AN ANALYSIS OF THE EFFICIENCY OF AUSTRALIAN SUPERANNUATION FUNDS

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In memory of my loving mother

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ABSTRACT

This study investigates the relative economic efficiency of Australian superannuation funds using Data Envelopment Analysis (DEA), a non-parametric linear programming technique. The study has two phases. The first phase, which covers a seven-year period from 2005 to 2012, estimates the efficiency scores of Australian superannuation funds. The sample in the first phase is 183 superannuation funds, which approximates 79% of APRA-regulated active[2] funds as at 30 June 2012. The second phase, spanning a two-year period from 2010 to 2012, investigates the drivers that may influence superannuation fund efficiency. The sample in the second phase is 145 superannuation funds, which approximates 63% of active funds. The number of sample superannuation funds is reduced in the second phase due to data availability issues.

The first phase findings indicate that most Australian superannuation funds are inefficient relative to the efficiency frontier, an internal benchmark established by efficient funds. In the second phase, the study investigates the effect of trustee board structure, risk management mechanism and investment activities on efficiency, as identified through the structure, conduct and performance (SCP) framework of the Australian superannuation system. The results in the second phase reveal that board size, insurance cover and investment options have marginally negative relationships with efficiency scores. By contrast, female directors and investments in international shares have positive relationships with efficiency scores.

The findings from the first phase of the study highlight the need to improve the efficiency of Australian superannuation funds by reducing overall fund expenses and volatility of investment returns to narrow the gap in performance between efficient and inefficient funds. The finding on board size indicates that the number of directors on the board is not a driver of superannuation fund efficiency performance. This result is

[2] Active funds reported non-zero assets and expenses

consistent with the argument that the quality of the board and other unobserved factors such as board day-to-day activities have more effect on an organisation's performance. The finding also implies that smaller board size may be more beneficial to superannuation fund members. Similarly, simplified low-cost insurance offers as well as fewer investment options may enhance the efficiency performance of superannuation funds. The positive association between female directors and efficiency scores support the current trend in Australia and elsewhere in regards to board diversity and the appointment of female board directors. Efficiency may also be enhanced by the diversification of superannuation asset investments into the global financial markets.

STATEMENT OF ORIGINAL AUTHORSHIP

I certify that this thesis does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any university; and that to the best of my knowledge and belief it does not contain any material previously published or written by another person except where due reference is made in the text.

Yen Hoang Bui

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PUBLICATIONS ARISING FROM THE RESEARCH

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Writing in progress:

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Industry publication

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LIST OF ABBREVIATIONS

APRA	Australian Prudential Regulation Authority
ASFA	Association of Superannuation Funds of Australia
ASIC	Australian Securities and Investments Commission
ASX	Australian Securities Exchange
ATO	Australian Tax Office
BCC	Banker, Charnes and Cooper
CAPM	Capital asset pricing model
CCR	Charnes, Cooper and Rhodes
CRS	Constant return to scale
DEA	Data envelopment analysis
DMU	Decision making unit
EET	Exempt, exempt, taxable
ERF	Eligible rollover fund
GDP	Gross domestic product
GFC	Global financial crisis
ICAA	Institute of Chartered Accountants in Australia
OECD	Organisation for Economic Co-operation and Development
OLS	Ordinary least squares
PACFL	President's Advisory Council on Financial Literacy
PAYG	Pay-as-you-go
RBA	Reserve Bank of Australia
SCP	Structure-Conduct-Performance
SD	Standard deviation
SG	Superannuation Guarantee (Act)
SIS	Superannuation Industry Supervision (Act)
SMSF	Self-managed superannuation fund
TTE	Taxable, taxable, exempt
UK	United Kingdom
USA	United States of America
VRS	Variable return to scale

Chapter 1
INTRODUCTION

The issue of the efficiency of Australian superannuation funds has emerged as one of significant interest to superannuation fund regulators, industry practitioners, and members and academics alike, especially after the global financial crisis (GFC) of 2007–2009. Highlights from a regulatory perspective include the Super System and a series of superannuation legislation amendments since 2012. This study has been conducted in the midst of many changes in the Australian superannuation landscape.

1.1 Background

The Australian superannuation industry plays a major role in the three–pillar retirement system comprising the Age Pension, compulsory superannuation and voluntary contributions or savings (Henry 2009). As at June 2013, superannuation assets totalled approximately A$1.6 trillion, or the size of Australia's Gross Domestic Product (GDP) (APRA 2014a). Australian superannuation assets are the fifth largest in the world, ranked only after the Netherlands, Iceland, Switzerland and the United Kingdom (OECD 2014). There are five functional classifications of Australian superannuation funds: corporate, industry, public sector, retail and small funds (APRA 2005).

Australian superannuation funds operate under a trustee model established by the general law of equity. A corporate trustee or a group of trustees is appointed to manage the fund (Cooper et al. 2009). The trustee controls the fund's assets, invests and/or distributes them for the benefit of fund members and beneficiaries. The trustee is responsible for ensuring that the trust is administered in accordance with the trust deed and the superannuation legislation framework. Each trustee has a fiduciary obligation to members and beneficiaries of the trust, including acting honestly and exercising care, skill and diligence (ComLaw Authoritative Act 2013). The Australian superannuation market involves three key participants: members, trustees and third–party service providers. Participants in the superannuation market are regulated by an ever-expanding and increasingly complex superannuation legislation built around corporation, tax and family laws. The two key acts for the superannuation system are the *Superannuation Guarantee Act 1992*, which prescribes the compulsory superannuation contribution amount as a percentage of salaries or wages; and the *Superannuation Industry Supervision Act 1993*, which provides for the prudent management and operation of superannuation funds (CCH Australia 2013; ComLaw Authoritative Act 2013).

Aspects of the operations and taxation of the Australian superannuation system were reviewed in the aftermath of the GFC and a significant reduction in the value of total superannuation assets. A major part of the review was carried out under the Super System Review, commonly referred to as the Cooper Review. The Super System Review examined and proposed reforms to the superannuation system in key areas such as governance, efficiency, structure and operation (Cooper et al. 2010a). Major reforms through amendments to the superannuation legislation have been taking place since 2012 (Australian Government 2012).

As the Australian superannuation market plays a major role in the economy, as well as contributing significantly to the welfare of most Australian retirees (Commonwealth of Australia 2010), the academic and industry literature dedicated to the study of the system is quite diverse. The main focus of these studies is investment performance, and the ranking of superannuation funds and agency issues (Clark-Murphy & Gerrans 2001; Coleman, Esho & Wong 2006; Cummins 2012; Drew & Stanford 2001; Ellis, Tobin & Tracey 2008; Sy & Liu 2009); fees and charges (Bateman 2003; Bateman & Mitchell 2004; Drew & Stanford 2003a; Nguyen, Tan & Cam 2012); governance structure (Cooper et al. 2009; Newitt 2009; Sy 2008), and the outsourcing of activities (Cooper 2010; Delpachitra, Ralston & Wickramasinghe 2012; Liu & Arnold 2010). The superannuation sector regulator, the Australian Prudential Regulation Authority

(APRA), publishes superannuation statistics annually at both the industry and fund levels, except for self-managed superannuation funds (SMSFs) (APRA 2014a). Against this backdrop, the study aims to explore the relative economic efficiency of APRA-regulated superannuation funds, incorporating critical issues identified in the literature such as investment returns, fees and charges using Data Envelopment Analysis (DEA), a non-parametric programming model. In addition, the study applies the Structure-Conduct-Performance (SCP) framework pioneered by Mason (1939) and Bain (1968) to investigate the relationship between efficiency and explanatory factors pertaining to several key aspects in superannuation fund structure and activities.

1.2 Definitions

As terminologies used by the researchers in this area of research are not uniform, it is important to provide a summary of several key definitions and their variations in the literature.

Pension refers to a retirement benefit and is often used as a short form for *private pension*. A *private pension* is administered by an institution other than the general government. *Private pension funds* may be administered directly by a private sector employer, a private pension fund or a private sector provider. Private pension funds may include funds which receive contributions from public sector workers (OECD 2005). In this thesis, *private pension funds* and *private pension plans* may be referred to as *pension funds* and *pension plans* respectively. *SMSFs* are private pension funds but are managed by trustee members for their own benefits (ATO 2014).

Public pension refers to a pension funded from pay-as-you-go (PAYG) tax revenues controlled and owned by the government. This is in contrast with pension plans which are designated to individual fund members. In Australia, there is one form of public pension, often referred to as the *Age Pension* (Henry 2009).

In this thesis, *pension* is used interchangeably with *superannuation***.** The meaning of *pension* and *superannuation* are similar (Macquairie Dictionary 2013). Their difference in this thesis relates to the geographical boundaries. *Pension* is used in the global context while *superannuation* is used in the Australian context.

A mutual fund or *managed fund* refers to an *investment fund* which is run on behalf of (an) investor(s) by an agent or fund manager (Turnbull, Lea & Phillips 2010). These terms have the same meaning in this thesis. *Mutual fund* is used in the global context and *managed fund* is employed in the Australian one.

1.3 Research objectives and questions

This study has the following objectives:

- To provide an overview of the SCP theoretical framework and the global pension markets in light of the SCP framework
- To review alternative measures to evaluate performance of pension funds and to introduce DEA, a non-parametric linear programming model to estimate efficiency of superannuation funds
- To provide a comprehensive overview of the Australian superannuation system and its current issues, the gaps in the literature, and the conceptual model for the study
- To estimate the efficiency scores of Australian superannuation funds using the DEA model and analyse the results
- To explore the relationship between efficiency scores and explanatory factors and analyse the results

The study aims to address two major research questions:

1) To what extent do Australian superannuation funds operate efficiently?

2) What are the drivers that influence this efficiency?

The first research question is addressed by estimating the efficiency of Australian superannuation funds using the DEA model. The second research question is addressed by regressing efficiency scores against a series of independent explanatory variables that influence the efficiency performance of superannuation funds. The independent explanatory variables pertain to several key aspects in the structure and conduct of Australian superannuation funds. The research methods used in answering the two research questions are detailed in the following section.

