evaluate all of their capital projects. The most probable reasons for this are, firstly, the use of multiple project-specific discount rates is complex and analytically challenging and the benefits of doing so have not been articulated well enough in practice and in the literature. Secondly, most firms believe that using project-specific discount rates may open up incentives for managerial opportunistic behaviour, agency problem and hence they prefer firm-wide single discount rates that might moderate the managerial bias (Martin & Titman, 2008). However, these agency problems can be reduced by applying a systematic and verifiable model to estimate project-specific discount rates.

Moreover, the determination of these project-specific discount rates should be tied to outside market forces that are not under the control of the manager.

This study proposes estimating the discount rate using WACC with unique risks associated with individual projects. Hence every project will have a unique project-specific discount rate for efficient capital budgeting and a better allocation of resources. The proposed project risk specific WACC based discount rate approach makes use of market information, in the form of project debt capacity and the firm-wide costs of debt and equity. This approach provides very little discretion to managers and hence limits the occurrence of managerial bias and influence in distorting the estimate. It provides a correct project-specific discount rate as a good approximation dictated by theory. This approach is in line with the study undertaken by Martin and Titman (2008).

The key component in the effectiveness of this method is the use of a project's debt capacity. This debt financing capacity is sourced to define the weights of capital structure in order to calculate the WACC as a discount rate for the specific project (Martin & Titman, 2008). Therefore the proposed method is simply a weighted average of the firm-wide cost of debt and equity and the weights are determined by debt capacity.

The key assumption in this analysis of project-specific WACC is that differences in project risk are fully reflected by accounting for differences in project debt capacity. This assumption is reasonable and suitable for the same line of business with the same risk factors and different cost structures and profit margins.

4.5.3. Debt Capacity

As previously discussed, manager's opportunistic behavioural problem, that is selection of lower discount rates to maximise their benefits, can be mitigated through a methodical and justifiable way to estimate the weighted average cost of capital. This study proposes that when project specific discount rates are applied, the determination of these discount rates should be dependent on outside market forces that are not under the control of the managers. In other words, financial institutions that provide debt funds for the projects would

determine the level of debt funds based on the risk level of the project, which forms as an input (weights) for the WACC estimation. Hence, the assessment of project risks and the determination of appropriate discount rates required to entrust with the independent financial institutions.

Martin & Titman (2008) defined the project debt capacity as the amount of debt that the project can support without affecting the company's credit rating. In other words, the additional debt the firm can obtain for a project without lowering the firm's credit rating. Moreover, the value of debt capacity vary to project to project based on their profit margins, serviceability and most importantly level of risk determine the level of debt capacity of a project. Generally, higher riskier projects have lower debt capacity, as they need more equity to compensate the associated higher risk (Martin & Titman, 2008). Since the lower debt capacity represent the reduction in company's borrowings, managers tend to offset the operating risks by spreading over a larger equity base (Brealey, Myers & Allen, 2014). Usually, projects relate to new products are riskier and hence have quite little debt capacity. Conversely, projects relate to existing product expansions have less risk and hence higher debt capacity.

4.5.3.1 Determination of Debt Capacity

The volatility of the project's cash flows is the most important factor that determine the debt capacity of the project. If the project cash flow were more volatile than the firm's cash flow then the debt capacity of that project would be most likely lower than the firm's debt capacity. In contrast, if the volatility of the new project's cash flow were less than the volatility of firm's cash flows then the debt capacity of the project would be higher than the firm's debt capacity. In essence, the differences in appropriately estimated debt capacity among projects fully and accurately reflect the differences in systematic risk among the projects (Martin & Titman, 2014). In other words, projects with lower systematic risk have respectively higher debt capacity.

Project contribution through diversification is another factor that determine the debt capacity. For example, if the introduction of the diversified business project

reduces the volatility of total company cash flows then the debt capacity of that project would be higher than the company debt capacity.

Demand for company assets is also another factor that determine debt capacity. That is convertibility of asset into cash when required, also known as liquidity assets. If the investment assets can be sold reasonably quickly in the event of financial crisis, then this project would have high debt capacity, as the risk level is not as high.

As previously discussed, estimation of debt capacity is undertaken by the third party institutions such as financial institutions, merchant banks etc. as it is imperative to remove the potential managerial bias and manipulations. These outsiders' estimates are mainly based on project risk and evidently impartial assessments, as they do not have any stake in the company. Hence, mitigate agency costs. If the project is deemed to be very risky, then the likely estimate of debt capacity would be much less and hence their advice would be to use more equity in order to spread the risks to the shareholders and maintain the company's credit rating.

For further illustration, consider two telecommunication network plants, an old technology plant and a new technology plant, both produce the same capacity and expected revenue from both would be same $10m each, but the operating cost for the old technology plant is $8m and for the new technology plant is $5m. In this example, the new technology plant yields higher profit margin of $5m compare to the old technology plant that yields only $2m. Hence, it makes the new technology plant less risky and thus offer higher debt capacity.

Moreover, debt capacity provides appropriate weights for the estimation of WACC. The other required components to estimate the WACC is the cost of capital for debt and equity. The suggested approach is to use the company cost of capital with the debt capacity based weightings to estimate the WACC. The next section discuss the project specific estimation with examples.

4.5.3.2 Estimation of Project Specific Discount rate and Debt Capacity

The suggested method is to use the WACC formula with debt capacity based weights to estimate the project specific discount rate. The table below illustrate the method to determine debt capacity based project specific WACC:

Table 4.2: Debt Capacity based WACC

Source of capital	Funds value	Weights	Cost of capital	WACC
Debt	Determined by the financial institution based on project's earnings, risk etc. Project specific. (DC)	Percentage of the debt capacity over total capital required for the project DC/(DC+E)	The rate of interest for the debt	Cost of capital multiply by weights of debt
Equity	Total capital required for the project minus debt capacity	Percentage of equity value over total capital required E/(DC+E)	Share holders' expected return	Cost of capital multiply by weights of equity

Let us take a simple example to illustrate the above methodology for two different projects. The key assumption is that differences in projects risks fully accounted for when estimating debt capacity for different projects. Project A is highly risky and the estimated debt capacity is $2.5m. The project B is less risky and the estimated debt capacity is $7.5m. Firm's cost of equity is 10% and cost of debt is 5%. Both projects require initial investment of $10m. Based on this information, project specific discount rates are estimated using the WACC as follows.

Table 4.3: Project Specific WACC comparison

Project A

Source of capital	Funds value	Weights	Cost of capital	WACC
Debt	$2.5m	$2.5m/$10m = 0.25	5%	0.25*5% = 1.25%
Equity	$7.5m	$7.5m/$10m = 0.75	10%	0.75*10% = 7.5%
WACC				**8.75%**

Project B

Source of capital	Funds value	Weights	Cost of capital	WACC
Debt	$7.5m	$7.5m/$10m = 0.75	5%	0.75*5% = 3.75%
Equity	$2.5m	$2.5m/$10m = 0.25	10%	0.25*10% = 2.5%
WACC				**6.00%**

Estimated project specific discount rate for project A is 8.75% being a risky project and project B has project specific discount rate of 6% being relatively less risky project.

4.5.3.3 Applicability of Debt Capacity Method and Summary

Based on the discussions in the previous sections, it emerges that estimating project debt capacity is somewhat subjective undertaking (Martin & Titman, 2014). Hence, it may be challenging to undertake this task with small investments. However, firms with larger investments can easily undertake the estimation of debt capacity with the assistance from financial institutions and merchant bankers. Moreover, although the estimation of debt capacity is rather subjective, it is simpler and reliable if appropriately estimated by the third party institution. In this way, it is a useful tool to estimate project specific discount rates while minimising agency costs.

Moreover, the characterization of project debt capacity and its linkage with project risks are summarised as follows:

- Debt capacity is the maximum amount of new debt that can be used to finance the investment projects without resulting in a decline in the credit rating of the firm. Thus the debt capacity determines the amount of debt the project can support.
- Debt capacity is determined by financial institutions (external parties) based on serviceability of interest. In other words, debt capacity is determined using market-based information.
- Serviceability of interest is determined by the project's net profit after tax; the higher the net profit, the lower the risk and the higher the debt capacity.

- Project-specific risks reflect the level of debt capacity; the higher the risk, the lower the debt capacity, and vice versa.

Firms also make adjustments to the cost of capital for factors other than the type of project risk. For example, if investing in foreign projects, firms would make an adjustment for exchange rate risk, inflation risk and political risk.

Detail estimation of the project-specific discount rates and the implications and benefits are investigated using the Wal-Mart case study. This is discussed in the next section.

4.5.4. The case study and empirical data

Wal-Mart is the world's largest retailers and operates in the US. It has nearly 2,000 discount stores, accounting for around 73% of sales, approximately 200 Sam's Club membership-warehouse stores, accounting for around 22% of sales, and a speciality distribution segment that serves 30,000 convenience stores and independent grocers, accounting for around 5% of sales. Wal-Mart has resisted the trend toward diversifying its business. However, this has not equated to lack of growth and its new capital expenditure in 1992 alone was $3.5 billion, plus an associated investment in working capital of $1.8 billion. If Wal-Mart were to make optimal capital investment decisions, an accurate estimate of the cost of capital would be needed.

Wal-Mart has 2.3 billion shares of common stock outstanding, with a beta of 1.3 and selling at $30 a share. The yield to maturity on US Treasury bonds was 6.5%, and Treasury bills were selling to yield 3% in 1993. Based on dividends to date, dividends per share during 1993 were expected to be $0.12. Historical dividends per share and earnings per share are shown in the table below.

Table 4.4: Wal-Mart historical dividends and earnings per share

Year	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Dividends	.01	.01	.01	.02	.02	.03	.04	.06	.07	.09	.11
Earnings	.06	.09	.12	.15	.20	.28	.37	.48	.57	.70	.87

Source: Seitz & Ellison (2005)

Wal-Mart's balance sheet of January 31, 1993, summarises the company's financial structure. This is shown in Table 4.6. Most of the company's debt was

not actively traded. However, the company disclosed in a note to the financial statements that long-term debt with a book value of $3.073 billion had a fair market value of $3.357 billion. Assuming the average stated rate on outstanding securities was 7.5%, the yield to maturity would be 6.87%. It was assumed that other long-term debt would sell at a similar yield to maturity if the debt was sold publicly. Wal-Mart was a heavy user of commercial paper, with an average daily balance outstanding in 2002 of $1.184 billion. The weighted average before tax interest rate on this paper was 3.5%.

Wal-Mart has $1.818 billion in capital lease obligations on the balance sheet. In a footnote there is a historical 8% to 14% imputed discount rate used in calculating these obligations. Given the overall decline in interest rates, the lower end of the range, or 8%, is probably the better estimate of what future leases will cost. Details of the long-term capitalised lease obligations and additional operating lease obligations are provided in the table below.

Table 4.5 Wal-Mart lease payment schedule

Year	Aggregate minimum lease payments due ($ millions)
1993	486
1994	476
1995	470
1996	475
1997	464
Thereafter	5,316

Source: Seitz & Ellison (2005)

The ‘thereafter’ amount was assumed to be due at $443 million per year for the following 12 years, from 1998 to 2009. The market rate of interest to be used to find the market value of these lease obligations was 8%. There were no shares of preferred stock outstanding. Wal-Mart had a 30% combined federal and state marginal tax rate in 1992.

Table 4.6: Wal-Mart balance sheet as at January 31, 1993

	In $ millions
ASSETS	
Current assets	10,197
Property, plant, and equipment	9,794
Other assets	574
TOTAL ASSETS	20,565
LIABILITIES AND EQUITIES	
Current Liabilities:	
Accounts Payable	3,873
Commercial paper	1,588
Accrued expenses and taxes	1,233
Long-term debt maturing within 1 year	13
Capital Lease obligations due within 1 year	46
Long-term Liabilities:	
Long-term Debt	3,073
Capital lease obligations	1,772
Deferred income taxes	207
Shareholder Equity:	
Common stock	230
Capital in excess of par	527
Reinvested earnings	8,003
TOTAL LIABILITIES AND STOCKHOLDERS EQUITY	20,565

Source: Seitz & Ellison (2005)

Details of income at various unit prices, operating costs and operating revenue for the proposed two investment projects are summarised in Table 4.7 below. Both projects require an initial investment of $90m. Project A and project B, respectively, had estimated residual values of $10m and $70m. Both projects were evaluated based on a 10-year useful life. Operating income/cash flows were estimated based on a unit price of $14.

Table 4.7: Proposed projects' financial data

	Project A	Project B
Capacity per year in unit	3,300,000	3,300,000
Fixed operating costs	24,000,000	24,000,000
Variable operating costs per unit	$0.90	$2.00
Total operating costs at capacity	$26,970,000	$30,600,000
Revenue at unit price $10	33,000,000	33,000,000
Operating Income	$6,030,000	$2,400,000
Revenue at unit price $12	39,600,000	39,600,000
Operating Income	$12,630,000	$9,000,000
% Change in Revenue	20.0%	20.0%
% Operating Income	109.5%	275.0%
Revenue at unit price $14	46,200,000	46,200,000
Operating Income	$19,230,000	$15,600,000
% Change in Revenue	16.7%	16.7%
% Operating Income	52.3%	73.3%
Revenue at unit price $16	52,800,000	52,800,000
Operating Income	$25,830,000	$22,200,000
% Change in Revenue	14.3%	14.3%
% Operating Income	34.3%	42.3%

Source: Martin & Titman (2005)

Note: Numbers are multiplied by 3 to obtain larger numbers for illustration

4.5.5. Estimation of the discount rate–the WACC Model

As discussed in the previous sections, WACC can be estimated at firm-wide or project-specific levels. It is worthwhile comparing these two approaches to highlight the benefits of the recommended project-specific approach.

4.5.5.1 Firm–wide WACC

The estimation of Wal-Mart's firm-wide WACC is discussed in this section. The long-term liabilities and shareholder equity listed in Wal-Mart's balance sheet are relevant to identify the sources of funds. However, deferred liabilities, such as deferred income taxes, are ignored as they are not reflected in the cash flows, and thus, do not constitute source of funds for capital budgeting. Similarly, current liabilities are ignored as they are not permanent items. Therefore, only the costs of long-term debt, leases and common equity are included in the WACC calculation.

As already indicated, Wal-Mart's financial statements disclosed a long-term debt with a book value of $3.073 billion and a fair market value of $3,357 billion. The market value is used to calculate the WACC. The component cost of debt is the effective interest rate on new debt, adjusted for taxes. Wal-Mart must provide investors with a rate of return at least equal to the yield to maturity on the existing bonds as a component cost of debt, which would be 6.87%. In other words, investors would not be interested in buying new Wal-Mart bonds unless they could expect a return of at least 6.87%. Thus, this rate was used as a component cost of debt, implying an after tax cost of debt of:

$$K_d = 0.0687\ (1 - .3) = 4.8\% \qquad (4.3)$$

Wal-Mart's balance sheet shows that the capital lease obligations book value was $1.772 billion. However, the value of minimum lease payments due over the following 16 years, based on reliable discount rate estimation of 8%, was calculated to be $4.016 billion, which was used to calculate the weight for WACC. Moreover, the lessee reports the lease payment as an expense in computing taxable income. Hence the required return must be calculated after tax as similar to cost of debt:

$$K_L = 0.08\ (1 - .3) = 5.6\% \qquad (4.4)$$

The market price per share of common stock was $30, and with 2.3 billion shares outstanding, the total market value of equity would be $69 billion. Wal-Mart stock had a beta of 1.3. The risk-free rate represented by the US Treasury bond was 6.5%. Using the expected market rate of return of 12%, the estimated risk premium was (12%-6.5%) 5.5%, the required return on equity can be estimated using the mean-variance CAPM formula:

$$K_e = r_f + \beta(r_m - r_f)$$

$$K_e = 0.065 + 1.3(.12 - .065) = 13.7\% \qquad (4.5)$$

Using the above information, the firm-wide WACC for Wal-Mart would therefore be 12.8%. This is illustrated in Table 4.8 below.

Table 4.8: Wal-Mart firm-wide WACC

Source	Marke value $m	Weight	Required Return	Weighted cost
Equity	69,000	90.3%	13.7%	12.33%
Debt	3,357	4.4%	4.8%	0.21%
Lease	4,016	5.3%	5.6%	0.29%
Total	76,373			
WACC				**12.8%**

If Wal-Mart's policy is to use the firm-wide WACC as a discount rate for their capital investment decision making, the applicable discount rate would be 12.8% for all projects. However, this is not a correct approach and may lead to the selection of unprofitable projects and hence, inefficient allocation of resources. The recommended approach is the estimation of project-specific discount rates, as discussed in the next section.

4.5.5.2 Proposed project–specific WACC

Using market-based information, the method proposed in this study generates different discount rates. This can be achieved in different ways. The normal process is to determine the relevant cost of equity and debt for the project and use the weight as per a firm's WACC. This approach could be very complex and may be time consuming.

By contrast, the recommended method in this study is very straightforward and reasonably accurate. It determines the project-specific WACC using the same estimates of cost of debt and equity used to estimate the firm-wide WACC, but using different weights for debt and equity, reflecting the debt capacity of the projects. Thus, the important element in this estimation is choosing appropriate debt capacity to provide the right weights that embody the project risks. This approach delivers theoretically correct discount rates, provided the differences in debt capacities among projects fully and accurately reflect the differences in the systematic risks of those projects (Martin & Titman, 2008). In other words, projects with higher project risk have proportionately lower debt capacities and projects with lower project risk have higher debt capacities.

As discussed above, a project's debt capacity is used in this analysis to determine the appropriate weights for sources of financing for a specific project and thus, it is important to understand the concept of a project's debt capacity. Martin and Titman (2008) defined project debt capacity as the amount of additional debt the firm can undertake as a result of commencing the project without impacting the firm's credit rating. Usually, riskier projects have lower debt capacities as they require more equity to counterbalance their higher risk. For example, take a new business project and a project related to replacement of existing equipment. The new business project might be very risky and, hence, provide very little debt capacity. In contrast, the replacement project that supports the current business is less risky and should have more debt capacity. It should be highlighted that the debt capacity of a project is not necessarily the same as the amount of debt the firm borrows to finance the project (Martin & Titman, 2008). Borrowing can depend on various aspects of the company, but the debt capacity is determined purely on individual project risks associated with forecast performance.

Estimating the debt capacity for projects is an important task in this approach to estimating project-specific discount rates. The Wal-Mart case study illustrates how the proposed method generates different project-specific WACC for different projects based on debt capacity that reflects the risk level. Generally, financial institutions determine the debt capacity based on a project's net profit after tax, which establishes the serviceability of the interest payments of the debt. The higher the net profit after tax, the higher the serviceability of interest, hence the

higher the debt capacity of the project. Table 4.9 below shows the estimation of each project's debt capacity and equity risk.

Table 4.9: Debt capacity and equity risk

	Project A	Project B
Debt Capacity	$75,375,000	$30,000,000
Interest rate	8%	8%
Interest expense	$6,030,000	$2,400,000
Tax rate	30%	30%

	Net Income after tax	
Unit Price	Project A	Project B
$10	$0	$0
$12	$4,620,000	$4,620,000
$14	$9,240,000	$9,240,000
$16	$13,860,000	$13,860,000

The above table shows that after deducting interest for debt and tax, both projects have the same net income at various unit prices. This means that the debt capacity estimated for both projects offsets the risk as both projects generate the same net profit. In other words, the higher the project net cash flow, the lower the risk and the higher the debt capacity. Project A, being low risk, has a debt capacity of $75.375m and the riskier project B has a debt capacity of $30m.

It should be noted that project A has a greater debt capacity as its profits are less volatile in response to changes in prices. For example, if the unit price dropped from $12 to $10, and assuming both projects continue to operate with the same output capacity, the operating profit of project A will drop by 52% and that of project B by 73%, which is a significant difference of 21%. This greater sensitivity means that project B has less ability to service debt, compared to project A, and thus, project B is riskier and associated with lower debt capacity.

One of the important determinants of the debt capacity is the volatility of the project's net cash flows. Also, investments that can be promoted easily with minimal loss of value may have higher debt capacity (Martin & Titman, 2008). As previously defined, investment debt capacity is the maximum amount of new debt that can be used to finance investment projects without resulting in a decline in the credit rating of the firm. It should be noted that estimation of debt capacity is very subjective and may be difficult to calculate, particularly for small investment entities. However, firms with larger investments can develop a reasonably

impartial estimation of debt capacity by consulting with their outside credit agencies. These agencies can advise on financing sources of equity and debt amounts based on the risk levels of each project without damaging firm credit ratings. In this way, using external parties to assess the project debt capacity is crucial to a firm as it eliminates possible internal managerial bias. In other words, it mitigates managerial opportunistic behaviour and thus removes potential agency costs.

The project-specific WACC estimation would take the recommended project's debt capacity as the appropriate weights for equity and debt that are used in the WACC formula, that is, $75.375m for project A and $30m for project B, as shown in Table 4.10.

The next step is to determine the relevant costs of equity and debt for the projects. The recommendation was to use Wal-Mart's firm-wide RRR for debt, capital lease and equity, which were 4.8%, 5.6% and 13.7% respectively, by using different weights based on the determined project's debt capacity. As both projects required investment of $90m, the debt capacity weights would be 83.8% for project A and 33.3% for project B, the latter being a riskier project. Although this appears to be a short-cut method, it is a good proxy for project-specific risk adjusted returns. If the debt capacities were estimated appropriately, this would provide reasonable estimates of the appropriate project-specific discount rates and reflect the differences in project risk, hence creating theoretically suitable discount rates (Martin & Titman, 2008).

As discussed previously, the key assumption of the project-specific discount rate (WACC) is that project risks are fully accounted for by sourcing differences in project debt capacity. However, it can be argued that since both the projects are in the same line of business and thus subject to the same risk factors, they have different cost structures and profitability and hence these risk factors can be attributed to different sensitivities. Therefore it is reasonable to assume that project debt capacity reflects the risk factors of different projects (Martin & Titman, 2008).

The following table illustrates how the project's debt capacity method generates the project-specific discount rates (WACC), with a lower WACC estimate for the

less risky project A, which has a higher debt capacity, and a higher WACC for riskier project B, which has a lower debt capacity.

Table 4.10: Project-specific WACC estimate

Project A Specific WACC

Source	Marke value $m	Weight	Required Return	Weighted cost
Equity	14.625	16.3%	13.7%	2.2%
Debt	75.375	83.8%	4.8%	4.0%
Total	90.000			
WACC				**6.2%**

Project B Specific WACC

Source	Marke value $m	Weight	Required Return	Weighted cost
Equity	60.000	66.7%	13.7%	9.1%
Debt	30.000	33.3%	4.8%	1.6%
Total	90.000			
WACC				**10.7%**

The above table clearly shows that 83.8% could be borrowed to finance the lower risk project A project, resulting in a lower project WACC of 6.2%. In contrast, up to 33.3% could be borrowed to finance the riskier project B, resulting in a higher project WACC of 10.7%.

As illustrated in the above estimation, the proposed project-specific discount rate approach provides clear guidance for managers to justify the different discount rates for different projects. This approach also limits the managers' opportunistic behaviour when choosing discount rates, as the debt capacity is determined by external market conditions.

4.5.6. Application of project-specific discount rates

Estimated project-specific discount rates for both project A and project B were used in this investment evaluation process to select the most viable project. Also, the analysis compared the outcomes of applying firm-wide discount rates to evaluate these projects. As stated in the case study, both projects required an initial investment of $90m and the evaluation undertaken was based on a 10-year cash flow forecast. The residual value for project A is $10m and $78m for project B.

The projects were compared using a company-wide discount rate and project B was selected as it had a greater NPV compared to project A. The summaries of

the projects' NPV calculations based on Wal-Mart's firm-wide discount rate are provided in the table below.

Table 4.11: NPV estimates applying Wal-Mart's firm-wide single discount rate

Applied Firm-wide Discount Rate

$'000

Project A												
	Year	0	1	2	3	4	5	6	7	8	9	10
	Cash Flows -	90,000	19,230	19,230	19,230	19,230	19,230	19,230	19,230	19,230	19,230	29,230
	Discount Rate	**12.8%**										
	NPV	**18,014**										
Project B												
	Year	0	1	2	3	4	5	6	7	8	9	10
	Cash Flows -	90,000	15,600	15,600	15,600	15,600	15,600	15,600	15,600	15,600	15,600	93,600
	Discount Rate	**12.8%**										
	NPV	**18,510**										

Project A had a NPV of $18m while project B had $18.5m. Hence, project B would be selected for investment. The application of a firm-wide discount rate has no relevance to the projects under evaluation and thus may lead to selection of a risky unprofitable project.

This outcome would change if applying project-specific discount rates to both projects. This resulted in using discount rates of 6.2% and 10.7% for project A and project B respectively as shown earlier in Table 4.10, shows that project A, being the higher NPV project, hence project A would be selected as shown in the Table 4.12 below.

Table 4.12: NPV estimate applying project-specific discount rates

Applied Project Specific Discount Rate

$'000

Project A												
	Year	0	1	2	3	4	5	6	7	8	9	10
	Cash Flows -	90,000	19,230	19,230	19,230	19,230	19,230	19,230	19,230	19,230	19,230	29,230
	Discount Rate	**6.2%**										
	NPV	**55,358**										
Project B												
	Year	0	1	2	3	4	5	6	7	8	9	10
	Cash Flows -	90,000	15,600	15,600	15,600	15,600	15,600	15,600	15,600	15,600	15,600	93,600
	Discount Rate	**10.7%**										
	NPV	**31,244**										

In this case, project A had a NPV of $55.3m and project B $31.2m. These different discount rates theoretically represent the risks attached to each project and are an appropriate method for investment evaluation.

If both projects were evaluated using a single lower discount rate, such as a less risky project discount rate of 6.2%, the outcome would be reversed again, that is, project B would have a NPV of $66.m and hence would be selected. Using a single discount rate is not appropriate and will lead to incorrect investment decisions. These case study examples illustrate that the project-specific discount rates method, that is, a multiple discount rate approach, is appropriate for projects that are very similar in all aspects other than the risk factors attached to them.

A comparison of the various outcomes by applying Wal-Mart's firm-wide discount rate and project-specific discount rates are summarised in the table below.

Table 4.13: NPV and various discount rates

Single vs Multiple Discount Rates	Firm-wide		Project Specific	
	Discount Rate	NPV	Discount Rate	NPV
Project A	12.8%	18,014	6.2%	***55,358***
Project B	12.8%	**18,510**	10.7%	31,244

The firm-wide column shows the estimated firm-wide discount rate and the NPV outcome for both projects. The project-specific column shows the project-specific multiple discount rates and the NPV outcome for both projects. The table clearly illustrates that if a firm-wide single discount rate is used, project B would be selected, whereas if project-specific discount rates are applied, project A would be preferred.

4.5.7. An analysis of discount rate selection outcomes

The discount rate selection analysis shows that estimating firm-wide WACC is simpler and provides managers with less degree of freedom. In the Wal-Mart case, the market value of capital sources were used as weights and the firm's RRRs for debt and equity were used to estimate the WACC of 12.8%. However this discount rate was not tailored to the risks of the investment projects, and resulted in the selection of the riskier project B. Thus, applying this firm-wide discount rate would lead to the inefficient allocation of the firm's capital.

The project-specific discount rates were estimated for both projects based on their debt capacity, reflecting the risk factors of each project as weights and firm-wide RRRs, resulting in 6.2% for project A and 10.7% for project B. Using debt capacities is a short-cut and simpler method, nevertheless, it reflects the risks associated with the projects. Project A had higher profit margins and was less volatile in response to changes in prices, making it less risky, with higher debt capacity resulting in a lower discount rate. In contrast, project B had lower profit margins, making it sensitive to changes in prices and riskier, with lower debt capacity resulting in a higher discount rate. Applying these different discount rates to evaluate both projects, project A was preferred, in contrast to the previous outcome of using a firm-wide discount rate. As project-specific discount rates are tailored to the risks of the investment projects, efficient capital budgeting decisions would result.

In some cases, it is possible to identify project-specific risks and hence estimate the project-specific cost of capital. In these circumstances, project-specific WACC can be estimated using the weights of equity and debts as required by each project, with the risk adjusted project-specific cost of capital. The important point to emphasise here is that project-specific discount rate is the superior method for project appraisal, leading to efficient capital allocation and the maximisation of firm wealth.

Apart from the complexity, the major criticism of using the project-specific discount rate is that it will provide managers with the opportunity to select lower discount rates to maximise their own benefits. However, the proposed project-specific WACC model is based on project debt capacity, which is determined by external market conditions, and this limits the managers' ability to misuse the discount rate. Moreover, mechanisms such as quality accounting reports and managerial incentives and control can be used to mitigate these opportunistic managerial behaviours. Thus, it can be concluded that the project-specific discount rates estimation method, tailored to the risks of the investment project, would lead to efficient capital budgeting and sound allocation of resources.

4.6. Implications and benefits

4.6.1. The implications and benefits of project-specific discount rates

The Wal-Mart case study discount rate estimation outcome shows that the project-specific discount rate was 6.2% for project A, being a less risky project, and 10.7% for project B, being a riskier project. It was evident that using a firm-wide single discount rate would result in the selection of project B, whereas using project-specific discount rates would result in the selection of project A. It is clearly shown that project-specific discount rates are suitable for project evaluation, leading to efficient capital allocation and sound investment decisions. If the debt capacity is estimated appropriately, the recommended project-specific approach would help managers to choose the appropriate risk adjusted discount rates for projects, with clear justification.

The criticism of a project-specific multiple discount rate approach is that it will offer flexibility for managers to engage in opportunistic behavior, which means that managers could choose lower discount rates to maximise their benefits. However, this problem can be mitigated if there is a methodical and justifiable way to estimate the weighted average cost of capital. This study propose that when project specific discount rates are applied, the determination of these discount rates should be tied to outside market forces that are not under the control of the managers. In other words, financial institutions that provide debt/ funds for the projects would determine the interest rates based on the risk level of the projects, which forms as an input for the estimation of WACC. Hence, the assessment of project risks and the determination of appropriate discount rates are entrusted with the independent financial institutions.

In summary, the debt capacity based project-specific discount rate method will not permit this managerial bias as it depends on external assessment as discussed above. In addition, various incentives and control mechanisms, such as bonuses and accounting controls can be used to motivate managers to work towards shareholder interest in estimating appropriate discount rate for capital budgeting that in return maximize shareholder value.

4.6.2. The implications and benefits of accounting quality

Empirical tests have established that investors use financial accounting information in practice as much as the theory predicts (Scott, 2015). Adopting the appropriate accounting methods among the available alternative methods, such as historical costing, current costing, creative accounting, responsibility accounting and conservative accounting, is important for estimating the discount rate and cash flows of projects in a capital budgeting exercise. This study recommends the historical cost accounting method as it is more reliable than other methods and prevents managers from manipulating reported net income for their own interests. Hence, the quality of accounting information would help to achieve efficient capital budgeting decisions by applying appropriate discount rates and reliably forecasting cash flows. This would result in the selection of the right set of projects for long-term investments and prevent over investment or under investment by firms.

Moreover, accounting helps us to understand managerial behaviour. The principal-agent game model, which includes executive compensation plans to motivate and control managers, has improved our understanding of managerial interests in financial reporting, accounting policy choice and why managers might want to manipulate reported net income and profitability.

Quality accounting that prevents harmful managerial behaviours becomes imperative when developing a fair contract under the principal-agent framework, since net income is commonly used to determine managers' pay as it is easily observable by both parties. This type of contract can be made even more efficient if share price is used as a second variable as it provides information in addition to net income (Scott, 2015).

GAAP and accounting standards set guidelines to calculate net income, which is used to forecast cash flows for capital budgeting, and hence prevent managerial manipulation of financial reports for their own benefit. Thus, a strict application of GAAP is an effective control mechanism for fair financial reporting and helps in determining the correct estimation of discount rates and cash flows and, thus, sound capital budgeting decisions.

Audit is another essential control mechanism for maintaining quality accounting reports, avoiding potential fraud or financial reporting errors. Audit plans involve the setting up of a control system to ensure that net income is calculated according to the guidelines set out in the accounting standards. Hence, audit activities discourage managerial manipulation of financial numbers and hence, uphold quality accounting.

4.6.3. The implications and benefits of principal/agent game

Efficient capital allocation depends on how effective the decision process is in mitigating agency problems (Marino & Matsusaka, 2005). Agents tend to select projects that can provide quick payback in order to maximise their benefits with minimal effort. Game theory, as a valuable capital investment methodology, helps us to understand these issues and aids mitigation of potential agency costs, thus protecting the principal's wealth (Scott, 2015).

Game theory helps us to understand the process of choosing appropriate discount rates, accounting policies and standards, and capital investment decision making. It also helps us to understand why, in certain circumstances, managers misrepresent financial statements for their advantage. It is also a useful theory to show shareholders, and other stakeholders, such as accounting standard boards, the disadvantage of not considering the interests of all parties affected by accounting policy changes that are found to be tricky to apply (Scott, 2015).

An important aspect of game theory is that it is an optimisation method, generating a solution that is optimal and cannot be improved upon. Thus, a compromise is the optimal solution possible if both players are playing a perfect game to maximise their benefits (Schniederjans et al., 2004). Furthermore, a cooperative principal-agent game would help in designing contracts to motivate a rational agent to act on behalf of a principal when the agent's interests would otherwise conflict with those of the principal, which is the usual case in capital budgeting decision making processes.

4.7. Conclusion

This chapter has provided a diverse set of insights into emerging good practice in the estimation of suitable discount rates for capital budgeting. It has highlighted critical areas, such as risks, inflation, income tax and, most importantly, accounting quality and principal-agent game to create management incentives to act in favour of firm value. Although many authors have recommended the application of project-specific discount rates to evaluate projects for efficient capital allocation, in practice, many companies prefer to use their firm-wide WACC as a discount rate. Generally, this is for two reasons. Firstly, firm-wide discount rates are easy to calculate, whereas project-specific discount rate estimations are analytically challenging. Secondly, the application of project-specific discount rates might facilitate opportunistic managers with excessive flexibility to choose different discount rates to maximise their own interests and not those of shareholders.

However, the proposed simple debt capacity based, project-specific, multiple discount rate method, would limit managerial bias and hence minimise agency costs, as the debt capacity is determined by external assessment. The debt capacity is defined as the amount of debt financing each project can support without affecting the firm's credit rating. Capital structure weights are determined by the project debt capacity and capital costs are approximated by the firm-wide cost of equity and debt to perform project-specific WACC calculations. Under this project-specific discount rate method, if project debt capacity is determined appropriately and fully reflects systematic risks, a reasonable approximation for risk adjusted cost of capital for each project can be made, producing suitable discount rates that theory dictates. Moreover, the proposed project-specific discount rate approach illustrates a clear case for project evaluators to justify the different discount rates for different projects, while limiting managers' ability to manipulate lower discount rates for their own benefit.

Accounting reports are widely used as part of the inputs for the estimation of suitable discount rates and thus, correct application of accounting standards and accounting measurement methods are critical for maintaining accounting quality that leads to efficient capital budgeting. Owners are usually concerned that managers might be able to manipulate net income figures periodically to

maximise their own benefits, hence owners expect managers to comply with GAAP and appoint auditors to ensure that managers follow accounting standards in order to mitigate agency costs. Furthermore, the principal requires income statements to be prepared based on historical costs rather than on current costs, which prevents managerial manipulation of reporting.

The application of game theory in capital budgeting, and suggested incentive mechanisms to resolve capital budgeting issues, is worthwhile. More importantly, the application of game theory in the selection of suitable discount rates and capital project selection within the principal-agent framework will certainly enhance the efficiency of capital budgeting practices. The game theoretic capital budgeting optimisation within a mechanism design framework is investigated in the next chapter.

CHAPTER 5: A JOINT OPTIMISATION GAME THEORY MODEL FOR MECHANISM DESIGN IN CAPITAL BUDGETING

5.1 Introduction

The key objective of this chapter is to highlight this study's original and significant contribution to accounting through the development of an integrated game theoretic mechanism design model. Applying case study data, this model is used to solve joint optimisation problems in order to mitigate agency problems, which are emerging and critical issues in accounting, particularly in capital budgeting decision making. As discussed in Chapter 4, capital budgeting decisions are extremely important policy decisions, as they assist organization to methodically analyse prospective long-term business opportunities to decide the right set of projects worth undertaking. It is assumed that the discount rate applied to determine the cash flows provided in the selected case study in this chapter is estimated based on debt capacity as suggested in Chapter 4.

Communication between parties is vital to efficient decision making and the success of organisations. However, managers frequently have incentives to withhold private information or distort it for personal gain (Lambert, 2007). Since agency problems are complicated issues in capital budgeting, a game theoretic mechanism design model is recommended as an appropriate approach to resolving such problems in order to enhance capital budgeting decision making efficiency and achieve good corporate governance. Research suggests that there has been increasing acceptance and implementation of quantitative techniques in capital budgeting practices, such as linear programing, optimisation modeling, game theory, and mechanism design approaches (Stein, 2003; Bernardo et al., 2001; Levary & Seitz, 1990).

Generally, company owners delegate the capital budgeting decision making task to managers within the principal-agent framework. This may lead to managerial bias, referred to as an agency problem due to information asymmetry. It can also be defined as a principal-agent game, under a game theoretic framework. Agency theory has become one of the most vital theoretical notions in accounting, allowing conflicts of interest, incentive problems, and strategies for controlling incentive issues to be clearly incorporated into a mechanism design model (Lambert, 2007). Within this context, this chapter outlines the development of a

mechanism design model to mitigate agency problems and maximise shareholder wealth by selecting the right set of projects for efficient capital budgeting decisions.

Moral hazard problems arise due to the un-observability of effort in contract performance, also known as intentionally incomplete contracting, leading to post-contractual opportunistic behaviour by agents. Contractual moral hazard problems can be mitigated using governance mechanisms. This includes incentive contracting, which aligns principal/owner interests with those of agents/managers through carefully chosen contract terms. Such contracts are supplemented by post-contractual monitoring, including auditing, variance analysis, benchmarking, an ethically dutiful corporate culture, and whistle-blowing (McGuigan et al., 2014).

Managerial compensations to motivate managers can be done in several ways, including salary, profit-sharing and share options. Generally, optimal incentive contracts involving some guaranteed salary and profit-sharing bonus can resolve principal-agent problems. In other words, optimal mechanism design seeks to motivate value-maximising behaviour while reducing transaction costs. Furthermore, mechanism design features, such as lack of communication between managers and owners in the case of capital budgeting, can be analysed as a sequential game (McGuigan et al., 2014). Hence, agency issues in capital budgeting are analysed as optimisation problems within a game theoretic and mechanism design framework.