1.4 Research design

This study is conducted in two phases. The first phase estimates the efficiency scores of Australian APRA-regulated superannuation funds. The period of study in the first phase is from 2005 to 2012.The second phase investigates the relationship between efficiency scores and explanatory factors. The period of study for this phase spans two years, from 2010 to 2012. The period of study in the second phase is reduced due to data availability issues.

1.4.1 The first phase

In this phase, the DEA linear programming model is used to estimate efficiency scores of 183 Australian superannuation funds in the sample using the variable return to scale (VRS) model where funds are benchmarked against those of the same size. Only pure efficiency scores under the VRS model can be estimated for superannuation funds in this study due to the presence of negative investment returns (to be discussed in detail in Chapter 5).

The DEA method is based on the efficiency frontier concept where production input and output variables need to be identified. The efficiency frontier and efficiency scores are then estimated based on the inputs and outputs (Coelli et al. 2006). Efficiency scores of superannuation funds are estimated in two steps, for individual years and for the whole period using average values. The input variables for the individual year DEA estimates comprise investment expenses, operation expenses, management fees, administration fees and director fees. The input variables for the period estimates are the same as those in the individual year estimates except for the addition of an input variable which represents the volatility or standard deviation (SD) of investment return for the period of study (2005–12). The SD of investment return is an undesirable output of the investment activities and often included as an input by DEA researchers (Choi & Murthi 2001; Cook & Zhu 2008). The DEA model allows the inclusion of this undesirable output in the input set. The output variables for the individual year and period estimates are investment return, net assets and number of member accounts.

1.4.2 The second phase

The second phase has been commonly used in DEA analysis. This phase aims to relate efficiency scores for a given group of decision making units (DMUs) to a number of exogenous variables that may influence the level of efficiency using a prescribed regression model (Hoff 2007). In this study, two regression models are used for the second phase: Tobit and ordinary least square (OLS).

The Tobit regression is applied when the dependent variable is limited by being truncated, censored or in a 'corner solution' situation (Wooldridge 2010). The dependent variable, DEA efficiency scores, is of continuous positive fractional value and has a natural boundary of being between 0 and 1. DEA efficiency scores are uncensored data with all efficiency scores included. Nevertheless, due to DEA efficiency scores having a natural boundary of 0 and 1, Tobit is commonly used in the second phase (Hoff 2007).

The OLS regression offers a simpler alternative to investigate the relationship between efficiency scores and explanatory factors. The fundamental difference between the Tobit and OLS regressions is that Tobit is a qualitative response or probability model applied to situations where the dependent variable is qualitative in nature. In situations where the dependent variable is quantitative with continuous random data, the objective is to find the mean value, given the values of the independent variables, and the OLS model can provide sufficiently robust results (Gujarati & Porter 2009). The DEA efficiency scores have the characteristics of both qualitative and quantitative data. Although the efficiency scores fall between the range of 0 and 1, they strongly resemble quantitative data with continuous fractional values. As evidenced in studies by past researchers (Bravo-Ureta et al. 2007; Hoff 2007; McDonald 2009), the regression coefficients estimated by OLS do not differ significantly from those predicted by Tobit. In this study, the Tobit and OLS regression models are used in parallel for comparative purposes and to provide more substance to the regression results.

The independent explanatory variables chosen for OLS and Tobit are classified under governance and board structure, risk management mechanisms, and investment activities. They are detailed as follows:

a) Governance and board structure

- *Number of directors on the board*
- *Presence of employer-member representatives on the board*
- *Number of female directors on the board*
- *Number of independent directors on the board*

b) Risk management mechanism

- *Insurance covers offered to members*
- *Reserves*

c) Investment activities

- *Proportion of assets invested in Australian fixed assets*
- *Proportion of assets invested in Australian equities*
- *Proportion of assets held in cash*
- *Proportion of assets invested in international fixed assets*
- *Proportion of assets invested in international equities*
- *Number of investment options*

1.5 Justification for the research

The study aims to contribute to theory, policy and practice across several dimensions. The performance of pension funds worldwide has been in the spotlight due to poor returns and volatility of global financial markets. Members of superannuation funds in Australia have arguably been vulnerable parties. Unlike other types of investors who can liquidate their investments (subject to sufficient liquidity), members of superannuation funds are generally passive and are not allowed direct access to their investments until certain times. Members rely on funds' trustees who often employ fund managers to supervise their superannuation contributions. The importance of ensuring member protection and the efficiency of the superannuation system, therefore, cannot be overstated (Cooper et al. 2010a). In that context, a study on efficiency is important and is expected to contribute useful information to regulators, industry policy makers, members, and other market participants.

Apart from the *APRA Annual Superannuation Bulletin* and *Super Ratings* which rank funds according to their investment returns, there is hardly any other comprehensive approach in evaluating superannuation fund performance on an on-going basis. Ranking of superannuation funds tends to be a one-off approach. Therefore, the measurement and ranking of the superannuation funds' performance have become a pressing issue. The study contributes to this gap in the literature with the aim of setting a foundation for the ranking of Australian superannuation funds on an on-going basis using the DEA model.

Despite its importance, efficiency has only been discussed in relation to operational issues such as managing agency relationships, fees and charges, investment return or economies of scale. The relative efficiency of the Australian superannuation system from an economic productivity perspective has rarely been examined, except for a study by Njie (2006), where the Malmquist productivity DEA technique was used to measure the efficiency of Australia's retirement income system. This study extends the application of the DEA model to Australian superannuation funds.

The study aims to contribute to the literature in two other perspectives. The study uses the SCP framework for industrial organisations pioneered by Mason (1939) and developed by Bain (1968) to dissect the organisational structure and conduct of superannuation funds. The study links several key elements in superannuation fund structure and conduct with fund efficiency performance. A set of explanatory drivers will be constructed based on structural and behavioural characteristics of Australian superannuation funds. Thus, the study is expected to contribute to literature in the field of applied economics. In addition, superannuation research is not seen as being as robust as studies on other types of investment funds or on the corporate sector due to transparency and financial reporting issues. The lack of superannuation research is not only confined to Australia (Ambachtsheer, Capelle & Lum 2008). The study therefore contributes to filling the literature gap.

1.6 Scope of the research

The study is conducted on Australian APRA-regulated superannuation funds. These are large institutional funds which manage compulsory contributions from employers and voluntary contributions from employees. It is within large superannuation funds that the issues of separation of ownership and control, agency costs and their effect on members' benefits are more critical (Coleman, Esho & Wong 2006). The study excludes small funds or SMSFs where members manage their own superannuation assets. SMSFs are regulated by the Australian Tax Office (ATO).

The first phase of the study covers 183 superannuation funds over a period of seven years, from financial years 2005–6 to 2011–12. The second phase of the study covers 145 superannuation funds over two years, 2010–11 and 2011–12. The main reason for the reduced number of sample superannuation funds and thus reduced observations in the second phase are due to the non-availability of data from public sources for the periods prior to 2010.

1.7 Thesis structure

The thesis comprises nine chapters, the flow of which is outlined in Figure 1.1. Chapter 1 discusses the background to, and justification for, the research. Research objectives and questions as well as research methods with two distinctive phases are introduced. The literature review of the thesis is covered by three separate chapters, from Chapters 2 to 4. Chapter 2 introduces the SCP framework and investigates the global pension markets based on their structural characteristics, the conduct of market participants, and the performance of pension funds from an investment return perspective. Chapter 3 discusses the parametric and non-parametric production frontier models for measuring the economic efficiency performance of DMUs, which in the context of this thesis are superannuation funds. Chapter 4 provides a detailed overview of the Australian superannuation system, discusses current issues, gaps in the literature, and introduces the conceptual model for the study. The research design for the study consists of two phases. Chapter 5 introduces the research method for the first phase – estimation of efficiency scores. Chapter 6 analyses the results from the first phase and discusses implications. Chapter 7 introduces the research method for the second phase – the relationship between efficiency scores and explanatory factors. Chapter 8 analyses the results found in the second phase. Chapter 9 summarises the findings and concludes the study.