The remaining sections of this chapter discuss the interdisciplinary impacts of agency theory, game theory, contract theory, accounting and internal control. Moreover, this chapter also discusses different forms of optimisation models, including capital budgeting optimisation models (Ragsdale, 2018), game theory (Perloff, 2012) and mechanism design frameworks. Issues are then analysed and an appropriate financial model for an optimisation model is developed and applied to the World Airways case study for mitigating agency problems within the game theory and mechanism design framework. Computation of the model and the results are analysed, implications and benefits are discussed. Also highlighted

are further applications of the model and the potential limitations and set agenda for further research.

5.2 Contract design for the principal-agent game

When the principal does not have perfect information, then the game between the principal and agents becomes a screening game. In other words, information asymmetry, adverse selection and moral hazard come into play (Gardner, 2003). In this case, the principal has to offer material incentives to the agents to motivate them to put forth the desired effort to maximise the principal's interests. Otherwise the agents might shirk or slack off, a problem generally called moral hazard. Agency problems between agents and principals can be reduced by appropriately designing an incentive contract for managers (Barucci & Barucci, 2003). Gardner (2003) noted that some empirical studies have found a positive and significant relationships between corporate performance and incentives. As already discussed, the goal of an incentive contract is to align the managers' interests with those of shareholders to mitigate opportunistic behaviour.

5.2.1 Incentive contracts

In the principal-agent game setting, the key aim of the principal is to maximise his benefit, knowing that the agent is free to reject a contract completely and that the contract must offer the agent with an incentive to elect the preferred effort. These two constraints are usually referred to as the participation constraint and the incentive compatibility constraint. The participation constraint means that the agent prefers the contract to his reservation utility, known as individual rationality. An incentive compatibility constraint means that the agent picks the desired contract and actions. This is also known as group rationality (Myerson, 1989). These constraints also elements of incentive contract mechanism design.

Incentive payments include wages, deferred compensation, bonuses, and stock options. Incentives such as stock options rather than straight salary increases are of interest to principal/shareholders. A fixed wage does not handle the incentive aspect well, whereas a pure piece-rate payment or measure-based payment does not handle the participation aspect well. Thus, an incentive scheme has to incorporate a compromise between the two extremes: the incentive compatibility

constraint (measure-based payments) and the participation constraint (a fixed sum). A flat wage plus an incentive bonus is an appropriate incentive scheme to motivate agents (Dixit & Nalebuff, 2008). Other commonly used payment schemes are distinctly non-linear and paid if the outcome exceeds a specific threshold or an assigned quota, that is, a lower fixed sum if the quota is not met, and higher fixed sum if the quota is met. Also, mixed linear and non-linear incentive payments are possible (e.g. a percentage of the target plus extra for exceeding targets). Other schemes apply a 'carrot and stick' method, including an average payment to fulfil the participation constraint, plus another payment based on good or bad outcomes, which is what provides the incentive to exert more effort. Such schemes can be designed as either a carrot (incentive for high effort) or a stick (punishment for low effort) (Dixit & Nalebuff, 2008). A share option plan minimises agency costs as it induce managers to adopt more risky projects to maximise shareholder wealth (Barucci & Barucci, 2003). Scott (2015) has pointed out that the overall efficiency of incentive contracts will increase if a second variable, such as share price, is used in addition to net income and accounting ratios, as this provides more information on agents' efforts

When designing incentive contracts, principals should consider psychological and social aspects, including personal attributes, and interactional characteristics such as social compassion, fairness and justice. They should also consider behavioural aspects, including time discounting, inequity aversion, and the trade-off between intrinsic and extrinsic motivation (Kunz, 2018).

An important characteristic of an efficient compensation contract is its sensitivity, or the rate at which the expected value of a performance measure increases as the manager works harder, or decreases as the manager shirks (Scott, 2015). In other words, sensitivity influences efficient compensation contracts as it strengthen the association among a manager's effort and the performance measure, in this manner causing simpler to motivate that effort.

In the presence of asymmetric information, managers who deal with high valued important investment projects will secure greater incentive-based pay than managers deal with lesser valued projects. However, better performance-based pay does not essentially induce an increase in firm value, rather managers may

receive greater performance-based pay for managing higher quality projects (Bernardo et al., 2001). This intuition has vital implications for the managerial compensation contract strategy that is linked to firm value.

5.2.2 Implications of principal-agent game for accounting

Incentive payments must be based on some observable metric, such as the outcome or net profit. Moral hazard is the un-observability of managers/agents' action or effort, hence payments cannot be based on effort. Generally, incentive plans are calculated based on the accounting outcome, such as net income, asset turnover ratio (ATO), return on equity (ROE), return on assets (ROA), earnings to total assets (ETA) and net interest margin (NIM). These measures are observable by both parties, the principal and the agent and hence are commonly used to measure performance. However, there are concerns that creative agents/managers looking to maximise their benefits often manipulate the reported accounting figures. This suggests a greater accountability on the organisation's accounting systems and accounting statements to report comprehensive and accurate information. Hence, the principal should use controls, such as accounting standards and GAAP, audits and historical based accounting measures instead of current value accounting to limit adverse managerial behaviour.

Historical cost-based accounting measures are less exposed to management manipulation, and hence are more stringent measures of net income and accounting ratios (Scott, 2015). Furthermore, GAAP and accounting standards set guidelines as to how net income is calculated and prevent managers/agents from switching accounting policies to influence net income for their own benefit. Auditing functions as a control system that limits the prospect of fraud or errors and ensures that accounting reports, including net income are prepared in accordance with approved accounting standards. Moreover, auditors reassure the principal/shareholders that the audit is independent and free from influence. Accounting information issues are further discussed in the next section.

5.2.3 Accounting information and performance measurement

Many aspects of both financial and management accounting have been developed to monitor agency relationships (Davidson et al., 1988). Usually, the corporate centre of a company provides financial statements (e.g. annual reports) to shareholders, which is a financial accounting function. Division managers report on their activities to their superiors at the corporate centre, which is a management accounting function. Managerial accounting focuses on operational and divisional planning and control. However, organisation-wide methods involve external financial reporting, external auditing, executive incentive systems, and various government regulations, all designed to make top management accountable to their stakeholders (Scott, 2015).

Generally, accounting provides information about managers (agents) to senior directors (principals) for performance evaluation, allowing senior directors to make decisions about the managers' future employment prospects, such as promotion, pay increases, or dismissal. Accounting information is also used in employment contracts, with managers' bonus payments made based on accounting performance measures. In this way, it can be concluded that accounting information affects managers' motivation. Some have criticised the notion of rewarding managers based on financial performance revealed in periodic accounting reports, as this offers managers the incentive to choose appropriate action to improve short-term performance but not actions that are more beneficial in the long-term. Moreover, the use of accounting figures to measure manager's performance motivate them to dominate accounting choices and manipulate accounting numbers to place their performance in the most favourable light (Scott, 2015; Davidson et al., 1988).

It is vital to note that the accounting measure suited to solving accounting challenges created by adverse selection is not suitable to meet the accounting challenges created by moral hazard. Therefore, the actual financial reporting should represent a compromise between both measures. Investors require relevant information to predict a firm's future performance, which helps them make effective decisions. Hence, the obvious choice is to use current value based information as this is generally the best predictor of future values. On the other hand, current value measures are not suitable for measuring manager

performance, as instability and low reliability of fair values reduces the effectiveness of net income. Thus, it can be argued that a reliable and conservative accounting measure such as historical cost better motivates manager performance. Hence, information relating to both current value accounting and historical cost accounting must be used appropriately for efficient contracting (Scott, 2015).

5.2.4 Internal control, internal auditing and mechanism design

Internal control refers to a set of accounting and administrative controls and practices that assist ensure that endorsed and proper decisions are made in an organisation. It is also a procedure intended to deliver sound assurance that an organisation will achieve its objectives in terms of the effectiveness and efficiency of operations, accuracy and reliability of financial reporting, safeguarding of assets, improving accountability for its actions, and compliance with applicable laws and regulations (Maher et al., 2012; Horngren et al., 2014; Wilford, 2016). Thus, internal control provides management with rational assurance that the organisation's assets are safeguarded and the accounting statements in the company is of high quality and reliable.

One of the key components in mechanism design is an incentive contract that generally uses accounting numbers to determine appropriate incentives for managers for their efforts. Hence, the quality of accounting reports are vital for incentive contracts, and thus internal control is fundamental to ensure that such quality is maintained at all times and business decisions are made accordingly.

Accounting standards are the general guidelines that define how precise financial transactions should be measured, recognised, presented and disclosed in financial reports. Conversely, the main objective of internal control of an organisation should not be obstructed by the accounting standards. However, the actual internal control that is applied in an organisation must be in line with the standards that are being used (Wilford, 2016; EY, 2009).

A capital budgeting model efficiency relies profoundly on the estimates sourced in that model, specifically the discount rate, cash flows and life-span of the project. Generally, these estimations are based on past experience and judgement (Maher et al., 2012). The process that compares the capital budgeting

original forecasts with actual outcomes is referred as post-implementation review, or more commonly, internal auditing. This provides several advantages, including the following:

- Internal auditing identifies incorrect estimates that assists managers to incorporate these knowledge into future estimates in order to avoid similar errors.
- Organisations can use internal audits to identify and reward those managers who made better capital budgeting decisions, and hence allow decision makers to consider the skills of managers in making the capital investment decisions.
- Internal audits form an environment where managers are not attracted to exaggerate their estimate of the benefits related to the project. In other words, it prevents managerial manipulation.

Moreover, internal audits deliver a vital discipline to a subjective judgemental process and offer insights for managers to make sound decisions.

The crisis that occurred at the turn of the century and the financial scandals during the early 2000s in the US, brought internal control and risk management issues into the spotlight. The emphasis now seems to be on the broader management of risks rather than on the quality of the internal control system itself (Daelen et al., 2010). This new approach commands further enhancement of the quality of mechanism design in accounting and capital budgeting.

5.2.5 Monitoring and control mechanisms

Monitoring a manager's efforts and actions helps to reduce agency costs and can mitigate more obvious agency costs, such as transparent perks (Brealey et al., 2014). Moreover, monitoring and control are also used as incentives to motivate managers/agents to improve their efforts in maximising the principal's interest (Seitz & Ellison, 2005). Brealey et al. (2014) stated that agency costs can be mitigated by risk management and, in some cases, hedging can facilitate to monitor and motivate managers. Commonly, the following monitoring and control mechanisms can be used in capital budgeting to motivate managers who make capital project investment decisions:

- Financial and accounting regulations and performance.
- Compliance with GAAP and accounting standards.
- Auditing.
- Risk management.
- Choice of suitable discount rates.
- Corporate governance
- Maintain targeted debt/equity ratio.
- Optimal investment and capital rationing.

Principals may believe that managers/agents will be held liable for opportunism and moral hazard behaviour, but the fear of liability does not always avert cheating. Hence accounting control mechanisms such as GAAP, accounting standards, full disclosure of financial activities, internal and external audits, can play a key role in preventing managerial opportunism (Scott, 2015). In this way, from an accounting perspective, the role of high quality financial reporting to maintain owner/principal trust in managers/agents is crucial. Seits and Ellison (2005) stated that financial reports prepared in accordance with generally accepted accounting principles, and independently audited, are important tools for shareholders in monitoring and maximising company value.

Maintaining optimal investment and capital rationing is another vital control mechanism that can be applied in an organisation to incentivise the agent in order to work for the interest of the principal. In this way, internal capital rationing can emerge, even when the firm has surplus cash, in order to preserve incentive compatibility (Stein, 2003). In other words, limiting capital allocations to divisions, despite potentially leading to under investment in some divisions, is needed to uphold incentive compatibility and motivate managers to perform in the interests of shareholders.

Roper and Ruckes (2012) have demonstrated with evidence from field studies that organisations can reach their optimal investment by allocating capital to divisions based on dynamic rationing. In other words, if a division receives a substantial allocation, then it may need to await longer period to receive an additional allocation. This is based on the view that in the principal-agent relationship among head office and divisional managers, head office guards

against the volatile future investment prospects. This policy directs divisional managers to disclose information regarding the scope of future investment opportunities (Roper & Ruckes, 2012). Bernardo et al. (2001) stated that organisations usually under invest in capital when the division manager's information is known to head office. This is in line with empirical evidence that organisations embrace considerably higher discount rates compare to the rates commanded by general accounting and finance theory.

The control mechanisms discussed above are pertinent to minimising agency costs that affect capital budgeting decisions. Hence, they have been used in this study to develop the appropriate mechanism design to mitigate agency problems. These controls are discussed further in the following section.

5.3 The game theoretic mechanism design approach of this study

This study adopts the principal-agent game framework in capital budgeting involving two parties: shareholders as the principal, and managers as agents. They are assumed to be rational and hence both parties attempt to maximise their own interests. In this framework, it can be assumed that there are information asymmetry and moral hazard problems. The agent's actions are unobservable by the principal, thus creating agency problems when selecting the right set of capital projects to maximise firm wealth. Generally, principal-agent models reflect game situations in the form of incentive compatibility problems between two players, the principal and agents. Game theory defines games and predicts their outcome conditional on the rules of the game, available information with the players, and other factors (Perloff, 2012). In this context, the players are involved in strategic interactions to find the most optimal payoff that they can accept in a rational and intelligent way (Salanie, 2005). In line with this principle, the game theory and the mechanism design framework are adopted to solve agency problems by specifying an optimisation problem in order to find the equilibrium solution (Narahari, 2014; Montet & Serra, 2003).

The principal's mechanism design relating to the incentive contract regarding the agent's performance should ensure that the agent will perform in the best interest of the principal (Narahari, 2014). Efficient contracting theory examines the role of financial accounting information in moderating information asymmetry among

contracting parties (owner and managers), thereby contributing to efficient contracting, stewardship and corporate governance (Scott, 2015). Furthermore, Rasmussen (1994) stated that the contract delivers a mechanism for inducing agents to truthfully report their efforts.

The mechanism design equilibrium can be obtained by applying various methods, such as Nash equilibrium, Bayesian equilibrium, sub-game perfect equilibrium, and dominant strategy implementation. The model reflects the problem of the principal's wealth maximisation (total NPV), subject to the agent's incentive/control and resulting efforts for achieving the principal's goal in efficient and effective ways. In other words, the mechanism specifies the incentive compatible constraints using controls such as the debt/equity ratio and application of other accounting regulations to mitigate agency problems and solve the principal's objective of wealth maximisation. The interest of agents is incorporated through optimal contract designs, with incentive compatibility and participation constraints, in order to motivate agents to perform in the best interest of the principal.

The participation constraints (the agent's expected utility) and incentive compatibility constraints (truthful reporting) are commonly applied to the whole firm in order to overcome agency problems. However, the capital budgeting tasks are generally performed by a division or department of a firm, hence the above mechanism may not be fully effective. Thus, this study incorporate incentive wages for the managers in addition to the normal wages, incentive rules, such as compliance with accounting rules and regulations, accounting ratios, choice of suitable discount rate, good corporate governance and risk management, as mechanisms to eliminate agency costs and improve the efficiency of capital budgeting decisions to maximise the principal's interest.

This study also adopts the capital budgeting optimisation problem and the existing mechanism design models developed in the current literature as a basis for the proposed mechanism design model, where the objective function is specified as maximising the principal's wealth. The proposed model is a direct mechanism design model, as the agent is motivated to perform via incentive controls, such as incentive wages, accounting rules and regulations, accounting

standards, and risk management, based on the incentive principle, assuming the revelation by agents of their preferences. In particular, this study assumes that managers/agents would follow the set of rules (mechanism) specified in the contract, and make significant effort to accomplish their tasks, such as complying with accounting regulations and standards, choosing appropriate discount rates for capital budgeting analysis, minimising agency costs, enhancing corporate governance and risk management, as well as maintaining optimal investments.

5.4 The case study and empirical data

As already discussed, this study used a case study methodology. Despite the fact that the maximisation of NPV is a well-researched topic in capital budgeting, the area of incentive compatibility based efficient contracts to mitigate agency conflict in a capital budgeting environment has not been researched in-depth. As stated in Chapter 3, the selected case study approach adopted four types of research method, as it involved an in-depth description of the organisations being assessed. The strategic importance of the study lies in the development a new framework for optimisation modelling and analysing the capital budgeting optimisation model by reflecting its impact on NPV and, hence, efficient capital investment decisions. This study developed a model that formalised agency problems within the game theory and mechanism design framework, solved as an optimisation problem.

5.4.1 Case study–World Airways

The case study, World Airways is a hypothetical international airline company based in the USA (Levary & Seitz, 1990). The airline industry operates in a highly competitive and vigorous environment in many countries, including Australia, the US, Canada and the UK, and significantly impacts global economic growth. Although many industries would be suitable candidates for the research, this study chose an airline for three primary reasons. Firstly, the industry has a long history, thus providing a relatively large sample of data. Secondly, the airline industry is unique and highly competitive, hence production efficiency and product quality are imperative. Finally, although it is one of the main industries in many countries, financially it has not performed well and is struggling to attract investment capital (Walsh, 2011). Key information and relevant data relating to

case study are summarised below. Detail information of World Airways Limited are provided in appendix H.

The company acquired a new ‘narrow-body’ aircraft in January 2001 for $28 million. The airplane flies the East Coast commuter routes and generates revenue of $18,980,000 a year. The company’s operating expense, other than depreciation, is $12,509,280 a year. Depreciation was $741,680 in the first year, and the company pays a 34% income tax rate. At the time of acquisition, World Airways had to pay $28 million plus $2,847,000 to increase working capital, a total of $30,847,000. World Airways was also considering purchasing ‘wide-body’ airplanes for use on European routes. Each airplane costs $146 million.

In the previous year, World Airways was considering replacing its last obsolete narrow-body airplane. The old airplane costs $28,570,000 per annum to operate. The new airplane costs $16,325,720 a year to operate, before considering depreciation or taxes. The new airplane requires a working capital of $2,487,000, whereas the old airplane requires a working capital of $1,814,000. A feasibility study to determine the costs and benefits had already cost $15,000. The old airplane could be sold for $12 million and had a basic value (cost minus depreciation) of $9 million. The depreciation for year one for the new airplane was $1,112,520, whereas depreciation for the old airplane was $613,000 for the same period, if the old airplane was kept. The estimated RRR for the planning horizon of five years was 14%. World Airways accepted capital rationing during the entire five-year period. The company evaluated the purchase of the new airplane using the NPV method. The company assumed a number of economic conditions, as follows in Table 5.1 below.

Table 5.1: NPV assumptions

1. Cash flows are estimated for all projects and they all have equal risk
2. Unlimited external funds are available and can be invested externally at a discount rate.
3. A constant one discount rate (r) is applied for entire life of the projects.
4. All relevant costs and benefits are quantifiable and can be expressed in terms of cash flows.
5. If more than one source of capital is used, each source remains a constant proportion of the present value of the remaining cash flows throughout the life of the asset.
6. The capital structure is optional (generate the lowest possible cost of capital for a given asset base).

Source: Levar & Seitz (1990)

As indicated above, World Airways owns two types of airplanes, wide-body and narrow-body. The wide-body airplanes operate three routes: Europe, the Caribbean and transcontinental. The narrow-body airplanes also operate three routes: commuter, short and intermediate. Tables 5.2 and 5.3 below summarise the cash flow analysis of each route and the calculation of coefficient variables. The transatlantic route is particularly vulnerable to price competition and fear of terrorism has created economic disaster on that route. As a result, management decided to limit transatlantic revenue to a maximum of 30% of the total revenue during both the summer and winter seasons. Because short flight routes are potential feeders to intermediate flight routes, management decided that the number of short flights per day should range from 10% to 30% of the number of intermediate flights per day.

The cost of capital for World Airways is estimated to be 14% per annum. Given this, there are limits to the amount of capital that can be raised at this cost. Therefore, the company decided that the new external capital must be limited to $1 billion. If World Airways tried to raise capital faster than this, the marginal cost of capital would increase to 20%. The company also decided that any unusual funds raised could be temporarily invested at an interest rate of 10% a year.

The capital budgeting was based on a project life of five years. The level of activities for the first year was treated differently as the operations were estimated

to be slower than the following years two to five. The objective of the company was to maximise shareholder value by maximising the NPV of activities from various routes in different seasons of the year, and through the purchase of a number of airplanes of different sizes within available limited capital resources, both equity and debt. In this setting, a principal-agent game theoretic based capital budgeting optimisation model within a mechanism design framework was developed to maximise the NPV and mitigate agency costs.

Table 5.2: World Airways - Cash flow summary

I. Airlines purchase and operating costs						
			---------- **Costs per flight hour ($)** ----------			
	Purchase price ($000)	Flight operations	Maintenance	Depreciation	Total	No. of seats
Wide-bodied airplane	146,000	2,850	1,143	612	4,605	404
Narrow-bodied airplane	28,000	1,437	547	254	2,238	150
II. Costs and revenue per route type						
Airplane/route type	Average passengers	Ticket price ($)	Flight hours	Fixed ground cost ($) [a]	Variable ground cost ($) [b]	Flights per day [c]
Wide-bodied						
Europe	249	490	6	6,000	15	1.8
Caribbean	282	325	4	6,000	16	2.3
Transcontinental	315	274	4	6,000	17	2.3
Narrow-bodied						
Commuter	130	50	1	1,000	20	8
Short	100	85	1.5	1,000	19	8
Intermediate	90	130	2	2,000	18	6
III. Cash flow analysis per route type						
				---------- **Costs per flight ($)** ----------		
Route type	Revenue per flight	Fixed ground cost	Variable ground cost	Airplane operating costs [d]	Cash flow per flight [e]	Cash flow per day
Summer Europe	122,010	6,000	18,302	27,630	49,924	89,863
Winter Europe	122,010	6,000	18,302	27,630	49,924	89,863
Transcontinental	86,310	6,000	14,673	18,420	33,611	78,315
Short flights	8,500	1,000	1,615	3,357	2,049	16,396
Intermediate	11,700	2,000	2,106	4,476	2,566	15,395
Summer Caribbean	91,650	6,000	14,664	18,420	37,142	86,540
Winter Caribbean Commuter	91,650	6,000	14,664	18,420	37,142	86,540
1st Yr Caribbean	6,500	1,000	1,300	2,238	1,549	12,391
	58,500	6,000	9,360	18,420	18,763	43,718

Source: Levary & Seitz (1990)

Notes:

a Per flight
b As a percentage of revenue
c Per airplane
d Hourly costs x hours per flight
e [(Revenue – Costs per flight) (1 - T) + D] x Daily flights per plane, where T = tax rate and D = depreciation per flight

Table 5.3: World Airways – Calculation of coefficients and cash flows

Routes	1	2	3	4	5	6	7	8	comments
Constraint 1									
R1: Year 1									
Income per route per day	49,924	49,924	33,611	2,049	2,566	18,763	18,763	1,549	Cash flow constraints for Year 1
Days in year	182.5	182.5	365	365	365	182.5	182.5	365	
Total - dollars	9111130	9111130	12268015	747885	936590	3424247.5	3424247.5	565385	
Total in millions	9.111	9.111	12.268	0.748	0.937	3.424	3.424	0.565	
Constraint 2 - 5									
R2-R5: Year 2-5									
Income per route per day	49,924	49,924	33,611	2,049	2,566	37,142	37,142	1,549	Cash flow constraints for Years 2-5
Days in year	182.5	182.5	365	365	365	182.5	182.5	365	
Total - dollars	9111130	9111130	12268015	747885	936590	6778415	6778415	565385	
Total in millions	9.111	9.111	12.268	0.748	0.937	6.778	6.778	0.565	
Additonal Constraint 6									
Income per route per day	122,010	122,010	86,310	8,500	11,700	58,500	58,500	6,500	Trans-Atlantic revenue limited to at most 30% of summar and w inter combined
Days in year	182.5	182.5	365	365	365	182.5	182.5	365	
Total - dollars	22266825	22266825	31503150	3102500	4270500	10676250	10676250	2372500	
Total in millions	22.267	22.267	31.503	3.103	4.271	10.676	10.676	2.373	
	6.680	6.680	9.451	0.931	1.281	3.203	3.203	0.712	
Net income for route 1 and 2 (22.267-6.680)	15.587	15.587	9.451	0.931	1.281	3.203	3.203	0.712	
Additonal Constraint 7									
Income per route per day	122,010	122,010	86,310	8,500	11,700	91,650	91,650	6,500	Trans-Atlantic revenue limited to at most 30% of summar and w inter combined
Days in year	182.5	182.5	365	365	365	182.5	182.5	365	
Total - dollars	22266825	22266825	31503150	3102500	4270500	16726125	16726125	2372500	
Total in millions	22.267	22.267	31.503	3.103	4.271	16.726	16.726	2.373	
Net income for route 1 and 2 (22.267-6.680)	15.587	15.587	9.451	0.931	1.281	5.018	5.018	0.712	

Source: Levary & Seitz, 1990 and Kalyebara & Islam, 2014

Table 5.4: World Airways – Summary of calculation of coefficient variables

Flight routes		Year 1		Year 2 - 5		Year 1	Year 2 - 5
		Cash Flow per flight $	Flight days	Cash Flow per flight $	Flight days	Coefficients	
						$'million	$'million
x_1	Summer Europe	49,924	182.5	49,924	182.5	9.111	9.111
x_2	Winter Europe	49,924	182.5	49,924	182.5	9.111	9.111
x_3	Transcontinetal	33,611	365	33,611	365	12.268	12.268
x_4	Short flights	2,049	365	2,049	365	0.748	0.748
x_5	Intermediate	2,566	365	2,566	365	0.937	0.937
x_6	Summer Caribbean	18,763	182.5	37,142	182.5	3.424	6.778
x_7	Winter Caribbean	18,763	182.5	37,142	182.5	3.424	6.778
x_8	Commuter	1,549	365	1,549	365	0.565	0.565
x_w	Wide-bodied purchase price	$146 m in Year 1					
x_N	Narrow-bodied purchase price	$28 m in Year 1					
α_{1-5}	Interest on lending	10%					
β_{1-5}	Interest on borrowing	14%					

Source: Levary & Seitz, 1990 and Kalyebara & Islam, 2014

World Airways' management estimated that the present value of total cash flows (calculated on a five-year horizon) was expected to be generated by various routes, as summarised below in Table 5.5. The figures include the terminal value of the existing airplanes at the end of the fifth year.

Table 5.5: World Airways – Estimated NPV of total cash flows

Routes	NPV $m
Summer Europe (x_1)	11.11
Winter Europe (x_2)	0.00
Transcontinental (x_3)	0.00
Short flights (x_4)	0.25
Intermediate (x_5)	0.25
Summer Caribbean (x_6)	0.00
Winter Caribbean (x_7)	2.15
Commuter (x_8)	0.00

Source: Levary & Seitz (1990)

5.4.2 Other data and tools

Data for different subjective and objective variables and parameters are required for the optimisation model input. These data were obtained from the World Airways case study. Other necessary data, such as interest rates, tax rates and other relevant accounting and regulatory environments were obtained from various institutions, including the RBA, World Bank and other agencies. Some data that were not available from public sources were calculated and simulated based on reasonable assumptions from previous studies and historical data.

In this study, Microsoft Excel Solver was applied to run the optimisation model to find the optimal solution to the capital budgeting problem formulated in the model. Excel Solver is user-friendly and permits for the inputting of multiple objectives and constraints into the system without any difficulties. The following three key components of the proposed spreadsheet model needed to be defined for Solver in order to obtain the expected solution (Ragsdale, 2018):

- Objective cell: The cell that represents the objective function in the model and the objective value must be maximised or minimised. In this case maximise NPV.

- Variable cells: These cells represent the decision variables in the model and also any applicable upper and lower bounds can be included to these cells.
- Constraint cells: These cells represent the LHS formulas of the constraints in the model and also any applicable upper and lower bounds to these formulas.

5.5 Specification and characteristics of the proposed model

This study developed an optimisation model within a mechanism design and game theoretic framework for optimal capital budgeting decision making. Specified NPV is an objective function of the principal, subject to the constraints required for operational and accounting regulation constraints, corporate governance, risk management and accounting issue constraints.

A linear programming model for capital budgeting was used for this task. Linear programming is a prescriptive model and very dominant device that can be used in various business situations (Ragsdale, 2018). The model allows for flexibility in allocating the target value for the decision variables, which is one of the essential features in decision making, specifically for capital budgeting decisions. NPV was chosen as a proxy for measuring shareholder value. Generally, an efficient spreadsheet model design simply conveys its purpose and is also the most reliable, auditable, and modifiable design (Ragsdale, 2018). The model used in this study has been directed towards these goals to achieve the end results. The World Airways case study was chosen to examine the effects/benefits of the model.

A mechanism design model can be represented as an optimisation problem as discussed in next section (adopted from Levary and Seitz, 1990). The NPV of estimated cash flows for a five-year horizon were provided in Table 5.5. The values in this table include the residual value of the existing airplanes at end of the fifth year. The value of newly purchased airplanes is $100\boldsymbol{x_w} + 20\boldsymbol{x_N}$. According to the company's policy, the debt/equity ratio must be maintained at a limit of 40% per annum. The debt capital must be less than or equal to $1million. Thus, the equity value is estimated to be equal to or less than $2.5 million.

The proposed mechanism model was developed in two phases. The first phase is focused on the base Levary and Seitz model (1990), the second phase involved the development of a new, modified model with additional constraints, such as the debt/equity ratio, agency costs, the return on equity ratio, equity limit, risks, corporate governance, accounting performance ratios and a suitable discount rate to maximise shareholder wealth. The agency costs constraint was included in the revised model one, developed by Kalyebara and Islam (2014). Moreover, it was assumed that all cash flows provided in the case study were estimated using appropriate risk adjusted discount rates, as discussed in Chapter 4. The theoretical framework of the developed model is discussed below.

In the base model (Levary & Seitz, 1990), risk management is implemented by defining variable coefficients, that is, defining the maximum NPV for each objective variable and defining constraints for limited economic resources. In other words, risk management will ensure that the defined coefficient variables for each objective variable are realised and the economic resources are utilised within the defined limits in order to achieve the firm's objective of maximising NPV. Moreover, the modified model incorporated extra defined limits in the objective function using agency costs, that is minimise agency costs. Also added following constraints;

- upper limits of equity capital to be equal to, or greater than $2,500 million,
- debt/equity ratio be equal to or greater than 40%,
- upper limit of agency costs be equal or less than 48% of debt/equity ratio,
- return on equity ratio greater than 20%, and
- weighted average risk ranking of flight routes in order to enhance the risk management and increase the possibility of maximising World Airways' NPV.

5.5.1 The objective function of the base model

The objective function of the model specifies the maximisation of the principal's NPV that exhibits an increase in shareholder wealth. Hence the principal will employ necessary strategies to maximise their interest by selecting the right set of projects for investments. The objective is to maximise the NPV of the appraisal

horizon of five years. Accordingly, the objective function of this model is formulated as specified below:

Maximise NPV:

$$Z = 11.11x_1 + 0.25x_4 + 0.25x_5 + 2.15x_7 + 100x_w + 20x_N + \alpha_5 - \beta_5 \quad (5.1)$$

5.5.2 Decision variables of the base model

The following decision variables are defined in order to find the optimal allocation of capital for World Airways, given the constraints discussed below.

Variable $\boldsymbol{x_1}$: Summer season average number of transatlantic flights per day. These flights used wide-bodied airplanes.

Variable $\boldsymbol{x_2}$: Winter season average number of transatlantic flights per day. These flights used wide-bodied airplanes.

Variable $\boldsymbol{x_3}$: All season average number of transcontinental flights per day. These flights used wide-bodied airplanes.

Variable $\boldsymbol{x_4}$: All season average number of short flights (feeder routes) per day. These flights used narrow-bodied airplanes.

Variable $\boldsymbol{x_5}$: All season average number of intermediate flights per day. These flights used narrow-bodied airplanes.

Variable $\boldsymbol{x_6}$: Summer season average number of Caribbean flights per day. These flights used wide-bodied airplanes.

Variable $\boldsymbol{x_7}$: Winter season average number of Caribbean flights per day. These flights used wide-bodied airplanes.

Variable $\boldsymbol{x_8}$: The average number of commuter flights per day. These flights used narrow-bodied airplanes.

Variable $\boldsymbol{x_w}$: The number of wide-bodied airplanes to be purchased and operation commence at the start of the first year.

Variable $\boldsymbol{x_N}$: The number of narrow-bodied airplanes to be purchased and operation commence at the start of the first year.

Variable $\boldsymbol{\alpha_t}$: Lent value in year t (t = 1, 2,…,5).

Variable $\boldsymbol{\beta_t}$: Borrowed value in year t (t = 1, 2,…,5).

5.5.3 Constraints of the base model

There are several operational and financial types of capital budgeting constraints included in the model, namely cash flow constraints, revenue limits for some flight route constraints, number of flights constraints, number of airplanes constraints, and capital constraints.

The first five constraints are yearly cash flow constraints for the horizon of five years and are formulated based on the cash flow data provided earlier in Table 5.2. Cash inflows are indicated as negative (-) numbers and cash outflows as positive (+) numbers.

Constraint 1: Cash flow for year 1

$$\begin{aligned} &-(49{,}924)(182.5)x_1 - (49{,}924)(182.5)x_2 - (33{,}611)(365)x_3 \\ &\quad - (2{,}049)(365)x_4 \\ &-(2{,}566)(365)x_5 - (18{,}763)(182.5)x_6 - (18{,}763)(182.5)x_7 \\ &\quad - (1{,}549)(365)x_8 \\ &+146{,}000{,}000x_w + 28{,}000{,}000x_N + \alpha_1 - \beta_1 \leq 0 \end{aligned} \tag{5.2}$$

Constraint 2: Cash flow for year 2

$$\begin{aligned} &-(49{,}924)(182.5)x_1 - (49{,}924)(182.5)x_2 - (33{,}611)(365)x_3 \\ &\quad - (2{,}049)(365)x_4 \\ &-(2{,}566)(365)x_5 - (37{,}142)(182.5)x_6 - (37{,}142)(182.5)x_7 \\ &\quad - (1{,}549)(365)x_8 \\ &-1.1\alpha_1 + \alpha_2 + 1.14\beta_1 - \beta_2 \leq 0 \end{aligned} \tag{5.3}$$

Constraint 3: Cash flow for year 3

$$\begin{aligned} &-(49{,}924)(182.5)x_1 - (49{,}924)(182.5)x_2 - (33{,}611)(365)x_3 \\ &\quad - (2{,}049)(365)x_4 \\ &-(2{,}566)(365)x_5 - (37{,}142)(182.5)x_6 - (37{,}142)(182.5)x_7 \\ &\quad - (1{,}549)(365)x_8 \\ &-1.1\alpha_2 + \alpha_3 + 1.14\beta_2 - \beta_3 \leq 0 \end{aligned} \tag{5.4}$$

Constraint 4: Cash flow for year 4

$$\begin{aligned} &-(49{,}924)(182.5)x_1 - (49{,}924)(182.5)x_2 - (33{,}611)(365)x_3 - \\ &(2{,}049)(365)x_4 \\ &-(2{,}566)(365)x_5 - (37{,}142)(182.5)x_6 - (37{,}142)(182.5)x_7 - \\ &(1{,}549)(365)x_8 \\ &-1.1\alpha_3 + \alpha_4 + 1.14\beta_3 - \beta_4 \leq 0 \end{aligned} \tag{5.5}$$

Constraint 5: Cash flow for year 5

$$\begin{aligned} &-(49{,}924)(182.5)x_1 - (49{,}924)(182.5)x_2 - (33{,}611)(365)x_3 - \\ &(2{,}049)(365)x_4 \\ &-(2{,}566)(365)x_5 - (37{,}142)(182.5)x_6 - (37{,}142)(182.5)x_7 - \\ &(1{,}549)(365)x_8 \\ &-1.1\alpha_4 + \alpha_5 + 1.14\beta_4 - \beta_5 \leq 0 \end{aligned} \tag{5.6}$$

The next two constraints are related to the transatlantic revenue limit, with a maximum limited of 30% of winter and summer combined revenue. As per the estimated revenue summary presented earlier in Table 5.2, the first year revenue

was less than the other years. Thus, constraint 6 applies to the first year and constraint 7 to years two to five.

Constraint 6: Transatlantic revenue limit for year 1

$$(122{,}010)(182.5)x_1 + (122{,}010)(182.5)x_2 \leq 0.3[(122{,}010)(182.5)x_1 + (122{,}010)(182.5)x_2 + (86{,}310)(365)x_3 + (8{,}500)(365)x_4 + (11{,}700)(365)x_5 + (58{,}500)(182.5)x_6 + (58{,}500)(182.5)x_7 + (6{,}500)(365)x_8] \quad (5.7)$$

Constraint 7: Transatlantic revenue limit for years 2-5

$$(122{,}010)(182.5)x_1 + (122{,}010)(182.5)x_2 \leq 0.3[(122{,}010)(182.5)x_1 + (122{,}010)(182.5)x_2 + (86{,}310)(365)x_3 + (8{,}500)(365)x_4 + (11{,}700)(365)x_5 + (91{,}650)(182.5)x_6 + (91{,}650)(182.5)x_7 + (6{,}500)(365)x_8] \quad (5.8)$$

Constraint 8: Winter season transatlantic flights should be limited to two-thirds of summer flights

$$x_2 = \frac{2}{3}x_1 = 2x_1 - 3x_2 = 0 \quad (5.9)$$

Constraint 9: Summer season Caribbean flights should be limited to one-half of winter flights

$$x_6 = \frac{1}{2}x_7 = 2x_6 - x_7 = 0 \quad (5.10)$$

The next three constraints relate to the availability of wide-bodied and narrow-bodied airplanes

Constraint 10: Summer season availability of wide-bodied airplanes

$$\frac{x_1}{1.8} + \frac{x_3}{2.3} + \frac{x_6}{2.3} \leq 43 + x_w \quad (5.11)$$

Constraint 11: Winter season availability of wide-bodied airplanes

$$\frac{x_2}{1.8} + \frac{x_3}{2.3} + \frac{x_7}{2.3} \leq 43 + x_w \quad (5.12)$$

Constraint 12: All season availability of narrow-bodied airplanes

$$\frac{x_4}{8} + \frac{x_5}{8} + \frac{x_8}{8} \leq 125 + x_N \quad (5.13)$$

The next two constraints relate to the number of short flight routes compared to the number of intermediate flight routes.