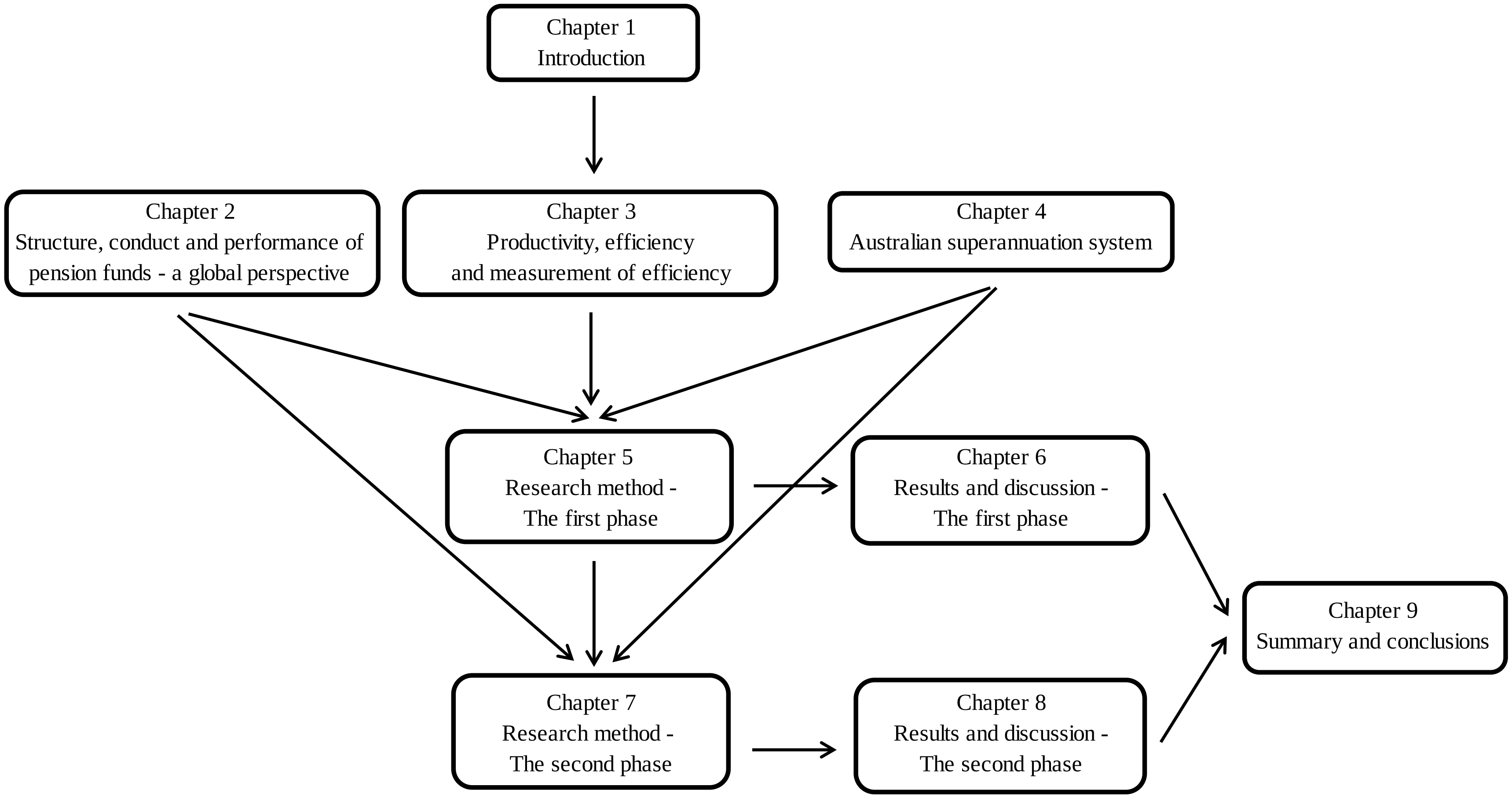


Figure 1.1. Flow of the thesis chapters

Chapter 2

STRUCTURE, CONDUCT AND PERFORMANCE OF PENSION FUNDS – A GLOBAL PERSPECTIVE

The literature review of this thesis is divided into three chapters: Chapters 2, 3 and 4. Chapter 2 discusses the SCP framework and provides an overview of organisational structure, operation and performance of pension funds from a global perspective. Chapter 3 discusses productivity and efficiency concepts and their application in estimating the relative economic efficiency of DMUs. Chapter 4 provides an overview of the Australian superannuation system and current issues identified in the literature. Chapter 4 further discusses the gap in the literature, states the main research questions and introduces the conceptual model for the study.

2.1 Introduction

Economists over the time have proposed different approaches to analyse the organisation of a particular industry, and have studied the associations between its structure, the behaviour and activities of its participants, and the results of these behaviour and activities. The results are reflected in the enterprise's performance. Studies of individual enterprises' performance are important as such, given that the performance of the industry depends strongly on the functioning of individual enterprises (Bain 1968).

One of these approaches is the SCP framework. This framework proposes a method of dissecting the structure of a particular industry, the conduct of its participants and its performance. The SCP framework was initially applied to industrial organisations (Mason 1939; Bain 1968), and in recent years has been applied to the mutual and pension fund industry. The SCP framework is seen as useful in identifying areas in organisational structure and behaviour that may have correlations with the performance of the organisation (Otten & Schweitzer 2002; Wang & Venezia 2009).

This chapter is organised as follows. Section 2.2 introduces the SCP framework. Section 2.3 provides an overview of the development of pension systems from a global perspective. Section 2.4, 2.5 and 2.6 discuss the structure, conduct and performance aspects, respectively, of pension funds. Sector 2.7 summarises the chapter.

2.2 Structure-Conduct-Performance (SCP) framework

The Structure-Conduct-Performance framework was pioneered by Mason (1939) and further developed by Bain (1968). With a special reference to the economy of the USA, Bain (1968) provided detailed explanations as to patterns of market structure, types of market conduct for sellers and buyers and, subsequently, the performance of business enterprises. Bain's works further sought demonstrable associations and inter-relations between the three elements of structure, conduct and performance. Regulations and public policies were analysed as to what extent they affected enterprise competition and monopoly.

In analysing performance which is the last element in the framework, it is necessary to consider other elements which are the determinants of performance. In particular, the analysis of the structure of the organisation and the wider industry, and the conduct of its participants help answer a critical question as to why some organisations perform better or worse than their peers (Wang & Venezia 2009). This knowledge is desirable, not only due to its academic interest, but also because it is important for the public policy setting (Bain 1968; Clements, Dale & Drew 2007).

The following sections discuss the original definitions and theories on the interactions of industry and market structure, conduct and performance.

2.2.1 Industry, market and market structure

A market is defined as an inter-related group of buyers and sellers. An industry in the market is a sub-group where outputs of each business firm can be substitutes for each other. An industry may comprise all the sellers in that market. Market structure refers to the organisational characteristics of a market, and analyses the relations between sellers and buyers. The most prominent dimensions of market structure are seller concentration (number and size distribution of sellers), buyer concentration, production differentiation, and condition of entry to the market (Bain 1968; Davis & Steil 2001).

From a firm's perspective, structure refers to the firm’s relative size such as the scale of its purchase and sales. Structure can also refer to the firm’s absolute size, determined by assets, employees, volume of sales and other characteristics. Structure may include elements other than product numbers and product differentiation (Mason 1939).

2.2.2 Market conduct

Market conduct refers to the behaviour and activities that market participants (sellers and buyers) undertake to adapt to the market in which they sell or buy. When these firms are sellers, market conduct encompasses price and product policies of the firms and the process of coordination of these policies. Price policies include the aims that sellers pursue and the methods that are applied in determining the prices charged. Product policies relate to which products are produced. Sales support policies determine which types of sales promotion are used (Bain 1968).

The market conduct of a firm is directly and indirectly affected by its organisational structure and characteristics. The scale of the firm’s purchase and sales relative to the total transactions of the market can indicate its market control. Further, the absolute size of the firm in assets, employees and production scale influences its price and production policies (Mason 1939). This demonstrates the inter-relationship between structure and conduct.

2.2.3 Market performance

Market performance refers to the final results of the application of the price, product and sales support policies. For firms which are sellers, these results measure the effectiveness of the firm’s adjustments to the demands for their outputs. For firms acting as buyers, the results measure the quality of adjustments to the supply conditions of the goods they purchase (Bain 1968).

Market performance of a firm and its industry depend on several dimensions. Prominent among these dimensions are the relative technical efficiency of production, as influenced by the size of the firm, selling price and profit margin, size of industry output, sales promotion costs relative to the costs of production, character of the products, and rate of progressiveness of the industry (Bain 1968).

2.2.4 Structure, conduct and performance of firms in the financial markets

It has been contended that structure has some effect on performance. In most SCP studies on financial markets, the examination of conduct is under-studied and direct links are assumed between structure and performance. Board structure, fee structures or globalisation have been seen as important drivers of performance. Industrial economists suggest that the traditional approach under-weighing conduct remains relevant for stagnant or heavily regulated markets. Nevertheless, more dynamic theories highlight the importance of conduct, which is often the case in more competitive markets (Davis & Steil 2001).

The conduct of existing firms in financial markets may be of great hindrance to a new entrant. For instance, there may be instances of overcapitalisation, high research expenditures, and high wage rates which offer a credible threat to entry on the cost side. On the one hand, firms may act strategically by advertising expenditures, product differentiation or brand proliferation to increase demand. Nevertheless, demand may be inelastic to prices due to sunk costs such as expertise, relationships or reputations which themselves make up principal assets of a financial intermediary. Consequently, more liberalised markets may not always be contestable and competitive. On the other hand, financial services tend to be ‘commoditised’ homogeneous products, with any innovations easily copied and technical advances easily adapted. Firms tend to supply multiple products, facilitating cross-entry. These characteristics may favour contestability which then affects price reductions and profitability (Davis & Steil 2001).

2.3 Development of pension systems – a global perspective

The reason for the establishment of pension systems in different countries is subject to continuing debates. The development of pension systems is closely related to social and economic changes (Thane 2006). It is widely argued that this development has been politicised in many different ways across countries (Arza & Johnson 2006). Philanthropy, politics and economics all influence the structure of public pension systems. Public pensions have generally been confined to high and middle income economies. Consequently, most studies on pensions are restricted to these countries. Even in these nations, in-depth studies on the history and development of pension systems are rather limited. Discussions about pension systems depend on the information available, rather than generalisation (Thane 2006).

The establishment of pension systems to cater for older people and to ameliorate old age poverty was initiated as early as the 19th century in many countries in Europe. Germany was the first country in the world to introduce a compulsory national public old-age pension scheme. In 1889, German Chancellor Otto von Bismarck introduced a contributory old-age pension plan for industrial and lower-paid white-collar workers. The scheme covered a large proportion of the population up to 54% by 1895, focusing on full-time workers and, thus, mostly males. Other countries such as Italy and Belgium had similar schemes. Nevertheless, these later schemes did not have the scope of a comprehensive social security system as it did in Germany (Arza & Johnson 2006).

Many countries had their first pension laws as early as the late 19th century or early 20th century (see Table 2.1). Pension schemes began in Europe and were later introduced in Africa and Asia, which had been European countries' colonies. The coverage of these schemes in less developed countries was narrower. This situation is similar to that at the inception of the public pension systems in more developed countries. Public pension schemes were limited in coverage and modest in expenditure. For instance, Germany's contributory pension system covered less than half the workforce in 1889, rose to two-thirds only sixty years later and did not become comprehensive until the mid-1980s. In the United Kingdom, public pension expenditure was just 0.44% of GNP in 1910, increased to 2% in the late 1940s and reached nearly 6% by the early 1980s (Arza & Johnson 2006).

Table 2.1. Year of the first pension laws in selected countries across six continents

Europe		**Oceania**		**Latin America**	
Germany	1889	New Zealand	1898	Argentina	1904
UK	1908	Australia	1908	Brazil	1923
France	1910			Chile	1924
Sweden	1913			Costa Rica	1941
Italy	1919			Mexico	1943
Netherlands	1919				
Spain	1919				
Poland	1927				
Greece	1934				
North America		**Africa**		**Asia**	
Canada	1927	South Africa	1928	Japan	1941
USA	1935	Egypt	1955	Turkey	1949
		Tunisia	1960	China	1951
		Nigeria	1961	India	1952
		Ethiopia	1963	Singapore	1953
		Gabon	1963	Saudi Arabia	1952
		Kenya	1965	Pakistan	1972

Source: Arza and Johnson (2006)

The extension of the coverage generated immediate revenues, as new groups of workers had to pay for the pension for quite a significant number of years before receiving it. Immediate increases in real benefits were therefore seen without any corresponding increase in per capita contributions. This situation appeared attractive to politicians, and was often promoted as an inducement to electors. However, by the late 1980s, most pension systems in developed countries had reached maturity. The number of contributors remained stable whereas the number of pensioners increased. Public pension systems faced the challenge of being unable to provide adequate retirement incomes for the growing number of pensioners (Arza & Johnson 2006).

With over a hundred years of growth and development, in the late 1980s, it was believed the public pensions in high and middle income countries were facing many problems, prominent among them were population ageing, system maturity and rising expenses. Old age public pensions, despite many of their positive effects on the living standards of pensioners, were the most expensive element of social security in many countries (Arza & Johnson 2006). The ageing of the population is invariably the first item on the agenda of various debates on the sustainability of the pension system (World Bank 1994). From a comparative economics perspective, countries vary significantly in their ability to fund for pensioners. From a philosophical perspective, the projected shortfall in funding raises many issues of social justice and inter-generational equity (Clark, Munnell & Orszag 2006).

Alongside the public pension schemes, occupational pension plans also took shape in the late 19th century. These plans were standard practice in large government and business organisations around the 1930s. In Anglo-Saxon countries (as opposed to continental European countries), retirement income plans from large employers had become a significant component of national retirement systems. Anglo-Saxon countries were mostly spared from hyperinflation and the severe destruction of the Second World War. Thus, their political culture was more resistant to an expansive dominating role of the state. These countries were also early industrialisers with a well-established employer plan tradition (Clark 2000, 2003; Esping-Andersen 1990; Whiteside 2003).

Public pension or PAYG and employer-sponsored systems dominated much of the 20th century. In the last few decades, policy makers have realised the enormous fiscal burden created by public pension systems (Clark, Munnell & Orszag 2006). Many countries have introduced alternative systems to alleviate this burden. Chile is the worldwide pioneer in introducing a private pension system in 1983 (Arza & Johnson 2006).

The worldwide development of pension systems is not based on a single or common institutional model. When pension systems are reformed, new or supplementary provisions are combined with original and existing systems. This results in ever increasing complex pension arrangements. Table 2.2 summarises possible schemes for public and private pensions. There are significant variations and combinations of these types of pension in different countries (Engelen 2006). Some countries have only predominant public system schemes (Greece), or have completely removed mandatory private pension plans (Hungary). At the other extreme, several countries have introduced mandatory private pension schemes to replace almost all public pension provisions (Mexico) (OECD 2012a).

Table 2.2. Major global pension schemes

Type	**Funding**	**Benefit**	**Coverage**
Public	▪ contributory, earnings-related ▪ non-contributory, tax-funded	▪ wage-indexed ▪ means-tested ▪ flat rate	▪ depends on countries
Private	▪ occupational, mandatory ▪ personal, mandatory ▪ occupational, voluntary ▪ personal, voluntary	▪ defined benefit ▪ defined contribution	▪ depends on countries and industries

Sources: Arza and Johnson (2006), OECD (2012a)

Pension reforms have created enormous flows of new capital into pension systems worldwide. Pension funds, both public and private, together with insurance companies, are currently the largest institutional investors in the global financial markets (Hebb & Wojcik 2005; OECD 2012a). In OECD countries, pension funds account for approximately 25% of stock market capitalisation and 10% of bond market capitalisation (Boeri et al. 2006). Private pension assets have grown steadily over the last two decades, and despite the effect of the recent financial crisis, hit a record of USD 20.1 trillion by December 2011. Weighted average private pension assets to GDP ratio have increased from 67.3% in 2001 to 72.4% in 2011 (OECD 2012b). Remarkable growth has been noted in Anglo-Saxon countries. Similarly, in continental Europe, the ratios of the Netherlands, Iceland and Switzerland have exceeded 100%. Emerging markets such as Chile and Mexico have shown significant developments. This global trend is fast and steady since the PAYG social security system will be ultimately unviable and unsustainable, due to the ageing of the population, low birth rates and other fiscal constraints (OECD 2012a).

In 2011, total OECD private pension markets, including both occupation-related and personal arrangements, were approximately USD 29.5 trillion. 68.4% (USD 20.1 trillion) was held by pension funds. 18.4% (USD 5.4 trillion) was in retirement products provided by banks or investment management companies. 12.4% (USD 3.7 trillion) was held in pension insurance contracts run by life or pension insurance companies. 0.8% (USD 0.2 trillion) were book reserves. While in Denmark, France, Korea or Sweden, pension insurance contracts accounted for the largest shares of aggregate private pension assets, private pension funds were the main financing vehicle for countries such as Australia, Austria, Finland, Iceland, Mexico and Portugal (OECD 2012b).

The size of assets and consequently the size of funds have several implications. Firstly, there may be economies of scale, which result in lower administration costs for investors. Large funds can transact in large volumes, resulting in lower commission charges. With larger sizes, funds may however have to invest into large indivisible investments. This may be a disadvantage due to lower diversification alternatives which can result in lower investment return performance (Davis & Steil 2001).

2.4 Pension fund structure

As one of the major institutional investors, private pension funds have common characteristics which are similar to other types of asset management funds. Three inter-related building blocks exist in the structure of a simplified pension fund (see Figure 2.1). The first building block is pension fund investors or members. Members contribute funds or have their funds contributed to pension fund managers. The second building block is the trustee board and its management team. The third building block is the service providers that cover consulting, investment and administrative services. Information flows along the three main channels: between members and the trustee board/management team; between the trustee board/management team and service providers and to a lesser extent, between service providers/consulting services and members (Boeri et al. 2006). From a market structure perspective, pension funds and institutional investors are both sellers and buyers. Pension funds provide services to members (sellers) and, at the same time, receive services from service providers (buyers). While other participants in the pension market can be sellers and buyers simultaneously, members are essentially buyers who are represented by institutions which are their employers in occupational pension plans or individual investors in personal arrangements (Davis & Steil 2001).

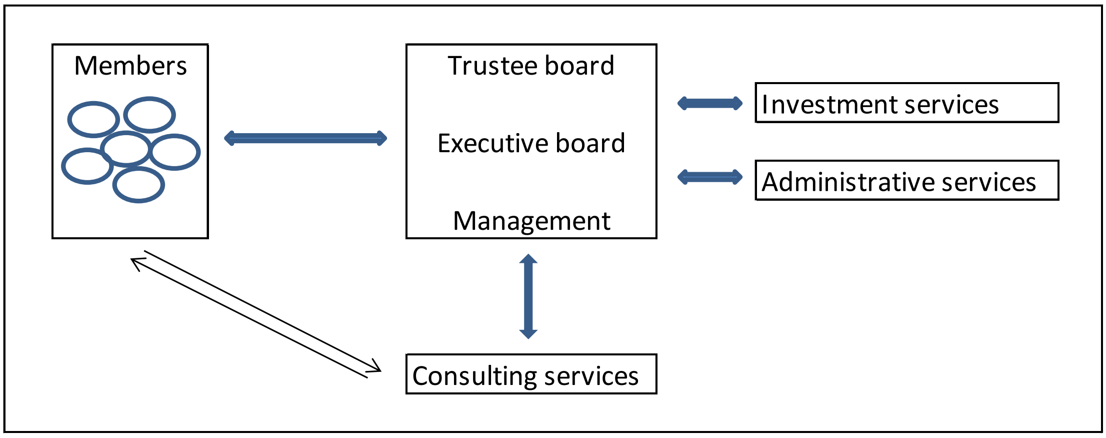


Figure 2.1. Organisation of a simplified pension fund

Source: Boeri et al. (2006)

2.4.1 Pension fund governance

Central to the organisation of a pension fund is its trustee board and governance principles, and the processes and structures used to direct and manage the affairs of the pension plan(s) in accordance with the best interests of the plan participants. The processes and structures define the division of power and establish mechanisms for ensuring accountability (OECD 2009).

Governance is ‘the framework of rules, relationships, systems and processes within and by which authority is exercised and controlled in corporations’ (ASX 2011, p. 3). Governance framework influences how objectives are set and achieved, how risk is monitored and assessed, and how performance is optimised (ASX 2011). Despite many similarities, pension funds are distinctively different from other types of managed fund as they are linked to social security benefits for pensioners. Pension funds are responsible for protecting beneficiaries’ retirement income, the objective of which is central in many governments’ public policies (Clark 2004).

Research indicates there is a relationship between fund performance and governance quality. Research also highlights other issues in pension fund governance in OECD countries. For instance, the selection processes for trustee boards are often found to be haphazard. Competing financial interests of differing stakeholders are not resolved due to poor oversight functions. There is a lack of delegation clarity between board and management (Ambachtsheer, Capelle & Lum 2008). There is also a considerable lack of expertise with inertia being commonplace and a significant reliance on consultants and fund managers evident (Clark 2004).

The period 2007–11 witnessed major reforms in the pension system due to financial and economic crises, and subsequently, fiscal crises in many OECD countries. In 2009, the OECD Secretariat re-published a revised version of the Guidelines for Pension Fund Governance published in 2002 (OECD 2009). Since the GFC, one of the most notable changes has been the increase of pensionable age from 65 to 67 in several

OECD countries. Many governments are convinced that as people live longer, they should work longer, which is less painful than increasing taxes. Further, deliberations over governance structure and regulation of pension funds were undertaken and recommendations were proposed (OECD 2012a).