Constraint 13: Short-flight routes should be more than 10% of intermediate flight routes

$$x_4 \geq 0.1x_5 = x_4 - 0.1x_5 \geq 0 \quad (5.14)$$

Constraint 14: Short-flight routes should be below 30% of intermediate flight routes

$$x_4 \leq 0.3x_5 = x_4 - 0.3x_5 \leq 0 \quad (5.15)$$

Constraint 15: Capital acquired from external sources must be limited to $1 billion

$$\beta_1 + \beta_2 + \beta_3 + \beta_4 + \beta_5 \leq 1{,}000{,}000{,}000 \quad (5.16)$$

Constraint 16: All flight routes reflected equal to or greater than zero

$$x_i \geq 0 \; for \; i = 1, 2, \ldots 8 \quad (5.17)$$

Constraint 17: The number of airplanes, both wide-bodied and narrow-bodied, purchased considered to be equal to or greater than zero

$$x_w \geq 0, x_N \geq 0 \quad (5.18)$$

Constraint 18: The company lending and borrowing a number of airplanes, both wide-bodied and narrow-bodied, purchased considered to be equal to or greater than zero

$$\alpha_j \geq 0, \; \beta_j \geq 0 \; for \; j = 1, 2, \ldots, 5 \quad (5.19)$$

The amount of cash borrowed during year t after payments of prior loans are made is represented by β_t. The cash flow constraints for the five years include the payments of prior loans as part or all of the amount of cash available for lending during time period t, represented by α_t, can be used to pay prior loans.

5.5.4 Summary of the base model

The capital budgeting optimisation model is summarised below by rearranging the above terms, and with cash components in million dollars.

$$Maximise \; NPV: 11.11x_1 + 0.25x_4 + 0.25x_5 + 2.15x_7 + 100x_w + 20x_N + \alpha_5 - \beta_5 \quad (5.20)$$

Subject to:

$$-9.111x_1 - 9.111x_2 - 12.268x_3 - 0.748x_4 - 0.937x_5 - 3.424x_6 - 3.424x_7 - 0.565x_8 + 146x_w + 28x_N + \alpha_1 - \beta_1 \leq 0 \quad (5.21)$$

$$-9.111x_1 - 9.111x_2 - 12.268x_3 - 0.748x_4 - 0.937x_5 - 6.778x_6 - 6.778x_7 - 0.565x_8 - 1.1\alpha_1 + \alpha_2 + 1.14\beta_1 - \beta_2 \leq 0 \quad (5.22)$$

$$-9.111x_1 - 9.111x_2 - 12.268x_3 - 0.748x_4 - 0.937x_5 - 6.778x_6 - 6.778x_7 - 0.565x_8 - 1.1\alpha_2 + \alpha_3 + 1.14\beta_2 - \beta_3 \leq 0 \quad (5.23)$$

$$-9.111x_1 - 9.111x_2 - 12.268x_3 - 0.748x_4 - 0.937x_5 - 6.778x_6 - 6.778x_7 - 0.565x_8 - 1.1\alpha_3 + \alpha_4 + 1.14\beta_3 - \beta_4 \leq 0 \quad (5.24)$$

$$-9.111x_1 - 9.111x_2 - 12.268x_3 - 0.748x_4 - 0.937x_5 - 6.778x_6 - 6.778x_7 - 0.565x_8 - 1.1\alpha_4 + \alpha_5 + 1.14\beta_4 - \beta_5 \leq 0 \quad (5.25)$$

$$15.587x_1 + 15.587x_2 - 9.451x_3 - 0.931x_4 - 1.281x_5 - 3.203x_6 - 3.203x_7 - 0.712x_8 \leq 0 \quad (5.26)$$

$$15.587x_1 + 15.587x_2 - 9.451x_3 - 0.931x_4 - 1.281x_5 - 5.018x_6 - 5.018x_7 - 0.712x_8 \leq 0 \quad (5.27)$$

$$2x_1 - 3x_2 = 0 \quad (5.28)$$

$$2x_6 - x_7 = 0 \quad (5.29)$$

$$1.277x_1 + x_3 + x_6 - 2.3x_w \leq 98.9 \quad (5.30)$$

$$1.277x_2 + x_3 + x_7 - 2.3x_w \leq 98.9 \quad (5.31)$$

$$x_4 + x_5 + x_8 + 8x_N \leq 1000 \quad (5.32)$$

$$x_4 - 0.1x_5 \geq 0 \quad (5.33)$$

$$x_4 - 0.3x_5 \leq 0 \quad (5.34)$$

$$\beta_1 + \beta_2 + \beta_3 + \beta_4 + \beta_5 \leq 1000 \quad (5.35)$$

$$x_i \geq 0 \; for \; i = 1, 2, \ldots\ldots, 8 \quad (5.36)$$

$$x_w \geq 0,\ x_N \geq 0 \tag{5.37}$$

$$\alpha_j \geq 0,\ \beta_j \geq 0\ for\ j = 1, 2, \ldots, 5 \tag{5.38}$$

This formulation merely states that World Airways wants to maximise its NPV without violating any of the capital budgeting constraints. As explained in Section 5.5.2, the major variables of the model are various airline routes, borrowings and airplane purchases. The above model was used as a basis to develop the proposed new extended capital budgeting optimisation model within a game theoretic approach and mechanism design framework. This incorporates incentive computability constraints, corporate governance constraints, and accounting regulations constraints to motivate agents to minimise agency costs, related agency theory issues, and other relevant constraints.

This study followed the common practice identified in the literature on mechanism design to specify a stochastic non-linear model for designing the mechanisms. However the model was developed by using variables to convert the non-linearity to linearity in order to solve the selected case study problem using Excel Solver.

5.6 Kalyebara and Islam Model (revised model 1)

The base model (Levary & Seitz Model) discussed above was modified by Kalyebara & Islam (2014) to mainly include the Agency costs.

This model assumed agency costs (AC) should be less than or equal to 120% of the debt/equity ratio (DER) which is assumed to be 0.4. The additional constraints included in this model are as follows:

$$DER = T_\beta / T_E = 0.4\ (1000/2500) \tag{5.39}$$

$$AC \leq 1.2DER \tag{5.40}$$

The outcome of this model shows an increase in overall NPV by \$1.865.11, from \$16,510.64 to \$18,375.75

These additional constraints are included in the proposed improved optimisation model discussed in the next section.

5.7 An improved new optimal mechanism design model: The multi-objective optimisation problem (revised model 2)

The modified multi-objective optimisation model within the game theoretic mechanism design framework is a revised model that integrates accounting performance, application of the more appropriate discount rate, risk management and corporate governance mechanisms.

In capital budgeting and agency theory analysis, agency problems can be formalised within the game theory and mechanism design framework, and solved as an optimisation problem (Narahari, 2014). The agents' interest is incorporated through optimal contract designs with incentive rules as a mechanism used to motivate agents to act in the interest of the principal.

The optimisation model specifies the incentive contracts and accounting rules and regulations, accounting standards, corporate governance and risk management as constraints to mitigate the agency problems that commonly occur in the principal-agent relationship. Furthermore, the discount factors as the optimal solution represent the OCC to the firm in the case of capital rationing (Dayananda et al., 2002; Levary & Seitz, 1990). The objective function is specified for maximising the shareholder wealth of a single principal, in this case maximising the NPV of capital projects and minimising agency costs. Hence the modified model is classified as multi-objective or a joint optimisation problem.

The contract constraints are specified in the form of managerial compensation plans, which are calculated based on the accounting outcome results from the model, such as debt/equity ratio, return on equity ratio, borrowing and lending capacity, and equity availability. Furthermore, three types of constraints are included in the model, namely incentive accounting rules for mechanism design, accounting constraints, and risk management constraints that lead to good corporate governance. The model illustrates incentive contracts between managers and shareholders that align the interests of both parties, and thus reduce agency costs and generate sound capital budgeting decisions.

In this study, the base model was modified by incorporating agency costs (AC) as per Kalyebara and Islam (2014) and the proposed incentive wages in the

objective function and adding the incentive wages both participative and incentive compatibility, equity limit, debt/equity ratio, return on equity ratio and risk control ranking in the constraints. The two objectives, the maximisation of NPV and minimisation of agency costs and incentive wages, were assigned equal weights of one in order to achieve optimal value for the company and compliance with accounting rules and regulations for World Airways.

Constraints relating to behavioural aspects such as altruism, bounded rationality, reciprocity and environmental impacts were not included in the model. However, it is worth noting that these constraints are imperative and impact the optimal outcome, hence, there is an opportunity for further development of the mechanism design model.

5.7.1 The objective function

The objective function of the model specifies jointly the maximisation of the principal's NPV, the minimisation of agency costs and incentive wages to increase shareholder wealth. Hence, the principal would employ the necessary strategies to motivate agents so they act rationally to maximise the principal's interest by selecting the right set of projects for investments. The objective was to maximise the NPV of the appraisal period of five years and minimise the agency costs for the organisation. Accordingly, the multi-objective, joint optimisation function of this model is formulated as follows:

Maximise NPV:

$$Z = 11.11x_1 + 0.25x_4 + 0.25x_5 + 2.15x_7 + 100x_w + 20x_N + \alpha_5 - \beta_5 - AC - \frac{1}{2}(w_H + w_L) \quad (5.41)$$

5.7.2 Decision variables

The new joint optimisation model includes the variables defined in the base model, as discussed in the previous section and summarised below.

Variable $\boldsymbol{x_1}$: Summer season average number of transatlantic flights per day. These flights used wide-bodied airplanes.

Variable $\boldsymbol{x_2}$: Winter season average number of transatlantic flights per day. These flights used wide-bodied airplanes.

Variable $\boldsymbol{x_3}$: All season average number of transcontinental flights per day. These flights used wide-bodied airplanes.

Variable $\boldsymbol{x_4}$: All season average number of short flights (feeder routes) per day. These flights used narrow-bodied airplanes.

Variable $\boldsymbol{x_5}$: All season average number of intermediate flights per day. These flights used narrow-bodied airplanes.

Variable $\boldsymbol{x_6}$: Summer season average number of Caribbean flights per day. These flights used wide-bodied airplanes.

Variable $\boldsymbol{x_7}$: Winter season average number of Caribbean flights per day. These flights used wide-bodied airplanes.

Variable $\boldsymbol{x_8}$: The average number of commuter flights per day. These flights used narrow-bodied airplanes.

Variable $\boldsymbol{x_w}$: The number of wide-bodied airplanes to be purchased and operation commence at the start of the first year.

Variable $\boldsymbol{x_N}$: The number of narrow-bodied airplanes to be purchased and operation commence at the start of the first year.

Variable $\boldsymbol{\alpha_t}$: Lent value in year t (t = 1, 2,…,5).

Variable $\boldsymbol{\beta_t}$: Borrowed value in year t (t = 1, 2,…,5).

Variable $\boldsymbol{AC}$: The agency costs.

Variable $\boldsymbol{e_t}$: The equity in year t (t = 1,2,…..,5).

Variable w_H: wage for agent behaving according to the principal wishes (i.e. High effort)

Variable w_L: wage for agent acting contrary to the principal wishes (i.e. Low effort)

5.7.3 Constraints

The first five constraints were formulated for years 1-5 cash flow constraints. Cash inflows are indicated as negative (-) numbers and cash outflows as positive (+) numbers.

Constraint 1: Year 1 net cash flow

$$-9.111x_1 - 9.111x_2 - 12.268x_3 - 0.748x_4 - 0.937x_5 - 3.424x_6 - 3.424x_7 - 0.565x_8 + 146x_w + 28x_N + \alpha_1 - \beta_1 - e_1 \leq 0 \quad (5.42)$$

Constraint 2: Year 2 net cash flow

$$-9.111x_1 - 9.111x_2 - 12.268x_3 - 0.748x_4 - 0.937x_5 - 6.778x_6 - 6.778x_7 - 0.565x_8 - 1.1\alpha_1 + \alpha_2 + 1.14\beta_1 - \beta_2 + e_1 - e_2 \leq 0 \quad (5.43)$$

Constraint 3: Year 3 net cash flow

$$-9.111x_1 - 9.111x_2 - 12.268x_3 - 0.748x_4 - 0.937x_5 - 6.778x_6 - 6.778x_7 - 0.565x_8 - 1.1\alpha_2 + \alpha_3 + 1.14\beta_2 - \beta_{3+} e_2 - e_3 \leq 0 \quad (5.44)$$

Constraint 4: Year 4 net cash flow

$$-9.111x_1 - 9.111x_2 - 12.268x_3 - 0.748x_4 - 0.937x_5 - 6.778x_6 - 6.778x_7 - 0.565x_8 - 1.1\alpha_3 + \alpha_4 + 1.14\beta_3 - \beta_4 + e_3 - e_4 \leq 0 \quad (5.45)$$

Constraint 5: Year 5 net cash flow

$$-9.111x_1 - 9.111x_2 - 12.268x_3 - 0.748x_4 - 0.937x_5 - 6.778x_6 - 6.778x_7 - 0.565x_8 - 1.1\alpha_4 + \alpha_5 + 1.14\beta_4 - \beta_5 + e_4 - e_5 \leq 0 \quad (5.46)$$

The next two constraints relate to transatlantic revenue restricted to 30% of both summer and winter total revenue.

Constraint 6: Transatlantic revenue limit for Year 1

$$15.587x_1 + 15.587x_2 - 9.451x_3 - 0.931x_4 - 1.281x_5 - 3.203x_6 - 3.203x_7 - 0.712x_8 \leq 0 \quad (5.47)$$

Constraint 7: Transatlantic revenue limit for Years 2-5

$$15.587x_1 + 15.587x_2 - 9.451x_3 - 0.931x_4 - 1.281x_5 - 5.018x_6 - 5.018x_7 - 0.712x_8 \leq 0 \quad (5.48)$$

Constraint 8: The number of winter season transatlantic flights should be limited to $^2/_3$ of summer season flights.

$$x_2 = \frac{2}{3}\, x_1 = 2x_1 - 3x_2 = 0 \quad (5.49)$$

Constraint 9: The summer season number of Caribbean flights should be limited to ½ of winter season flights.

$$x_6 = \frac{1}{2}\, x_7 = 2x_6 - x_7 = 0 \quad (5.50)$$

The next three constraints relate to the accessibility of wide-bodied and narrow-bodied airplanes.

Constraint 10: Summer season wide-bodied airplanes

$$\frac{x_1}{1.8}+\frac{x_3}{2.3}+\frac{x_6}{2.3} \leq 43 + x_w = 1.277x_1 + x_3 + x_6 - 2.3x_w \leq 98.9 \quad (5.51)$$

Constraint 11: Wide-bodied during winter season

$$\frac{x_2}{1.8}+\frac{x_3}{2.3}+\frac{x_7}{2.3} \leq 43 + x_w = 1.277x_2 + x_3 + x_7 - 2.3x_w \leq 98.9 \quad (5.52)$$

Constraint 12: Narrow-bodied at all times

$$\frac{x_4}{8}+\frac{x_5}{8}+\frac{x_8}{8} \leq 125 + x_N = x_4 + x_5 + x_8 + 8x_N \leq 1000 \quad (5.53)$$

The following two constraints relate to the number of short flights, which must be greater than 10% and lower than 30% of intermediate flights.

Constraint 13: Short flights should be equal to or more than 10%

$$x_4 \geq 0.1x_5 = x_4 - 0.1x_5 \geq 0 \quad (5.54)$$

Constraint 14: Short flights should be equal to or less than 30%

$$x_4 \leq 0.3x_5 = x_4 - 0.3x_5 \leq 0 \quad (5.55)$$

Constraint 15: The total external borrowing for the project life of five years must be less than or equal to $1 billion

$$\beta_1 + \beta_2 + \beta_3 + \beta_4 + \beta_5 \leq 1000 \quad (5.56)$$

Constraint 16: All flight routes reflected greater than or equal to zero.

$$x_i \geq 0 \; for \; i = 1, 2, \ldots, 8 \quad (5.57)$$

Constraint 17: The number of wide-bodied and narrow-bodied airplanes purchased reflected greater than or equal to zero

$$x_w \geq 0, \; x_N \geq 0 \quad (5.58)$$

Constraint 18: Company borrowings, lending and equity for the project life of five years reflected greater than or equal to zero

$$\alpha_j \geq 0, \; \beta_j \geq 0, \; e_j \geq 0 \; for \; j = 1, 2, \ldots, 5 \quad (5.59)$$

Mechanism design constraints: Incentive contracts, agency costs, accounting rules and controls and risk management

One way to mitigate the problem of asymmetric information is to design an incentive contract, referred to as mechanism that can motivate managers to act in the interest of the principal (McGuigan, 2014; Sameelson & Marks, 2015). Generally, the managers' (agents') efforts are unobservable by the shareholders (principal), hence the contract design must be based on verifiable variables such as net cash flow and net income that are reported based on historical cost accounting.

In a Principal agent game setting, moral hazard is a usual occurrence where the managers seeking to maximise their benefits by simply ignoring the principal's objective of maximising the company value (Scott, 2015). Incentive contract design is one of the effective tools used to mitigate agency problem and motivate managers to act in the interest of the principal (Samuelson & Marks, 2015). In this way, the study proposes an incentive remuneration that encourage mangers to minimise agency costs and exert their best efforts to select the right set of projects in capital budgeting exercise. Although manager's incentive has no direct correlation to the project NPV, the specified remuneration incentive would lead to reduction in agency cost and hence reduction in total costs that would contribute to the increase in NPV. Thus, this study propose an appropriate wage structure as one of the incentive mechanisms to motivate managers to exert their best efforts when undertaking capital budgeting for investment decisions.

Primarily, the principal should offer the manager the minimum level of incentive wages in order to motivate the managers to cooperate and enter into a contract, which is commonly referred as the participative constraint (Samuelson & Mark, 2015).

Furthermore, manager is given a percentage of the income/ payoff to motivate the manger to exert his high effort to select right set of projects and maximise company value, which is known as the incentive compatibility constraint (Scott, 2015). Participative constraints and incentive compatibility constraints proposed in this study are summarised below.

Basic commission (Manager's participative constraint)	0.1
Max commission (principal's participative constraint)	0.25
Agent incentive commission (Incentive compatibility)	0.02

The above incentives are paid annually based on the realized yearly net cash flow/income of the five year project life. These incentive wages are proposed in addition to the normal wages paid to the managers. Furthermore, the financial measurement should be based on financial reports that are prepared using historical cost accounting method as it prevent from managerial manipulation of data and hence an appropriate tool to mitigate moral hazard resulting from asymmetric information (Scott, 2015). Moreover, it is very vital to find the right equilibrium of incentive wage structure, as low wages may discourage mangers from taking risks, and very high incentive wages may encourage the managers to take too high risky projects that eventually affect the company value. Based on this principle, the following constraints were formulated.

Constraint 19: **Participation constraints**:

These constraints mean that the agent will earn a basic wage of 10% the obtained NPV, regardless of his behaviour

$$w_H \geq (11.11x_1 + 0.25x_4 + 0.25x_5 + 2.15x_7) \cdot 0.1 \tag{5.60}$$

$$w_L \geq (11.11x_1 + 0.25x_4 + 0.25x_5 + 2.15x_7) \cdot 0.1 \tag{5.61}$$

Constraint 20: **Participation constraints for the principal:**

Of course the principal has to make a profit, otherwise there would be no incentive for offering a contract. Therefore, the principal establishes that the wage cannot go beyond 25% of the NPV in either case:

$$w_H \leq (11.11x_1 + 0.25x_4 + 0.25x_5 + 2.15x_7) \cdot 0.25 \tag{5.62}$$

$$w_L \leq (11.11x_1 + 0.25x_4 + 0.25x_5 + 2.15x_7) \cdot 0.25 \tag{5.63}$$

Constraint 21: **Incentive compatibility constraints:**

Ensure that the agent always behaves the way the principal wants. That is, always choose a high effort. We will assume that if the agent behaves the way he wants he charges an additional commission of 2%. This becomes the disutility value for working the way the principal wants, but in the end ends up being the better option:

$$w_H - (11.11x_1 + 0.25x_4 + 0.25x_5 + 2.15x_7) \cdot 0.02 \geq w_L \quad (5.64)$$

Constraint 22: Total equity of the company must be less than or equal to $2.5 billion. Generally, once the budget has been finalised, firms really required to operate in a strict capital rationing environment. Hence, in many conditions equity rationing is a valid assumption to minimise agency costs.

$$e_1 + e_2 + e_3 + e_4 + e_5 \leq 2500 \quad (5.65)$$

Constraint 23: Capital structure: the debt equity ratio (loan capital to equity capital ratio) should be greater than 0.4 (Kalyebara & Islam, 2014).

Capital structure restrictions are critical to mitigate agency costs, hence a company must maintain its capital structure and set its maximum leverage as a constraint of the financial model (Scott, 2015; Carleton et al., 1973). Furthermore, optimal capital structure related topics is commonly discussed by academics and accounting practitioners (Lee et al., 2009). Since the capital structure has an impact on the value of the organisation, the debt/equity ratio was incorporated in the modified model (Kalyebara & Islam, 2014). Although hypothetical data has been applied in the model, they really represent the possible capital structure. Moreover, a fairly greater debt/equity ratio results in better corporate governance since borrowers are usually required to maintain sound financial control to protect company value. The company management generally establish an effective financial management system, as well as policies and procedures in order to gain the confidence of lending institutions. This will ensure the likelihood of acquiring further debt for future fund requirements.

The constraint below permits debt/equity ratio to be greater than or equal to 0.4 to minimise agency costs and maintain good corporate governance, leading to the maximisation of shareholder value.

$$\frac{\sum \beta_j}{\sum e_j} \geq 0.4$$

$$= \beta_1 + \beta_2 + \beta_3 + \beta_4 + \beta_5 - 0.4e_1 - 0.4e_2 - 0.4e_3 - 0.4e_4 - 0.4e_5 \geq 0 \qquad (5.66)$$

Constraint 24: Agency costs must be equal to or below 120% of the debt/equity ratio (Kalyebara & Islam, 2014).

This constraint would enable World Airways to minimise total costs and maximise principal wealth. Although a pure risk perspective of a lower debt/equity ratio is considered better, a modest increase in the ratio will incentivise agents to act on behalf of the principal, leading to minimised agency costs. Moreover, an increase in borrowing would reduce the retained earnings of the firm as they have to pay interest for borrowings. This would leave a minimum of free cash flow for managers, thus limiting the opportunities for misuse of funds for empire building and so on (Brealey et al., 2014). Therefore an increase in the debt/equity ratio would help control agency costs.

$$AC - 1.2\beta_1 - 1.2\beta_2 - 1.2\,\beta_3 - 1.2\beta_4 - 1.2\beta_5 + 0.48e_1 + 0.48e_2 + 0.48e_3 + 0.48e_4 + 0.48e_5 \leq 0 \qquad (5.67)$$

Net cash flows or net income is commonly used to measure the performance of managers as these are observable (Scott, 2015). On the other hand, there are concerns that creative mangers can manipulate the accounting reports to maximise their benefits, hence, it is vital that historical cost accounting to be used to limit moral hazard that arise from information asymmetry.

Constraint 25: Financial performance constraints. The return on equity ratio must be equal to or higher than 0.2 (i.e. return on equity ratio ≥ 20%), which is expected in similar industries (Horngren et al., 2014).

The return on equity ratio is a profitability ratio that measures the ability of making profits from the firm's shareholders investments (Zimmermann, 2011; Ross, 2011). This ratio indicates the level of profit that each dollar of equity generates.

This constraint fosters compliance with accounting standards and regulations and improves the accounting quality. Consequently, it would enable World Airways to maximise the NPV and boost the value of the principal's wealth.

$$11.11x_1 + 0.25x_4 + 0.25\,x_5 + 2.15x_7 - 0.2e_1 - 0.2e_2 - 0.2e_3 - 0.2e_4 - 0.2e_5 \leq 0 \quad (5.68)$$

Constraint 26: Risk Management. Ranking risk from 1 to 10 for each route to make sure the weighted average degree of risk doesn't ever exceeds 5. Risk ranking based on assumed risk per route is as shown below:

$x_1\ rank\ 1,\ x_2\ rank\ 3,\ x_3\ rank\ 8,\ x_4\ rank\ 2,\ x_5\ rank\ 2,\ x_6\ rank\ 8,\ x_7\ rank\ 1,\ x_8\ rank\ 4$

Risk is an integral part of many capital budgeting decisions and usually managers seek to measure, control and consider risk in the selection of capital projects (Levary & Seitz, 1990). In other words, considered risk in this constraint is from the total project risk perspective.

$$1x_1 + 3x_2 + 8x_3 + 2x_4 + 2x_5 + 8x_6 + 1x_7 + 4x_8 \leq 5\,(x_1 + x_2 + x_3 + x_4 + x_5 + x_6 + x_7 + x_8) \quad (5.69)$$

The above equation can be represented as follows:

$$-4x_1 - 2x_2 + 3x_3 - 3x_4 - 3x_5 + 3x_6 - 4x_7 - 1x_8 \leq 0 \quad (5.70)$$

5.7.4 Summary of the modified model computation

The modified joint optimisation model objective function was to maximise the NPV and minimise agency costs and incentive wages. The revised model is formulated by rearranging the terms and defining all cash flows in millions of dollars. The following summary of the joint optimisation model is formulated as a linear programming problem and solved using Excel Solver.

$$Maximise\ NPV: 11.11x_1 + 0.25x_4 + 0.25x_5 + 2.15x_7 + 100x_w + 20\boldsymbol{x_N} + \alpha_5 - \beta_5 - AC - \frac{1}{2}(w_H + w_L) \quad (5.71)$$

Subject to:

Constraints

$$-9.111x_1 - 9.111x_2 - 12.268x_3 - 0.748x_4 - 0.937x_5 - 3.424x_6 - 3.424x_7 - 0.565x_8 + 146x_w + 28x_N + \alpha_1 - \beta_1 - e_1 \leq 0 \quad (5.72)$$

$$-9.111x_1 - 9.111x_2 - 12.268x_3 - 0.748x_4 - 0.937x_5 - 6.778x_6 - 6.778x_7 - 0.565x_8 - 1.1\alpha_1 + \alpha_2 + 1.14\beta_1 - \beta_2 + e_1 - e_2 \leq 0 \quad (5.73)$$

$$-9.111x_1 - 9.111x_2 - 12.268x_3 - 0.748x_4 - 0.937x_5 - 6.778x_6 - 6.778x_7 - 0.565x_8 - 1.1\alpha_2 + \alpha_3 + 1.14\beta_2 - \beta_{3+}\, e_2 - e_3 \leq 0 \quad (5.74)$$

$$-9.111x_1 - 9.111x_2 - 12.268x_3 - 0.748x_4 - 0.937x_5 - 6.778x_6 - 6.778x_7 - 0.565x_8 - 1.1\alpha_3 + \alpha_4 + 1.14\beta_3 - \beta_4 + e_3 - e_4 \leq 0 \quad (5.75)$$

$$-9.111x_1 - 9.111x_2 - 12.268x_3 - 0.748x_4 - 0.937x_5 - 6.778x_6 - 6.778x_7 - 0.565x_8 - 1.1\alpha_4 + \alpha_5 + 1.14\beta_4 - \beta_5 + e_4 - e_5 \leq 0 \quad (5.76)$$

$$15.587x_1 + 15.587x_2 - 9.451x_3 - 0.931x_4 - 1.281x_5 - 3.203x_6 \; 3.203x_7 - 0.712x_8 \leq 0 \quad (5.77)$$

$$15.587x_1 + 15.587x_2 - 9.451x_3 - 0.931x_4 - 1.281x_5 - 5.018x_6 \; 5.018x_7 - 0.712x_8 \leq 0 \quad (5.78)$$

$$2x_1 - 3x_2 = 0 \quad (5.79)$$

$$2x_6 - x_7 = 0 \quad (5.80)$$

$$1.277x_1 + x_3 + x_6 - 2.3x_w \leq 98.9 \quad (5.81)$$

$$1.277x_2 + x_3 + x_7 - 2.3x_w \leq 98.9 \quad (5.82)$$

$$x_4 + x_5 + x_8 + 8x_N \leq 1000 \quad (5.83)$$

$$x_4 - 0.1x_5 \geq 0 \quad (5.84)$$

$$x_4 - 0.3x_5 \leq 0 \quad (5.85)$$

$$\beta_1 + \beta_2 + \beta_3 + \beta_4 + \beta_5 \leq 1000 \quad (5.86)$$

$$e_1 + e_2 + e_3 + e_4 + e_5 \leq 2500 \quad (5.87)$$

$$\beta_1 + \beta_2 + \beta_3 + \beta_4 + \beta_5 - 0.4e_1 - 0.4e_2 - 0.4e_3 - 0.4e_4 - 0.4e_5 \geq 0 \quad (5.88)$$

$$AC - 1.2\beta_1 - 1.2\beta_2 - 1.2\beta_3 - 1.2\beta_4 - 1.2\beta_5 + 0.48e_1 + 0.48e_2 + 0.48e_3 + 0.48e_4 + 0.48e_5 \leq 0 \quad (5.89)$$

$$11.11x_1 + 0.25x_4 + 0.25x_5 + 2.15x_7 - 0.2e_1 - 0.2e_2 - 0.2e_3 - 0.2e_4 - 0.2e_5 \leq 0 \quad (5.90)$$

$$-4x_1 - 2x_2 + 3x_3 - 3x_4 - 3x_5 + 3x_6 - 4x_7 - 1x_8 \leq 0 \quad (5.91)$$

$$w_H \geq (11.11x_1 + 0.25x_4 + 0.25x_5 + 2.15x_7) \cdot 0.1 \quad (5.92)$$

$$w_L \geq (11.11x_1 + 0.25x_4 + 0.25x_5 + 2.15x_7) \cdot 0.1 \quad (5.93)$$

$$w_H \leq (11.11x_1 + 0.25x_4 + 0.25x_5 + 2.15x_7) \cdot 0.25 \quad (5.94)$$

$$w_L \leq (11.11x_1 + 0.25x_4 + 0.25x_5 + 2.15x_7) \cdot 0.25 \quad (5.95)$$

$$w_H - (11.11x_1 + 0.25x_4 + 0.25x_5 + 2.15x_7) \cdot 0.02 \geq w_L \quad (5.96)$$

$$x_i \geq 0 \; for \; i = 1, 2, \ldots\ldots, 8 \quad (5.97)$$

$$x_w \geq 0, \qquad x_N \geq 0 \quad (5.98)$$

$$\alpha_j \geq 0, \; \beta_j \geq 0, \; e_j \geq 0 \; for \; j = 1, 2, \ldots\ldots, 5 \quad (5.99)$$

$$w_H, w_L \geq 0 \quad (5.100)$$

5.8 Model results and analyses

The optimisation problem was solved by using Excel Solver. The excel solver spreadsheet model has been designed to communicate its purpose more clearly, to be highly reliable, auditable, and easily modifiable (Ragsdale, 2018). Excel Solver settings and parameters, including the cells associated with objective function, variables, and constraints required to solve World Airways' capital budgeting problem were clearly identified, as shown in Appendix C. Solver generated three reports for the specified capital budgeting model problem: the answer report, sensitivity report, and limits report. Among these three reports, the first two are considered to be the most useful for finance managers in making efficient capital budgeting decisions. The sensitivity report is the most valuable, as it contains the parameters that explain the unique characteristics of the model. One of these parameters, which explains how sensitive the objective function will be to impact, is the shadow price of the constraint. These reports are discussed in the next sections.

5.8.1 The answer report and analysis

The answer report shown in Table 5.6, summarises the resolution to the problem, and is easy to understand. The first part of the report summarises the original and optimal final value of the objective cell. The second part summarises the original and optimal final values of the decision variable cells. The final part of this report deals with the information about the constraints' final values, assumed by the LHS formula of each constraint. The formula column specifies the upper or lower bounds that relate to respective constraint cell. The status column shows both constraints that are binding and non-binding. If a constraint is satisfied as a strict equality in the optimal solution then it is binding, otherwise, it is non-binding. The values in the slack column shows the difference between the LHS and RHS of each constraint (Ragsdale, 2018). World Airways' optimal solution, results and the analysis are discussed below.

5.8.1.1 Answer report of the base model

The base model answer report results presented in Table 5.6 show the optimal target NPV, which is the company's total net horizon value of $16,510.64 million. The summer Europe route (x_1) is 72.25, the winter Europe route (x_2) is 48.17,

transcontinental (x_3) is 35.17, short flights (x_4) is 90.91, intermediate (x_5) is 909.09, summer Caribbean (x_6) is 30.76, winter Caribbean (x_7) is 61.51, commuter (x_8) is 0, wide-bodied purchase (x_w) is 25.78, narrow-bodied purchase (x_N) is 0, money lent year 1 (α_1) is \$0, lent year 2 (α_2) is \$1,933.64 million, lent year 3 (α_3) is \$5,200.64 million, lent year 4 (α_4) is \$8,794.35 million, lent year 5 (α_5) is \$12,747.42 million, money borrowed year 1 (β_1) is \$1,000 million, and borrowed from years 2 – 5 (β_2, β_3, β_4 , β_5) are \$0.

The results indicate that the company should not operate the commuter route. Moreover, the results also indicate that no narrow-bodied airplanes should be purchased and 26 wide-bodied airplanes need to be purchased. As noted above, wide-bodied (x_w) and narrow-bodied (x_N) airplanes are not integer numbers. Although the outcome may not significantly change in the World Airways case, the linear programming problem can be formulated and solved as a mixed-integer programming problem by adding the extra constraints that both the number of wide-bodied airplanes (x_w) and the number of narrow-bodied airplanes (x_N) to be purchased must be integer numbers. The results also indicate that the company should borrow \$1 billion during year 1 only, with no borrowing from years 2-5. The company should not lend money during year 1, but must be allowed to lend money during years 2-5 as per the limits indicated above, that is, \$1,933.64 million, \$5,200.64 million, \$8,794.35 million, and \$12,747.42 million respectively. The amount of \$12,747.42 million free cash flow, available for lending at the end of the project life, that is fifth year, includes the company's profit. Overall, the results provide useful financial information for World Airways' management to make strategic decisions regarding operations and route selections.

5.8.1.2 Answer report of the modified new model

The modified new model results are shown in column two of Table 5.6. These results indicate that the optimal company total net horizon value is \$18,880.3 million, which is an increase of \$2,370 million compared to the base model and an increase of \$504.5 million compared to Kalyebara & Islam model. There is no change in the value of flight routes, purchased air planes, money borrowed and money lent (except in year 5). Summer Europe route (x_1) is 72.26, Winter Europe (x_2) is 48.17, Transcontinental (x_3) is 35.17, Short flights (x_4) is 90.91,

Intermediate (x_5) is 909.09, Summer Caribbean (x_6) is 30.76, Winter Caribbean (x_7) is 61.51, Commuter (x_8) is 0, Wide-bodied purchase (x_w) is 25.78, Narrow-bodied purchase (x_N) is 0, Money lent year 1 (α_1) is \$0, Lent year 2 (α_2) is \$1,933.64 million, Lent year 3 (α_3) is \$5,200.64 million, Lent year 4 (α_4) is \$8,794.35 million, Lent year 5 (α_5) has increased by 2,500 million to \$15,247.42 million. This represent the company's total value increased as compared to the base model. Money borrowed is the same as in the base model, year 1 (β_1) \$1,000 million, and borrowed from years 2 – 5 (β_2, β_3, β_4 , β_5) are \$0.

The new model indicates that the company should not operate the commuter route, no narrow-bodied airplanes should be purchased and 26 wide-bodied airplanes need to be purchased. Moreover, as per the base model, the new model results indicate that the company should borrow \$1 billion during year 1 only, with no borrowing from years 2-5. The company should not lend money during year 1 but be allowed to lend money during years 2-4 as per limits indicated in the base model, that is, \$1,933.64 million, \$5,200.64 million and \$8,794.35 million respectively. Lending money during year 5 (α_5) increased to \$15,247.42 million in the revised model, and this amount, which includes the company profit increase of \$2,500 million, would be available for lending at the end of the fifth year. On the whole, the new model results provide useful financial information for World Airways' management to make strategic decisions regarding operations, route selections by seasons, airplane purchase, money borrowing and money lending.

Shadow price in the new models shows that the mangers incentive wages constraint -0.5m, which means that if the managers' incentives increased by a unit, the company optimal value will be reduced by \$0.5million. If incentive wages decreased by a unit company value will be increased by \$0.5 million. As these values are not significant, we can conclude that the incentive wage structure proposed in this study is at equilibrium level. Answer report shows that the low and high wages remain between \$118.5m and \$142.2m.