It is observed that in Anglo-American countries as well as continental European nations, pension funds are hardly transparent organisations. Trustee intentions are difficult to observe. The interests of fund managers and service providers are not always in line with those of members and beneficiaries. Pension funds are vulnerable to the principal-agent challenges and moral hazard problems (Clark 2003). Principal-agent issues are more prominent in the pension fund member-trustee relationship due to its special characteristics, which are discussed in the following section.

2.4.2 Agency relationship and pension fund trustees' fiduciary duties

Agency relationship was discussed in studies on the theory of the firm as early as the 1930s (Baumol 1959; Coase 1937). Throughout the 1960s and into the 1990s, studies on agency relationship expanded to cover many areas of social sciences; in particular, management, economics (Alchian 1965; Eisenhardt 1989; Jensen & Meckling 1976; Ross 1973), sociology and political science (Mitnick 1973; Shapiro 2005; Sharma 1997). Agency theory has always been controversial (Eisenhardt 1989). Agency theory from an economic point of view as proposed by Jensen and Meckling in 1976 dominates the literature (Shapiro 2005).

According to Jensen and Meckling (1976, p. 5), ‘an agency relationship [is] a contract in which one or more persons (the principals) engage another person (the agent) to perform some service on their behalf which involves delegating some decision-making authority’. Agency relationships are universal and ubiquitous, and essentially all contractual arrangements have some of principal-agent characteristics (Eisenhardt 1989; Ross 1973). Agency relationships can arise from several sources. Shapiro (2005) summarised four basic sources of agency relationships. The first and simplest ‘acting for' relationship occurs when it becomes clear that not everything can be done independently. Complex tasks require more than one doer to be completed. The second type of agency relationship arises from one party (the agent) possessing expertise or accessing specialised knowledge. An agency relationship also arises when there is a need for the bridging of physical, social (that is, brokering or intermediation) or time distance. Finally, agency relationships are necessary to enjoy economies of scope and scale or protection from risk. Insurance and investments are examples of the last type of agency relationship. These are social relationships in which principals invest resources for agents to act on their behalf for uncertain future return. These relationships require trust and commitment from the principals (Shapiro 1987).

Due to the special characteristics of the principal-agent relationship, several aspects of the agency problem may emerge. Adverse selection happens when principals are unable to evaluate the skills of prospective agents. It can occur that the goals of the principal and the agent are incompatible or conflict (Shapiro 2005). When both the agent and the principal are utility maximisers and focus on self-interest, it is likely that the agent will not always act in the best interests of the principal (Ross 1973). The agent's behaviour and course of actions may not occur as the principal prefers, as it does not benefit the agent to be perfect (Mitnick 2011). Moral hazard refers to the inappropriate activities on the part of the agent, which are not detected by the principal (Eisenhardt 1989). This behaviour is also referred to as hidden action (Arrow 1985). When faced with complexity and uncertainty, the principal is affected by bounded rationality, or 'constraints' which limits their ability to process and manage information (Simon 1972, p. 162). Bounded rationality also includes incomplete information on alternatives (Simon 1957). Together with information asymmetry where the agent has the advantage over the principal, it may be difficult or too expensive for the principal to monitor the agent's activities (Eisenhardt 1989). From a risk-sharing perspective, agency issues can arise when the principal and agent have different attitudes towards risk. The agent may decide on a certain course of actions that are not preferred by the principal (Eisenhardt 1989).

Agency relationships may be discussed from different perspectives. The first perspective is when the principal has a certain power and control over the agent's activities and performance. This is the traditional relationship between an owner and a manager. The principal (owner) may decide to put in place a mechanism to make an agent (manager) accountable for their self-interested activities. This mainstream view was proposed by Jensen and Meckling (1976). The ability of the principal to set contracts and to monitor the agent has been challenged in the literature. This view is debated when the principals are small shareholders in a public company. It is argued that managers have too much discretion and undue influence on compensation contracts. Even with governance mechanisms in place, managers still have the controlling power (Bebchuk & Fried 2004; Crystal 1991).

The assumption of the agent having controlling power is again questionable in an agency relationship between a non-expert principal and a professional agent. The non-expert principal faces obstacles or has no power to monitor agents. They may be undermined not only by information asymmetry (to know what), but more importantly, by knowledge asymmetry (to know how) (Sharma 1997). Information asymmetry weakens principals' prerogative to design and set agreements (Eisenberg 1989). The importance of knowledge, not so emphasised in the traditional agency model, plays an important role in principal and professional exchange relationships between non-expert principals and professional agents (Sharma 1997). As principals seek agents for their expert knowledge, the power will naturally shift from principals to agents. Asymmetry of power may prevail to benefit agents and disadvantage principals. Consequently, the assumption that the principal can make contracts and create mechanisms to monitor the agent's activities proves problematic (Shapiro 2005). Relationships between non-expert principals and professional agents is pervasive in the business world. They are present in professional service organisations and business consulting firms, such as advertising agencies, accounting and taxation services firms, investment companies or law partnerships (Sharma 1997). In the case of a pension fund, members are primary principals yet have little or no say in its operation and investment strategy. Even if members were provided with information, being non-expert principals, they may have difficulties in interpreting the information. Trustees and fund managers' activities may be completely opaque to members. This special relationship emphasises the importance of governance structure, and fiduciary responsibilities as well as qualifications of trustees (Cooper et al. 2009; Shapiro 2005; Sharma 1997).

The theory of solitary principal-agent relationships has been extended to include multiple principals and agents. A multiple principal-agent relationship adds complexity to the already diverse interests of many parties concerned. There is not only the issue of agents having conflicting interests with principals. Agents may have competing interests, or the interests of some agents may be congruent with those of principals. It is arguably difficult for agents to reconcile conflicting interests and those of different parties (Shapiro 2005). In the case of investment fund management, it is inevitable that the disjunction often arises from the issue of delegation and trust due to multiple principal-agent relationships. This disjunction demands appropriate communication, incentives and control mechanisms between the parties to ensure intended outcomes (Davis & Steil 2001). In the particular case of pension fund management, the more that parties are involved and the larger the intermediary spread, the more agency problems there are and consequently the higher the agency costs are (Coleman, Esho & Wong 2006). The special characteristics of the multiple agency relationships in pension fund management affect the conduct and activities of pension fund members, trustees and other participants.

2.5 Pension fund operation

The operation of a pension fund is two-sided and guided by asset and liability management activities. These aspects are deliberated in the following sections.

2.5.1 Pension fund asset management

The key aspects in the operation of a pension fund consist of asset and liability management. Asset management, which is often referred to as fund management, portfolio management or investment management, is the process of pooling and investing collected assets in the capital or money markets. Asset management comprises wholesale management on behalf of an institutional investor and retail management on behalf of an individual investor (Davis & Steil 2001).

Wholesale asset management is practised in three ways. Generic asset management refers to non-discretionary operations. The services provided by generic asset management are rather homogeneous, as there is little discretion involved in investment, and little need for special investment skills. Reputation for the ability to match the indexes and the stability of investments is more important. Generic asset management can readily be verified such as whether the indexation has been properly followed. Few issues with information asymmetries or agency monitoring exist. The cost structure of this sector tends to be declining average costs. This characteristic is likely to lead to high concentration and stability of market shares, a form of oligopoly underpinned by benefits of reputation. Nevertheless, given that the services and products are ‘commoditised’, they can also be easily copied. There are few opportunities for raising prices to gain supernormal profitability. These markets are contestable when low barriers to entry allow new competitors to establish themselves in the market (Davis & Steil 2001; Lakonishok, Schleifer & Vishny 1992).

Specialised asset management involves the manager carrying out only discretionary security selection (choice of individual securities) and asset allocation (choice of markets and instruments). Discretionary selecting and managing portfolios of specific types of assets give rise to a major difficulty in observing the quality of fund management. Pension fund managers often have a large choice of specialised managers. Monitoring schemes tend to be more elaborate as compared to the generic asset management. These schemes may include ongoing control mechanisms and fees related to performance. The turnover of managers can be high given that consistent performance above certain benchmarks is difficult. Consequently, overall costs are higher than in the generic asset management style and affect net returns. Studies in the USA and UK show that security selection tends to be value deducting. Internal management is found to be superior to external management. Principal-agent problems are less severe since internal managers are subject to closer monitoring. Balanced management is between generic and specialised asset management. The asset manager carries out, on a discretionary basis, both asset allocation and security selection (Ang, Goetzmann & Schaefer 2009; Davis & Steil 2001).

The retail asset management sector manages assets for individual investors. Its structure is characterised by a set of contracts between fund trustees and various service providers. This sector deals with a pool of informed and uninformed retail investors possessing various levels of financial literacy. Information asymmetries between fund managers and investors are prevalent. Money flowing into the retail sector reflects not only the performance of the fund but also the promotion of product packages and access to distribution networks (of financial advisors and planners). This barrier to entry is now somewhat offset by technology (product purchases through the Internet). When investors are well informed, benefits of branding are weakened. Nevertheless, in all cases, retail investors have little bargaining power with fund managers (Phillips 1997).

There are two investment techniques in regards to asset management: active management and passive management. Active management involves an effort to select and purchase mispriced securities. The implicit assumption is that the market is inefficient and relevant information, at a certain time, is not reflected in securities prices. Passive management assumes that the market is efficient. Returns are maximised by remaining in the market. Active management results in higher fees than passive management. While there may be gains for active management, these gains do not flow to principals (investors), but are captured entirely by agents (fund managers) (Ang, Goetzmann & Schaefer 2009; Lakonishok, Schleifer & Vishny 1992).

It is observed that, since the late 1990s, there has been a rise in the allocation of pension fund assets to equity (as compared to bonds) among many OECD countries. Several reasons for this development are proposed: the reduction of risk aversion of members who control their funds, taxation rules which favour share investments, the advent of the European Economic and Monetary Union, and the advance of technology. Accounting rules related to the market valuation of shares and bonds may also encourage equity holdings during 'good' years, as in the case of the Netherlands where shares are accounted for at market value and bonds at book value (Davis & Steil 2001). However, despite the rise in share investments, bonds still form a significant portion in pension funds' portfolios. During the period 2001–11, while investments in bonds remained stable, investments in equity declined by 3.5% to 24.0%. In the OECD countries, asset allocation to shares declined to 19.1% in the year 2011 alone. This is compared with 53.2% assets invested in bonds, and 11.5% in cash and deposits. The trend is a result of risk-averse attitude after the GFC. Nevertheless, assets invested in equity are still very high in Anglo-Saxon countries. For instance, Australia had 49.7% of its pension assets invested in equity as compared to 9% invested in bonds. The USA had 48.1% of its assets invested in equity as compared to 26% invested in bonds (OECD 2012b).

Global diversification of pension asset investments, although believed to be able to reduce risk, is not widely employed or allowed. In developed countries, institutions tend to invest at least 60% to 90% of their assets in the home market. While most pension funds tend to be conservative in their global diversifications, the narrowness of international investments is more acute in Australia and the UK. Emerging countries also tend to restrict investments in foreign assets (Boeri et al. 2006; Jorion & Goetzmann 1999; Kumara & Pfau 2013). There appear various reasons for the preference over the domestic market. Foreign investments will not overcome systemic risks to world capital markets. Downside market movements generally occur in parallel. There are the issues of information and other costs. Better information on home markets may be a reason investors choose their investments there. International investment poses additional risk compared with domestic investment, settlement, liquidity, transfer, and exchange rate risk (Frankel & Schmukler 1996; Kang & Stulz 1995).

2.5.2 Pension fund liability management

The asset management aspect of a pension fund is closely linked to its liability management aspect. Liability management is a key distinction between pension funds and other types of investment funds. Liabilities have a major influence in the setting up of the portfolio. The duration of liabilities in combination with the strictness of minimum funding rules will set a benchmark for the duration of assets. For instance, UK funds tend to shift towards bonds owing to growing maturity. The inflation sensitivity of liabilities will determine the demand for assets acting as inflation hedges such as index-linked bonds. The need for cash flow plays an important role by determining liquidity to meet cash flow requirements (Davis & Steil 2001; WM Company 2000).

Another factor that will influence asset allocations of a pension fund is the ratio of non-retiring to retired members (Davis & Steil 2001). The average time to discounted pension payment requirements is much longer for an immature fund having few pensions in payment than for a mature fund for which sizable repayments are required. A fund that is closing down will have even shorter duration liabilities. Given the varying duration of liabilities, it is rational for immature funds having real liabilities to invest in equities, for mature funds to invest in a mix of equities and bonds, and for ‘closing down’ funds to invest mainly in bonds (Blake 1999, 2000).

Pension funds can allocate assets into investment products according to the nature of the pension plans. The two most common plans are defined benefit and defined contribution, and a small number of funds offer a hybrid plan, a combination of defined benefit and defined contribution in a single account. In a defined benefit plan, sponsors (often employers) guarantee fixed pension benefits by absorbing financial market and demographic risks (Boeri et al. 2006). Although the main objective of all pension funds is to maximise returns, investment strategies of defined benefit funds significantly depend on debts owed to members and beneficiaries (Bodie 1990).

A commonly used strategy in a defined benefit plan is the projected benefit obligation. This forward looking plan assumes that rights will continue to accrue and will be indexed according to a final salary scheme up to retirement. The fund manager may include a significant proportion of real assets such as equities and property in the portfolio as well as bonds. By doing this they diversify investment risk and reduce liability risk which is largely risk of inflation (Ambachtsheer & Ezra 1998; Daykin 1995). When assets are selected in such a way that their risk, return, and duration characteristics match those of liabilities, a liability-focused portfolio may be put in place. Such a strategy protects the portfolio against the risks of variation in interest rates, real earnings growth and inflation in liabilities (Blake 1997). The strategy may be assisted by an asset-liability modelling exercise. The model structures an asset allocation in relation to the maturity structure of liabilities. It forecasts liabilities over a particular time horizon, combining the size of currently accrued liabilities with projections based on assumptions on members' salary, age and gender (Davis & Steil 2001).

In a defined contribution plan, sponsors (employers) are responsible only to the extent of the contribution. There is no guarantee in terms of protecting assets during the accumulation phase or benefit payments when exiting a fund or in retirement. Fund trustees (managers) choose the portfolio of investment, assign investment managers or simply allow beneficiaries (employees) to decide the asset allocation (OECD 2012b). With regards to portfolio objectives, a defined contribution pension plan has the propensity to maximise return for a given risk so as to obtain a high replacement ratio at retirement. To choose the appropriate point on the frontier of efficient portfolios, it is necessary to determine the degree of risk tolerance of the scheme member: the higher the acceptable risk, the higher the expected value at retirement. The plan will also need to adjust to lower-risk assets for older workers as they approach retirement (Blake 1997).

Since the 1990s, a number of countries have implemented major reforms in their pension system, including Australia, countries in Latin America and Europe. The reforms emphasise the role of individually managed defined contribution plans, which effectively shifts the liability risk from employers and governments to individuals (Boeri et al. 2006). This trend has been fast growing especially after the GFC (OECD 2012a).

2.5.3 Structural risks of pension funds

The global movement from the defined benefit to defined contribution system taking place over the last few decades has significantly exposed pension funds to a number of risks, both systematic and non-systematic (Srinivas, Whitehouse & Yermo 2000). The systematic risk relates to the market and other external forces outside the control of the fund. The most discussed risk is the market risk when global market prices of assets are unstable or volatile. Policy risks, where certain groups of members benefit and where others can be disadvantaged due to policy changes, are a concern in many jurisdictions. Between 2007 and 2012, Australia and the UK demonstrated more reforms than any other OECD countries in almost all key areas of pension policy, such as adequacy, sustainability, work incentives, administrative efficiency, diversification and security (OECD 2012a). Non-systematic risks are industry-specific and firm-specific risks. These risks can be rectified or diversified. Management inefficiency, incompetence and agency risk are major among the non-systematic risks (Srinivas, Whitehouse & Yermo 2000).

Governments have attempted to regulate pension funds with the objective of mitigating these risks. For instance, pension provision is organised in a multiple pillar structure in many countries. These pillars include the public pension, employer-contributed pension, private pension and other savings to diversify the risks. Private or employer-contributed pensions can also be implemented through a government guarantee scheme or insurance plans (Srinivas, Whitehouse & Yermo 2000). Pensioners can rely on several sources to fund their retirement. If their private pension resource is running short, they may resort to other public schemes. As such, pension benefits are underwritten by the government. Consequently, fund managers are indirectly underwritten. With the existence of guarantee and underwriting, pension fund managers may not work in a fiercely competitive environment as compared to managers of mutual funds or hedge funds. Inefficiency may prevail. In other words, government guarantees can reduce member benefit risks, however they may increase other non-systematic risks relating to fund operation and performance. Pension funds generally do not have the high level of operational transparency prevailing in other asset management funds. This issue can again result in management inefficiency or inexperience being undisclosed to the market, which can further lead to more agency issues and moral hazards being unnoticed and unrectified (Klapper, Sulla & Vittas 2004; Srinivas, Whitehouse & Yermo 2000).

2.5.4 Role of individual members

The growth of defined contribution plans entails an increasing influence of individuals on the asset allocations in pension funds. The lower the guarantee component of the product the fund provides, the greater the degree of discretion. However, depending on constitutions, members can have control over asset allocation only for some defined contribution funds (Davis & Steil 2001). In Australia, apart from having discretion in choosing their plan asset allocations, members can also take full control of their fund management in SMSFs. This trend has been strong since the late 2000s after the GFC. SMSFs hold the highest proportion of assets invested in superannuation (APRA 2014a).

Individual members show a low risk tolerance attitude in managing their pension assets as compared to institutional investors. Studies of member-directed investments in the USA have found that members concentrated the majority of their funds in low-risk but low-return investments (KPMG Peat Marwick 1998). Risk aversion tends to be higher for certain groups, such as women and low-income earners. Women tend to invest more cautiously than men, perhaps reflecting a less continuous career structure. By contrast, wealthier and higher income people hold a greater proportion of equity in their pension plans (Goodfellow & Schieber 1997).

While using discretion in investment decisions has certain benefits, more risks are entailed if members have limited financial education. This issue is prevalent among pension fund members. Most of them do not have the mathematical skills for complex calculations of pension contributions and other areas of investments. Pension markets expect investors (members) to have sufficient rationality, knowledge, and decision-making capacities, which is not the reality for many pension fund members (Bajtelsmit & VanDerhei 1997; Boeri et al. 2006).

2.6 Pension fund performance

The growth of private pension funds and their role in helping individuals save for retirement and contributing capital to the global financial markets emphasise the importance of performance, especially from a long-term investment return perspective. The growth of fund assets and their investment performance receive great attention in policy, industry and media reports (APRA 2013b; OECD 2014).

The performance of global pension funds over the last decade has not been outstanding. The unweighted average net investment return of 28 selected OECD countries in 2001–11 was 1.36% (OECD 2012c). Seven countries showed negative returns. The majority of other countries showed low single digit returns (Table 2.3).

The importance of private pensions and the growth of defined contribution plans also highlight the role of performance measurement. There are common features of all types of institutional investment that form a useful introduction to an assessment of performance, such as identification of objectives and preferences (risk-return) and constraints (liquidity, investment horizon, inflation sensitivity, regulations, tax, accounting) (Bodie, Kane & Marcus 2014; Trzcinka & Shukla 1992). The development of a relevant performance measurement benchmark is essential for effective investments. Performance measurement benchmarks are important for all institutions, albeit in different ways (Davis & Steil 2001).