Table 5.6: Answer report summary

		Final Value (million)		
		Base Model	New Model	Base vs New
	Opjective Function			
1	Optimal NPV (Objective value)	16510.642	18880.288	**2369.647**
	Variables			
1	trans-Atlantic Flights - Summer	72.257	72.257	0.000
2	trans-Atlantic Flights - Winter	48.171	48.171	0.000
3	transcontinental Flights	35.169	35.169	0.000
4	Short Flights Narrow-boddied Airplanes	90.909	90.909	0.000
5	Intermediate Flights	909.091	909.091	0.000
6	Caribbean Flights - Summer	30.757	30.757	0.000
7	Caribbean Flights -Winter	61.515	61.515	0.000
8	Commuter Flights	0.000	0.000	0.000
9	Wide-bodied airplanes purchased	25.782	25.782	0.000
10	Narrow-bodied airplanes purchased	0.000	0.000	0.000
11	Amount lent - Year 1	0.000	0.000	0.000
12	Amount lent - Year 2	1933.639	1933.639	0.000
13	Amount lent - Year 3	5200.643	5200.643	0.000
14	Amount lent - Year 4	8794.346	8794.346	0.000
15	Amount lent - Year 5	12747.420	15247.420	2500.000
16	Amount borrowed - Year1	1000.000	1000.000	0.000
17	Amount borrowed - Year2	0.000	0.000	0.000
18	Amount borrowed - Year3	0.000	0.000	0.000
19	Amount borrowed - Year4	0.000	0.000	0.000
20	Amount borrowed - Year5	0.000	0.000	0.000
21	Agency Costs	N/A	0.000	0.000
22	Wage H	N/A	142.204	142.204
23	Wage L	N/A	118.503	118.503
24	Equity - Year 1	N/A	0.000	0.000
25	Equity - Year 2	N/A	0.000	0.000
26	Equity - Year 3	N/A	0.000	0.000
27	Equity - Year 4	N/A	0.000	0.000
28	Equity - Year 5	N/A	2500.000	2500.000
	Constraints			
1	trans-Atlantic flights - Winter	0.000	0.000	0.000
2	Caribbean Flights - Summer	0.000	0.000	0.000
3	Short Flights > 10% of Intermediate flights	0.000	0.000	0.000
4	Total value - Year 1	0.000	0.000	0.000
5	Total value - Year 2	0.000	0.000	0.000
6	Total value - Year 3	0.000	0.000	0.000
7	Total value - Year 4	0.000	0.000	0.000
8	Total value - Year 5	0.000	0.000	0.000
9	trans-Atlantic Rev Year 1	0.000	0.000	0.000
10	trans-Atlantic Rev Year 2-5 *	-167.474	167.474	**334.947**
11	Wide-body airplanes availability - Summer	98.900	0.000	**-98.900**
12	Wide-body airplanes availability - Winter	98.900	0.000	-98.900
13	Narrow-bodied airplanes availability -All times	1000.000	0.000	-1000.000
14	Short Flights < 30% of Intermediate flights *	-181.818	181.818	363.636
15	External Capital Limit	1000.000	0.000	-1000.000
16	Debt Equity Ratio	N/A	0.000	
17	Equity Limit	N/A	0.000	
18	Agency Costs	N/A	0.000	
19	Risk ranking	N/A	3609.495	3609.495
20	Participation Principal - H	N/A	154.054	154.054
21	Participation Principal - L	N/A	177.754	177.754
	* Not Binding and Slack			

Source: Final Value Reports - Appendix C Base Model & Appendix E New Model

5.8.2 Sensitivity report and analysis

A complete analysis of the optimal solution is a critically important step in the effective use of linear programming models. Post-optimality analysis consists of interpretation of the shadow prices and the performance of sensitivity analysis. This is vital for determining the impact of changes in input values on the decisions made by financial managers (Clark et al., 1989). Sensitivity analysis is required in cases in which the exact amount of future cash flows for capital budgeting

cannot be estimated with certainty as they are sensitive to the expected values of cash earnings and costs in the analysis (Ragsdale, 2018; Kalyebara & Islam, 2014; Dayananda et al., 2002). Seitz & Ellison (2005) defined sensitivity analysis as the calculation of present value or other profitability measures for multiple values of at least one variable that will affect the investment. In the sensitivity analysis, single variable at a time is changed and the resulting set of NPVs for projects will identify the variables that have a material impact on the financial outcome.

The sensitivity report shown in Table 5.7 summarises the facts about the variable cells and constraints for the model. This is useful information for finance managers in assessing how sensitive the optimal solution is to changes in various coefficients in the model. Moreover, the report shows the optimal value and values for each variable that contributes to the optimum value. The allowable increase and decrease shown in the sensitivity report in Table 5.7 (detailed analysis is provided in Appendix D), apply only if all other coefficients in the LP model remain constant.

Solver's sensitivity report highlights the reduced cost for each variable, which is the difference between its marginal profit and the marginal value of the resources it consumes, priced at their shadow prices (Ragsdale, 2018). When the marginal profits are less than the marginal value of the resources, that is, negative reduced cost, this indicates a non-optimal solution and should not be incorporated in the objective function.

Generally, the linear programming optimisation model is sensitive to changes in the coefficient variables in the objective function and constraints. In the World Airways case, the variables are: 11.11 for the average number of transatlantic flights per day during the summer season using wide-bodied airplanes, 0.25 for transatlantic flights per day during the winter season using wide-bodied airplanes, and so on. In real life, the value of these variables can change based on demand and other economic and social factors. For example, if the average number of transatlantic flights per day during the summer season using wide-bodied airplanes is changed by one unit from 11.11 to 12.11, this will impact the objective function for the NPV. The model is also sensitive to constraints such as the

availability of wide-bodied airplanes in winter, the availability of narrow-bodied airplanes at all season, and so on. The shadow prices are used to identify the constraints that impact on the optimal value the most. Hence, finance managers must take into consideration utilising sensitivity analysis to factor in predictable changes that provide more sensible financial outcomes for efficient decision making.

5.8.2.1 Sensitivity of the base model

In the World Airways case, the objective coefficient for transatlantic flights during the summer season can assume any value increase of up to 6,848 and value decrease of up to 24, without changing the optimal solution. Constraints that have zero slack in the optimal solution are called binding constraints. In other words, a constraint is binding if its final value is equal to its constraint RHS value. Binding constraints prevent further improvement to the objective function.

The shadow price for a constraint shows the amount by which the objective function value changes given a unit increase in the RHS value of the constraint, assuming all other constraints remain constant. As shown in Table 5.7, if a shadow price is positive, a unit increase in the RHS value of the associated constraint results in an increase in the optimal objective function value. For example, if World Airways increases the number of wide-bodied airplanes by one unit ($1 million) during summer, the objective function value, that is company value, would increase by $50.6 million. If the shadow price is negative, a unit increase in the RHS value of the related constraint results in a decrease in the optimal objective function value. For example, if World Airways increases its Caribbean flights during the summer season by one, the company value would decrease by $5 million. Similarly, the effects of decreases in the RHS values can be analysed by reversing the sign on the shadow price.

For all slack variables in the optimal solution (in the answer report), the corresponding shadow prices are zero. In other words, the shadow price for the non-binding constraints have zero values. For example, transatlantic route revenue for the years 2-5 constraint has a shadow price of zero with an allowable increase of infinity and an allowable decrease of 167. Hence, if the RHS value of this constraint increases by any amount, the objective function value does not

change. Furthermore, World Airways can reduce the RHS value of this constraint by $167 million without affecting the optimal solution.

Based on the sensitivity report shown in Table 5.7, the most sensitive objective variable of World Airways is the availability of wide-bodied airplanes in summer, which had the highest value of the shadow price of $50.6 million. The variable, availability of wide-bodied airplanes in winter, had the second highest shadow price value of $37.7 million. The variable, availability of narrow-bodied airplanes at all season, had the third highest shadow price value of $7.2 million. In summary, these three variables are the most sensitive when one of these variables is changed by one unit, leading to significant impact on the objective value of World Airways. The sensitivity analysis was performed for these top three constraints, increased by one unit for one constraint at a time. The impacts are summarised in Table 5.7.

The results for the horizon of five years show that the two variables contributing most to the optimal value are the NPV of interest earned on money lent and the NPV from purchased wide-bodied airplanes, contributing 77.2% and 15.6% respectively. In other words, these two variables contributed 92.8% of the total optimal value of $16,510.6 million. Reduced cost in the sensitivity report highlights that World Airways should not undertake commuter flight routes, and should not purchase narrow-bodied airplanes. This is in line with management estimates of NPV for both wide-bodied and narrow-bodied airplanes, as shown in the Table 5.5.

5.8.2.2 Sensitivity of the modified new model

The modified new model sensitivity report is shown in column 2 of Table 5.7. The three most sensitive objective variables of World Airways are: the availability of wide-bodied airplanes in summer, which had the highest value of the shadow price of $50.6 million; the availability of wide-bodied airplanes in winter, which had the shadow price value of $37.7 million; and the availability of narrow-bodied airplanes at all times, which had the shadow price value of $7.2 million. If one of these variables was changed by one unit, this would lead to significant impact on the objective value of World Airways. In other words, if the number of wide-bodied airplanes increased by one unit, this would increase the optimal company value

by $50.6 million. One other important shadow price change in the new model is the external capital limit to 3.06, which means that if external capital increased by $1 million, the optimal company value would increase by three times to $3 million. The debt/equity ratio is another prominent shadow price in the new model outcome, which had the value of -2.5. If the debt/equity ratio increased by one unit, it would result in a decrease in optimal value of the company by $2.5 million. Similarly, if incentive compatibility wages increase by one unit would lead to reduction in optimal value by $0.5 million.

Sensitivity analyses have been carried out for the three most sensitive decision variables: the availability of wide-bodied airplanes in summer; wide-bodied airplanes in winter; and the narrow-bodied airplanes at all times. When the constraints of these variables increase by one unit, one constraint at a time, the optimal value as well as the values of some other variables change, as shown in Table 5.7 and Appendix F. These constraints could be changed within the allowable increase and decrease in order to maximise the NPV of the company.

As shown in Table 5.7, the availability of summer season wide-bodied airplanes, with the highest shadow price, impacts most on the objective value of maximising the NPV of World Airways, followed by the availability of wide-bodied airplanes in winter, and then by the availability of narrow-bodied airplanes at all times. In summary, the results show that the purchase of airplanes impacts most on the maximisation of the NPV.

Table 5.7: Sensitivity report

Ranking	Constraints	Shadow Price	
		Base Model	New Model
	trans-Atlantic flights - Winter	-1.093	-1.464
	Caribbean Flights - Summer	-5.043	-5.129
	Short Flights > 10% of Intermediate flights	-1.352	-1.339
	Total value - Year 1	2.077	2.070
	Total value - Year 2	1.331	1.331
	Total value - Year 3	1.210	1.210
	Total value - Year 4	1.100	1.100
	Total value - Year 5	1.000	1.000
	trans-Atlantic Rev Year 1	0.629	0.591
	trans-Atlantic Rev Year 2-5 *	0.000	0.000
1	Wide-body airplanes availability - Summer	50.668	50.697
2	Wide-body airplanes availability - Winter	37.688	37.223
3	Narrow-bodied airplanes availability -All times	7.213	7.132
	Short Flights < 30% of Intermediate flights *	0.000	0.000
	External Capital Limit	0.560	3.053
	Debt Equity Ratio	N/A	-2.500
	Equity Limit	N/A	0.000
	Incentive Compatibility	N/A	-0.500
	Participation Agent High	N/A	0.000
	Participation Agent Low	N/A	-1.000
	Participation Principal - H	N/A	0.000
	Participation Principal - L	N/A	0.000
	Agency costs	N/A	0.000

Source: Sensitivity Reports - Appendix 1 & 2 Base Model & New Model

Table 5.8: Summary of the contribution of variables to optimal value

Base Model

Decision Variables	x1	x4	x5	x7	xw	α5	Total
Cash Flow	11.11	0.25	0.25	2.15	100.00	1.00	
Value changing cell	72.26	90.91	909.09	61.51	25.78	12747.42	
Contribution to Company value	802.77	22.73	227.27	132.26	2578.19	12747.42	**16510.64**
	4.9%	0.1%	1.4%	0.8%	15.6%	77.2%	100.0%

Modified New Model

Decision Variables	x1	x4	x5	x7	xw	α5	Wage H	Wage L	Total
Cash Flow	11.11	0.25	0.25	2.15	100.00	1.00	-0.50	-0.50	
Value changing cell	72.26	90.91	909.09	61.51	25.78	15247.42	142.20	118.50	
Contribution to Company value	802.77	22.73	227.27	132.26	2578.19	15247.42	-71.10	-59.25	**18880.29**
	4.3%	0.1%	1.2%	0.7%	13.7%	80.8%	-0.4%	-0.3%	100.0%

Source: Apendices 1 & 2

Table 5.8 summarises the contribution of variables to the optimal NPV for both the base model and the modified joint optimisation model. The amount lent in year 5 is the major contributor to the optimal NPV in both cases.

5.8.3 Analysis of results

The base model results show NPV of $16,510.64 million, which is a positive net cash flow that increases company wealth by that amount. As shown in Table 5.8, the key decision variables that impact on the NPV of the company are summer season transatlantic flights using wide-body airplanes (x_1), intermediate flights using narrow-bodied airplanes (x_5), short flights using narrow-bodied airplanes (x_4), Winter season Caribbean flights using wide-bodied airplanes (x_7), new wide-body airplanes purchased (x_w), and the amount of money lent in year 5 (α_5).

The modified new multi-objective optimisation game theoretic mechanism design model was developed to incorporate agency costs in the objective function. The debt/equity ratio and equity limit were added to the constraints of this modified model. This model's results indicate that the key decision variables that impact on the NPV of the company are the same as those of the base model: summer season transatlantic flights using wide-body airplanes; intermediate flights using narrow-bodied airplanes; short flights using narrow-bodied airplanes; winter season Caribbean flights using wide-bodied airplanes; new wide-bodied airplanes purchased; and the amount of money lent in year 5. However, the NPV of the new model increased significantly to $18,880.3 million compared to the base model NPV of $16,510.64 million. This incremental benefit of $2,370 million is mainly contributed by the reduction in agency costs as incorporated in the

objective function, as well as the application of incentive contract, accounting control constraints, for example, the debt/equity ratio and equity constraint.

The sensitivity analysis of the base model shows that the critical constraint is summer season transatlantic flights using wide-bodied airplanes, which has the highest shadow price of $50.67 million. In other words, when this constraint is increased by $1 million, the optimal NPV increases by $50.67 million to $16,561.31 million. Similarly, with an increase of $1 million for the constraint, wide-bodied airplanes during the winter season, with the second highest shadow price of $37.69 million, the optimal NPV increased to $16,548.57 million. As for the constraint, the availability of narrow-bodied airplanes at all season, with the third highest shadow price of $7.21 million, an increase by $1 million increased the optimal NPV to $16,517.85 million. The results suggest that investing an additional $1 million on wide-bodied airplanes during the summer season would increase the NPV by $50.67 million, which is a very significant boost to the value of the company.

The most critical constraints (with higher shadow prices) shown in the sensitivity analysis report of the modified new model are the same as those in the base model: summer season transatlantic flights using wide-body airplanes; winter season wide-bodied airplanes; and the availability of narrow-bodied airplanes at all seasons. External capital has the fourth highest shadow price in the revised new model. Sensitivity analysis was carried out by changing one unit ($1 million) of the top three constraints, one at a time, and the optimal NPV outcomes were $18,931.0 million, $18,917.5 million, and $18,887.4 million respectively. As stated before, the constraint with the highest shadow price impacts the NPV the most, hence management must give priority to these key constraints when they make decisions on further capital investment or expansion in World Airways. Moreover, the revised model results clearly show that the NPV increased when incorporating incentive contract, accounting controls and agency costs in the model. In other words, the new approach to an investment appraisal mechanism model incorporating various factors, such as incentive contracts, accounting control, risk management and corporate governance, enhanced the efficiency of the model. This resulted in improved NPV, leading to increased World Airways' wealth. Furthermore, this new model can provide better operational guidance in

determining the right set of airline route schedules, purchases of new airplanes, external capital, and so on.

As indicated in Table 5.5, World Airways' management estimated wide-bodied airplanes would contribute more NPV than narrow-bodied airplanes, and assigned higher coefficient variables/contributions per unit for wide-bodied airplanes than narrow-bodied airplanes. The final results are consistent with this management expected outcome. Overall, the results provide useful financial and strategic information for World Airways' management to make efficient and effective decisions on capital investment, airline route selections and industry operations.

5.9 Validation of the model

Usually, the most challenging element of model testing is validation. This is the process of assessing the model once developed in order to make sure of its effectiveness and efficiency in general and, most specifically, that the model sustains the expected project objectives (Dayananda et al., 2002). The validation process is executed by repeating the operation of the model several times under the same input conditions that impact the decision. A valid model is one that correctly signifies the relevant characteristics of the object or decision problem being studied and, most importantly, allows us to gain insights into, and understanding about, the object or decision problem under investigation (Ragsdale, 2018).

The validation process can be descriptive, experimental or analytical. Descriptive validation involves defining the objective function of the model, the decision variables, the coefficient variables and the expected results (Kalyebara & Islam, 2014). The objective function of the model in this study is to maximise the NPV and mitigate agency costs and increase shareholder value, subject to limited funds.

Analytical validation involves the practical application and robustness of the model and the outcome, and to ensure the effective use in real life capital budgeting. The model developed in this study achieved the expected objective and endorsed the capital budgeting decision criteria of maximising NPV, minimising agency costs, and maximising shareholder value. The validation

process could involve examining the costs, demands and sales earnings (cash flow) experience of similar airline operators. Preferably, data used for in constructing the model should not be used for validation.

Experimental validation entails justification of the model by testing parameters such as cash flow, discount rate, risk, and agency costs, as well as the specification of the solver and the actual execution of the model until credible results are generated. The mechanism design model developed in this study used the Excel Solver program, which is capable of handling multi-constraint problems and is widely used in many countries to solve complex mathematical problems. Hence, the developed model in this study is an appropriate model for capital budgeting decision making.

Once the model had been validated, the usual practice is to undertake sensitivity analysis to establish what forces errors in the parameter estimates would have on NPV calculation (Dayananda et al., 2002). Validation, followed by sensitivity analysis ensures the acceptability and credibility of the model and of the results. This is discussed in the next section.

5.10 Implications of using a multi-objective mechanism design model

The model presented in this chapter analysed multi-objective optimal mechanisms designed by the principal to mitigate agency costs that occur from the principal-agent relationship game. The modified model outcome evidently demonstrates the mitigation of agency costs and the overall improvement of the optimal NPV. The new integrated multi-objective mechanism design approach to the capital budgeting decision making process has significant implications and benefits for firms investing in capital projects. These benefits relate not only to the airline industry but also other industries, as this integrated model approach will assist managers to make sound decisions by incorporating various areas and issues that impact investment decisions. The multi-objective mechanism design model reflected the effect of the allocation of economic resources and their NPV contributions towards the company objective function.

The multi-objective model incorporates maximising NPV and minimising agency costs in the objective function that can be applied to many other economic areas. For example, it could be used in resource allocation, the objective of which is to

maximise profits and minimise total cost. Furthermore, the model can be applied in various analyses, such as financial analysis, cost allocation, pricing, risk management and supply chain management.

Efficient capital investment appraisal decisions are carried out, taking into consideration interdisciplinary functions such as agency costs, accounting practices, accounting issues, corporate governance and risk management (Kalyebara & Islam, 2014). The multi-objective mechanism design model developed in this study incorporates these elements, thus creating a significant contribution to capital investment evaluation practices and contemporary capital budgeting literature.

From an accounting perspective, the higher NPV results from the model are the outcome of the strategic decisions produced by the optimal mechanisms. In other words, by applying incentive/control mechanisms such as accounting regulations and standards, suitable discount rates, and sustaining the right level of debt/equity ratio, the model outcome improved, and World Airways' wealth increased as a consequence. Moreover, the accounting controls embedded in the model as accounting mechanisms will increase the quality of accounting numbers and predictability of cash flows and hence are incentives for managers to comply with accounting standards and regulations, leading to sound capital investment decisions. These optimal mechanisms are beneficial for the underlying strategic investment plan, accounting, corporate governance and risk management policies of organisations.

5.11 Conclusion

This chapter analysed the relationship between capital budgeting decisions and the game theoretic mechanism design optimisation model designed to mitigate agency costs. The model addresses the problem of shareholder/principal wealth maximisation, subject to the managerial incentive and control mechanism for achieving the goal of the shareholders, referred to as incentive compatibility. The model was applied to the World Airways case study to establish the operationalisation and significance of this theory for designing mechanisms and solutions to mitigate agency problems and achieve efficient capital budgeting decisions. Further, the developed model provides credible results and

implications for mechanism designs for the practical and efficient allocation of resources, good corporate governance, accounting practices and efficient capital budgeting decisions.

The model results highlighted in particular the optimal NPV of the base model, and after incorporating incentive wages, agency costs, accounting issues and capital budgeting principles, resulted in a new integrated approach to capital budgeting, representing a significant contribution to contemporary capital budgeting practices and literature.

The main conclusion of this chapter is that the principal-agent game based mechanism model can be beneficial for recognising how organisations select their capital investment projects within the framework of agency problems and information asymmetry. These issues may also be beneficial in understanding the adoption of rules for efficient capital budgeting (Marino & Matsusaka, 2005).

Overall, the multi-objective joint optimisation game theoretic mechanism design model developed in this study makes a real contribution to the literature on contemporary accounting and finance, management science, corporate governance and, particularly, capital budgeting. It fosters further prospects for future research to establish the usefulness of game theoretic mechanism design models in solving the real life capital budgeting problems of any organisation. The model is also sufficiently flexible and can be operationally replaced with various objective functions instead of maximising NPV. Hence, it is very useful for decision makers. A vital direction for future research is to investigate the relationship of incentive contracts and capital budgeting decisions in other real life industry sectors.

CHAPTER 6: DISCUSSION OF RESULTS AND IMPLICATIONS

6.1 Introduction

This chapter extends the discussions of the research findings presented in the Chapter 4 and Chapter 5. In particular, the focus is on how the proposed project-specific discount rate selection method and the developed joint optimisation game theoretic model for mechanism design in capital budgeting, establish an incentive contract that can mitigate agency problems, ensure sound accounting practices and provide a basis for efficient capital budgeting decisions leading to enhanced company value. This chapter also broadens the discussion on the significance of accounting quality and the principal-agent game in providing benefits for the model in relation to mitigating agency costs. Moreover, the implications of debt capacity based project-specific discount rate estimation and the implications of a mechanism design framework for integrating the research issues and analysing the interrelationships between accounting methods, risk management, corporate governance and firm value are discussed based on the principal-agent game theory and from the information economics perspectives. The results of this study highlight some implications of applying the project-specific discount rate concept for the selection of the right set of capital projects, and incentives and controls for mechanism design within game theoretic framework. This would ensure that the application of robust accounting and capital budgeting practices would lead to maximised firm value.

The reminder of this chapter is structured as follows. Section 6.2 expands the discussion on the results presented in Chapter 4 and Chapter 5. Section 6.3 discusses the implications of discount rate, particularly the extent to which the correct estimation of discount rate is conducive, for achieving efficient capital budgeting decisions. Section 6.4 discusses the implications of the mechanism design framework on the principal-agent game. Section 6.5 discusses the implications of applying game theory for achieving efficient capital budgeting and improving company value. Section 6.6 presents the implications of accounting methods and practices, in particular accounting quality that can lead to efficient capital budgeting. Section 6.7 discusses the theoretical and policy implications of the study. Section 6.8 presents the sensitivity analysis implications. Section 6.9

discusses the plausibility of the results and generalisation of the model. Finally, Section 6.10 concludes the chapter.

6.2 Discussion of the results

In Chapter 4, the choice of suitable discount rates for capital project appraisal was discussed and project-specific discount rates were estimated for the two projects described in the Wal-Mart case study. The outcomes were analysed. In Chapter 5, the mechanism design and its role in designing an optimal contract to mitigate agency problems and help achieve optimal capital budgeting decisions to enhance company value were investigated using the World Airways case study. The results of both case studies provide an essential basis for scrutinising the investigated research issues related to efficient capital budgeting decisions.

6.2.1 Discount rate selection and projects results

Firm-wide WACC is a simple discount rate method and provides managers with a limited degree of freedom (Jagannathan et al., 2016). However, this approach may lead to flawed capital budgeting decisions and hence curtail shareholder value. In the Wal-Mart case, the market values of capital sources were used as weights and the firm's RRRs for debt and equity were used to estimate the firm-wide WACC outcome of 12.8% (calculation shown in Table 4.7). However this discount rate was not tailored to the risks of the investment projects, and favoured the less profitable and riskier project B. Thus, applying this firm-wide discount rate would lead to inefficient allocation of the firm's capital.

Most accounting and finance theories suggest that firms evaluate each investment project with individual discount rates that reflect both the debt capacity and the unique risks of the project. However, in practice, a firm-wide average single WACC is widely used to evaluate capital projects (Martin, 2008). In this study, the project-specific discount rates were estimated for projects based on their debt capacities, reflecting risk factors as weights and the firm's RRRs. The application of this method to the Wal-Mart case study, resulted in the discount rate of 6.2% for project A and 10.7% for project B, which were significantly lower than the firm-wide discount rate of 12.8%, as shown in Table 4.9. Using debt capacities is a short-cut and simpler method, but it reflects the risk associated with projects. Project A has higher profit margins and is less volatile in response

to change in prices, which makes it less risky with a higher debt capacity. This results in a lower discount rate. In contrast, project B has lower profit margins, which makes it sensitive to changes in prices and riskier, with a lower debt capacity. This results in a higher discount rate.

Applying the two different estimated project-specific discount rates to evaluate both projects, project A was preferred, in contrast to the outcome of using a firm-wide discount rate, which showed a preference for project B (see Table 4.12). As project-specific discount rates are tailored to the risks of the investment projects, their use can lead to efficient capital budgeting decisions and optimal allocation of resources, this maximising firm wealth.

The major criticism of using the project-specific discount rate, apart from the complexities involved, is that it might lead to managerial opportunistic behaviour. In other words, managers can manipulate the system by using the flexibility to select inappropriate discount rates in order to maximise their own interests. However, as discussed in Chapter 4 Section 4.5.2 and 4.5.4, the proposed project-specific WACC model in this study is based on project debt capacity, which is determined by the external market conditions, thus limiting managers' ability to misuse the discount rate and in most cases project specific WACC provides an appropriate estimate to the discount rate that theory dictates. Moreover, mechanisms such as quality accounting reports and managerial incentives and control can be used to motivate managers to mitigate these opportunistic managerial behaviour. Thus, it can be concluded that the proposed project-specific discount rates selection method, tailored to the risks of the investment projects, would lead to efficient capital budgeting and sound allocation of resources.

6.2.2 Mechanism design and capital budgeting optimisation results

In this study a new multi-objective optimisation game theoretic mechanism design model has been developed, incorporating the maximisation of NPV, incentive wages, and reduction in agency costs in the objective function (formula 5.41). Debt/equity ratio and equity limit (formula 5.66 and 5.65), agency cost (5.67), participation constraints (5.60, 5.61, 5.62 and 5.63), incentive compatibility (5.64), financial performance (5.68) and risk management (5.70) were added to the

constraints of the new model in addition to the operational constraints. Agency costs were calculated by using a debt/equity ratio as a proxy, as the debt capital from the capital markets discipline management, thereby mitigating agency costs (Kalyebara & Islam, 2014).

The model results indicate that the key decision variables that impact on the NPV of World Airways were transatlantic flights during the summer season using wide-bodied airplanes, intermediate flights using narrow-bodied airplanes, short flights using narrow-bodied airplanes, Caribbean flights during winter using wide-bodied airplanes, new wide-bodied airplanes purchased, and the amount of money lent in year 5. The NPV of the new model increased significantly to $18,880.3 million, compared to the base model NPV of $16,510.64 million (see Table 5.6). This incremental benefit of $2,370 million, was mainly contributed by the reduction in agency costs as incorporated in the objective function and the application of incentive wages, accounting control constraints, such as debt/equity ratio and equity rationing. The incremental benefit of $504.5 million compare to Kalyebara and Islam model (2014).

The sensitivity analysis of the model discussed in Section 5.8.2, shows that the critical constraint was transatlantic flights during the summer season using wide-bodied airplanes, which had the highest shadow price of $50.67 million. In other words, by increasing this constraint by $1 million, the optimal NPV increased by $50.67 million to $16,561.31 million. Similarly, an increase by $1 million for the constraint, wide-bodied airplanes during the winter season, with the second highest shadow price of $37.69 million, resulted in an increase in optimal NPV to $16,548.57 million. For the constraint, availability of narrow-bodied airplanes at all times, with the third highest shadow price of $7.21 million, an increase by $1 million increased the optimal NPV to $16,517.85 million. The results suggest that investing an additional $1 million on wide-bodied airplanes during the summer season would increase the NPV by $50.67 million, which is a very significant boost to the value of the company.

The most critical constraints shown in the sensitivity analysis report of the new model (see Table 5.7) were transatlantic flights during the summer season using wide-bodied airplanes, wide-bodied airplanes during the winter season and

availability of narrow-bodied airplanes at all times. External capital had the fourth highest shadow price in the new model. Sensitivity analysis was carried out by changing one unit of the top three constraints, one at a time, and the optimal NPV outcomes were $18,931.0 million, $18,917.5 million and $18,887.4 million respectively (detailed analysis in provided in Appendix F). As stated before, the constraint with the highest shadow price impacted the NPV the most, hence management must give priority to these key constraints when they make decisions on further capital investment or expansion of World Airways' business. As illustrated in Chapter 5, World Airways' management estimated wide-bodied airplanes to contribute more NPV than narrow-bodied airplanes, and assigned higher coefficient variables/contributions per unit for wide-bodied airplanes than narrow-bodied airplanes. Sensitivity analysis implications are discussed further in Section 6.8.

The new capital budgeting optimisation model results clearly show that NPV increased by incorporating agency costs in the model objective function. In other words, the new approach to an investment appraisal mechanism model incorporating various factors, such as accounting quality and control, agency theory, game theory, risk management and corporate governance, has enhanced the efficiency of the model and resulted in improved NPV, leading to an increase in World Airways' wealth. The final results of the model are consistent with management's expected outcomes.

Overall, the optimisation model results provide useful financial and strategic information for World Airways' management to make efficient and effective capital investment decisions, airline route selections and route scheduling, external capital arrangements and industry operations. Most importantly, the new model is proven to be a very useful model for various industries in general, and for the airline industry in particular, to evaluate capital investment projects more efficiently.

6.3 Suitable discount rate implications on capital budgeting decisions and company value

Capital budgeting is a crucial business function for the efficient allocation of firm resources to enhance company value. Although techniques such as payback

period continue to be widely used to evaluate projects, the NPV method is more popular as this approach considers the time value of money and opportunity cost of investments, as well as the risk of the particular investment projects that are under evaluation (Jagannathan et al., 2016; Vesty et al., 2015; Truong et al., 2008; Ogier et al., 2004). The NPV analysis discounts the cash flows of future years to make them equivalent to those of the current year. Instead of using an appropriate discount rate, if a higher discount rate is chosen to evaluate capital projects, profitable projects may get rejected and if a lower discount rate is chosen, an unprofitable project may be selected. Hence, the accurate estimation of the discount rate is critical to sound capital budgeting (Levary & Seitz, 1990). However, very little is known about factors that determine the discount rate that firms use and thus considerable effort has been made by accounting and finance professionals to find the empirical derivation of the suitable discount rate, resulting in unsatisfactory outcomes (Jagannathan et al., 2016; Murray, 1997). Given the lack of appropriate guidance regarding such a key variable, this study presents the results of the development an informed and defensible position regarding the estimation of suitable discount rates.

6.3.1 Implications of project-specific discount rates

As discussed in Chapter 4, many firms use their company-wide WACC to evaluate all of their capital projects due to a number of reasons. Firstly, using project-specific multiple discount rates is complex and analytically challenging and the benefits of doing so have not been articulated well enough in practice and in the literature. Secondly, most firms believe that using project-specific discount rates may offer too much flexibility, resulting in managerial opportunistic behaviour (Martin & Titman, 2008). However, these problems can be mitigated by applying a systematic and verifiable model to estimate project-specific discount rates. The debt capacity based project-specific discount rate method proposed in this study, as outlined in Section 4.5.4.2, is a simple method and it limits managers' discretion, as the estimation is based on external information. Various incentives and control mechanisms can also be used to motivate managers to work towards shareholders' interests.

The discount rate estimation outcomes of this study clearly show that project-specific discount rates are suitable for project evaluation, leading to efficient capital allocation and sound investment decisions. If the project debt capacity is estimated appropriately, the proposed project-specific approach would help mangers choose the appropriate risk adjusted discount rates for projects with clear justifications.

6.3.2 Risk management and the discount rate

Risk management is not a new feature of businesses and corporate governance. However, recent financial scandals, particularly in the US, have brought internal control and risk management issues into the spotlight. It is currently high on the corporate agenda and drawn the focus of academics, policymakers, lawmakers and practitioners. Furthermore, the current trend of risk management shows signs that more accounting and auditing standards will be developed to improve the quality of financial reporting and good corporate governance (Daelen et al., 2010). This study highlights the importance of risk management for quality accounting information and mitigating agency costs, which lead to correct estimation of discount rates and efficient capital budgeting decisions.

There is growing evidence that agency costs lead to total firm risk (Bernado et al., 2001; Seits & Ellison, 2005). Risk management can be used to align the interests of managers with those of the shareholders and can also be used to design management compensation plans that hold management accountable for their actions. As discussed in Chapter 4, there are various ways in which risk can be incorporated into the NPV computation and capital budgeting decision process. This includes risk-adjusted discount rates, the certainty equivalent, sensitivity analysis, break-even analysis and simulation.

Although there are various tools available to assist managers in measuring and evaluating project risk, most of these tools when used in practice are subjective, often based on judgements that may lead to incorrect capital investment decisions. This may result in a firm rejecting profitable projects with risk levels below the firm's average risk and accepting unprofitable projects that have risk levels above the firm's average risk (Pachamanova & Fabozzi, 2010). This study has sought to resolve these issues and proposes project-specific discount rates

that consider project-specific risks to improve capital budgeting decisions and minimise under and over investments.

6.4 Mechanism design implications on the principal-agent game in capital budgeting

This study has analysed the mechanism design model based on the game theoretic framework, designed by the owner (principal) and offered to the manager (agent) to mitigate agency problems that occur in the principal-agent relationship. As discussed in Chapter 5, particularly in Section 5.10, one of the benefits of applying agency theory in this study is the design of management evaluation and compensation systems that reduce conflicts of interest between managers/agents and shareholders/principals by aligning their interests. The optimal business combination proposed by the mechanism design model embeds the best strategic decisions needed to protect shareholders' interests, while offering incentives for managers to work to enhance shareholder value. (Beck et al., 2013).

The new optimisation model outcomes clearly demonstrate the mitigation of agency costs and the overall improvement in the optimal NPV, as shown in Table 5.6, leading to efficient capital budgeting decisions. The new integrated multi-objective mechanism design approach to capital budgeting decision making has significant implications and benefits for firms investing in capital projects. These benefits could apply to many industries, not just the airline industry as studied in this research.

The multi-objective mechanism design model has considered the impact of economic resources allocation and their NPV contributions towards a company's objective function. Efficient capital investment appraisal decisions are carried out, taking into consideration the interdisciplinary functions such as agency costs, accounting practices, accounting issues, corporate governance and risk management (Kalyebara & Islam, 2014). The multi-objective mechanism design model developed in this study has incorporated these elements and hence it make significant contribution to capital investment appraisal practices and contemporary accounting literature.

6.4.1 Mechanism design for ensuring accounting quality and mitigating agency costs

From an accounting perspective, the higher NPV results from the model are the outcome of the strategic decisions produced by the optimal mechanisms. In other words, by applying incentive control mechanism such as accounting regulations and standards, suitable discount rates and sustaining right level of debt equity ratio have improved the model outcome and hence increased World Airways' value.

Moreover, the accounting control embedded in the model as accounting mechanism can increase the quality of accounting numbers as indicated in table 5.6, and predictability of cash flows and hence incentive for managers to comply with accounting standards and regulations, that lead to sound capital investment decisions. These optimal mechanisms are beneficial for the underlying strategic investment plan, accounting, corporate governance and risk management policies of organisations.

An important aspect of mechanism design is to develop a fair incentive contract between the manager and shareholders to align the interests of both parties. This is important when the manager's efforts are unobservable by the owner/shareholders, while at the same time payoff is jointly observable by both players (Scott, 2015). The optimal incentives offered through this contract motivate managers to choose the best strategic decisions that can maximise shareholder value. As specified in Chapter 5, a performance-based incentives contract captures the incentive mechanism offered to the managers by the shareholders. A number of potential measures of performance can be used to determine managers' payoffs, but net income is commonly used as it is observable by both parties.

The proposed model in this study incorporates compensation contracts based on net present value as performance measures, hence managers have an incentive to act to enhance firm value as expected by shareholders. The alignment of interest between the two players describes the way accounting policies and practices can provide financial benefits for the firm and thus can have economic consequences (Scott, 2015). Moreover, this can lead to managerial concerns about the accounting policies implemented in the company in terms of the

usefulness of accounting reports to potential investors, particularly when related to capital budgeting decisions. Incentive contracts based on accounting numbers to measure manager performance can motivate management to participate in designing sound accounting policies and practices to enhance firm value.

Conversely, creative managers can manipulate accounting numbers and engage in potential earning management and managerial shirking to maximise their payoffs. Thus, control mechanisms, such as GAAP, audits, and conservative accounting methods, particularly historical cost-based accounting, need to be used by owners to prevent such managerial activities. Furthermore, an efficient contract would require managers to apply appropriate accounting policies and practices in accordance with the GAAP and approved accounting standards, motivating them to exert their highest effort to enhance shareholder value.

6.4.2 Mechanism design based on a game theoretic framework for efficient capital budgeting

As stated in Chapters 4 and 5, this study adopted the principal-agent game relationship in capital budgeting as two parties are involved: shareholders as the principal, and managers as the agent. In this framework, it can be assumed that there is information asymmetry and moral hazard problems, where the agent's actions are unobservable by the principal This creates agency problems when selecting the right set of capital projects to maximise firm wealth. Therefore, the principal's mechanism design, relating to incentive contracts, should ensure that agents act in the best interests of the principal and truthfully report their efforts (Narahari, 2014; Rasmussen, 1994). Capital budgeting tasks are generally performed by a division or a department of a firm. Thus, this study adopted incentive wages, incentive rules, such as compliance to accounting rules, regulations, GAAP and accounting standards, suitable discount rates, a sustainable debt/equity ratio, and risk management, as mechanisms to mitigate agency costs and improve the efficiency of capital budgeting decisions.

Based on agency theory, a branch of game theory, such incentive contracts establish strategic interactions between both players that can align their interests in an optimal way and hence mitigate agency costs (Scott, 2015). In line with this principle, the game theory and the mechanism design framework are adopted to

solve the agency problems by specifying a capital budgeting optimisation problem in order to find the equilibrium solution (Narahari, 2014; Montet & Serra, 2003).

The mechanism design equilibrium can be obtained by applying various methods such as Nash Equilibrium, Bayesian Equilibrium, sub-game perfect equilibrium, and dominant strategy implementation etc. The proposed mechanism design model reflects the problem of principal wealth maximisation and increase in total NPV, subject to the managerial incentive and control mechanism and resulting in efforts for achieving the principal's interest in efficient and effective ways. In other words, the mechanism specifies the incentive-compatible constraints using controls such as debt-equity ratio and application of other accounting regulations to mitigate agency problems and to solve the principal's objective of wealth maximisation. The interest of agents is incorporated through optimal contract designs with incentive compatibility and participation constraints in order to motivate agents to act on behalf of the principal.

The results of the optimisation model, shown in Chapter 5 (formulas from number 5.60 to 5.70), suggest that the developed model gives incentives to managers to maintain the incentive wages and firm's debt/equity ratio within the optimal range and comply with GAAP and other accounting regulations in order to minimise agency costs and maximise NPV. Thus, the mechanism design model ensures that the firm can sustain its investment and financial strength over the long-term and enhance shareholder value.

6.5 Implications of applying game theory in capital budgeting

In real world capital budgeting, shareholders (as principals) who provide funds for investment have to rely on self-interested managers (as agents) to identify the right set of profitable projects and provide information on expected returns. Therefore, the quality of capital allocation depends on how effective the decision process aligns both players' interests, thereby mitigating agency problems (Marino & Matsusaka, 2005). Opportunistic managers tend to choose inappropriate discount rates and select unprofitable projects that can provide quick payback with minimal effort to maximise their own benefits. Game theory, as a valuable capital investment tactic, can help in understanding these issues

and to achieve positive sum outcomes; a win-win situation that mitigates potential agency costs and protects shareholder wealth (Scott, 2015).

As discussed in Chapters 4 and 5, game theory guides the process of choosing appropriate discount rates, accounting policies, accounting standards and managerial incentives and controls to achieve efficient capital investment decisions. It also validates managerial opportunistic behaviour, noting that, under certain circumstances, managers misrepresent financial statements for their own advantage. Game theory is a very useful tool to understand the difficulties in implementing new accounting policies and procedures associated with low incentives/payoffs for management.

An important aspect of game theory is that it is an optimisation method, generating a solution that is optimal, as shown in Table 4.2. Thus, a compromise is the optimal solution if both players are playing a perfect game to maximise their respective benefits in a cooperative way (Schniederjans et al., 2004). Furthermore, applying cooperative game theory, where there is a binding agreement between the players, the principal-agent relationship that exists in the capital budgeting decision making process would help in designing contracts to motivate rational managers to act on behalf of the shareholders. This would be achieved by appropriately estimating discount rates and selecting the right set of projects to maximise shareholder value (Scott, 2015).

6.5.1 Analysing the principal-agent game in capital budgeting

The separation of ownership and control in a firm leads to asymmetric information, which instigates agency conflicts between the principal and agents. When performing capital budgeting, principals/shareholders expect agents/managers to perform to the best of their abilities to maximise company wealth by applying suitable discount rates and selecting the right set of projects for long-term investments. However, in practice, the principal often has inadequate information about the business, making it difficult to determine whether managers have contributed to the success of the company. This illustrates the existence of information asymmetry (Gul, 2007; Scott, 2015). Hence, managers can arbitrarily choose the discount rate or manipulate the cash flows that allow them to pick a set of unprofitable projects that maximize their

interests in order to maximize their interests that creates agency costs. However, evidence of efficient contracting suggests that it is possible to align managers' interests with that of shareholders (Scott, 2015).

Managers can resolve these agency problems by accepting the shareholders' interest in wealth maximisation as an ethical obligation. Alternately, these agency problems can be resolved through close monitoring, compensation plans, or even capital structure decisions (Seits & Ellison, 2005). Monitoring managers can be difficult and expensive, but compensation plans have proven to be powerful tools for limiting agency problems. The aim of the incentive is to use explicit contracts to limit the divergent preferences and thus reduce agency costs. In this way, the principal designs a contract in which an agent's compensation is tied to firm performance. Hence, agents have to work towards maximising company value in order to ensure they will receive a high level of compensation in return. A principal can also allocate company shares to managers to motivate them to work hard to maximise company value. Empirical evidence supports the theory that dividend policy plays a role in solving agency problems (Fenn & Liang, 2001; Seits & Ellison, 2005). Thus, the higher the proportion of the equity owned by managers, the greater the incentive for managers to act in the interest of shareholders, thereby reducing agency costs.

As discussed in Chapter 5, another important mechanism is monitoring, where the principal invests in various systems and controls designed to monitor the agents' actions so they act according to the company's rules, regulations and GAAP. Investments in monitoring systems include budgeting and accounting systems.

Incentive contracts and monitoring devices are broadly described as corporate governance mechanisms (Gul, 2007).

6.5.2 Implications of game theory in accounting

As discussed in Chapters 4 and 5, game theory models the interaction between two or more players and predicts the outcome of a conflict between rational individuals who try to maximise their respective interests. Similar situations often

arise in accounting decision making and hence the application of game theory in accounting to resolve these issues is worthwhile (Scott, 2015).

Accounting information is an important input in the capital budgeting decision making process. However, in some circumstances, managers can distort this information to suit their own personal interests. This can lead to inefficient capital budgeting decisions. In these settings, game theory can play a major role in resolving the accounting distortion problem, by applying a cooperative game between managers and shareholders through managerial incentives and control mechanisms. These rules are sometimes considered bureaucratic, leading to sub-optimal choice. However, limiting managers' ability to misuse accounting information can prevent even worse accounting distortion and intense agency costs (Martin & Titman, 2008).

Game theory can also be used to prove to accounting standards boards the risks associated with trying to implement accounting policies that do not consider the interests of all stakeholders (Scott, 2015). In other words, game theory helps to design appropriate accounting standards that achieve the cooperation of all stakeholders.

6.6 Accounting quality implications on capital budgeting

Quality accounting practices play an important role in capital budgeting as decisions are based on the expected future cash flows discounted to the present value, using risk adjusted discount rates. As discussed in Chapter 4, the estimation of discount rates requires correct accounting information, particularly the value of balance sheet items such as debt and equity. Similarly, future cash flow estimations are usually based on previous period accounting reports. Thus, quality accounting reports are imperative for the correct estimation of these two critical inputs, discount rate and future cash flows, and for efficient capital budgeting decisions.

Quality accounting reports should convey information about a firm's operations with precision (Biddle et al., 2009). A manager's preference for certain types of accounting policies at different times, associated with earnings management, would seriously impact the quality of accounting reports (Scott, 2015). Capital budgeting activities that rely on poor quality accounting reports could lead to

inefficient investment decisions. Therefore, it is vital that accounting reports are prepared in accordance with GAAP and approved accounting standards, and undergo periodic audits to safeguard quality. Research evidence suggests that higher quality accounting statements can improve investment efficiency by mitigating information asymmetries that give rise to moral hazard and adverse selection (Biddle et al., 2009).

6.6.1 Accounting methods

As discussed in Chapter 4, Section 4.3, accounting statements are prepared in accordance with GAAP and accounting standards and, in most cases, are based on historical cost accounting. Nevertheless, these numbers can be converted into market value, particularly for the estimation of cost of capital (Brigham & Ehrhardt, 2014). Debates still exist among academics and accounting professionals on which method should be used when estimating the cost of capital and cash flows for capital budgeting. The main arguments in favour of historical cost value are that accounting numbers are reported in book value and are more stable than current value, hence they produce more stable inputs for capital budgeting. Conversely, the main arguments in favour of current value are that firms raise funds by selling securities at their market values and current values are more consistent with the idea of value maximisation (Brigham & Ehrhardt, 2014).

The current values of assets and liabilities are potentially of greater interest to equity investors than their historical costs, since current values provide the best available indication of future firm performance and investment returns, particularly where current values are relevant in determining correct weights for WACC estimates. However, the unrealised gains and losses from adjusting the carrying values of assets and liabilities to current values do not reflect managers' own performance (Scott, 2015). Therefore, managers generally prefer current costing methods and shareholders prefer historical cost methods, which can reliably measure management performance. As a consequence, accounting standard setters are required to play the role of moderator between shareholders and managers who have conflicting preferences.

Both types of information asymmetry (adverse selection and moral hazard) create accounting estimation risks, as both involve different accounting methods.

Adverse selection means that managers and other insiders have more knowledge than outside investors about the financial status of the firm. The accounting challenge here is that investors need relevant information to predict the firm's future performance to make investment decisions. Therefore, current value based accounting information is preferred as it is the best predictor of future value. Moral hazard relates to the fact that the effort exerted by a manager is unobservable to shareholders. The accounting challenge here is to offer managers accounting performance-based (e.g. net income) incentive contracts to motivate them to work harder and to protect shareholders from managerial opportunism. However, the high volatility and low reliability of current value accounting reduces the informativeness of net income as a measure for managerial performance. Consequently, historical cost accounting is a more reliable, conservative and less vulnerable measure of net income and subject to fewer managerial manipulations (Scott, 2015). Therefore, a trade-off between current value and historical cost accounting is crucial for accounting standard setters to moderate this issue.

Current developments in accounting and available evidence suggest that the current cost accounting method has gained more supporters. Nevertheless, in a dynamic world, considering increased volatility, it is simply not feasible to blindly and mechanically focus on the current value method (Scott, 2015). The experience of the stock market crash of 2008-2009 indicates that neither historical value nor market value represent how firms wanted to be financed in the future (Brigham & Ehrhardt, 2014).

6.6.2 Accounting statements and capital budgeting

Accounting reports are critical information sources use to determine a company's financial health, particularly its financial performance and position. Accounting statements are also considered important mechanisms to maintain the integrity of capital markets around the world. However, some recent academic studies have found a decline in the usefulness of accounting reports for investors over time, due to the loss of relevance of accounting information. In addition, there has been an increase in the variety of other types of information available to investors, and amazingly some are interested in corporate financial information (Davern et

al., 2018). However, the research findings of Davern et al. (2018) established that accounting reports remain useful to investors over time.

In Chapters 4 and 5, it was emphasised that a project's net cash flows, not accounting income, are critical for capital budgeting decisions. Some elements, such as assets purchased and depreciation, net working capital and interest payments, are treated differently in accounting reports and cash flow reports. Assets purchased for projects are treated as cash outflows but not included as expenses in accounting reports. In contrast, depreciation of these assets is deducted as an expense in accounting reports but is not a cash outflow item for cash flows. The net working capital required for projects is considered cash outflow and reversed by the end of the project as cash inflow, but this item is not an expense in accounting reports. Interest charged is not included as project cash outflow, as the cost of debt has already been embedded in the discount rate, but this item is included in accounting reports as an expense. Therefore, when using accounting reports for cash flow forecasting, extra care needs to be taken to differentiate these items.

As discussed in Section 4.3, the role of high quality accounting reporting to maintain shareholder trust in managers is crucial for efficient capital budgeting decisions. Deviation of reported information in financial statements from the underlying business reality leads to accounting distortions (Wild et al., 2004). These distortions can be referred to as accounting risks, as they influence the quality of the accounting information that is used as a key resource for business decision making. Accounting distortions generally arise due to errors in estimation, non-compliance with relevant accounting standards, constraints in measurements and concepts, or flaws in earnings management activities and so on. It is imperative to note that a contributing factor to the market collapse during the early 2000s, was numerous financial reporting irregularities (Scott, 2015).

The criticism of accounting over time has motivated accounting standard setters around the world to develop standards that improve the quality of accounting information in terms of qualitative characteristics such as understandability, relevance, reliability, comparability and consistency, which in turn can improve the decision making process (Warfield et al., 2008; Weygandt et al., 2010). Thus,

this study enhances accounting standards based quality reporting that can provide effective inputs for sound capital budgeting decisions.

6.6.3 Implications of ethical behaviour for accounting

As highlighted in Section 4.3.4, it is important to note that there is a social dimension to integrity and independence, in addition to compliance with rules and regulations, GAAP, and audits. In recent years, more attention has been given to behavioural aspects and the basic agency model has been extended to include behavioural phenomena (Lucas, 2018). Ethical behaviour by all stakeholders, particularly managers and accountants, is crucial to restore and maintain public confidence in financial reporting, since numerous accounting professionals were involved in various reporting irregularities during recent company scandals (Scott, 2015). The prospects for survival and prosperity will be enhanced if accountants have a critical awareness of the longer-run impact of financial reporting on all stakeholders, particularly on investors, managers, the economy and society.

As stated previously, one of the responses to the financial crisis during the 2000s in the US, and the subsequent collapse of public confidence in financial reporting, was increased regulation, including new accounting standards. However, complying with regulations alone is not sufficient to prevent financial reporting failures. The ethical behaviour of professionals who are responsible for preparing accounting reports is also vital, since numerous managers were directly or indirectly involved in the various reporting irregularities. Ethical behaviour means that managers and accounting professionals should do the right thing, they must behave with integrity and independence in placing the public interest ahead of other stakeholders, when these two interests conflict. Although behavioural aspects are not incorporated in the developed optimisation game theoretic model, this study highlights the importance of ethical social behaviour that would enrich the quality of accounting reports and lead to optimal capital investment decisions and enhanced company value.

6.7 Theoretical and policy implications of the study

The study's findings have highlighted many theoretical and policy implications, particularly accounting theory implications, mechanism design and game theory

implications in capital budgeting, policy implications and methodology implications. These are discussed below.

6.7.1 Accounting theory implications

In accounting, mechanism models have been developed in several areas, such as a principal-agent model applied to the design of performance measures (Kanodia, 2014); an incentive compatibility model for resolving agency problems in cost accounting (Demski, 2008); and an agency model for management accounting (Lambert, 2007). However, no mechanism design model has been identified in the current accounting literature that can be used to analyse capital budgeting decision making within a principal-agent game based mechanism design framework incorporating accounting quality issues, risk management and good corporate governance. Hence, an integrated mechanism design model for use in accounting is a theoretical advancement that can be used to resolve agency problems that impact capital budgeting decisions and improve the corporate governance of firms.

This study sought to bridge the literature gap by incorporating estimation of suitable discount rates for efficient capital budgeting decisions and a joint optimisation model within a game theoretic mechanism design framework. The integrated mechanism model makes a valuable contribution to accounting and finance literature and accounting practices. The developed multi-objective model that incorporates maximising NPV and minimising agency costs in the objective function to achieve optimal capital budgeting decisions, can be applied to many other economic areas. For example, optimal resource allocations, where the objective is to maximise profits and minimise total cost. The model can also be applied in various analysis such as financial analysis, cost allocation, strategic pricing, risk management and supply chain management areas.

An important accounting theory implication of this study is the contribution it makes to the debates about the need for accounting policy improvements and new accounting standards to prevent managerial distortion and protect shareholders' interests. The results of this study demonstrate the effectiveness of accounting quality in providing economic benefits for achieving sound investment decisions, good corporate governance, effective risk management

and enhanced company value. The implementation of the mechanism design approach to social and ethical choice in accounting shows the information usefulness of accounting policies and standards for addressing the emerging issues. This creates a need for accounting standards bodies to deal with these issues through sound accounting standards as debated by possibility theorem (Montet & Serra, 2003; Scott, 2015).

6.7.2 Mechanism design and game theory implications

As discussed in Chapter 5, mechanism design is an approach used to find a set of rules of the game that can achieve the objective of the mechanism designer as the principal (Barron, 2013; Narahari, 2014). In the principal-agent game settings, the mechanism design aims to achieve the alignment of interests of both players, the shareholders as the principal and the manager as the agent, in order to resolve the underlying agency problems arising from such a relationship. In other words, players' interest alignment is achieved through strategic interactions between both players' actions and payoffs (Salanie, 2005). The literature review presented in Chapter 2 established that there is a gap in the research. Mechanism design and game theory have not been integrated in capital budgeting together with other aspects, such as accounting policy, corporate governance and risk management in developing an optimisation model within a game theoretic mechanism framework. Hence this study addresses this literature gap.

As discussed in Chapter 5, this study adopted a capital budgeting optimisation model within the game theoretic mechanism design framework, with the objective function specified as maximising the principal's wealth. The proposed model is a direct mechanism design model, as the agents are motivated to perform to maximise the principal's interest via incentive control mechanisms. These mechanisms include accounting rules and regulations, accounting standards, good corporate governance and risk management, which are based on incentive principles and assuming the revelation of these preferences directly by the agents. Particularly, this study assumes that managers/agents must follow the set of rules specified in the contract, and make significant effort to accomplish their tasks in the interests of shareholders/principals.

As noted earlier, game theory is also useful to show shareholders and other stakeholders the disadvantages of not considering the interests of all parties affected by accounting policy changes that are found to be too tricky to apply (Scott, 2015). Moreover, the current literature on mechanism design and game theory highlights the absence of real life implications of the mechanism design model, particularly in capital budgeting optimisation (Douma & Schreuder, 2008). The mechanism design game theoretic based capital budgeting optimisation model proposed in this study was operationalised and demonstrated using a case study. Validity testing and sensitivity analysis of the mechanism model endorsed the plausibility of the outcome produced by the model. Hence, this study once again addressed the existing literature gap, providing significant theoretical and practical contributions to accounting, finance and, particularly, optimal capital budgeting.

6.7.3 Policy implications

This study aimed to investigate the benefits of suitable discount rate estimation for efficient capital budgeting practices, to achieve sound investment decisions and optimal company value in an integrated setting. The outcomes of the study show that correct estimation of suitable discount rates and unbiased project selection practices can improve the quality of accounting information, achieve efficient corporate governance and financial risk management, and contribute to sound company investment policy. Moreover, this study proposes a framework for designing a mechanism that incorporates all necessary aspects for designing an efficient capital budgeting process, including accounting policies, principal-agent game based incentive contracts, audit and governance mechanisms.

Based on the outcomes of this study, the optimisation game theory model based on the mechanism design framework can be applied as an incentive to motivate management performance and prevent managerial opportunistic behaviours. It can monitor the managers' actions through company performance measures, compliance with contract mechanisms, and the encouragement of truthful representations of accounting information that is audited by external auditors. However, the mechanism design approach alone cannot prevent ex-post contract managerial opportunistic behaviour (Zingales, 2008). There are also

opportunities for managers to carry out earnings management activities that can weaken the quality of accounting information. Thus, standard setters face the challenge of designing appropriate accounting rules and processes that emphasise incentives and control of human behaviour rather than focusing mainly on reporting and analysis (Kanodia, 2014). Firms face the challenge of designing rigorous mechanisms that include policies and procedures to prevent earning management opportunities, persuade performance-based incentive contracts, promote good ethics and culture, and implement internal control functions. The adoption of good accounting practices in accordance with GAAP and accounting standards can reduce the opportunity for earning management and thus increase the quality of accounting reports. However, managers can misuse the implied flexibility in accounting standards by using different methods for different periods to manipulate accounting numbers for their own advantage. Hence, accounting standard setters are required to further improve the standards to close these loopholes and prevent managerial opportunistic behaviour, particularly earning management activity.

6.7.4 Methodology implications

As discussed in Chapter 4, various methods can be adopted to determine the discount rate for capital budgeting. These include cost of capital, cost of debt plus risk premium, cost of equity, WACC, current prime interest rate, and established rates based on similar projects carried out previously. However, economic theory suggests that the appropriate discount rate to use in capital budgeting is the WACC, which should be based on the risk profile of the investment project being analysed (Martin & Titman, 2008; Ogier et al., 2004; Dayananda et al., 2002; Davidson et al., 1988). This study proposes the estimation of discount rates using WACC with unique risks associated with individual projects. Consequently, every project will have a unique project-specific discount rate, leading to efficient capital budgeting and sound allocation of resources. The proposed project risk specific WACC based discount rate approach makes use of market information, in the form of project debt capacity and the firm-wide costs of debt and equity. These provide very little discretion for managerial bias but provide a correct project-specific discount rate as a good approximation dictated by theory. This approach is in line with the study undertaken by Martin and Titman (2008).

The model developed in this study is a joint optimisation game theory model for mechanism design in capital budgeting. This methodology was adopted to obtain optimal capital investment solutions from the incentive contract mechanism. The model provides the optimal strategy that should be used by managers (agent) in order to minimise agency costs and to achieve maximum value for the shareholders (principal). This methodology appears to be cost effective in the way of allocating capital resources and thus supports efficient capital budgeting, financial engineering and development of sound investment planning to maximise company value (Morris & Daley, 2017). Therefore, the use of the developed principal-agent relationship based game theory concept methodology is appropriate for achieving the goal of the mechanism design model. This was to mitigate agency problems by aligning the interests of managers and shareholders to maximise company value.

The optimisation model based method has been applied in many studies to solve the mechanism design problem (Demski, 2008; Kanodia, 2014). However, the use of an optimisation approach, incorporating accounting quality, corporate governance, agency theory, and game theory within a mechanism design framework to analyse optimal capital budgeting, has not been researched adequately in the existing literature. This study employed a joint optimisation game theory model within a mechanism design framework to analyse the principal-agent relationships, suitable discount rate estimation, financial and management accounting policies, risk management strategy and corporate governance mechanisms. Thus, from the methodological perspective, the optimisation model developed in this study is original in computational accounting research and management science.

6.8 Sensitivity analyses implications

The post-optimality analysis consists of interpretation of the shadow prices and the performance of sensitivity analysis. This is vital to determine the impact of changes in input values on the decisions made by managers (Clark et al., 1989). The term sensitivity analysis describe a situation in which the exact amount of future cash flows for capital budgeting cannot be calculated with certainty and is sensitive to the assumed values of cash receipts and costs in the analysis

(Ragsdale, 2018, Kalyebara & Islam, 2014 and Dayananda et al., 2002). In the sensitivity analysis, only one variable at a time is changed and the resulting set of NPVs for the projects will show the management which variables have material impact on the financial outcome.

The sensitivity analysis undertaken in this study provided a summation of the variable cells and constraints for the model. This creates useful information for finance managers in evaluating how sensitive the optimal solution is to changes in various coefficients in the model. The sensitivity report shows the optimal value, and the value for each variable that contributes to the optimum value.

Generally, the linear programming optimisation model is sensitive to changes in the coefficient variables in the objective function and constraints. In the World Airways case, the variables include the average number of transatlantic flights per day during the summer season using wide-bodied airplanes, transatlantic flights per day during the winter season using wide-bodied airplanes and so on. In real life, the value of these variables can change based on demand and other economic and social factors that will impact the objective function for NPV. The model is also sensitive to constraints, and shadow prices were used to identify the constraints with the most impact on the optimal value. Hence managers should consider using sensitivity analysis to factor in predictable changes that provide more sensible financial outcomes for efficient capital budgeting.

6.8.1 Base model: Changes of the value of constraints in RHS

In the base model of this study, the objective coefficient for transatlantic flights during the summer season can assume any value increase of up to 6,848 and value decrease of up to 24 without changing the optimal solution. Constraints that have zero slack in the optimal solution are called binding constraints. In other words, a constraint is binding if its final value is equal to its constraint RHS value. Binding constraints prevent further improvement of the objective function.

The shadow price for a constraint indicates the amount by which the objective function value changes given a unit increase in the RHS value of the constraint, assuming all other constraints remained constant. As discussed in Chapter 5, if a shadow price is positive, a unit increase in the RHS value of the associated constraint resulted in an increase in the optimal objective function value. In the

World Airways case, if the number of wide-bodied airplanes during used during summer is increased by one unit, the company value would increase by $50.6 million. If the shadow price is negative, a unit increase in the RHS value of the associated constraint would result in a decrease in the optimal objective function value. In this case, if World Airways increased Caribbean flights during the summer season by one unit, the company value would decrease by $5 million. Similarly, the effects of decreases in the RHS values could be analysed by reversing the sign on the shadow prices.

For all slack variables in the optimal solution, the corresponding shadow prices are zero. In other words, the shadow prices for the non-binding constraints have zero values. For example, transatlantic route revenue for years 2-5 constraint had a shadow price of zero with an allowable increase of infinity and an allowable decrease of 167. Hence, if the RHS value of this constraint increases by any amount, the objective function value does not change. Furthermore, World Airways can reduce the RHS value of this constraint by $167 million without affecting the optimal solution.

Based on the sensitivity analysis of this study, the most sensitive objective variable of World Airways is the availability of wide-bodied airplanes in summer, which had the highest value of the shadow price of $50.6 million. Availability of wide-bodied airplanes in winter had the second highest shadow price value of $37.7 million and availability of narrow-bodied airplanes at all times had the third highest shadow price value of $7.2 million. These three variables were the most sensitive when one variable changed by one unit, leading to significant impacts on the objective value of World Airways.

Moreover, the results for the horizon of five years show that the two variables contributing most to the optimal value were the NPV of interest earned on money lent and the NPV from purchased wide-bodied airplanes, at 77.2% and 15.6% respectively. In other words, these two variables contributed 92.8% of the total optimal value of $16,510.6 million. The reduced cost in the sensitivity report highlights that World Airways should not undertake commuter flight routes, and should not purchase narrow-bodied airplanes. This aligned with management estimates of NPV for both wide-bodied and narrow-bodied airplanes.

6.8.2 New model: Changes of the value of constraints in RHS

Similar to the base model, the new model sensitivity report showed the three most sensitive objective variables of World Airways. First was the availability of wide-bodied airplanes in summer, which had the highest value of the shadow price of $50.6 million. Second was the availability of wide-bodied airplanes in winter, which had the shadow price value of $37.7 million; and third was the availability of narrow-bodied airplanes at all times, which had the shadow price value of $7.2 million. When one of these variables changed by one unit, there was a resulting significant impact on the objective value of World Airways. In other words, if the number of wide-bodied airplanes is increased by one unit, this will increase the optimal company value by $50.6 million. Another important shadow price change in the new model is the external capital limit of 3.06, which means that if external capital is increased by $1 million, the optimal company value will increase by three times to $3 million. The debt/equity ratio is another prominent shadow price in the new model outcome, which had a value of -2.5. If the debt/equity ratio is increased by one unit, this would result in a decrease in the optimal value of the company by $2.5 million.

Moreover, the availability of wide-bodied airplanes in summer, with the highest shadow price, impacts the most on the objective value of maximising the NPV of World Airways, followed by the availability of wide-bodied airplanes in winter, and then the availability of narrow-bodied airplanes at all times. In summary, the results show that the purchase of airplanes impacts the most on the maximisation of the NPV.

6.9 Plausibility of the results, consistency with the theory and generalisation of the model

As discussed previously, the discount rate method proposed in this study generates different discount rates for each project using market-based information, while providing managers with very little discretion in discount rate the selection. The method is quite simple. Project-specific WACC using different weights for debt and equity reflect the project debt capacity and provide a good approximation to the discount rate that theory dictates. Therefore the method is considered plausible and promotes efficient capital budgeting decisions.

The joint optimisation model developed in this study has been tested at various sensitivity levels, and the model satisfies all the assertions necessary to satisfy the validation procedures. The model produced credible optimal results, increased NPV and minimised agency costs. Thus it resulted in plausible and valid outcomes. Hence, it is an operationable and valid model that can be applied, not only in the airline industry but also in other industries, for capital budgeting relating to multi-objectives and high levels of risk.

The answer report provided by the mechanism design optimisation game theoretic model in this study revealed that the mitigation of agency costs as the objective function contributed significantly to the maximisation of the company value by increasing NPV. This contrasted with the base model. The new model also identified four flight routes, namely the summer transatlantic route, short flight route, intermediate flight route, and winter Caribbean route, as well as wide-bodied airplane purchase and lending free cash flow in the fifth year, to be the key decision variables that impact on the NPV of World Airways. Moreover, the model indicates that lending free cash flow activity is the key contributor to the optimal NPV outcome for World Airways. Incentive wages also playing a vital part in motivating managers to exert their best efforts in order to achieve optimal outcome.

Generally, intuitive judgement was applied to check whether the generated outcome of the study was consistent with the theory in capital budgeting that implicated maximisation of NPV after considering risk and uncertainty. The final result of the model in this study is consistent with the theory, as it increases the NPV of the company. Several surveys dealing with capital budgeting practices have suggested that the acceptance and implementation of quantitative techniques and modelling for capital budgeting has increased with time (Seitz, 1990). However, to our knowledge, few if any multi-objective capital budgeting optimisation models that incorporate principal-agent game, agency theory, minimisation of agency costs, and accounting quality, are available for comparison. Hence it is difficult to compare the model developed in this study with other theoretical models. Inclusion of agency cost mitigation in this study's model has contributed significantly to the enhancement of corporate governance. This will helps companies make efficient capital budgeting decisions.

The integrated approach of this study, incorporating accounting issues, mitigation of agency costs, game theory, corporate governance and risk management into the multi-objective mechanism model, extends the current capital budgeting optimisation modelling theory. Hence the developed model in this study could be used as a valuable capital budgeting model for investment appraisal for the airline industry and for other industries in the future.

In summary, the proposed project-specific discount rates and the application of the proposed principal-agent game optimisation model within a mechanism design framework for efficient capital budgeting decisions with many constraints, offers significant advantages over solutions generated by other techniques. As such, it makes a significant contribution to the accounting, finance and management science literature.

6.10 Conclusion

This chapter has discussed the results, implications and benefits of this study. The case study investigation of project-specific discount rates estimation elaborates the significance of suitable discount rates for achieving efficient capital budgeting, sound investment decisions, good corporate governance, effective risk management and enhanced shareholder value. Furthermore, this chapter has highlighted the benefits of the principal-agent game, accounting methods and practices for improving the quality of suitable discount rates estimation for optimal capital budgeting decisions.

This chapter has also discussed the implications of using a principal-agent game theoretic mechanism design framework in capital budgeting, particularly incentive and control based contract design that can help to align the interests of both managers and shareholders. This will then mitigate agency costs, achieve sound capital budgeting decisions and optimise company value. The chapter has also highlighted the implications of this study from the perspective of accounting policies, particularly comparing the historical cost method with the current value method, and the importance of accounting standards in resolving agency problems.

The proposed project-specific discount rate estimation, mechanism design model and the integrated approach analysis that includes agency theory, game theory,

accounting practices, risk management and corporate governance, make significant contributions to the literature on contemporary accounting, finance, economics and management science. The model and the analysis set an agenda for further research in agency problems, contract theory, game theory, optimal contract incentives and capital budgeting. The proposed optimisation model is sufficiently flexible and can be operationally replaced with various objective functions in addition to maximising NPV. Consequently, this model is very useful for accounting professionals and business decision makers in modern organisations.

CHAPTER 7: RESEARCH SUMMARY AND CONCLUSION

7.1 Introduction

The main aim of this thesis is to extend the capital budgeting framework, based on a game theory approach, to resolve information asymmetry and agency problems, and provide incentives to achieve an efficient capital budgeting outcome for enhanced company value. The study focused on addressing the question of discount rate choice and proposed a new methodology to estimate that rate, incorporating accounting quality and principal-agent game to mitigate agency costs. The results of this study provides insights into various valuable analyses, particularly project-specific discount rate selection for capital budgeting and a joint optimisation model developed within the mechanism design and game theoretic framework. These insights offer the potential to provide remarkable economic benefits to firms.

This chapter summarises the main research questions and findings and discusses their implications for theory and practice. This study began with a discussion on unresolved discount rate issues and strived to propose an appropriate methodology incorporating accounting methods and principal-agent game theory to estimate suitable project-specific discount rates for capital investment projects. This method was applied to the Wal-Mart case study. This study also focussed on the development of a new joint optimisation model based on mechanism design concepts, game theory, accounting principles, risk management, and corporate governance mechanisms and applied this to the World Airways case study. The model results show the significance of mechanism design and game theory concepts in resolving underlying agency problems, and achieving optimal capital budgeting decisions leading to sound investment and maximised company value.

The reminder of this chapter discusses the research issues, the results of this study and their implications, major findings of the research, re-appraisal of the theoretical and practical contributions of the study, the limitations of this study, and some potential areas for further research.

7.2 Research questions and issues

As highlighted in the literature review presented in Chapter 2, one of the oldest issues dominating the accounting, finance, economics and management science disciplines is the question of what discount rate should be adopted for an investment appraisal. Until this study, this question remained unanswered. Most capital projects are evaluated using DCF techniques. In addition, most firms use one discount rate for all projects, generally a firm-wide WACC. However, this is not an appropriate method as it does not accurately reflect the correct project-specific risks. Thus, the effectiveness and efficiency of the investment appraisal process significantly depends on the choice of a suitable discount rate.

This study aims to develop a methodology based on the issues of agency costs and accounting practices to assist in appropriately choosing the discount rate for efficient capital investment decision making.

The other major research question is how to integrate a large number of issues relating to discount rate and agency costs that arise from principal-agent relationships and existing capital budgeting models in an integrated financial model. In order to address this research question, this study focused on developing a new joint optimisation capital budgeting model within a game theoretic and mechanism design framework. This model is considered the most suitable method for finding rules for the principal-agent game to achieve the objective of the designer, in this case the principal. The principal-agent game theory approach is appropriate for establishing a strategic interaction between shareholders and managers. This is achieved by designing an incentive and control based contract to realise the best interests of shareholders by aligning both parties' interests.

Although the body of literature on accounting, finance, management science and financial modelling is obviously growing, several limitations were identified in previous studies that motivated the undertaking of this study. Most importantly, no practical model could be found in the existing literature that could be used to scrutinise the relationships between discount rate, agency problems, game theory, incentive and contracting problems, corporate governance, risk management and firm value. Also, there are few, if any, mechanism design models that have been developed in an integrated way to analyse the

contemporary issues in accounting and finance, agency theory, game theory, risk management and corporate governance.

Based on the research gaps discussed above, this study develops a new methodology for selecting appropriate project-specific discount rates and a new joint optimisation game theory model for mechanism design in capital budgeting to resolve the underlying agency problems in an organisation. This study also discusses the importance of sound accounting policies that can encourage the provision of adequate information to shareholders (principal) about managers' (agents') efforts and performance, to ensure that managers act in the best interests of shareholders. Thus, sound accounting policy can help mitigate agency problems and lead to enhanced company value.

7.3 Study results and implications

The estimation of suitable discount rate model for capital budgeting in this study was developed based on project debt capacity, reflecting project-specific risks. Operationalisation of this methodology and the model were tested by estimating project-specific discount rates for the two projects described in the Wal-Mart case study. These discount rates were used to evaluate both projects, and to scrutinise the outcomes and establish the benefits of the model.

The new capital budgeting joint optimisation model represents a non-cooperative game that maximises the objective of the principal, subject to a set of constraints. These constraints include the controls that bind managers to exert their best efforts for the interests of the principal. In other words, the model resolves the underlying agency problems and ensures efficient capital budgeting practices. The optimisation model was simulated by applying the World Airways case study to achieve the optimal capital budgeting solutions and outcomes, and to analyse the results from the game theoretic and accounting perspectives. The main findings and their implications are discussed below.

7.3.1 Suitable discount rate estimation for efficient capital budgeting

Most firms use firm-wide WACC as a discount rate as it is a simple method and provides managers with less degree of freedom (Jagannathan et al., 2016;

Martin, 2008). However, this approach may lead to inefficient capital budgeting decisions and hence curtail shareholder value.

In the Wal-Mart case, the market value of capital sources had been used as weights and the firm's required rates of returns for debt and equity were used to estimate the firm-wide WACC of 12.8%. However this discount rate was not tailored to the risks of the investment projects, and favoured the less profitable and riskier project B. Thus, applying this firm-wide discount rate would lead to inefficient allocation of the firm's resources. In this study, a project-specific discount rate method was scrutinised and proposed as a suitable discount rate for sound capital budgeting decisions.

The project-specific discount rates were estimated based on each project's debt capacity, which reflected risk factors as weights. The application of this method to the Wal-Mart case study, resulted in a discount rate of 6.2% for project A and 10.7% for project B, both significantly lower than the firm-wide WACC of 12.8%. Project A had higher profit margins and was less volatile in response to changes in prices, making it less risky and with a higher debt capacity, resulting in a lower discount rate. In contrast, project B had lower profit margins, making it sensitive to changes in prices and riskier, with a lower debt capacity, resulting in a higher discount rate. Applying these respective discount rates to projects A and B, project A was obviously the preferred project, being less risky and with a higher NPV. This contrasted with the preference for project B if the firm-wide discount rate was used.

Being tailored to the risks of each investment project, project-specific discount rates lead to more efficient capital budgeting decisions and the optimal allocation of resources to maximise firm wealth. The major criticisms against project-specific discount rates are the complexities involved, and the opportunities created for managerial opportunistic behaviour. However, as the proposed project-specific discount rate model in this study is based on project debt capacity, which is determined by external market conditions, the managers' ability to misuse the discount rate is limited. Moreover, mechanisms such as quality accounting reports and managerial incentives and controls can be used to mitigate these opportunistic managerial behaviours. Thus, it can be concluded that the proposed

project-specific discount rates estimation method, tailored to the risks of the investment projects, would lead to sound allocation of resources and optimal shareholder value.

7.3.2 Mechanism design as a framework for resolving agency problems and achieving optimal capital budgeting

The optimisation model in this study was developed within principal-agent game theory and a mechanism design framework. It incorporated maximising NPV and minimising agency costs in the objective function, reflecting the utility of shareholders, who act as the principal in a strategic interaction with managers as agents. The function was constrained, in addition to the operational constraints, by a set of mechanisms. These mechanisms are incentive wages, accounting regulations and controls, regulatory environments, effective risk management, and good governance mechanisms, in the form of debt/equity ratios and equity limits. Agency costs were calculated using a debt/equity ratio as a proxy, as the debt capital from capital markets discipline management, thereby mitigating agency costs (Kalyebara & Islam, 2014). The mechanism design concepts were specified as an optimisation problem that could align the interests of managers and shareholders to mitigate the underlying agency problems. The results of the model application, as discussed in Chapter 6, suggest that the incentives and controls embedded in the model motivate managers to exert strategies to increase company value.

The mechanism design framework allows the principal to set up rules for related parties, and predicts the outcomes of such strategic interactions. In other words, the incentive mechanisms embedded in the model can align the interests of related parties in an optimal way, resulting in reduction in agency costs (Scott, 2015). The results of the proposed optimisation model in this study support this argument, as shown by the increase in NPV and reduction in agency costs.

The World Airways case study results indicate that the key decision variables impact on the NPV of the company are trans-Atlantic flights during the summer season using wide-bodied airplanes, intermediate flights using narrow bodied airplanes, short flights using narrow-bodied airplanes, Caribbean flights during winter using wide-bodied airplanes, new wide-body airplanes purchased, and the

amount of money lent in year 5. NPV of the new model has increased significantly to $18,880.3 million, compared to the base model NPV of $16,510.64 million. This incremental benefit of $2,370 million is mainly contributed by the reduction in agency costs as incorporated in the objective function and the application of incentives and accounting control constraints such as incentive wages, financial performance ratios, risk management index, debt/equity ratio and equity constraint.

The new capital budgeting optimisation model results clearly show that NPV increased by incorporating agency costs in the model objective function. Therefore, the new investment appraisal mechanism model incorporating various factors, such as accounting quality and control, agency theory, game theory, risk management and corporate governance, enhanced efficiency and resulted in improved NPV leading to increased firm wealth. In summary, the optimisation model results provide useful financial and strategic information for management to make sound capital investment decisions. Most importantly, the incentive controls embedded in the model establish an appropriate mechanism that can minimise and resolve the underlying agency problems in a firm. The new optimisation model developed in this study can be applied to various industries to evaluate capital investment projects more efficiently and effectively and lead to enhanced shareholder value.