Table 2.3. Pension funds' real investment returns in selected OECD countries, 2002–11

Country	Period	Average Return	Country	Period	Average Return
Australia	2003-11	2.59	Luxembourg	2005-11	2.96
Austria	2002-11	0.14	Mexico	2002-11	2.41
Belgium	2002-11	1.35	Netherlands	2002-11	3.16
Canada	2002-11	3.30	New Zealand	2002-11	1.44
Chile	2003-11	4.01	Norway	2002-11	3.57
Czech Republic	2002-11	0.50	Poland	2002-11	4.17
Denmark	2002-11	4.74	Portugal	2002-11	1.20
Finland	2002-11	1.89	Slovak Republic	2007-11	-2.44
Greece	2002-11	–2.79	Slovenia	2007-11	–0.49
Hungary	2002-11	0.36	Spain	2008-11	–2.05
Iceland	2002-11	1.44	Switzerland	2002-11	1.22
Italy	2002-11	–0.47	Turkey	2005-11	6.10
Japan	2002-11	0.94	United Kingdom	2002-11	–0.45
Korea	2003-11	0.78	USA	2002-11	–1.52

Source: Calculated from OECD (2012c) data

2.7 Summary

This chapter provided an overview of the SCP framework, which explains structure, and conduct and predicts the performance of enterprises. The SCP framework sets a foundation for the thesis’s conceptual model at the end of Chapter 4. The chapter also discussed major developments and current issues pertaining to the global pension systems in mainly OECD countries under the SCP framework. It concluded with a brief discussion on pension fund performance and the need to establish performance measurement benchmarks. This discussion serves as a bridge to Chapter 3, in which an overview of pension fund and mutual fund performance measurement approaches is presented including a deliberation of a performance benchmarking framework using the relative economic efficiency concept.

Chapter 3
PRODUCTIVITY, EFFICIENCY AND MEASUREMENT OF EFFICIENCY

3.1 Introduction

This chapter takes the overview of the performance of pension funds from an investment return perspective presented in Chapter 2 to a theoretical discussion on alternative methods for the performance measurement of mutual and pension funds. Although mutual funds can be different from pension funds in benefit payments, investment time horizons, and are regulated under different legislation frameworks, the performance of both types of funds has often been measured from an investment return perspective. Studies on mutual funds have been more diverse due to the lack of transparency and limited information often experienced in pension research (Ambachtsheer, Capelle & Lum 2008; Klapper, Sulla & Vittas 2004). Thus, it is more practical to include a review on alternative methods to assess mutual fund performance.

From an investment return perspective, various methods of measurement have been applied including: dollar-weighted versus time-weighted rates of return; dealing with inflows; use of arithmetic versus geometric averages; or risk-adjusted performance measures. For a detailed discussion, see Bodie, Kane and Marcus (2014). These performance measurement approaches are perceived to have conceptual or practical problems or both (Davis & Steil 2001). With regards to risk-adjusted return measures, common approaches used include the well-known Jensen's alpha (1968), Sharpe's index (1966) or Treynor's ratio (1965). These measures aim to determine whether the activities of a professional fund manager provide additional returns to the fund beyond that of a passive benchmark. Despite their popularity, the measures have several drawbacks. The return and risk relationship, well established in the capital asset pricing model (CAPM) and the basis for Jensen's alpha and Treynor's ratio approaches, is a controversial benchmark. Researchers argue about the validity of the underlying assumptions of the CAPM model such as requiring the establishment of a market portfolio including all liquid and illiquid assets (Murthi, Choi & Desai 1997; Roll 1978; Tarim & Karan 2001). The CAPM beta is not a robust benchmark for risk and performance. Performance results are sensitive to the choice of benchmark where a slight alteration in the benchmark portfolio could change the performance ranking dramatically (Elton et al. 1993; Green 1986; Lehman & Modest 1987; Roll 1978). The Sharpe's index does not depend on the CAPM; however, similar to the CAPM-based models, the effect of transaction costs and other operational characteristics are not considered. The Sharpe’s index only takes into account net returns by subtracting costs from gross returns (Choi & Murthi 2001; Grinblatt & Titman 1989).

In the 1990s, researchers proposed a different approach to mutual fund performance measurement that addresses several of the limitations of Jensen, Sharpe and Treynor’s methods. This technique is called DEA, and is often used in service industries to estimate the relative efficiency of DMUs. DEA is does not require any theoretical model as a benchmark or any functional form. Instead, DEA measures how well a DMU performs relative to the best set of DMUs in the sample (Coelli et al. 2006). While the investment return is a very useful indicator of fund performance, it offers few insights into the operational activities of the fund and what could be done to improve the quality of these activities. DEA can overcome this disadvantage; it is flexible and can evaluate the performance of a DMU by incorporating multiple inputs and outputs *simultaneously*. The inputs and outputs can have *dissimilar* units of measurement. The inputs and outputs that reflect the financial and operational characteristics of the fund under evaluation can be presented in dollar values, percentage terms or other units of measurement (Murthi, Choi & Desai 1997). It is also possible to use DEA to set targets for input reduction such as costs and expenses so that if implemented, the DMU can operate at an optimal scale (Anderson et al. 2004).

This chapter discusses the DEA approach from a theoretical perspective and its application in various industry sectors. The chapter is organised as follows. Section 3.2 provides an overview of productivity and efficiency concepts, which is the theoretical foundation for the DEA model. Section 3.3 discusses the DEA model in depth. Section 3.4 provides an overview of the application of the DEA model in various industries, and Section 3.5 summarises the chapter.

3.2 Productivity and efficiency

This section provides an overview of productivity and efficiency theory including definitions of productivity and efficiency, relative efficiency, production frontiers and efficiency measurement techniques.

3.2.1 Definitions of productivity and efficiency

The terms *productivity* and *efficiency* are often used interchangeably. Although related, they are not similar. Productivity relates to the use of inputs and outputs in production. Productivity is an important concept from various perspectives, attracting interests from academic research, managerial decision-making and public policy. It is perceived as one of the critical factors that affects competitiveness and survival of an organisation (Fare, Grosskopf & Lovell 1994). Productivity is defined as the ratio between outputs (produced goods or services) and inputs (consumed resources) which can be expressed in the following equation (Coelli et al. 2006):

$$Productivity = \frac{Outputs}{Inputs}$$

Knight (1933, 1965) proposed that productivity be defined as the ratio between useful outputs to useful inputs. If all inputs and outputs are included, all producers would achieve the same productivity as no new material is created. However, the issue in practice is not how to include all inputs and outputs, but how to measure productivity when not all useful inputs and outputs are available (Fried, Lovell & Schmidt 2008).

Efficiency is a more elusive concept. It is often not defined in a precise manner, and is used in different contexts with various meanings (Beacham 1961). From an economic perspective, if resources of a firm are fully employed with maximum possible increase of real output, it can be said that the firm is operating with maximum efficiency. By contrast, a firm may be considered inefficient if, with the same input of resources, it could produce a larger output (Lau & Yotopoulos 1971). Thus, efficiency depends on the allocation of inputs for a production of outputs. Efficiency can be determined by comparing observed and optimal values of inputs and outputs (Fried, Lovell & Schmidt 2008):

$$Efficiency = \frac{Observed\ values\ of\ inputs\ and\ outputs}{Optimal\ values\ of\ inputs\ and\ outputs}$$

To illustrate the distinction between productivity and efficiency, an example using a production frontier is often used (Coelli et al. 2006). A production frontier represents the maximum output attainable from each given level of input (output-oriented), or the minimum input for each given level of output (input-oriented). A production frontier reflects the state of technology currently prevailing in the industry. In Figure 3.1, the production frontier is the non-linear line OP which represents efficient firms in the industry. Any firms that are not operating on the frontier are not efficient. Firm B operates on the industry's production frontier, therefore Firm B is considered to be technically efficient. By contrast, firm A operates beneath the production frontier. Firm A is operating inefficiently as technically it can increase its output level y to point B without requiring more input x.

Although a firm is technically efficient, it can still improve its productivity by changing the scale of production. In Figure 3.1, Firm B is operating efficiently on the production frontier. Firm B, however, may still improve its productivity by moving to point C. Point C is a tangent between the ray OC and the production frontier OP, which represents maximum possible productivity. This movement is an example of exploiting scale economies. Operation at any other point on the production frontier, albeit demonstrating technical efficiency, results in lower productivity (Coelli et al. 2006).

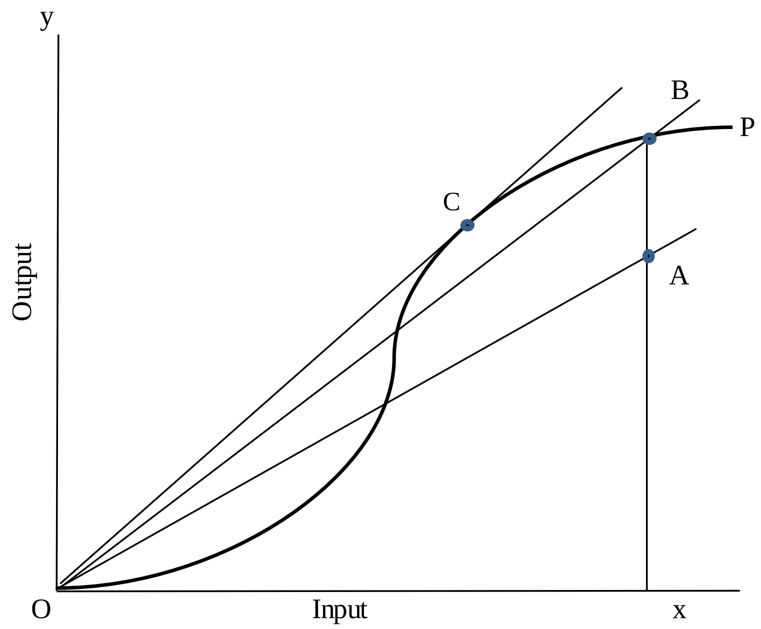


Figure 3.1. Production frontier with technically and scale efficient firms

Source: adapted from Coelli et al. (2006)

Efficiency consists of technical efficiency and allocative efficiency. Technical efficiency refers to the ability to avoid waste and reflects the ability of a firm to obtain maximum output from a set of given inputs or minimum inputs for a given set of outputs. The analysis of technical efficiency can have an output-maximising orientation or input-minimising orientation (Fried, Lovell & Schmidt 2008).