7.4 Summary of major findings

The major findings of this study are summarised below.

7.4.1 Suitable discount rate for efficient capital budgeting

The project-specific discount rate approach proposed in this study is a simple method that generates different discount rates for capital investment projects with different risks, while minimising the agency costs that arise when managers have discretion in the choice of discount rate. Furthermore, this approach provides managers with limited discretion in the selection of discount rates, since it is based on market information. In most cases, this discount rate selection method provides a good approximation of the discount rate that theory dictates, and is consistent with the arguments of Martin (2008). Therefore the proposed project-

specific discount rate approach enhances capital budgeting effectiveness and efficiency, leading to sound resource allocation and enhanced shareholder value.

7.4.2 Mechanism design modelling in capital budgeting

The mechanism design model developed in this study can be applied to resolve the underlying agency problems that arise from principal-agent relationships in capital budgeting. Resolution of such problems will result in the sound allocation of capital resources and improved corporate governance that will lead to maximised shareholder value. Furthermore, the optimisation model developed within the mechanism design framework in this study is operational and can be applied in a real business environment. Its usefulness was proven by the optimal results of the World Airways case study.

7.4.3 Incentive contracts

In this study, incentive contract constraints were specified within the mechanism design framework to address agency problems, particularly information asymmetry and moral hazard problems that impact efficient capital budgeting decisions. The incentives and controls embedded in the mechanism design model motivate managers to exert their best efforts in the interests of shareholders, hence maximising firm value. In certain circumstances, managers behave opportunistically in selecting unprofitable projects and, in some instances, choose to distort financial statements for their own advantage. However, evidence of efficient contracting suggests that it is possible to align managers' interests with those of shareholders (Scott, 2015).

7.4.4 Principal-agent game

This study has discussed a principal-agent non-cooperative game and illustrated that cooperation between the two parties can be achieved through an incentive control mechanism design to resolve underlying agency problems. Moreover, game theory helps in understanding the process of capital budgeting, particularly the estimation of suitable discount rates and project selections. Furthermore, as outlined above, opportunistic managers tend to select projects that can maximise their own interests. In this setting, game theory can provide new insights into the understanding and analysis of the principal-agent relationship game in capital

budgeting and aid the achievement of a positive outcome; a win-win situation that mitigates potential agency costs and protects shareholder wealth.

7.4.5 Accounting quality

The analysis undertaken in this study clearly shows that sound accounting policies and accounting standards play a significant role in producing reliable accounting information for stakeholders, helping them to make rigorous business decisions, particularly efficient capital budgeting decisions. Therefore, there is a need for standard setters to develop accounting standards that improve the quality of accounting information in terms of qualitative characteristics such as understandability, relevance, reliability, comparability and consistency (Weygandt et al., 2010). Moreover, this study identifies the suitability of historical cost accounting for the preparation of accounting statements. This is particularly important for resolving moral hazard as an incentive measure, since it is a conservative and less vulnerable measure of net income, and better motivates managerial performance. However, in contrast, fair value (current cost) accounting is preferred to resolve adverse selection, as it is the best predictor of future value. Therefore, this study demonstrates that trade-off between current value and historical cost accounting is crucial, highlighting the need for accounting standard setters to moderate this issue.

7.4.6 Integrated capital budgeting

This study demonstrates that within the principal-agent game framework, quality accounting reports, risk management and good corporate governance are integrated with optimal capital budgeting decisions. Hence, the integrated capital budgeting approach allows management to apply the most optimal strategies to improve the efficiency of the firm’s resource allocations, thus increasing shareholder value. Moreover, this study demonstrates that, within the agency framework, risk management is interrelated with accounting, finance, business, law and taxation, leading to company value creation and good corporate governance.

The accuracy of the capital budgeting model relies heavily on the estimates used in the model, particularly, the discount rate, project cash flows and life span.

Internal auditing brings an important discipline and provide insights for decision makers.

7.5 Contributions of the study

The research findings of this study provide several significant contributions to theory and practice, which are summarised below.

7.5.1 Theoretical contributions

Although empirical evidence suggests that the use of DCF methods has increased, the gap between theory and practice in relation to the determination of suitable discount rates still exists. This study has endeavoured to bridge this gap by proposing project-specific discount rates based on project debt capacity for optimal capital budgeting. Thus, this study makes a sufficient contribution to accounting theory, corporate finance, economics, and management science literature. It does so by investigating the economic benefits of suitable discount rates and the selection of the right capital projects for achieving optimal capital budgeting decisions, good corporate governance, effective risk management and enhanced firm value.

From the accounting theory perspective, no mechanism design model had been developed in the existing accounting literature to analyse capital budgeting decision making, related accounting quality issues, risk management and the achievement of good corporate governance within a principal-agent game framework. Hence, the joint optimisation game theoretic model within a mechanism design framework developed in this study represents a valuable contribution to accounting theory. The model scrutinises and incorporates the concepts and theories of mechanism design, principal-agent game relationships and accounting quality for achieving efficient allocation of capital resources in a firm. This is a theoretical advancement in attempts to resolve agency problems that impact capital budgeting decisions.

This study also contributes to the body of knowledge in mechanism design, computational accounting research and management science.

7.5.2 Practical contributions

One of the prime objectives of this study was to understand and analyse the choice of suitable discount rates and to scrutinise the extent to which accounting quality and principal-agent game relationships can provide real benefits for capital budgeting. This study's approach offers a reference tool for accounting professionals and finance managers by proposing a model and providing a diverse set of insights into the estimation of project-specific discount rates. This represents emerging good practice in discount rate estimation for optimal capital budgeting.

This study also contributes to improved financial accounting practices by providing practical guidance on how a firm should design a sound accounting policy within its corporate financial strategies. It offers valuable insights into accounting standard settings with game theory and accounting measurement analysis.

The optimisation game theoretic model within the mechanism design framework developed in this study could provide sound understanding on the applicability of incentive control mechanisms to support efficient capital budgeting processes in an organisation. This can help resolve underlying agency problems that arise from principal-agent relationships, resulting in enhanced shareholder value. This represents another valuable practical contribution made by this study.

7.6 Limitations and directions for future research

This study has several limitations due to the specific focus of the research. However, these limitations do not affect the findings of this study, but represent areas that need to be addressed in further research. The complexity of the underlying issues of the research questions and the very limited or even non-existence of previous studies, particularly in discount rate estimation and capital budgeting joint optimisation game theoretic mechanism design based models, contribute to the study's limitations. These are discussed in more detail below.

The estimation of suitable discount rates for capital budgeting is a complex area and the question of the correct methodology to use remains long-standing and unresolved. Although the project-specific discount rate estimation approach proposed in this study is a simple method, it is an approximation that may create

controversy and bias, which, in turn, may cause uncertainty in the capital budgeting process. In addition, the method was tested using a case study, which may not be suitable for every organisation due to the complexity of issues. Moreover, it is a long-standing dilemma as to why so many firms are still using the payback period method to evaluate projects instead of the theoretically and practically superior NPV technique that utilises the discount rate (Graham & Harvey, 2001). The presumed reason for the popular application of the payback method is that it is less subject to manipulation by agents, and therefore reduces agency costs and information corruption. This necessitates further studies in project-specific discount rate estimation, incorporating project-specific risks, managerial opportunistic behaviour and agency problems, using real life case studies.

Moreover, research findings suggest that, for many firms, operational issues such as organisational and managerial bandwidth are more important than financial constraints for investment decisions (Jagannathan et al., 2016). These aspects are not considered in this study, hence understanding the nature of these organisational constraints is a potential area for further research.

In order to integrate the mechanism design concepts in the optimisation model, this study incorporated incentive control mechanisms such as accounting regulations, regulatory environment and incentive wages besides the managers' normal wages, as capital budgeting decisions are usually undertaken by a division of a firm. Moreover, in this study, the mechanism design model applied to the World Airways case study, which is airline industry specific and may not be adequate for generalisation to a wider range of organisations. Hence, further research on applications to real life case studies is required to prove the plausibility of the model.

The joint optimisation model can be developed to maximise both the principal's and the agent's interest as a joint principal-agent optimisation model. The model developed in this study focused on optimising the principal's interest by motivating agents through incentive control mechanisms to exert effort in the interest of the principal. This model could be further developed to incorporate the

joint optimisation of both parties' interests to enhance the applicability of the model, particularly in the principal-agent game framework.

As this study focused mainly on maximising principal wealth, it has ignored the interests of other stakeholders and thus social and behavioural aspects such as altruism, bounded rationality and reciprocity have not been incorporated. However, these constraints are imperative and impact the optimal outcome of the model. Hence, further studies could enhance the plausibility of the mechanism design model.

7.7 Conclusions

This study has proposed a new approach to project-specific discount rate selection that considers project-specific risks based on project debt capacity. It has also elaborated on the significance of suitable discount rates for achieving efficient capital budgeting, sound investment decisions, good corporate governance, effective risk management and enhanced shareholder value. Furthermore, this study has discussed the principal-agent game, and accounting methods and practices that can provide benefits by improving the quality of data required to estimate suitable discount rates for optimal capital budgeting decisions.

This study has also developed a new joint optimisation model for mechanism design in capital budgeting. This model represents principal-agent relationships based on a non-cooperative game that maximises the principal's interest by motivating agents via incentive control mechanisms such as incentive wages and accounting regulations. Thus, the developed model operationalises the objectives of mechanism design by aligning principal's and agents' interests and resolving the underlying agency problems that arise from principal-agent relationships.

Despite the fact that this study has some limitations, as discussed in the previous section, the research has been carried out in a methodological way to address the research questions and ensure the plausibility of the results and implications. The discount rate estimation method and mechanism design model provide significant theoretical and practical contributions, particularly on contemporary accounting, capital budgeting, mechanism design, game theory, risk

management and corporate governance. The developed optimisation model is sufficiently flexible and can be operationally replaced with various objective functions instead of merely maximising NPV. While caution should be used in generalising the model outcome, the capital budgeting joint optimisation game theoretic mechanism design model developed in this study truly deserves further investigation.

In conclusion, this study developed a game theoretic mechanism design framework for capital budgeting. Numerical experiments of suitable discount rates and optimisation model results provide information about how game theory and agency issues can be addressed in a capital budgeting and how mechanism design can be developed to resolve agency problems. The results are plausible and thus the framework developed in this study can be adopted in capital budgeting exercises for achieving sound capital budgeting decisions.

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APPENDICES

Appendix A: Summary of project debt capacity calculation

Operating costs, operating risk, and debt capacity

	Project A	Project B
Capacity per year in unit	3,300,000	3,300,000
Fixed operating costs	24,000,000	24,000,000
Variable operating costs per unit	$0.90	$2.00
Total operating costs at capacity	$26,970,000	$30,600,000
Revenue at unit price $10	33,000,000	33,000,000
Operating Income	$6,030,000	$2,400,000
Revenue at unit price $12	39,600,000	39,600,000
Operating Income	$12,630,000	$9,000,000
% Change in Revenue	20.0%	20.0%
% Operating Income	109.5%	275.0%
Revenue at unit price $14	46,200,000	46,200,000
Operating Income	$19,230,000	$15,600,000
% Change in Revenue	16.7%	16.7%
% Operating Income	52.3%	73.3%
Revenue at unit price $16	52,800,000	52,800,000
Operating Income	$25,830,000	$22,200,000
% Change in Revenue	14.3%	14.3%
% Operating Income	34.3%	42.3%

Debt Capacity and Equity Risk

	Project A	Project B
Debt Capacity	$75,375,000	$30,000,000
Interest rate	8%	8%
Interest expense	$6,030,000	$2,400,000
Tax rate	30%	30%

	Net Income after tax	
Unit Price	Project A	Project B
$10	$0	$0
$12	$4,620,000	$4,620,000
$14	$9,240,000	$9,240,000
$16	$13,860,000	$13,860,000

Project A Specific WACC

Source	Marke value $m	Weight	Required Return	Weighted cost
Equity	14.625	16.3%	13.7%	2.2%
Debt	75.375	83.8%	4.8%	4.0%
Total	90.000			
WACC				**6.2%**

Project B Specific WACC

Source	Marke value $m	Weight	Required Return	Weighted cost
Equity	60.000	66.7%	13.7%	9.1%
Debt	30.000	33.3%	4.8%	1.6%
Total	90.000			
WACC				**10.7%**

Appendix B: Summary of project appraisal

Applied Firm-wide Discount Rate

$'000

Project A												
	Year	0	1	2	3	4	5	6	7	8	9	10
	Cash Flows -	90,000	19,230	19,230	19,230	19,230	19,230	19,230	19,230	19,230	19,230	29,230
	Discount Rate	**12.8%**										
	NPV	**18,014**										
Project B												
	Year	0	1	2	3	4	5	6	7	8	9	10
	Cash Flows -	90,000	15,600	15,600	15,600	15,600	15,600	15,600	15,600	15,600	15,600	93,600
	Discount Rate	**12.8%**										
	NPV	**18,510**										

Applied Project Specific Discount Rate

$'000

Project A												
	Year	0	1	2	3	4	5	6	7	8	9	10
	Cash Flows -	90,000	19,230	19,230	19,230	19,230	19,230	19,230	19,230	19,230	19,230	29,230
	Discount Rate	**6.2%**										
	NPV	**55,358**										
Project B												
	Year	0	1	2	3	4	5	6	7	8	9	10
	Cash Flows -	90,000	15,600	15,600	15,600	15,600	15,600	15,600	15,600	15,600	15,600	93,600
	Discount Rate	**10.7%**										
	NPV	**31,244**										

Project B at	6.2%
NPV	**66,051**

Appendix C: Summary of the optimisation model–Base model

Excel Solver input sheet–Base model

Optimisation Model - Excel Solver Sheet																								
	Flight Routes								Airplane purchased		Money Lent					Money Borrowed							Target cell	
Decision Variables	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_W	x_N	α_1	α_2	α_3	α_4	α_5	β_1	β_2	β_3	β_4	β_5	Optimal NPV		16510.6	
Var	72.26	48.17	35.17	90.91	909.09	30.76	61.51	0.00	25.78	0	0	1933.64	5200.64	8794.35	12747.42	1000	0	0	0	0				
Coefficients CF	11.11	0	0	0.25	0.25	0	2.15	0	100	20	0	0	0	0	1	0	0	0	0	-1				
Constraints																					**LHS**	**Sign**	**RHS**	
Year 1	-9.111	-9.111	-12.268	-0.748	-0.9367	-3.424	-3.424	-0.565	146	28	1	0	0	0	0	-1	0	0	0	0	-2E-12	≤	0	
Year 2	-9.111	-9.111	-12.268	-0.748	-0.9367	-6.778	-6.778	-0.565	0	0	-1.1	1	0	0	0	1.14	-1	0	0	0	-2E-12	≤	0	
Year 3	-9.111	-9.111	-12.268	-0.748	-0.9367	-6.778	-6.778	-0.565	0	0	0	-1.1	1	0	0	0	1.14	-1	0	0	9E-13	≤	0	
Year 4	-9.111	-9.111	-12.268	-0.748	-0.9367	-6.778	-6.778	-0.565	0	0	0	0	-1.1	1	0	0	0	1.14	-1	0	5E-12	≤	0	
Year 5	-9.111	-9.111	-12.268	-0.748	-0.9367	-6.778	-6.778	-0.565	0	0	0	0	0	-1.1	1	0	0	0	1.14	-1	9E-12	≤	0	
Atlantic Rev Year 1 ≤ 0.3	15.587	15.587	-9.451	-0.931	-1.281	-3.203	-3.203	-0.712	0	0	0	0	0	0	0	0	0	0	0	0	-9E-13	≤	0	
Atlantic Rev Year 2-5	15.587	15.587	-9.451	-0.931	-1.281	-5.018	-5.018	-0.712	0	0	0	0	0	0	0	0	0	0	0	0	-167.47	≤	0	
Wide-body availability summer	1.277	0	1	0	0	1	0	0	-2.3	0	0	0	0	0	0	0	0	0	0	0	98.9	≤	98.9	
Wide-body availability winter	0	1.277	1	0	0	0	1	0	-2.3	0	0	0	0	0	0	0	0	0	0	0	98.9	≤	98.9	
Narrow-bodied availability	0	0	0	1	1	0	0	1	0	8	0	0	0	0	0	0	0	0	0	0	1000	≤	1000	
SF<30% of IMF	0	0	0	1	-0.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-181.82	≤	0	
External capital	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1000	≤	1000	
Trans-Atlantic flights 2/3 for sur	2	-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3E-14	=	0	
Caribbean flights	0	0	0	0	0	2	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	=	0	
SF >10% of IMF	0	0	0	1	-0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1E-14	≥	0	

Summary of base model answer report

Objective Cell (Max)

Cell	Name	Original Value	Final Value
$X$3	Optimal NPV Target cell	16510.6	16510.6

Variable Cells

Cell	Name	Original Value	Final Value	Integer
$B$4	Var x1	72.26	72.26	Contin
$C$4	Var x2	48.17	48.17	Contin
$D$4	Var x3	35.17	35.17	Contin
$E$4	Var x4	90.91	90.91	Contin
$F$4	Var x5	909.09	909.09	Contin
$G$4	Var x6	30.76	30.76	Contin
$H$4	Var x7	61.51	61.51	Contin
$I$4	Var x8	0.00	0.00	Contin
$J$4	Var xw	25.78	25.78	Contin
$K$4	Var xN	0	0	Contin
$L$4	Var α1	0	0	Contin
$M$4	Var α2	1933.64	1933.64	Contin
$N$4	Var α3	5200.64	5200.64	Contin
$O$4	Var α4	8794.35	8794.35	Contin
$P$4	Var α5	12747.42	12747.42	Contin
$Q$4	Var β1	1000	1000	Contin
$R$4	Var β2	0	0	Contin
$S$4	Var β3	0	0	Contin
$T$4	Var β4	0	0	Contin
$U$4	Var β5	0	0	Contin

Constraints

Cell	Name	Cell Value	Formula	Status	Slack
$V$20	Trans-Atlantic flights 2/3 for sum LH	2.84217E-14	$V$20=$X$20	Binding	0
$V$21	Caribbean flights LHS	0	$V$21=$X$21	Binding	0
$V$22	SF >10% of IMF LHS	-1.42109E-14	$V$22>=$X$22	Binding	0
$V$8	Year 1 LHS	-1.81899E-12	$V$8<=$X$8	Binding	0
$V$9	Year 2 LHS	-1.81899E-12	$V$9<=$X$9	Binding	0
$V$10	Year 3 LHS	9.09495E-13	$V$10<=$X$10	Binding	0
$V$11	Year 4 LHS	5.45697E-12	$V$11<=$X$11	Binding	0
$V$12	Year 5 LHS	9.09495E-12	$V$12<=$X$12	Binding	0
$V$13	Atlantic Rev Year 1 ≤ 0.3 LHS	-8.81073E-13	$V$13<=$X$13	Binding	0
$V$14	Atlantic Rev Year 2-5 LHS	-167.474	$V$14<=$X$14	Not Binding	167.474
$V$15	Wide-body availability summer LHS	98.9	$V$15<=$X$15	Binding	0
$V$16	Wide-body availability winter LHS	98.9	$V$16<=$X$16	Binding	0
$V$17	Narrow-bodied availability LHS	1000	$V$17<=$X$17	Binding	0
$V$18	SF<30% of IMF LHS	-181.818	$V$18<=$X$18	Not Binding	181.818
$V$19	External capital LHS	1000	$V$19<=$X$19	Binding	0

Summary of base model sensitivity report

Variable Cells

Cell	Name	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease
$B$4	Var x1	72.26	0.00	11.11	6848.29	24.03
$C$4	Var x2	48.17	0.00	0	10272.43	36.05
$D$4	Var x3	35.17	0.00	0	13.90	29.13
$E$4	Var x4	90.91	0.00	0.25	1.49	32.66
$F$4	Var x5	909.09	0.00	0.25	1E+30	1.49
$G$4	Var x6	30.76	0.00	0	58.43	37.78
$H$4	Var x7	61.51	0.00	2.15	29.21	18.89
$I$4	Var x8	0.00	-2.97	0	2.97	1E+30
$J$4	Var xw	25.78	0.00	100	2126.86	66.33
$K$4	Var xN	0.00	-95.85	20	95.85	1E+30
$L$4	Var α1	0.00	-0.61	0	0.61	1E+30
$M$4	Var α2	1933.64	0.00	0	0.32	1.331
$N$4	Var α3	5200.64	0.00	0	0.35	1.21
$O$4	Var α4	8794.35	0.00	0	0.39	1.1
$P$4	Var α5	12747.42	0.00	1	0.42	1
$Q$4	Var β1	1000	0	0	1E+30	0.56
$R$4	Var β2	0	-0.61	0	0.61	1E+30
$S$4	Var β3	0	-0.60	0	0.60	1E+30
$T$4	Var β4	0	-0.60	0	0.60	1E+30
$U$4	Var β5	0	-0.56	-1	0.56	1E+30

Constraints

Cell	Name	Final Value	Shadow Price	Constraint R.H. Side	Allowable Increase	Allowable Decrease
$V$20	Trans-Atlantic flights 2/3 for su	2.84217E-14	-1.09	0	49.74	64.58
$V$21	Caribbean flights LHS	0	-5.04	0	38.11	32.21
$V$22	SF >10% of IMF LHS	-1E-14	-1.35	0	153.85	100
$V$8	Year 1 LHS	-2E-12	2.08	0	1E+30	3056.32
$V$9	Year 2 LHS	-2E-12	1.331	0	1E+30	1933.64
$V$10	Year 3 LHS	9E-13	1.21	0	1E+30	5200.64
$V$11	Year 4 LHS	5E-12	1.1	0	1E+30	8794.35
$V$12	Year 5 LHS	9E-12	1	0	1E+30	12747.42
$V$13	Atlantic Rev Year 1 ≤ 0.3 LHS	-9E-13	0.63	0	178.28	2762.06
$V$14	Atlantic Rev Year 2-5 LHS	-167.47	0	0	1E+30	167.47
$V$15	Wide-body availability summe	98.9	50.67	98.9	35.47	20.22
$V$16	Wide-body availability winter l	98.9	37.69	98.9	34.16	30.83
$V$17	Narrow-bodied availability LHS	1000	7.21	1000	761.08	1000
$V$18	SF<30% of IMF LHS	-181.82	0	0	1E+30	181.82
$V$19	External capital LHS	1000	0.56	1000	2178.20	1000

Appendix D: Summary of the sensitivity analysis–Base model

Summary of base model answer report–Changing wide-bodied airplanes in summer by one unit

Objective Cell (Max)

Cell	Name	Original Value	Final Value
$X$3	Optimal NPV Target cell	16510.6	16561.3

Variable Cells

Cell	Name	Original Value	Final Value	Integer
$B$4	Var x1	72.26	72.57	Contin
$C$4	Var x2	48.17	48.38	Contin
$D$4	Var x3	35.17	36.91	Contin
$E$4	Var x4	90.91	90.91	Contin
$F$4	Var x5	909.09	909.09	Contin
$G$4	Var x6	30.76	29.89	Contin
$H$4	Var x7	61.51	59.78	Contin
$I$4	Var x8	0.00	0.00	Contin
$J$4	Var xw	25.78	25.90	Contin
$K$4	Var xN	0	0	Contin
$L$4	Var α1	0	0	Contin
$M$4	Var α2	1933.64	1942.08	Contin
$N$4	Var α3	5200.64	5218.37	Contin
$O$4	Var α4	8794.35	8822.28	Contin
$P$4	Var α5	12747.42	12786.59	Contin
$Q$4	Var β1	1000	1000	Contin
$R$4	Var β2	0	0	Contin
$S$4	Var β3	0	0	Contin
$T$4	Var β4	0	0	Contin
$U$4	Var β5	0	0	Contin

Constraints

Cell	Name	Cell Value	Formula	Status	Slack
$V$20	Trans-Atlantic flights 2/3 for sum LHS	3E-14	$V$20=$X$20	Binding	0
$V$21	Caribbean flights LHS	0	$V$21=$X$21	Binding	0
$V$22	SF >10% of IMF LHS	-1E-14	$V$22>=$X$22	Binding	0E+00
$V$8	Year 1 LHS	-2E-12	$V$8<=$X$8	Binding	0
$V$9	Year 2 LHS	-2E-12	$V$9<=$X$9	Binding	0
$V$10	Year 3 LHS	0E+00	$V$10<=$X$10	Binding	0
$V$11	Year 4 LHS	5E-12	$V$11<=$X$11	Binding	0
$V$12	Year 5 LHS	7E-12	$V$12<=$X$12	Binding	0
$V$13	Atlantic Rev Year 1 ≤ 0.3 LHS	-8E-13	$V$13<=$X$13	Binding	0
$V$14	Atlantic Rev Year 2-5 LHS	-162.75	$V$14<=$X$14	Not Binding	162.7517191
$V$15	Wide-body availability summer LHS	99.9	$V$15<=$X$15	Binding	0
$V$16	Wide-body availability winter LHS	98.9	$V$16<=$X$16	Binding	0
$V$17	Narrow-bodied availability LHS	1000	$V$17<=$X$17	Binding	0
$V$18	SF<30% of IMF LHS	-181.82	$V$18<=$X$18	Not Binding	181.8181818
$V$19	External capital LHS	1000	$V$19<=$X$19	Binding	0

Summary of base model sensitivity report–Changing wide-bodied airplanes in summer by one unit

Variable Cells

Cell	Name	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease
$B$4	Var x1	72.56880867	0	11.11	6848.286669	24.03189809
$C$4	Var x2	48.37920578	0	0	10272.43	36.04784714
$D$4	Var x3	36.90833692	0	0	13.90207926	29.1322521
$E$4	Var x4	90.90909091	0	0.25	1.487697257	32.66449755
$F$4	Var x5	909.0909091	0	0.25	1E+30	1.487697257
$G$4	Var x6	29.89012289	0	0	58.42692699	37.77675132
$H$4	Var x7	59.78024578	0	2.15	29.21346349	18.88837566
$I$4	Var x8	0	-2.969499777	0	2.969499777	1E+30
$J$4	Var xw	25.89949064	0	100	2126.85729	66.32664874
$K$4	Var xN	0	-95.85329985	20	95.85329985	1E+30
$L$4	Var α1	0	-0.612744658	0	0.612744658	1E+30
$M$4	Var α2	1942.08005	0	0	0.322030345	1.331
$N$4	Var α3	5218.368106	0	0	0.350015632	1.21
$O$4	Var α4	8822.284967	0	0	0.38818745	1.1
$P$4	Var α5	12786.59351	0	1	0.415515724	1
$Q$4	Var β1	1000	0	0	1E+30	0.559504658
$R$4	Var β2	0	-0.607904658	0	0.607904658	1E+30
$S$4	Var β3	0	-0.603504658	0	0.603504658	1E+30
$T$4	Var β4	0	-0.599504658	0	0.599504658	1E+30
$U$4	Var β5	0	-0.559504658	-1	0.559504658	1E+30

Constraints

Cell	Name	Final Value	Shadow Price	Constraint R.H. Side	Allowable Increase	Allowable Decrease
$V$20	Trans-Atlantic flights 2/3 for sum LHS	2.84217E-14	-1.093018793	0	52.19479789	62.75677552
$V$21	Caribbean flights LHS	0	-5.043237788	0	39.99165414	31.30008972
$V$22	SF >10% of IMF LHS	-1.42109E-14	-1.352452052	0	153.8461538	100
$V$8	Year 1 LHS	-1.81899E-12	2.076844658	0	1E+30	3070.262941
$V$9	Year 2 LHS	-2.27374E-12	1.331	0	1E+30	1942.08005
$V$10	Year 3 LHS	0	1.21	0	1E+30	5218.368106
$V$11	Year 4 LHS	5.45697E-12	1.1	0	1E+30	8822.284967
$V$12	Year 5 LHS	7.27596E-12	1	0	1E+30	12786.59351
$V$13	Atlantic Rev Year 1 ≤ 0.3 LHS	-8.2423E-13	0.628685629	0	173.2568998	2684.185952
$V$14	Atlantic Rev Year 2-5 LHS	-162.7517191	0	0	1E+30	162.7517191
$V$15	Wide-body availability summer LHS	99.9	50.66796975	99.9	34.4672983	21.22096032
$V$16	Wide-body availability winter LHS	98.9	37.68825639	98.9	35.85202035	29.9603072
$V$17	Narrow-bodied availability LHS	1000	7.212706177	1000	798.7225871	1000
$V$18	SF<30% of IMF LHS	-181.8181818	0	0	1E+30	181.8181818
$V$19	External capital LHS	1000	0.559504658	1000	2187.705152	1000

Summary of base model answer report–Changing wide-bodied airplanes in winter by one unit

Objective Cell (Max)

Cell	Name	Original Value	Final Value
$X$3	Optimal NPV Target cell	16561.3	16548.3

Variable Cells

Cell	Name	Original Value	Final Value	Integer
$B$4	Var x1	72.57	72.25	Contin
$C$4	Var x2	48.38	48.17	Contin
$D$4	Var x3	36.91	34.14	Contin
$E$4	Var x4	90.91	90.91	Contin
$F$4	Var x5	909.09	909.09	Contin
$G$4	Var x6	29.89	31.75	Contin
$H$4	Var x7	59.78	63.51	Contin
$I$4	Var x8	0.00	0.00	Contin
$J$4	Var xw	25.90	25.77	Contin
$K$4	Var xN	0	0	Contin
$L$4	Var α1	0	0	Contin
$M$4	Var α2	1942.08	1941.21	Contin
$N$4	Var α3	5218.37	5216.55	Contin
$O$4	Var α4	8822.28	8819.41	Contin
$P$4	Var α5	12786.59	12782.57	Contin
$Q$4	Var β1	1000	1000	Contin
$R$4	Var β2	0	0	Contin
$S$4	Var β3	0	0	Contin
$T$4	Var β4	0	0	Contin
$U$4	Var β5	0	0	Contin

Constraints

Cell	Name	Cell Value	Formula	Status	Slack
$V$20	Trans-Atlantic flights 2/3 for sum LHS	0E+00	$V$20=$X$20	Binding	0
$V$21	Caribbean flights LHS	0	$V$21=$X$21	Binding	0
$V$22	SF >10% of IMF LHS	-1E-14	$V$22>=$X$22	Binding	0E+00
$V$8	Year 1 LHS	-2E-12	$V$8<=$X$8	Binding	0
$V$9	Year 2 LHS	-2E-12	$V$9<=$X$9	Binding	0
$V$10	Year 3 LHS	0E+00	$V$10<=$X$10	Binding	0
$V$11	Year 4 LHS	7E-12	$V$11<=$X$11	Binding	0
$V$12	Year 5 LHS	7E-12	$V$12<=$X$12	Binding	0
$V$13	Atlantic Rev Year 1 ≤ 0.3 LHS	-1E-12	$V$13<=$X$13	Binding	0
$V$14	Atlantic Rev Year 2-5 LHS	-172.91	$V$14<=$X$14	Not Binding	172.9058807
$V$15	Wide-body availability summer LHS	98.9	$V$15<=$X$15	Binding	0
$V$16	Wide-body availability winter LHS	99.9	$V$16<=$X$16	Binding	0
$V$17	Narrow-bodied availability LHS	1000	$V$17<=$X$17	Binding	0
$V$18	SF<30% of IMF LHS	-181.82	$V$18<=$X$18	Not Binding	181.8181818
$V$19	External capital LHS	1000	$V$19<=$X$19	Binding	0

Summary of base model sensitivity report–Changing wide-bodied airplanes in winter by one unit

Variable Cells

Cell	Name	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease
$B$4	Var x1	72.25132973	0	11.11	6848.286669	24.03189809
$C$4	Var x2	48.16755315	0	0	10272.43	36.04784714
$D$4	Var x3	34.13963397	0	0	13.90207926	29.1322521
$E$4	Var x4	90.90909091	0	0.25	1.487697257	32.66449755
$F$4	Var x5	909.0909091	0	0.25	1E+30	1.487697257
$G$4	Var x6	31.75498269	0	0	58.42692699	37.77675132
$H$4	Var x7	63.50996538	0	2.15	29.21346349	18.88837566
$I$4	Var x8	0	-2.969499777	0	2.969499777	1E+30
$J$4	Var xw	25.76502814	0	100	2126.85729	66.32664874
$K$4	Var xN	0	-95.85329985	20	95.85329985	1E+30
$L$4	Var α1	0	-0.612744658	0	0.612744658	1E+30
$M$4	Var α2	1941.212744	0	0	0.322030345	1.331
$N$4	Var α3	5216.546762	0	0	0.350015632	1.21
$O$4	Var α4	8819.414182	0	0	0.38818745	1.1
$P$4	Var α5	12782.56834	0	1	0.415515724	1
$Q$4	Var β1	1000	0	0	1E+30	0.559504658
$R$4	Var β2	0	-0.607904658	0	0.607904658	1E+30
$S$4	Var β3	0	-0.603504658	0	0.603504658	1E+30
$T$4	Var β4	0	-0.599504658	0	0.599504658	1E+30
$U$4	Var β5	0	-0.559504658	-1	0.559504658	1E+30

Constraints

Cell	Name	Final Value	Shadow Price	Constraint R.H. Side	Allowable Increase	Allowable Decrease
$V$20	Trans-Atlantic flights 2/3 for sum LHS	0	-1.093018793	0	48.2793711	66.67220231
$V$21	Caribbean flights LHS	0	-5.043237788	0	36.99165414	33.25291805
$V$22	SF >10% of IMF LHS	-1.42109E-14	-1.352452052	0	153.8461538	100
$V$8	Year 1 LHS	-2.27374E-12	2.076844658	0	1E+30	3053.249391
$V$9	Year 2 LHS	-2.27374E-12	1.331	0	1E+30	1941.212744
$V$10	Year 3 LHS	0	1.21	0	1E+30	5216.546762
$V$11	Year 4 LHS	7.27596E-12	1.1	0	1E+30	8819.414182
$V$12	Year 5 LHS	7.27596E-12	1	0	1E+30	12782.56834
$V$13	Atlantic Rev Year 1 ≤ 0.3 LHS	-1.08002E-12	0.628685629	0	184.0664849	2761.851893
$V$14	Atlantic Rev Year 2-5 LHS	-172.9058807	0	0	1E+30	172.9058807
$V$15	Wide-body availability summer LHS	98.9	50.66796975	98.9	36.61773037	19.62905615
$V$16	Wide-body availability winter LHS	99.9	37.68825639	99.9	33.16255768	31.82954583
$V$17	Narrow-bodied availability LHS	1000	7.212706177	1000	738.8058917	1000
$V$18	SF<30% of IMF LHS	-181.8181818	0	0	1E+30	181.8181818
$V$19	External capital LHS	1000	0.559504658	1000	2186.728153	1000

Summary of base model answer report–Changing narrow-bodied airplanes by one unit

Objective Cell (Max)

Cell	Name	Original Value	Final Value
$X$3	Optimal NPV Target cell	16548.3	16517.9

Variable Cells

Cell	Name	Original Value	Final Value	Integer
$B$4	Var x1	72.25	72.29	Contin
$C$4	Var x2	48.17	48.20	Contin
$D$4	Var x3	34.14	35.12	Contin
$E$4	Var x4	90.91	91.00	Contin
$F$4	Var x5	909.09	910.00	Contin
$G$4	Var x6	31.75	30.77	Contin
$H$4	Var x7	63.51	61.55	Contin
$I$4	Var x8	0.00	0.00	Contin
$J$4	Var xw	25.77	25.79	Contin
$K$4	Var xN	0	0	Contin
$L$4	Var α1	0	0	Contin
$M$4	Var α2	1941.21	1934.88	Contin
$N$4	Var α3	5216.55	5203.24	Contin
$O$4	Var α4	8819.41	8798.44	Contin
$P$4	Var α5	12782.57	12753.16	Contin
$Q$4	Var β1	1000	1000	Contin
$R$4	Var β2	0	0	Contin
$S$4	Var β3	0	0	Contin
$T$4	Var β4	0	0	Contin
$U$4	Var β5	0	0	Contin

Constraints

Cell	Name	Cell Value	Formula	Status	Slack
$V$20	Trans-Atlantic flights 2/3 for sum LHS	3E-14	$V$20=$X$20	Binding	0
$V$21	Caribbean flights LHS	0	$V$21=$X$21	Binding	0
$V$22	SF >10% of IMF LHS	-1E-14	$V$22>=$X$22	Binding	0E+00
$V$8	Year 1 LHS	-2E-12	$V$8<=$X$8	Binding	0
$V$9	Year 2 LHS	-2E-12	$V$9<=$X$9	Binding	0
$V$10	Year 3 LHS	2E-12	$V$10<=$X$10	Binding	0
$V$11	Year 4 LHS	5E-12	$V$11<=$X$11	Binding	0
$V$12	Year 5 LHS	9E-12	$V$12<=$X$12	Binding	0
$V$13	Atlantic Rev Year 1 ≤ 0.3 LHS	-1E-12	$V$13<=$X$13	Binding	0
$V$14	Atlantic Rev Year 2-5 LHS	-167.56	$V$14<=$X$14	Not Binding	167.5596682
$V$15	Wide-body availability summer LHS	98.9	$V$15<=$X$15	Binding	0
$V$16	Wide-body availability winter LHS	98.9	$V$16<=$X$16	Binding	0
$V$17	Narrow-bodied availability LHS	1001	$V$17<=$X$17	Binding	0
$V$18	SF<30% of IMF LHS	-182.00	$V$18<=$X$18	Not Binding	182
$V$19	External capital LHS	1000	$V$19<=$X$19	Binding	0

Summary of base model sensitivity report–Changing narrow-bodied airplanes by one unit

Variable Cells

Cell	Name	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease
$B$4	Var x1	72.29395177	0	11.11	6848.286669	24.03189809
$C$4	Var x2	48.19596785	0	0	10272.43	36.04784714
$D$4	Var x3	35.122888	0	0	13.90207926	29.1322521
$E$4	Var x4	91	0	0.25	1.487697257	32.66449755
$F$4	Var x5	910	0	0.25	1E+30	1.487697257
$G$4	Var x6	30.77312547	0	0	58.42692699	37.77675132
$H$4	Var x7	61.54625094	0	2.15	29.21346349	18.88837566
$I$4	Var x8	0	-2.969499777	0	2.969499777	1E+30
$J$4	Var xw	25.78929995	0	100	2126.85729	66.32664874
$K$4	Var xN	0	-95.85329985	20	95.85329985	1E+30
$L$4	Var α1	0	-0.612744658	0	0.612744658	1E+30
$M$4	Var α2	1934.876981	0	0	0.322030345	1.331
$N$4	Var α3	5203.24166	0	0	0.350015632	1.21
$O$4	Var α4	8798.442807	0	0	0.38818745	1.1
$P$4	Var α5	12753.16407	0	1	0.415515724	1
$Q$4	Var β1	1000	0	0	1E+30	0.559504658
$R$4	Var β2	0	-0.607904658	0	0.607904658	1E+30
$S$4	Var β3	0	-0.603504658	0	0.603504658	1E+30
$T$4	Var β4	0	-0.599504658	0	0.599504658	1E+30
$U$4	Var β5	0	-0.559504658	-1	0.559504658	1E+30

Constraints

Cell	Name	Final Value	Shadow Price	Constraint R.H. Side	Allowable Increase	Allowable Decrease
$V$20	Trans-Atlantic flights 2/3 for sum LHS	2.84217E-14	-1.093018793	0	49.66986306	64.61071219
$V$21	Caribbean flights LHS	0	-5.043237788	0	38.05704907	32.224745
$V$22	SF >10% of IMF LHS	-1.42109E-14	-1.352452052	0	154	100.1
$V$8	Year 1 LHS	-1.81899E-12	2.076844658	0	1E+30	3057.200352
$V$9	Year 2 LHS	-2.27374E-12	1.331	0	1E+30	1934.876981
$V$10	Year 3 LHS	1.81899E-12	1.21	0	1E+30	5203.24166
$V$11	Year 4 LHS	5.45697E-12	1.1	0	1E+30	8798.442807
$V$12	Year 5 LHS	9.09495E-12	1	0	1E+30	12753.16407
$V$13	Atlantic Rev Year 1 ≤ 0.3 LHS	-1.44951E-12	0.628685629	0	178.3751889	2763.481147
$V$14	Atlantic Rev Year 2-5 LHS	-167.5596682	0	0	1E+30	167.5596682
$V$15	Wide-body availability summer LHS	98.9	50.66796975	98.9	35.48551805	20.19439169
$V$16	Wide-body availability winter LHS	98.9	37.68825639	98.9	34.11767098	30.84538314
$V$17	Narrow-bodied availability LHS	1001	7.212706177	1001	760.0842063	1001
$V$18	SF<30% of IMF LHS	-182	0	0	1E+30	182
$V$19	External capital LHS	1000	0.559504658	1000	2179.591073	1000

Appendix E: Summary of the new optimisation model

Excel Solver Input Sheet–New Model

	Flight Routes								Airplane purchased		Money Lent					Money Borrowed					Agcy Cost	Wage H	Wage L	Equity							Target cell
Decision Variables	X1	X2	X3	X4	X5	X6	X7	X8	Xw	XN	α1	α2	α3	α4	α5	β1	β2	β3	β4	β5	AC			e1	e2	e3	e4	e5	**Optimal NPV**		**18880.3**
Var	72.26	48.17	35.17	90.91	909.09	30.76	61.51	0.00	25.78	0	0	1933.64	5200.64	8794.35	15247.42	1000	0	0	0	0	0	142.2036	118.503	0	0	0	0	2500			
Coefficients CF	11.11	0	0	0.25	0.25	0	2.15	0	100	20	0	0	0	0	1	0	0	0	0	-1	-1	-0.5	-0.5	0	0	0	0	0			
Constraints																													**LHS**	**Sign**	**RHS**
Year 1	-9.111	-9.111	-12.268	-0.748	-0.9367	-3.424	-3.424	-0.565	146	28	1	0	0	0	0	-1	0	0	0	0	0		0	-1	0	0	0	0	2E-11	≤	0
Year 2	-9.111	-9.111	-12.268	-0.748	-0.9367	-6.778	-6.778	-0.565	0	0	-1.1	1	0	0	0	1.14	-1	0	0	0	0		0	1	-1	0	0	0	4E-12	≤	0
Year 3	-9.111	-9.111	-12.268	-0.748	-0.9367	-6.778	-6.778	-0.565	0	0	0	-1.1	1	0	0	0	1.14	-1	0	0	0		0	0	1	-1	0	0	7E-12	≤	0
Year 4	-9.111	-9.111	-12.268	-0.748	-0.9367	-6.778	-6.778	-0.565	0	0	0	0	-1.1	1	0	0	0	1.14	-1	0	0		0	0	0	1	-1	0	9E-12	≤	0
Year 5	-9.111	-9.111	-12.268	-0.748	-0.9367	-6.778	-6.778	-0.565	0	0	0	0	0	-1.1	1	0	0	0	1.14	-1	0		0	0	0	0	1	-1	2E-11	≤	0
Atlantic Rev Year 1 ≤ 0.3	15.587	15.587	-9.451	-0.931	-1.281	-3.203	-3.203	-0.712	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	-3E-12	≤	0
Atlantic Rev Year 2-5	15.587	15.587	-9.451	-0.931	-1.281	-5.018	-5.018	-0.712	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	-2E+02	≤	0
Wide-body availability sur	1.277	0	1	0	0	1	0	0	-2.3	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	1E+02	≤	98.9
Wide-body availability wit	0	1.277	1	0	0	0	1	0	-2.3	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	1E+02	≤	98.9
Narrow-bodied availabilit	0	0	0	1	1	0	0	1	0	8	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	1E+03	≤	1000
SF<30% of IMF	0	0	0	1	-0.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	-2E+02	≤	0
External capital	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0		0	0	0	0	0	0	1E+03	≤	1000
Equity limit	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	1	1	1	1	1	3E+03	≤	2500
Agency costs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1.2	-1.2	-1.2	-1.2	-1.2	1		0	0.48	0.48	0.48	0.48	0.48	-7E-13	≤	0
Risk ranking	1	3	3	2	2	8	1	4	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	3E+03	≤	6239
Trans-Atlantic flights 2/3 fo	2	-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	1E-13	=	0
Caribbean flights	0	0	0	0	0	2	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	-1E-13	=	0
Debt-Equity Ratio	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0		0	-0.4	-0.4	-0.4	-0.4	-0.4	5E-13	≥	0
SF >10% of IMF	0	0	0	1	-0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0E+00	≥	0
Earning-Equity Ratio	11.11	0	0	0.25	0.25	0	2.15	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	-0.2	-0.2	-0.2	-0.2	-0.2	7E+02	≥	0
Incentive Compatibility	-0.2222	0	0	-0.005	-0.005	0	-0.043	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	-1	0	0	0	0	0	0E+00	≥	0
Participation Agent High	-1.111	0	0	-0.025	-0.025	0	-0.215	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	2E+01	≥	0
Participation Agent Low	-1.111	0	0	-0.025	-0.025	0	-0.215	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	6E-14	≥	0
Participation Principal - H	-2.7775	0	0	-0.0625	-0.0625	0	-0.5375	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	-2E+02	≤	0
Participation Principal - L	-2.7775	0	0	-0.0625	-0.0625	0	-0.5375	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	-2E+02	≤	0

Basic commision	0.1
Agent commision	0.02
Max commision	0.25

Summary of new model answer report

Objective Cell (Max)

Cell	Name	Original Value	Final Value
$AF$5	Optimal NPV Target cell	18880.3	18880.3

Variable Cells

Cell	Name	Original Value	Final Value	Integer
$B$6	Var x1	72.257	72.257	Contin
$C$6	Var x2	48.171	48.171	Contin
$D$6	Var x3	35.169	35.169	Contin
$E$6	Var x4	90.909	90.909	Contin
$F$6	Var x5	909.091	909.091	Contin
$G$6	Var x6	30.757	30.757	Contin
$H$6	Var x7	61.515	61.515	Contin
$I$6	Var x8	0.000	0.000	Contin
$J$6	Var xw	25.782	25.782	Contin
$K$6	Var xN	0.000	0.000	Contin
$L$6	Var α1	0.000	0.000	Contin
$M$6	Var α2	1933.639	1933.639	Contin
$N$6	Var α3	5200.643	5200.643	Contin
$O$6	Var α4	8794.346	8794.346	Contin
$P$6	Var α5	15247.420	15247.420	Contin
$Q$6	Var β1	1000.000	1000.000	Contin
$R$6	Var β2	0.000	0.000	Contin
$S$6	Var β3	0.000	0.000	Contin
$T$6	Var β4	0.000	0.000	Contin
$U$6	Var β5	0.000	0.000	Contin
$V$6	Var AC	0.000	0.000	Contin
$W$6	Var Wage H	142.204	142.204	Contin
$X$6	Var Wage L	118.503	118.503	Contin
$Y$6	Var e1	0.000	0.000	Contin
$Z$6	Var e2	0.000	0.000	Contin
$AA$6	Var e3	0.000	0.000	Contin
$AB$6	Var e4	0.000	0.000	Contin
$AC$6	Var e5	2500.000	2500.000	Contin

Constraints

Cell	Name	Cell Value	Formula	Status	Slack
$AD$10	Year 1 LHS	2E-11	$AD$10<=$AF$10	Binding	0.000
$AD$11	Year 2 LHS	4E-12	$AD$11<=$AF$11	Binding	0.000
$AD$12	Year 3 LHS	7E-12	$AD$12<=$AF$12	Binding	0.000
$AD$13	Year 4 LHS	9E-12	$AD$13<=$AF$13	Binding	0.000
$AD$14	Year 5 LHS	2E-11	$AD$14<=$AF$14	Binding	0.000
$AD$15	Atlantic Rev Year 1 ≤ 0.3 LHS	-3E-12	$AD$15<=$AF$15	Binding	0.000
$AD$16	Atlantic Rev Year 2-5 LHS	-2E+02	$AD$16<=$AF$16	Not Binding	167.474
$AD$17	Wide-body availability summer LHS	1E+02	$AD$17<=$AF$17	Binding	0.000
$AD$18	Wide-body availability winter LHS	1E+02	$AD$18<=$AF$18	Binding	0.000
$AD$19	Narrow-bodied availability LHS	1E+03	$AD$19<=$AF$19	Binding	0.000
$AD$20	SF<30% of IMF LHS	-2E+02	$AD$20<=$AF$20	Not Binding	181.818
$AD$21	External capital LHS	1E+03	$AD$21<=$AF$21	Binding	0.000
$AD$22	Equity limit LHS	3E+03	$AD$22<=$AF$22	Binding	0.000
$AD$23	Agency costs LHS	-7E-13	$AD$23<=$AF$23	Binding	0.000
$AD$24	Risk ranking LHS	3E+03	$AD$24<=$AF$24	Not Binding	3609.495
$AD$25	Trans-Atlantic flights 2/3 for sum LHS	1E-13	$AD$25=$AF$25	Binding	0.000
$AD$26	Caribbean flights LHS	-1E-13	$AD$26=$AF$26	Binding	0.000
$AD$27	Debt-Equity Ratio LHS	5E-13	$AD$27>=$AF$27	Binding	0.000
$AD$28	SF >10% of IMF LHS	0E+00	$AD$28>=$AF$28	Binding	0.000
$AD$29	Earning-Equity Ratio LHS	7E+02	$AD$29>=$AF$29	Not Binding	685.030
$AD$30	Incentive Compatibility LHS	0E+00	$AD$30>=$AF$30	Binding	0.000
$AD$31	Participation Agent High LHS	2E+01	$AD$31>=$AF$31	Not Binding	23.701
$AD$32	Participation Agent Low LHS	6E-14	$AD$32>=$AF$32	Binding	0.000
$AD$33	Participation Principal - H LHS	-2E+02	$AD$33<=$AF$33	Not Binding	154.054
$AD$34	Participation Principal - L LHS	-2E+02	$AD$34<=$AF$34	Not Binding	177.754

Summary of new model sensitivity report

Variable Cells

Cell	Name	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease
$B$6	Var x1	72.257	0.000	11.11	54.066	22.608
$C$6	Var x2	48.171	0.000	0	81.098	33.913
$D$6	Var x3	35.169	0.000	0	13.079	29.149
$E$6	Var x4	90.909	0.000	0.25	1.473	32.115
$F$6	Var x5	909.091	0.000	0.25	1E+30	1.473
$G$6	Var x6	30.757	0.000	0	58.460	37.310
$H$6	Var x7	61.515	0.000	2.15	29.230	18.655
$I$6	Var x8	0.000	-2.920	0	2.920	1E+30
$J$6	Var xw	25.782	0.000	100	30.944	65.512
$K$6	Var xN	0.000	-95.018	20	95.018	1E+30
$L$6	Var α1	0.000	-0.606	0	0.606	1E+30
$M$6	Var α2	1933.639	0.000	0	0.318	0.349
$N$6	Var α3	5200.643	0.000	0	0.346	0.458
$O$6	Var α4	8794.346	0.000	0	0.384	0.696
$P$6	Var α5	15247.420	0.000	1	0.410	0.225
$Q$6	Var β1	1000.000	0.000	0	1E+30	0.553
$R$6	Var β2	0.000	-0.601	0	0.601	1E+30
$S$6	Var β3	0.000	-0.597	0	0.597	1E+30
$T$6	Var β4	0.000	-0.593	0	0.593	1E+30
$U$6	Var β5	0.000	-0.553	-1	0.553	1E+30
$V$6	Var AC	0.000	-1.000	-1	1	1E+30
$W$6	Var Wage H	142.204	0.000	-0.5	0.5	14.559
$X$6	Var Wage L	118.503	0.000	-0.5	1	17.471
$Y$6	Var e1	0.000	-0.261	0	0.261	1E+30
$Z$6	Var e2	0.000	-0.879	0	0.879	1E+30
$AA$6	Var e3	0.000	-0.890	0	0.890	1E+30
$AB$6	Var e4	0.000	-0.900	0	0.900	1E+30
$AC$6	Var e5	2500.000	0.000	0	6.49502E+15	0.261

Constraints

Cell	Name	Final Value	Shadow Price	Constraint R.H. Side	Allowable Increase	Allowable Decrease
$AD$10	Year 1 LHS	1.68257E-11	2.070	0	1E+30	3056.325
$AD$11	Year 2 LHS	3.63798E-12	1.331	0	1E+30	1933.639
$AD$12	Year 3 LHS	7.27596E-12	1.210	0	1E+30	5200.643
$AD$13	Year 4 LHS	9.09495E-12	1.100	0	1E+30	8794.346
$AD$14	Year 5 LHS	1.59162E-11	1.000	0	1E+30	15247.420
$AD$15	Atlantic Rev Year 1 ≤ 0.3 LHS	-3.35376E-12	0.591	0	178.284	2023.567
$AD$16	Atlantic Rev Year 2-5 LHS	-167.474	0.000	0	1E+30	167.474
$AD$17	Wide-body availability summer LHS	98.900	50.697	0	35.467	20.221
$AD$18	Wide-body availability winter LHS	98.900	37.223	0	34.163	30.830
$AD$19	Narrow-bodied availability LHS	1000.000	7.132	0	761.084	937.973
$AD$20	SF<30% of IMF LHS	-181.818	0.000	0	1E+30	181.818
$AD$21	External capital LHS	1000.000	3.053	0	7.1889E-13	1000.000
$AD$22	Equity limit LHS	2500.000	0.000	0	1E+30	1.79722E-12
$AD$23	Agency costs LHS	-6.82121E-13	0.000	0	1E+30	0
$AD$24	Risk ranking LHS	2629.851	0.000	0	1E+30	3609.495
$AD$25	Trans-Atlantic flights 2/3 for sum LHS	1.13687E-13	-1.464	0	49.735	0
$AD$26	Caribbean flights LHS	-1.13687E-13	-5.129	0	38.107	32.208
$AD$27	Debt-Equity Ratio LHS	4.54747E-13	-2.500	0	1000.000	0
$AD$28	SF >10% of IMF LHS	0	-1.339	0	153.846	100
$AD$29	Earning-Equity Ratio LHS	685.030	0.000	0	685.030	1E+30
$AD$30	Incentive Compatibility LHS	0	-0.500	0	154.054	23.701
$AD$31	Participation Agent High LHS	23.701	0.000	0	23.701	1E+30
$AD$32	Participation Agent Low LHS	5.68434E-14	-1.000	0	154.054	23.701
$AD$33	Participation Principal - H LHS	-154.054	0.000	0	1E+30	154.054
$AD$34	Participation Principal - L LHS	-177.754	0.000	0	1E+30	177.754

Appendix F: Summary of the sensitivity analysis–New model

Summary of new model answer report–Changing wide-bodied airplanes in summer by one unit

Objective Cell (Max)

Cell	Name	Original Value	Final Value
$AF$5	Optimal NPV Target cell	18880.3	18931.0

Variable Cells

Cell	Name	Original Value	Final Value	Integer
$B$6	Var x1	72.257	72.569	Contin
$C$6	Var x2	48.171	48.379	Contin
$D$6	Var x3	35.169	36.908	Contin
$E$6	Var x4	90.909	90.909	Contin
$F$6	Var x5	909.091	909.091	Contin
$G$6	Var x6	30.757	29.890	Contin
$H$6	Var x7	61.515	59.780	Contin
$I$6	Var x8	0.000	0.000	Contin
$J$6	Var xw	25.782	25.899	Contin
$K$6	Var xN	0.000	0.000	Contin
$L$6	Var α1	0.000	0.000	Contin
$M$6	Var α2	1933.639	1942.080	Contin
$N$6	Var α3	5200.643	5218.368	Contin
$O$6	Var α4	8794.346	8822.285	Contin
$P$6	Var α5	15247.420	15286.594	Contin
$Q$6	Var β1	1000.000	1000.000	Contin
$R$6	Var β2	0.000	0.000	Contin
$S$6	Var β3	0.000	0.000	Contin
$T$6	Var β4	0.000	0.000	Contin
$U$6	Var β5	0.000	0.000	Contin
$V$6	Var AC	0.000	0.000	Contin
$W$6	Var Wage H	142.204	142.172	Contin
$X$6	Var Wage L	118.503	118.477	Contin
$Y$6	Var e1	0.000	0.000	Contin
$Z$6	Var e2	0.000	0.000	Contin
$AA$6	Var e3	0.000	0.000	Contin
$AB$6	Var e4	0.000	0.000	Contin
$AC$6	Var e5	2500.000	2500.000	Contin

Constraints

Cell	Name	Cell Value	Formula	Status	Slack
$AD$10	Year 1 LHS	2E-11	$AD$10<=$AF$10	Binding	0.000
$AD$11	Year 2 LHS	4E-12	$AD$11<=$AF$11	Binding	0.000
$AD$12	Year 3 LHS	8E-12	$AD$12<=$AF$12	Binding	0.000
$AD$13	Year 4 LHS	9E-12	$AD$13<=$AF$13	Binding	0.000
$AD$14	Year 5 LHS	2E-11	$AD$14<=$AF$14	Binding	0.000
$AD$15	Atlantic Rev Year 1 ≤ 0.3 LHS	-3E-12	$AD$15<=$AF$15	Binding	0.000
$AD$16	Atlantic Rev Year 2-5 LHS	-2E+02	$AD$16<=$AF$16	Not Binding	162.752
$AD$17	Wide-body availability summer LHS	1E+02	$AD$17<=$AF$17	Binding	0.000
$AD$18	Wide-body availability winter LHS	1E+02	$AD$18<=$AF$18	Binding	0.000
$AD$19	Narrow-bodied availability LHS	1E+03	$AD$19<=$AF$19	Binding	0.000
$AD$20	SF<30% of IMF LHS	-2E+02	$AD$20<=$AF$20	Not Binding	181.818
$AD$21	External capital LHS	1E+03	$AD$21<=$AF$21	Binding	0.000
$AD$22	Equity limit LHS	3E+03	$AD$22<=$AF$22	Binding	0.000
$AD$23	Agency costs LHS	-5E-13	$AD$23<=$AF$23	Binding	0.000
$AD$24	Risk ranking LHS	3E+03	$AD$24<=$AF$24	Not Binding	3610.301
$AD$25	Trans-Atlantic flights 2/3 for sum LHS	9E-14	$AD$25=$AF$25	Binding	0.000
$AD$26	Caribbean flights LHS	-1E-13	$AD$26=$AF$26	Binding	0.000
$AD$27	Debt-Equity Ratio LHS	3E-13	$AD$27>=$AF$27	Binding	0.000
$AD$28	SF >10% of IMF LHS	0E+00	$AD$28>=$AF$28	Binding	0.000
$AD$29	Earning-Equity Ratio LHS	7E+02	$AD$29>=$AF$29	Not Binding	684.767
$AD$30	Incentive Compatibility LHS	3E-14	$AD$30>=$AF$30	Binding	0.000
$AD$31	Participation Agent High LHS	2E+01	$AD$31>=$AF$31	Not Binding	23.695
$AD$32	Participation Agent Low LHS	6E-14	$AD$32>=$AF$32	Binding	0.000
$AD$33	Participation Principal - H LHS	-2E+02	$AD$33<=$AF$33	Not Binding	154.020
$AD$34	Participation Principal - L LHS	-2E+02	$AD$34<=$AF$34	Not Binding	177.715

Summary of new model sensitivity report–Changing wide-bodied airplanes in summer by one unit

Variable Cells

Cell	Name	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease
$B$6	Var x1	72.569	0.000	11.11	54.066	22.608
$C$6	Var x2	48.379	0.000	0	81.098	33.913
$D$6	Var x3	36.908	0.000	0	13.079	29.149
$E$6	Var x4	90.909	0.000	0.25	1.473	32.115
$F$6	Var x5	909.091	0.000	0.25	1E+30	1.473
$G$6	Var x6	29.890	0.000	0	58.460	37.310
$H$6	Var x7	59.780	0.000	2.15	29.230	18.655
$I$6	Var x8	0.000	-2.920	0	2.920	1E+30
$J$6	Var xw	25.899	0.000	100	30.944	65.512
$K$6	Var xN	0.000	-95.018	20	95.018	1E+30
$L$6	Var α1	0.000	-0.606	0	0.606	1E+30
$M$6	Var α2	1942.080	0.000	0	0.318	0.349
$N$6	Var α3	5218.368	0.000	0	0.346	0.458
$O$6	Var α4	8822.285	0.000	0	0.384	0.696
$P$6	Var α5	15286.594	0.000	1	0.410	0.225
$Q$6	Var β1	1000.000	0.000	0	1E+30	0.553
$R$6	Var β2	0.000	-0.601	0	0.601	1E+30
$S$6	Var β3	0.000	-0.597	0	0.597	1E+30
$T$6	Var β4	0.000	-0.593	0	0.593	1E+30
$U$6	Var β5	0.000	-0.553	-1	0.553	1E+30
$V$6	Var AC	0.000	-1.000	-1	1.000	1E+30
$W$6	Var Wage H	142.172	0.000	-0.5	0.500	14.559
$X$6	Var Wage L	118.477	0.000	-0.5	1.000	17.471
$Y$6	Var e1	0.000	-0.261	0	0.261	1E+30
$Z$6	Var e2	0.000	-0.879	0	0.879	1E+30
$AA$6	Var e3	0.000	-0.890	0	0.890	1E+30
$AB$6	Var e4	0.000	-0.900	0	0.900	1E+30
$AC$6	Var e5	2500.000	0.000	0	6.49502E+15	0.261

Constraints

Cell	Name	Final Value	Shadow Price	Constraint R.H. Side	Allowable Increase	Allowable Decrease
$AD$10	Year 1 LHS	1.68257E-11	2.070	0	1E+30	3070.263
$AD$11	Year 2 LHS	3.86535E-12	1.331	0	1E+30	1942.080
$AD$12	Year 3 LHS	8.18545E-12	1.210	0	1E+30	5218.368
$AD$13	Year 4 LHS	9.09495E-12	1.100	0	1E+30	8822.285
$AD$14	Year 5 LHS	1.72804E-11	1.000	0	1E+30	15286.594
$AD$15	Atlantic Rev Year 1 ≤ 0.3 LHS	-3.38218E-12	0.591	0	173.257	2022.790
$AD$16	Atlantic Rev Year 2-5 LHS	-162.7517191	0.000	0	1E+30	162.752
$AD$17	Wide-body availability summer LHS	99.9	50.697	0	34.467	21.221
$AD$18	Wide-body availability winter LHS	98.9	37.223	0	35.852	29.960
$AD$19	Narrow-bodied availability LHS	1000	7.132	0	798.723	937.613
$AD$20	SF<30% of IMF LHS	-181.8181818	0.000	0	1E+30	181.818
$AD$21	External capital LHS	1000	3.053	0	6.47816E-13	1000.000
$AD$22	Equity limit LHS	2500	0.000	0	1E+30	1.61954E-12
$AD$23	Agency costs LHS	-4.54747E-13	0.000	0	1E+30	0
$AD$24	Risk ranking LHS	2627.332666	0.000	0	1E+30	3610.301
$AD$25	Trans-Atlantic flights 2/3 for sum LHS	8.52651E-14	-1.464	0	52.195	0.000
$AD$26	Caribbean flights LHS	-1.13687E-13	-5.129	0	39.992	31.300
$AD$27	Debt-Equity Ratio LHS	3.41061E-13	-2.500	0	1000.000	0.000
$AD$28	SF >10% of IMF LHS	0	-1.339	0	143.995	100.000
$AD$29	Earning-Equity Ratio LHS	684.7669928	0.000	0	684.767	1E+30
$AD$30	Incentive Compatibility LHS	2.84217E-14	-0.500	0	154.020	23.695
$AD$31	Participation Agent High LHS	23.69533986	0.000	0	23.695	1E+30
$AD$32	Participation Agent Low LHS	5.68434E-14	-1.000	0	154.020	23.695
$AD$33	Participation Principal - H LHS	-154.0197091	0.000	0	1E+30	154.020
$AD$34	Participation Principal - L LHS	-177.7150489	0.000	0	1E+30	177.715

Summary of new model answer report–Changing wide-bodied airplanes in winter by one unit

Objective Cell (Max)

Cell	Name	Original Value	Final Value
$AF$5	Optimal NPV Target cell	18880.3	18917.5

Variable Cells

Cell	Name	Original Value	Final Value	Integer
$B$6	Var x1	72.257	72.251	Contin
$C$6	Var x2	48.171	48.168	Contin
$D$6	Var x3	35.169	34.140	Contin
$E$6	Var x4	90.909	90.909	Contin
$F$6	Var x5	909.091	909.091	Contin
$G$6	Var x6	30.757	31.755	Contin
$H$6	Var x7	61.515	63.510	Contin
$I$6	Var x8	0.000	0.000	Contin
$J$6	Var xw	25.782	25.765	Contin
$K$6	Var xN	0.000	0.000	Contin
$L$6	Var α1	0.000	0.000	Contin
$M$6	Var α2	1933.639	1941.213	Contin
$N$6	Var α3	5200.643	5216.547	Contin
$O$6	Var α4	8794.346	8819.414	Contin
$P$6	Var α5	15247.420	15282.568	Contin
$Q$6	Var β1	1000.000	1000.000	Contin
$R$6	Var β2	0.000	0.000	Contin
$S$6	Var β3	0.000	0.000	Contin
$T$6	Var β4	0.000	0.000	Contin
$U$6	Var β5	0.000	0.000	Contin
$V$6	Var AC	0.000	0.000	Contin
$W$6	Var Wage H	142.204	142.711	Contin
$X$6	Var Wage L	118.503	118.926	Contin
$Y$6	Var e1	0.000	0.000	Contin
$Z$6	Var e2	0.000	0.000	Contin
$AA$6	Var e3	0.000	0.000	Contin
$AB$6	Var e4	0.000	0.000	Contin
$AC$6	Var e5	2500.000	2500.000	Contin

Constraints

Cell	Name	Cell Value	Formula	Status	Slack
$AD$10	Year 1 LHS	2E-11	$AD$10<=$AF$10	Binding	0.000
$AD$11	Year 2 LHS	4E-12	$AD$11<=$AF$11	Binding	0.000
$AD$12	Year 3 LHS	7E-12	$AD$12<=$AF$12	Binding	0.000
$AD$13	Year 4 LHS	1E-11	$AD$13<=$AF$13	Binding	0.000
$AD$14	Year 5 LHS	1E-11	$AD$14<=$AF$14	Binding	0.000
$AD$15	Atlantic Rev Year 1 ≤ 0.3 LHS	-3E-12	$AD$15<=$AF$15	Binding	0.000
$AD$16	Atlantic Rev Year 2-5 LHS	-2E+02	$AD$16<=$AF$16	Not Binding	172.906
$AD$17	Wide-body availability summer LHS	1E+02	$AD$17<=$AF$17	Binding	0.000
$AD$18	Wide-body availability winter LHS	1E+02	$AD$18<=$AF$18	Binding	0.000
$AD$19	Narrow-bodied availability LHS	1E+03	$AD$19<=$AF$19	Binding	0.000
$AD$20	SF<30% of IMF LHS	-2E+02	$AD$20<=$AF$20	Not Binding	181.818
$AD$21	External capital LHS	1E+03	$AD$21<=$AF$21	Binding	0.000
$AD$22	Equity limit LHS	3E+03	$AD$22<=$AF$22	Binding	0.000
$AD$23	Agency costs LHS	-7E-13	$AD$23<=$AF$23	Binding	0.000
$AD$24	Risk ranking LHS	3E+03	$AD$24<=$AF$24	Not Binding	3612.395
$AD$25	Trans-Atlantic flights 2/3 for sum LHS	1E-13	$AD$25=$AF$25	Binding	0.000
$AD$26	Caribbean flights LHS	-1E-13	$AD$26=$AF$26	Binding	0.000
$AD$27	Debt-Equity Ratio LHS	5E-13	$AD$27>=$AF$27	Binding	0.000
$AD$28	SF >10% of IMF LHS	0E+00	$AD$28>=$AF$28	Binding	0.000
$AD$29	Earning-Equity Ratio LHS	7E+02	$AD$29>=$AF$29	Not Binding	689.259
$AD$30	Incentive Compatibility LHS	3E-14	$AD$30>=$AF$30	Binding	0.000
$AD$31	Participation Agent High LHS	2E+01	$AD$31>=$AF$31	Not Binding	23.785
$AD$32	Participation Agent Low LHS	4E-14	$AD$32>=$AF$32	Binding	0.000
$AD$33	Participation Principal - H LHS	-2E+02	$AD$33<=$AF$33	Not Binding	154.604
$AD$34	Participation Principal - L LHS	-2E+02	$AD$34<=$AF$34	Not Binding	178.389

Summary of new model sensitivity report–Changing wide-bodied airplanes in winter by one unit

Variable Cells

Cell	Name	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease
$B$6	Var x1	72.251	0.000	11.110	54.066	22.608
$C$6	Var x2	48.168	0.000	0.000	81.098	33.913
$D$6	Var x3	34.140	0.000	0.000	13.079	29.149
$E$6	Var x4	90.909	0.000	0.250	1.473	32.115
$F$6	Var x5	909.091	0.000	0.250	1E+30	1.473
$G$6	Var x6	31.755	0.000	0.000	58.460	37.310
$H$6	Var x7	63.510	0.000	2.150	29.230	18.655
$I$6	Var x8	0.000	-2.920	0.000	2.920	1E+30
$J$6	Var xw	25.765	0.000	100.000	30.944	65.512
$K$6	Var xN	0.000	-95.018	20.000	95.018	1E+30
$L$6	Var α1	0.000	-0.606	0.000	0.606	1E+30
$M$6	Var α2	1941.213	0.000	0.000	0.318	0.349
$N$6	Var α3	5216.547	0.000	0.000	0.346	0.458
$O$6	Var α4	8819.414	0.000	0.000	0.384	0.696
$P$6	Var α5	15282.568	0.000	1.000	0.410	0.225
$Q$6	Var β1	1000.000	0.000	0.000	1E+30	0.553
$R$6	Var β2	0.000	-0.601	0.000	0.601	1E+30
$S$6	Var β3	0.000	-0.597	0.000	0.597	1E+30
$T$6	Var β4	0.000	-0.593	0.000	0.593	1E+30
$U$6	Var β5	0.000	-0.553	-1.000	0.553	1E+30
$V$6	Var AC	0.000	-1.000	-1.000	1.0E+00	1E+30
$W$6	Var Wage H	142.711	0.000	-0.500	5.0E-01	14.559
$X$6	Var Wage L	118.926	0.000	-0.500	1.0E+00	17.471
$Y$6	Var e1	0.000	-0.261	0.000	2.6E-01	1E+30
$Z$6	Var e2	0.000	-0.879	0.000	8.8E-01	1E+30
$AA$6	Var e3	0.000	-0.890	0.000	8.9E-01	1E+30
$AB$6	Var e4	0.000	-0.900	0.000	9.0E-01	1E+30
$AC$6	Var e5	2500.000	0.000	0.000	6.49502E+15	0.261

Constraints

Cell	Name	Final Value	Shadow Price	Constraint R.H. Side	Allowable Increase	Allowable Decrease
$AD$10	Year 1 LHS	1.81899E-11	2.070	0	1E+30	3053.249391
$AD$11	Year 2 LHS	3.86535E-12	1.331	0	1E+30	1941.212744
$AD$12	Year 3 LHS	7.27596E-12	1.210	0	1E+30	5216.546762
$AD$13	Year 4 LHS	1.09139E-11	1.100	0	1E+30	8819.414182
$AD$14	Year 5 LHS	1.40972E-11	1.000	0	1E+30	15282.56834
$AD$15	Atlantic Rev Year 1 ≤ 0.3 LHS	-2.78533E-12	0.591	0	184.0664849	2036.058324
$AD$16	Atlantic Rev Year 2-5 LHS	-172.9058807	0.000	0	1E+30	172.9058807
$AD$17	Wide-body availability summer LHS	98.9	50.697	0	36.61773037	19.62905615
$AD$18	Wide-body availability winter LHS	99.9	37.223	0	33.16255768	31.82954583
$AD$19	Narrow-bodied availability LHS	1000	7.132	0	738.8058917	943.7633599
$AD$20	SF<30% of IMF LHS	-181.8181818	0.000	0	1E+30	181.8181818
$AD$21	External capital LHS	1000	3.053	0	6.79886E-13	1000
$AD$22	Equity limit LHS	2500	0.000	0	1E+30	1.69972E-12
$AD$23	Agency costs LHS	-6.82121E-13	0.000	0	1E+30	0
$AD$24	Risk ranking LHS	2636.722718	0.000	0	1E+30	3612.394607
$AD$25	Trans-Atlantic flights 2/3 for sum LHS	1.13687E-13	-1.464	0	48.2793711	0
$AD$26	Caribbean flights LHS	-1.13687E-13	-5.129	0	36.99165414	33.25291805
$AD$27	Debt-Equity Ratio LHS	4.54747E-13	-2.500	0	1000	0
$AD$28	SF >10% of IMF LHS	0	-1.339	0	151.1240173	100
$AD$29	Earning-Equity Ratio LHS	689.2586988	0.000	0	689.2586988	1E+30
$AD$30	Incentive Compatibility LHS	2.84217E-14	-0.500	0	154.6036308	23.78517398
$AD$31	Participation Agent High LHS	23.78517398	0.000	0	23.78517398	1E+30
$AD$32	Participation Agent Low LHS	4.26326E-14	-1.000	0	154.6036308	23.78517398
$AD$33	Participation Principal - H LHS	-154.6036308	0.000	0	1E+30	154.6036308
$AD$34	Participation Principal - L LHS	-178.3888048	0.000	0	1E+30	178.3888048

Summary of new model answer report–Changing narrow-bodied airplanes by one unit

Objective Cell (Max)

Cell	Name	Original Value	Final Value
$AF$5	Optimal NPV Target cell	18880.3	**18887.4**

Variable Cells

Cell	Name	Original Value	Final Value	Integer
$B$6	Var x1	72.257	72.294	Contin
$C$6	Var x2	48.171	48.196	Contin
$D$6	Var x3	35.169	35.123	Contin
$E$6	Var x4	90.909	91.000	Contin
$F$6	Var x5	909.091	910.000	Contin
$G$6	Var x6	30.757	30.773	Contin
$H$6	Var x7	61.515	61.546	Contin
$I$6	Var x8	0.000	0.000	Contin
$J$6	Var xw	25.782	25.789	Contin
$K$6	Var xN	0.000	0.000	Contin
$L$6	Var α1	0.000	0.000	Contin
$M$6	Var α2	1933.639	1934.877	Contin
$N$6	Var α3	5200.643	5203.242	Contin
$O$6	Var α4	8794.346	8798.443	Contin
$P$6	Var α5	15247.420	15253.164	Contin
$Q$6	Var β1	1000.000	1000.000	Contin
$R$6	Var β2	0.000	0.000	Contin
$S$6	Var β3	0.000	0.000	Contin
$T$6	Var β4	0.000	0.000	Contin
$U$6	Var β5	0.000	0.000	Contin
$V$6	Var AC	0.000	0.000	Contin
$W$6	Var Wage H	142.204	142.291	Contin
$X$6	Var Wage L	118.503	118.576	Contin
$Y$6	Var e1	0.000	0.000	Contin
$Z$6	Var e2	0.000	0.000	Contin
$AA$6	Var e3	0.000	0.000	Contin
$AB$6	Var e4	0.000	0.000	Contin
$AC$6	Var e5	2500.000	2500.000	Contin

Constraints

Cell	Name	Cell Value	Formula	Status	Slack
$AD$10	Year 1 LHS	2E-11	$AD$10<=$AF$10	Binding	0.000
$AD$11	Year 2 LHS	3E-12	$AD$11<=$AF$11	Binding	0.000
$AD$12	Year 3 LHS	7E-12	$AD$12<=$AF$12	Binding	0.000
$AD$13	Year 4 LHS	1E-11	$AD$13<=$AF$13	Binding	0.000
$AD$14	Year 5 LHS	2E-11	$AD$14<=$AF$14	Binding	0.000
$AD$15	Atlantic Rev Year 1 ≤ 0.3 LHS	-3E-12	$AD$15<=$AF$15	Binding	0.000
$AD$16	Atlantic Rev Year 2-5 LHS	-2E+02	$AD$16<=$AF$16	Not Binding	167.560
$AD$17	Wide-body availability summer LHS	1E+02	$AD$17<=$AF$17	Binding	0.000
$AD$18	Wide-body availability winter LHS	1E+02	$AD$18<=$AF$18	Binding	0.000
$AD$19	Narrow-bodied availability LHS	1E+03	$AD$19<=$AF$19	Binding	0.000
$AD$20	SF<30% of IMF LHS	-2E+02	$AD$20<=$AF$20	Not Binding	182.000
$AD$21	External capital LHS	1E+03	$AD$21<=$AF$21	Binding	0.000
$AD$22	Equity limit LHS	3E+03	$AD$22<=$AF$22	Binding	0.000
$AD$23	Agency costs LHS	-7E-13	$AD$23<=$AF$23	Binding	0.000
$AD$24	Risk ranking LHS	3E+03	$AD$24<=$AF$24	Not Binding	3612.679
$AD$25	Trans-Atlantic flights 2/3 for sum LHS	9E-14	$AD$25=$AF$25	Binding	0.000
$AD$26	Caribbean flights LHS	-1E-13	$AD$26=$AF$26	Binding	0.000
$AD$27	Debt-Equity Ratio LHS	5E-13	$AD$27>=$AF$27	Binding	0E+00
$AD$28	SF >10% of IMF LHS	0E+00	$AD$28>=$AF$28	Binding	0E+00
$AD$29	Earning-Equity Ratio LHS	7E+02	$AD$29>=$AF$29	Not Binding	7E+02
$AD$30	Incentive Compatibility LHS	-3E-14	$AD$30>=$AF$30	Binding	0E+00
$AD$31	Participation Agent High LHS	2E+01	$AD$31>=$AF$31	Not Binding	2E+01
$AD$32	Participation Agent Low LHS	6E-14	$AD$32>=$AF$32	Binding	0E+00
$AD$33	Participation Principal - H LHS	-2E+02	$AD$33<=$AF$33	Not Binding	154.149
$AD$34	Participation Principal - L LHS	-2E+02	$AD$34<=$AF$34	Not Binding	177.864

Summary of new model sensitivity report–Changing narrow-bodied airplanes by one unit

Variable Cells

Cell	Name	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease
$B$6	Var x1	72.294	0	11.11	54.066	22.608
$C$6	Var x2	48.196	0	0	81.098	33.913
$D$6	Var x3	35.123	0	0	13.079	29.149
$E$6	Var x4	91.000	0	0.25	1.473	32.115
$F$6	Var x5	910.000	0	0.25	1E+30	1.473
$G$6	Var x6	30.773	0	0	58.460	37.310
$H$6	Var x7	61.546	0	2.15	29.230	18.655
$I$6	Var x8	0.000	-2.919559713	0	2.920	1E+30
$J$6	Var xw	25.789	0	100	30.944	65.512
$K$6	Var xN	0.000	-95.01818354	20	95.018	1E+30
$L$6	Var α1	0.000	-0.605872305	0	0.606	1E+30
$M$6	Var α2	1934.877	0	0	0.318	0.349
$N$6	Var α3	5203.242	0	0	0.346	0.458
$O$6	Var α4	8798.443	0	0	0.384	0.696
$P$6	Var α5	15253.164	0	1	0.410	0.225
$Q$6	Var β1	1000.000	0	0	1E+30	0.553
$R$6	Var β2	0.000	-0.601	0	0.601	1E+30
$S$6	Var β3	0.000	-0.597	0	0.597	1E+30
$T$6	Var β4	0.000	-0.593	0	0.593	1E+30
$U$6	Var β5	0.000	-0.553	-1	0.553	1E+30
$V$6	Var AC	0.000	-1	-1	1.000	1E+30
$W$6	Var Wage H	142.291	0	-0.5	0.500	14.559
$X$6	Var Wage L	118.576	0	-0.5	1.000	17.471
$Y$6	Var e1	0.000	-0.261	0	0.261	1E+30
$Z$6	Var e2	0.000	-0.879	0	0.879	1E+30
$AA$6	Var e3	0.000	-0.890	0	0.890	1E+30
$AB$6	Var e4	0.000	-0.900	0	0.900	1E+30
$AC$6	Var e5	2500.000	0	0	6.49502E+15	0.261

Constraints

Cell	Name	Final Value	Shadow Price	Constraint R.H. Side	Allowable Increase	Allowable Decrease
$AD$10	Year 1 LHS	1.63709E-11	2.069972305	0	1E+30	3057.200
$AD$11	Year 2 LHS	3.41061E-12	1.331	0	1E+30	1934.877
$AD$12	Year 3 LHS	7.27596E-12	1.21	0	1E+30	5203.242
$AD$13	Year 4 LHS	1.09139E-11	1.1	0	1E+30	8798.443
$AD$14	Year 5 LHS	1.77351E-11	1	0	1E+30	15253.164
$AD$15	Atlantic Rev Year 1 ≤ 0.3 LHS	-2.95586E-12	0.591447768	0	178.3751889	2025.724
$AD$16	Atlantic Rev Year 2-5 LHS	-167.5596682	0	0	1E+30	167.560
$AD$17	Wide-body availability summer LHS	98.9	50.69689106	0	35.48551805	20.194
$AD$18	Wide-body availability winter LHS	98.9	37.22309003	0	34.11767098	30.845
$AD$19	Narrow-bodied availability LHS	1001	7.132369876	0	760.0842063	938.973
$AD$20	SF<30% of IMF LHS	-182	0	0	1E+30	182.000
$AD$21	External capital LHS	1000	3.052632305	0	6.50571E-13	1000.000
$AD$22	Equity limit LHS	2500	0	0	1E+30	1.62643E-12
$AD$23	Agency costs LHS	-6.82121E-13	0	0	1E+30	0
$AD$24	Risk ranking LHS	2631.981774	0	0	1E+30	3612.679
$AD$25	Trans-Atlantic flights 2/3 for sum LHS	8.52651E-14	-1.463628784	0	49.66986306	0
$AD$26	Caribbean flights LHS	-1.06581E-13	-5.129100344	0	38.05704907	32.225
$AD$27	Debt-Equity Ratio LHS	4.54747E-13	-2.5	0	1000	0
$AD$28	SF >10% of IMF LHS	0	-1.339424721	0	144.6079184	100.100
$AD$29	Earning-Equity Ratio LHS	685.7602437	0	0	685.7602437	1E+30
$AD$30	Incentive Compatibility LHS	-2.84217E-14	-0.5	0	154.1488317	23.715
$AD$31	Participation Agent High LHS	23.71520487	0	0	23.71520487	1E+30
$AD$32	Participation Agent Low LHS	5.68434E-14	-1	0	154.1488317	23.715
$AD$33	Participation Principal - H LHS	-154.1488317	0	0	1E+30	154.149
$AD$34	Participation Principal - L LHS	-177.8640366	0	0	1E+30	177.864

Appendix G: Common labels for the financial number game and the expected rewards

Labels and definitions

Label	Definition
Aggressive accounting	A forceful and intentional choice and application of accounting principles designed to achieve desired results, typically higher current earnings, whether the practices followed are in accordance with GAAP or not.
Earnings management	The active manipulation of earnings toward a predetermined target, which may be set by management, a forecast made by analysts, or an amount that is consistent with a smoother, more sustainable earnings stream.
Income smoothing	A form of earnings management designed to remove peaks and valleys from a normal earnings series, including steps to reduce and store profits during good years for use during slower years.
Fraudulent financial reporting	Intentional misstatements or omissions of amounts or disclosures in financial statements, intended to deceive financial statement users. Determined to be fraudulent by an administrative, civil, or criminal proceeding.
Creative accounting practices	Any and all steps used to play the financial numbers game, including the aggressive choice and application of accounting principles, fraudulent financial reporting, and any steps taken toward earnings management or income smoothing.

Source: Mulford & Comiskey (2011)

Rewards of the game

Category	Rewards
Share-price effects	Higher share prices Reduced share-price volatility Increased corporate valuation Lower cost of equity capital Increased value of stock options
Borrowing cost effects	Improved credit quality Higher debt rating Lower borrowing costs Less stringent financial covenants
Bonus plan effects	Increased profit-based bonuses
Political cost effects	Decreased regulations Avoidance of higher taxes

Source: Mulford & Comiskey (2011)

Appendix H: Case Study used in Chapter 5 – World Airways

The case study, World Airways is a hypothetical international airline company based in the USA (Levary & Seitz, 1990). The airline industry operates in a highly competitive and vigorous environment in many countries, including Australia, the US, Canada and the UK, and significantly impacts global economic growth. Although many industries would be suitable candidates for the research, this study chose an airline for three primary reasons. Firstly, the industry has a long history, thus providing a relatively large sample of data. Secondly, the airline industry is unique and highly competitive, hence production efficiency and product quality are imperative. Finally, although it is one of the main industries in many countries, financially it has not performed well and is struggling to attract investment capital (Walsh, 2011). Key information and relevant data relating to World Airways Limited are summarised below.

The company acquired a new 'narrow-body' aircraft in January 2001 for $28 million. The airplane flies the East Coast commuter routes and generates revenue of $18,980,000 a year. The company's operating expense, other than depreciation, is $12,509,280 a year. Depreciation was $741,680 in the first year, and the company pays a 34% income tax rate. At the time of acquisition, World Airways had to pay $28 million plus $2,847,000 to increase working capital, a total of $30,847,000. World Airways was also considering purchasing 'wide-body' airplanes for use on European routes. Each airplane costs $146 million.

In the previous year, World Airways was considering replacing its last obsolete narrow-body airplane. The old airplane costs $28,570,000 per annum to operate. The new airplane costs $16,325,720 a year to operate, before considering depreciation or taxes. The new airplane requires a working capital of $2,487,000, whereas the old airplane requires a working capital of $1,814,000. A feasibility study to determine the costs and benefits had already cost $15,000. The old airplane could be sold for $12 million and had a basic value (cost minus depreciation) of $9 million. The depreciation for year one for the new airplane was $1,112,520, whereas depreciation for the old airplane was $613,000 for the same period, if the old airplane was kept. The estimated RRR for the planning horizon

of five years was 14%. World Airways accepted capital rationing during the entire five-year period. The company evaluated the purchase of the new airplane using the NPV method. The company assumed a number of economic conditions, as follows in Table 1 below.

Table H1: NPV assumptions

7. Cash flows are known or at least all projects have identical risk. 8. Unlimited amounts can be raised externally or invested externally at a discount rate. 9. The discount rate r is constant from year to year. 10. All costs and benefits can be expressed in terms of cash flows. 11. If more than one source of capital is used, each source remains a constant proportion of the present value of the remaining cash flows throughout the life of the asset. 12. The capital structure is optional (generate the lowest possible cost of capital for a given asset base).

Source: Levar & Seitz (1990)

As indicated above, World Airways owns two types of airplanes, wide-body and narrow-body. The wide-body airplanes operate three routes: Europe, the Caribbean and transcontinental. The narrow-body airplanes also operate three routes: commuter, short and intermediate. Tables 2 and 3 below summarise the cash flow analysis of each route and the calculation of coefficient variables. The transatlantic route is particularly vulnerable to price competition and fear of terrorism has created economic disaster on that route. As a result, management decided to limit transatlantic revenue to a maximum of 30% of the total revenue during both the summer and winter seasons. Because short flight routes are potential feeders to intermediate flight routes, management decided that the number of short flights per day should range from 10% to 30% of the number of intermediate flights per day.

The cost of capital for World Airways is estimated to be 14% per annum. Given this, there are limits to the amount of capital that can be raised at this cost. Therefore, the company decided that the new external capital must be limited to $1 billion. If World Airways tried to raise capital faster than this, the marginal cost

of capital would increase to 20%. The company also decided that any unusual funds raised could be temporarily invested at an interest rate of 10% a year.

The capital budgeting was based on a planning horizon of five years. The level of activities for the first year was treated differently as the operations were estimated to be slower than the following years two to five. The objective of the company was to maximise shareholder value by maximising the NPV of activities from various routes in different seasons of the year, and through the purchase of a number of airplanes of different sizes within available limited capital resources, both equity and debt. In this setting, a principal-agent game theoretic based capital budgeting optimisation model within a mechanism design framework was developed to maximise the NPV and mitigate agency costs.

Table H2: World Airways–Cash flow summary

IV. Airlines purchase and operating costs						
			---------- **Costs per flight hour ($)** ----------			
	Purchase price ($000)	Flight operations	Maintenance	Depreciation	Total	No. of seats
Wide-bodied airplane	146,000	2,850	1,143	612	4,605	404
Narrow-bodied airplane	28,000	1,437	547	254	2,238	150
V. Costs and revenue per route type						
Airplane/route type	Average passengers	Ticket price ($)	Flight hours	Fixed ground cost ($) [a]	Variable ground cost ($)[b]	Flights per day [c]
Wide-bodied						
Europe	249	490	6	6,000	15	1.8
Caribbean	282	325	4	6,000	16	2.3
Transcontinental	315	274	4	6,000	17	2.3
Narrow-bodied						
Commuter	130	50	1	1,000	20	8
Short	100	85	1.5	1,000	19	8
Intermediate	90	130	2	2,000	18	6
VI. Cash flow analysis per route type						
			---------- **Costs per flight ($)** ----------			
Route type	Revenue per flight	Fixed ground cost	Variable ground cost	Airplane operating costs [d]	Cash flow per flight [e]	Cash flow per day
Summer Europe	122,010	6,000	18,302	27,630	49,924	89,863
Winter Europe	122,010	6,000	18,302	27,630	49,924	89,863
Transcontinental	86,310	6,000	14,673	18,420	33,611	78,315
Short flights	8,500	1,000	1,615	3,357	2,049	16,396
Intermediate	11,700	2,000	2,106	4,476	2,566	15,395
Summer Caribbean	91,650	6,000	14,664	18,420	37,142	86,540
Winter Caribbean Commuter	91,650	6,000	14,664	18,420	37,142	86,540

1st Yr Caribbean	6,500 58,500	1,000 6,000	1,300 9,360	2,238 18,420	1,549 18,763	12,391 43,718

Source: Levary & Seitz (1990)

Notes:

a Per flight b As a percentage of revenue

c Per airplane d Hourly costs x hours per flight

e [(Revenue – Costs per flight) (1 - T) + D] x Daily flights per plane, where T = tax rate and D = depreciation per flight

Table H3: World Airways–Calculation of coefficients and cash flows

Routes	1	2	3	4	5	6	7	8	comments
Constraint 1									
R1: Year 1									
Income per route per day	49,924	49,924	33,611	2,049	2,566	18,763	18,763	1,549	Cash flow constraints for Year 1
Days in year	182.5	182.5	365	365	365	182.5	182.5	365	
Total - dollars	9111130	9111130	12268015	747885	936590	3424247.5	3424247.5	565385	
Total in millions	9.111	9.111	12.268	0.748	0.937	3.424	3.424	0.565	
Constraint 2 - 5									
R2-R5: Year 2-5									
Income per route per day	49,924	49,924	33,611	2,049	2,566	37,142	37,142	1,549	Cash flow constraints for Years 2-5
Days in year	182.5	182.5	365	365	365	182.5	182.5	365	
Total - dollars	9111130	9111130	12268015	747885	936590	6778415	6778415	565385	
Total in millions	9.111	9.111	12.268	0.748	0.937	6.778	6.778	0.565	
Additonal Constraint 6									
Income per route per day	122,010	122,010	86,310	8,500	11,700	58,500	58,500	6,500	Trans-Atlantic revenue limited to at most 30% of summar and w inter combined
Days in year	182.5	182.5	365	365	365	182.5	182.5	365	
Total - dollars	22266825	22266825	31503150	3102500	4270500	10676250	10676250	2372500	
Total in millions	22.267	22.267	31.503	3.103	4.271	10.676	10.676	2.373	
	6.680	6.680	9.451	0.931	1.281	3.203	3.203	0.712	
Net income for route 1 and 2 (22.267-6.680)	15.587	15.587	9.451	0.931	1.281	3.203	3.203	0.712	
Additonal Constraint 7									
Income per route per day	122,010	122,010	86,310	8,500	11,700	91,650	91,650	6,500	Trans-Atlantic revenue limited to at most 30% of summar and w inter combined
Days in year	182.5	182.5	365	365	365	182.5	182.5	365	
Total - dollars	22266825	22266825	31503150	3102500	4270500	16726125	16726125	2372500	
Total in millions	22.267	22.267	31.503	3.103	4.271	16.726	16.726	2.373	
Net income for route 1 and 2 (22.267-6.680)	15.587	15.587	9.451	0.931	1.281	5.018	5.018	0.712	

Source: Levary & Seitz, 1990 and Kalyebara & Islam, 2014

Table H4: World Airways–Summary of calculation of coefficient variables

Flight routes		Year 1		Year 2 - 5		Year 1	Year 2 - 5
		Cash Flow per flight $	Flight days	Cash Flow per flight $	Flight days	Coefficients	
						$'million	$'million
x_1	Summer Europe	49,924	182.5	49,924	182.5	9.111	9.111
x_2	Winter Europe	49,924	182.5	49,924	182.5	9.111	9.111
x_3	Transcontinetal	33,611	365	33,611	365	12.268	12.268
x_4	Short flights	2,049	365	2,049	365	0.748	0.748
x_5	Intermediate	2,566	365	2,566	365	0.937	0.937
x_6	Summer Caribbean	18,763	182.5	37,142	182.5	3.424	6.778
x_7	Winter Caribbean	18,763	182.5	37,142	182.5	3.424	6.778
x_8	Commuter	1,549	365	1,549	365	0.565	0.565
x_w	Wide-bodied purchase price	$146 m	in Year 1				
x_N	Narrow-bodied purchase price	$28 m	in Year 1				
α_{1-5}	Interest on lending	10%					
β_{1-5}	Interest on borrowing	14%					

Source: Levary & Seitz, 1990 and Kalyebara & Islam, 2014

World Airways' management estimated that the present value of total cash flows (calculated on a five-year horizon) was expected to be generated by various routes, as summarised below in Table 5. The figures include the terminal value of the existing airplanes at the end of the fifth year.

Table H5: World Airways–Estimated NPV of total cash flows

Routes	**NPV $m**
Summer Europe (x_1)	11.11
Winter Europe (x_2)	0.00
Transcontinental (x_3)	0.00
Short flights (x_4)	0.25
Intermediate (x_5)	0.25
Summer Caribbean (x_6)	0.00
Winter Caribbean (x_7)	2.15
Commuter (x_8)	0.00

Source: Levary & Seitz (1990

Appendix I: Historical Cost and Current Cost

The following advantages and weaknesses have been associated with the historical cost basis of accounting (CPA Australia, 2015):

Advantages

Very familiar, With preparers of financial reporting and users. According to Lee (1994), it has prevailed the time test and hence it should have been realised beneficial by a broader users.

Relevant to decision making, As it reflect the actual value paid and is based on the fair value of the consideration given for an asset or value received in exchange for a liability.

Reliable, As it make available relevant evidence of income based on actual transactions with external parties. Lee (1994) stated that the task of an accountant is to document actuality instead of value. The historical cost model is reliable as it is based on actual transactions that can be evidenced and verified. Therefore very limited exposure to dispute compared to other models.

Minute implementation costs, Since it is associated with the actual transactions. Thus, the measurement of historical cost is generally freely available. Social and economic perspective it is less costly as it minimises possible disputes regarding information reliability, as well as economy of information preparation time and effort.

High rate of return and better share prices. During inflation era, alternate models other than historical cost model, could lead to lower operating income and resulting lesser rates of return, and hence lower share prices and market ratings (Lee, 1994).

Weaknesses

Too little relevance to decision making, As it is simply a historical record of the sacrificed cost and not reflect the current or futuristic measure. Thus, it has limited analytical value.

Historical cost results in the measurement distortion of financial performance due to out-dated costs being linked to the current revenues. Some critics argue that it is better to match the revenue received with the cost spent to replace the asset.

Under historical cost, profits are recognised when realised, that is when a transaction occurs, irrespective of any changes in the prices or other values of assets and liabilities. As a result, profit can be impacted by the opted timing of the sale of assets.

Historical cost need to be accompanied by additional rules that verify the recoverable amount. This is necessary to ensure that the carrying value of the asset that appears in the balance sheet does not exceed the future economic benefits that the entity expects to derive from the asset. Conversely, market value indicates the market's assessment of the recoverable value of an asset. Moreover, historical cost fail to deal with assets acquired for no or nominal value.

Challenges the comparability of financial statements. Costs incurred at different time periods are totalled as equivalent in economic terms, while they are probably not.

In the case of self-constructed assets, the cost incurred depends on the efficiency of the entity. For example, if two firms were constructing equivalent assets, the less efficient of the two would incur higher costs. Thus, users may conclude that the firm with the higher cost base is healthier than the firm that incurred lower costs to construct the building, which is clearly a flaw.

Reliability Issues. There can be problems in objectively verifying the historical cost when computing the fair value of the purchase consideration and other incidental costs.

Historical cost reflects management expectations as the lowest point of recoverability of an assets rather than market expectations.

The historical cost of some items may have caused by an arbitrary cost allocation to assets, liabilities and expenses (e.g. overhead costs allocations to whole inventory items). These type of arbitrary costs allocations could undermine the realistic reliability of historical cost.

The historical cost model does not report contemporary values of resources, and while it states on an income number that comprises income items accrued in prior periods, it does so without separating these items. Furthermore, there is a resultant risk of providing financial statement users with the ambiguous impression that the traditional balance sheet is a value statement rather than merely a statement of unallocated cost balances (Lee, 1994).

Current Cost

As indicated earlier, there are two key current value methods for assets and liabilities: **value-in-use** and **fair value** (Scott, 2015). Arguments for and against the current value method are summarised below.

Arguments for current value

Pre-eminently, historical cost ignores current values and change in values, thus ignoring important information concerning wealth and progress of an entity. This is the key argument time and again present to back the current cost accounting. The users of financial reports must be interested in the current condition of a firm's affairs, and these must be articulated in current terms. In contrast, expressing these issues in historic terms is basically ignoring the truth in accounting (Lee, 1994).

The historical cost model also ignores value changes unless they are realised. Thus, unrealised income is ignored and heterogeneous income is not reported, which creates a misleading and confusing reporting of an entity's income that is neither suitable nor beneficial. Lee (1994) argued that truth and reality are obscured in the historical cost model and current cost accounting could minimise these errors by presenting current values, reporting unrealised gains and separating past period income elements from the current period.

Another argument for current value accounting is that income and value information must be of relevance to financial statements users who are anxious mostly with using current value information to assist them in decision making processes. Decision makers therefore need information that will assist them to establish alternate paths of action, predict the effects of such action and select

preferred courses of action. Lee (1994) concluded that current value information has better relevance to decision making processes compare to historical cost information.

Arguments Against current value

One argument against current value accounting is that accountants are mainly book-keepers rather than valuers. In other words, an accountant's task is to record actual transactions in value terms applicable to the transactions at the time of executing. These actual records will become submerged in a range of value adjustments, thereby concealing valuable stewardship information (Lee, 1994).

A second argument against current value accounting is that it is someway less objective and challenging to verify compare to the historical accounting model. The valuation task is subjective and requires a highest degree of personal judgement.

Conservatism is generally ignored in the current value method, in fact, which is an instrument to enrich contract efficiency by signaling investors with an early warning in relation to potential financial distress. It also provides a stewardship role by averting managers from overstating their performance for greater compensation through recognising unrealised gains. Furthermore, low reliability of unrealised fair value gains works against conservatism, contract efficiency, and governance (Scott, 2015).

The test of time has also been invoked to criticise the advocacy of current value (Lee, 1994) and to support a traditionally cautious approach. Other counter arguments raise mainly technical points associated with the calculation of current value and the validity of associated assumptions.

There are many alternatives to current value including fair value, net realisable value, settlement value and value-in-use. These methods are being discussed in next sections below.

Fair value

According to IFRS 13 definition, the fair value measure is the price that to be received from the sale of an asset or be paid to transfer a liability in a systematic

transaction among market participants at the measurement date. The assumption of a systematic transaction is important for fair value to reflect an amount at which market participants would willingly exchange an item, rather than a 'liquidation' or 'fire-sale' price that might be achieved in a forced sale if the vendors were financially distressed. IFRS does not propose the application of fair value, nonetheless, it provides a frameworks for the measurement of fair value when another standard prescribes or permits its use.

Accounting information for efficient contracting should be based on realised market transactions and be verifiable by third parties. Hence, contract theory supports fair value only when the value can be determined reliably. Moreover, fair value is valued by many academics and practitioners to be more relevant than cost-based measures (Scott, 2015). Conversely, the fair value measure has been criticised for numerous reasons, including the following:

Social preference. Historical cost accounting is generally preferred to fair value, since it avoids the possibility of financial contagion from one industry to another when the industries possess similar assets in common (Scott, 2015).

Absence of relevance to decision making. This relates to assets such as financial instruments that the entity intends to hold to maturity instead of selling them.

Issues with reliability. With regard to measuring the fair value of assets that are not traded in a common market, contract theory supports fair value only when this value can be determined reliably. According to Scott (2015), where assets and liabilities for which a market value cannot be observed or obtained, then the reliable determination of the fair value is very difficult and contrary to contract theory.

Net realisable value

Net realisable value is another value-based measure. This measurement is usually applied to inventory assets. This approach determines the value of economic benefits that an entity anticipates to obtain from selling an asset under normal business condition. According to International Accounting Standard IAS 2, net realisable value is the estimated selling price in the normal course of

business less the estimated costs to complete the item (e.g. non-completed inventory) and the estimated selling costs. Net realisable value may also reflect entity specific expectations regarding the estimated selling price under the normal business condition and the estimated completion costs and selling costs. These expectations may not be in accordance with market expectations on which fair value would generally be based.

A criticism of the net realisable value basis of measurement is that the netting of costs to complete the asset and make a sale against the estimated selling price can result in recognising liabilities for future costs for which there is no present obligation. Such a practice would be inconsistent with the definition of liabilities (CPA Australia, 2015).

Settlement value

Generally, the concept of settlement value applies to liabilities. The settlement value refers to the amount that would be paid to settle the liability with a counter party. This is contrary to the fair value definition of IFRS 13 (as discussed in the previous section) that the fair value of a liability is the amount that need to be paid to transfer a liability in a normal transaction among market participants at the valuation date. The settlement value embodies entity specific considerations, including whether or not the entity should settle the liability using its internal resources and the efficiency with which an entity can settle a liability.

Value-in-use

International Accounting Standard IAS 36 defines the value-in-use measure as the present value of expected future cash flows of an asset of cash generating unit. Value-in-use is also often expressed as the entity specific value. This measure should reflect the estimated future cash flows that the entity anticipates to obtain from the asset. Moreover, the discount rate that is applied to the expected cash flows must endorse with the current market estimate of the time value of money and adjusted risk specific to the future cash flow asset (IAS 36, para 55).

The key advantage of this measure is that management is in the best position to judge the expected value, timing and risk of future cash flows. Hence, accounting

statements are considered to be more relevant and reliable where they reflect management intentions and expectations. The other noteworthy advantage is that management would be held more accountable against measurements that reflect entity specific management objectives.

The major criticism of this measurement relates to **reliability problems**. As value-in-use is generally estimated as the discounted net incomes of an asset, it is specific to all entities and to each specific use. Thus, it relates to only one specific future course of action or combination of actions. This measure is subjective and very challenging for others to independently verify it. The application of value-in-use to assets that do not generate contractual cash flows is problematic, and an individual asset may work with other assets to generate cash flows. This results in the need to allocate expected cash flows across assets that may be arbitrary.

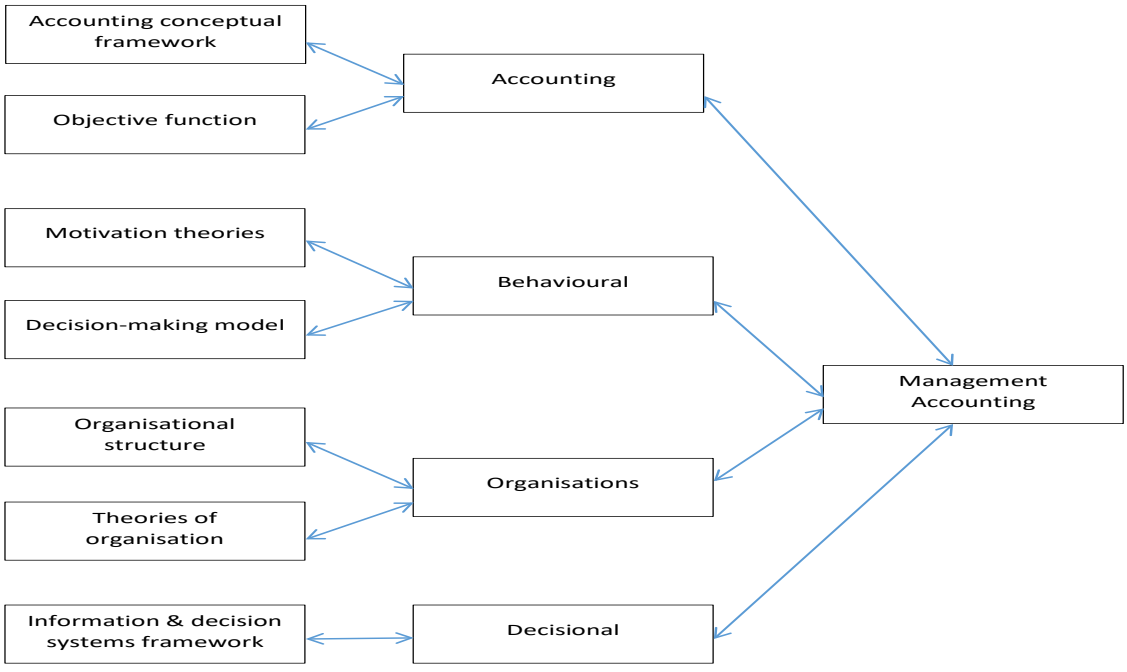
The other criticism of this measurement is the absence of **understandability**, in terms of the lack of clarity regarding whether value-in-use should reflect management or market expectations.

The next section discusses accounting information and the elements required to estimate a suitable discount rate.

Appendix J: Management Accounting and Capital Budgeting

According to Lambert (2007), management accounting is associated with measurement and information issues within an organisation. The management accounting information is very beneficial to evaluate former decisions and to improve future decisions, which include the allocation of resources within an organisation, coordination within sub-units, pricing, costing, and incentives and compensation. Moreover, management accounting information assist managers in performing their tasks of planning, controlling, and decision making (Hansen & Mowen, 2005). Planning is the detailed formation of action to achieve a particular end. Monitoring the plan implementation referred as controlling and choosing among competing alternatives is decision making. The American Institute of Certified Public accounts (AICPA) classified management accounting into three areas such as strategic management, performance management and risk management. These areas play a major role in efficient capital budgeting decisions, and capital budgeting has evolved with various disciplines, particularly management accounting as an integrated area. Conceptual foundations of management accounting are shown in the Figure below, representing an integrated theory of management accounting, including the range of skills needed by the functions' members and behavioural relationships.

Conceptual foundations of management accounting



Source: CPA Australia 2015

Appendix K: Management Accounting and Financial Accounting

Financial accounting differs from management accounting in several ways. Management accounting reports are beneficial for the users within the organisation, however financial accounting reports are prepared for external users. The externally imposed rules of financial reporting, such as GAAP and accounting standards are not applicable to management accounting. Management accounting sources both financial and non-financial measures, nevertheless, financial accounting offers audited objective financial information that includes a company's financial position, financial performance, and cash flow statement. This information is beneficial to a variety of users for making sound economic decisions about the reporting entity (Scott, 2015). Management accounting offers very detail information that are wide-ranging and multidisciplinary than financial accounting. Major differences in these two accounting areas are summarised in table below.

Comparisons between management and financial accounting

Management Accounting	Financial Accounting
Focused on internal activities	Focused on external users
No standards or rules apply	Mandatory to comply with standards and rules
Possible subjective information, financial and non-financial	Objective financial information
The future emphasis	Reporting historical outcome
Internal assessment and decisions made based on wide range of information	Total organisation based information
Tend to be broader and multidisciplinary	Single disciplinary and independent

Source: Hansen & Mowen (2005), slightly modified

Appendix L: Game Theory and Capital Budgeting

A game theory model involves the interaction between two or more players and has many practical applications (Scott, 2015). It predicts the outcome of games based on the rules of the game and the information available to the players. Major components of game theory in relation to a principal-agent game in capital budgeting are discussed below.

Game

A game is any competition between individuals, groups or firms in which strategic behaviour plays a major role (Perloff, 2012). In capital budgeting, a principal-agent game involves shareholders and managers and the choice of suitable discount rates and profitable sets of projects for efficient capital allocation. Shareholders expect the managers to perform their best in choosing the suitable discount rate to select the right set of projects for long term investments in order to maximize company value. However, in practice, where managers have more information and the owner has inadequate information about the business, self-interest managers try to maximize their benefits (Scott, 2015 and Gul, 2007). Hence, managers can arbitrarily choose the discount rate to pick the unprofitable investment projects that maximize their interest. These different motives of owner and managers create principal-agent game.

Players

There are two players in capital budgeting decisions: the owner or senior executive as principal, whose interest is to maximise company wealth by investing in the right set of projects, and managers as agents whose interest is to maximise their own benefits. The divergent interests and outcomes related to one player can affect the other.

Action

Action is a move that a player makes at each stage of the game. The owner provides managers with an executive compensation plan/contract to motivate and control management's operation of the firm. Managers are to perform operations based on the contract to maximise company wealth.

Strategies

A strategy is a plan that specifies the action that a player makes, conditional on the available information (Perloff, 2012). The main strategy in capital budgeting is to convert the non-cooperative game into a cooperative game. The players are in a situation with a binding agreement between them. In order to achieve cooperation the owner designs an optimal contract that shows the extent to which the principal willingly accepts risks and pays the agreed benefits, even if the company is underperforming, and commands managers to take more risks and execute strategic actions that enhance company wealth. This action is generally referred to as incentive contract and monitoring (Gul, 2007).

Payoffs

The payoffs of a game are the players' valuation of the outcomes, such as NPV, profits, and individual benefits. Incentive contracts are created to capture the risk-sharing mechanism between the principal and agents through executive compensation schemes based on managerial performance. Under such arrangements, managers receive incentives such as pay increases, share ownership, and better working conditions, and in return, shareholders receive company wealth, as the right sets of projects are chosen for investments. In the capital budgeting principal-agent game, for the principal the agent's efforts are unobservable, but the payoff is jointly observable by both the principal and the agent. Net income is commonly used to determine a manager's pay, as it is easily observable by both the manager and the owner. However, in some circumstances, creative managers can manipulate the reported financial numbers in order to maximise their pay. Hence, owners should use various control mechanisms, such as the strict application of GAAP, periodic audits and use of historical cost-based accounting to limit these harmful managerial behaviours (Scott, 2015).

Strategic behaviour

Strategic behaviour is a set of actions a player takes to increase his payoff based on the possible actions of other players. According to agency theory, the principal can use two devices to reduce agency problems: incentives and monitoring, referred to as the 'carrot and stick' methods. The aim of the incentive plan for the

agent/management is to use explicit contracts to limit the divergent preferences and thus reduce agency costs. In this way the principal designs a contract in which agent compensation is tied to firm performance. Hence, agents have to commit to maximising company value in order to ensure they receive a high level of compensation in return. The principal can also allocate company shares to managers, giving them a sense of ownership and again, motivating them to maximise the value of the company.

Common knowledge

Information that is known to all players is common knowledge, such as knowledge about the rules of the game; that each player's payoff is related to his/her actions and his/her aim is to maximise respective payoffs. Incentive contracts motivate managers to perform well and monitoring plans are put in place to observe the behaviour of management. Consequently, both players generally know each other's moves.

Strategic interdependence

A player's optimal strategy depends on the action taken by other players. An owner needs to motivate managers by providing generous incentive plans to perform well in selecting the suitable discount rate and right set of projects for investment. In other words, managers are expected to put in more effort to receive their maximum benefit. This in turn leads to an increase in company wealth, which is the aim of the principal.

Rules of the game

Regulations determine the players appropriate moves and actions. Management has to follow internal process regulations and control guidelines for project appraisal and performs well to maximise company wealth in order to receive adequate incentives. The principal requires managers to follow capital budgeting rules and methods, estimate suitable discount rates for capital project appraisal, and comply with accounting GAAP and standards. An example of the general sequence of moves of the game in capital budgeting is presented below, with the headquarters representing the principal and the manager is the agent.

Date 0: Headquarters offers the manager a mechanism and makes an effort recommendation

Date 1: The division manager reports

Date 2: Headquarters allocates capital to the division

Date 3: The division manager chooses effort and implements the project

Date 4: The project cash flow is realised and distributed to shareholders, less the compensation paid to the division manager

Source: Bernardo et al. (2001)

Complete information

Complete information is evident in a situation where the payoff process is commonly known by all the players. Generally, incentive plan contracts and control mechanisms are common knowledge to all players. Hence managers are expected to apply the appropriate discount rate and correct cash flow forecasts for capital budgeting to maximise shareholder value in order to receive the benefits agreed upon by the owner and disclosed in the contracts.

Perfect information

Perfect information is evident in a situation where the players know the full history of the game. Both principal and agent move as per the agreed contract and receive incentives in accordance with agreements, such as achieving the agreed level of net income for the approved projects to receive the set benefits.

Dynamic/ multi-period game

A dynamic or multi-period game is one in which players move repeatedly for multiple periods. Estimation of project-specific discount rates for capital budgeting is a continuous strategic investment activity, hence it is a dynamic game. Moreover, if a game is repeated for a number of periods, a trigger strategy may attain the cooperative solution. One source of trust is a belief by the principal that the agent will incur a penalty or forego benefits for opportunism. However, fear of liability does not always avert cheating. Hence accounting control mechanisms, such as GAAP, accounting standards, full disclosure of financial activities, internal and external audits, can play a key role in preventing managerial opportunism (Scott, 2015). In this way, the role of high quality financial reporting to maintain shareholders' trust in managers is crucial.

Outcome

The combination of strategies chosen by each player is known as the equilibrium, which shows what actions come out of the conjunction of all the players' plans and the resulting outcome of the game. In capital budgeting cases, efficient capital budgeting decisions are achieved through estimation of suitable discount rates, thereby selecting the right set of projects for capital investments that maximise shareholder wealth, minimise agency costs, and at the same time maximise managers' interests.

Game theory can be classified into two groups: non-cooperative game and cooperative game, and their applications in capital budgeting are discussed in the following sections.