Technical efficiency was first formally defined by Koopmans (Fried, Lovell & Schmidt 2008). A producer is technically efficient if an increase in any output requires a reduction in at least one other output or an increase in at least one input; or if a reduction in any input requires an increase in at least one other input or reduction in at least one output. Compared to other inefficient producers, a technically efficient producer could produce the same outputs with one less input or could use the same inputs to produce at least one more output. Debreu (1951) and Farrell (1957) introduced an alternative approach to measure technical efficiency. With an input-minimising orientation, the measure is defined as the maximum radial reduction in all inputs given a number of outputs. With an output-maximising orientation, the measure is defined as the maximum radial expansion in all outputs given a number of inputs. Debreu and Farrell's measures of technical efficiency are more popular due to the application of distance functions, although this application has a practical weakness. Although Debreu and Farrell's measures of efficiency correctly identify all Koopmans' technically efficient producers, they also classify as technically efficient any other producers located on the isoquant outside Koopmans' efficient subset. Therefore, Debreu and Farrell's technical efficiency is necessary, but not sufficient, for Koopmans' technical efficiency (Fried, Lovell & Schmidt 2008).

Empirical applications of efficiency measurement methods tend to focus on output-increasing orientation (Fried, Lovell & Schmidt 2008). It is however possible to combine the two directions simultaneously increasing outputs and reducing inputs to arrive at an efficient point between (yA, θxA) and (θyA, xA), as illustrated in Figure 3.2.

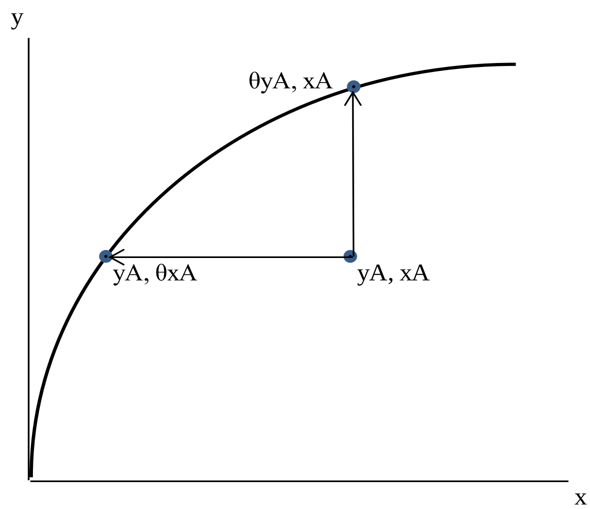


Figure 3.2. Technical efficiency with input-reduction and output-augmentation orientation

Source: adapted from Fried, Lovell and Schmidt (2008)

Allocative efficiency refers to the ability to combine inputs in optimal proportions under the prevailing production technology and current prices. Similar to technical efficiency, allocative efficiency can be estimated in an input-minimising or output-maximising orientation. Allocative efficiency in an input-minimising orientation is calculated residually as the ratio between cost efficiency and input-oriented technical efficiency. Allocative efficiency in an output-maximising orientation is the ratio between revenue efficiency and output-oriented technical efficiency (Coelli et al. 2006).

When input price information is available, it is possible to combine the efficiency isoquant (SS’) and the isocost line (AA’) in one figure (see Figure 3.3). Technical efficiency at point P is determined by 0Q/0P, allocative efficiency is measured by 0R/0Q, and cost efficiency is measured by 0R/0P. RQ implies the possible reduction in production costs if production were at point Q, which represents technical efficiency and allocative inefficiency (Coelli et al. 2006).

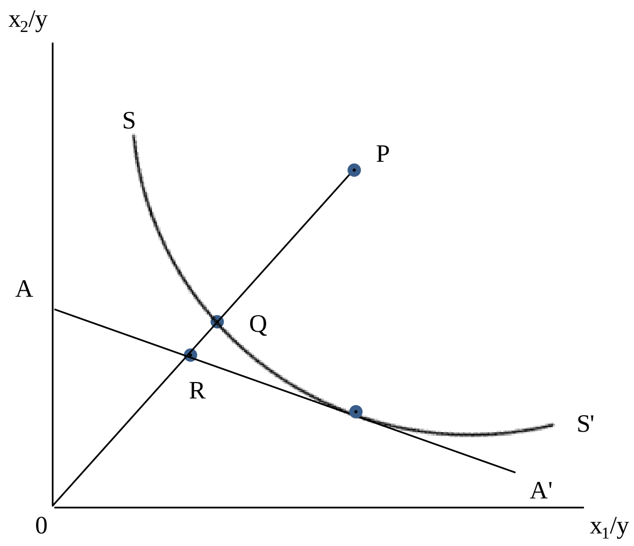


Figure 3.3. Technical efficiency and allocative efficiency (cost)

Source: adapted from Coelli et al. (2006)

Figure 3.4 illustrates allocative efficiency in an output-maximising orientation. Revenue efficiency is represented by the line DD’ and technical efficiency is represented by the isoquant ZZ’. Technical efficiency, when production is at point A, is determined by 0A/0B, allocative efficiency is defined by 0B/0C, and revenue efficiency is measured by 0A/0C. BC implies the possible increase in revenue when production is at the technically efficient but allocatively inefficient point B (Coelli et al. 2006).

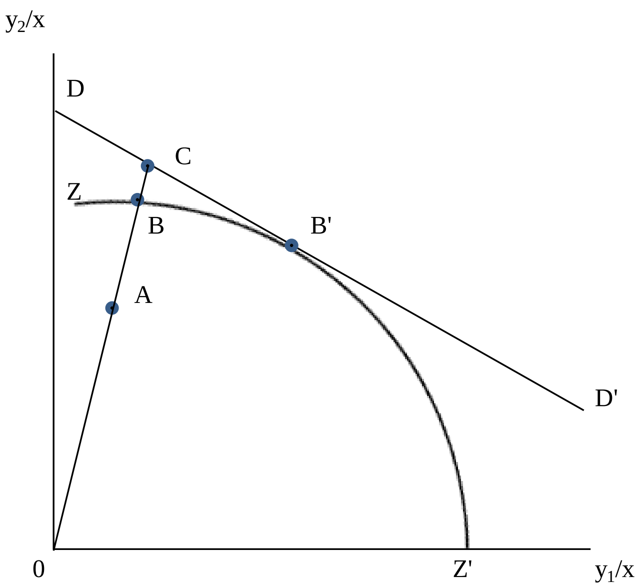


Figure 3.4. Technical efficiency and allocative efficiency (revenue)

Source: adapted from Coelli et al. (2006)

The technical and allocative efficiency discussed in the above paragraphs assume a constant return to scale (CRS) technology where firms are operating at an optimal scale where an increase in inputs will result in the same proportional increase of outputs. A firm can be technically and allocatively efficient, yet the scale of the operation is not optimal. The firm may be using a VRS technology. That is, the firm may be too small in its scale of operation and thus falls into the increasing return to scale region of the production function (Point A in Figure 3.5). An increase in inputs will result in a higher proportional increase in outputs. Conversely, the firm may operate on a scale of operation that is too large and thus fall in the decreasing return to scale region (Point C in Figure 3.5). An increase in inputs will result in a lower proportional increase in outputs. In both cases, the firms may improve efficiency by changing the scale of the operations, that is, to keep the same input mix but change the size of the operations to achieve scale efficiency which is represented by point B (Coelli et al. 2006).

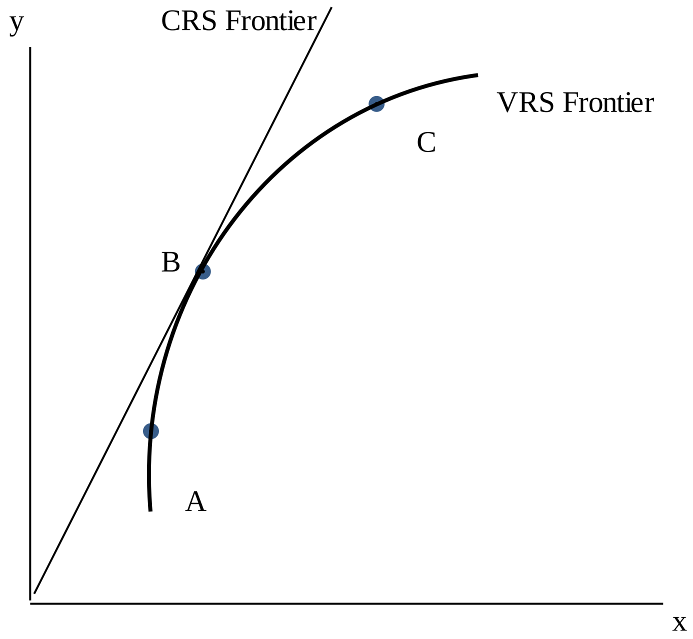


Figure 3.5. Increasing-to-scale and decreasing-to-scale technology

Source: adapted from Coelli et al. (2006)

3.2.2 Relative efficiency

Efficiency is often measured *relatively* to a benchmark (optimal performance). Farrell (1957) discussed the concept of *relative efficiency* by comparing the two possibilities of specifying an efficient production function: a theoretical function specified by engineers, and an empirical function based on the best results observed in practice. The first approach does not take into account practical complex issues relating to operating a firm or an industry. The second approach estimates an efficient production function from observations of the inputs and outputs of a number of firms. Each firm is represented by a point on the isoquant diagram. Connecting the points created by efficient firms forms the efficient production isoquant. Efficient firms lie on the isoquant while inefficient ones lie inside (or outside) the isoquant. The method of estimating efficiency of a real firm by comparing it with a hypothetical (virtual) firm which lies on the efficient isoquant (and therefore efficient) and which uses the inputs (or outputs) in the same proportions is referred to as measuring relative efficiency. A firm is considered efficient or inefficient relative to an efficient production function.

Relative efficiency has important practical implications. While it may be informative to evaluate firms using a theoretical benchmark, in practice it is more useful to identify what inefficient firms can do to be efficient based on similar practical constraints that other efficient firms may be facing (Farrell 1957). The concept of relative efficiency is fundamentally similar to that of benchmarking. Performance evaluation by benchmarking with industry peers is important in many business processes. Identifying and implementing best practices within an industry are critical for productivity growth, enhancing competition, and eventually the survival of firms (Camp 1995).

3.2.3 Production frontiers and efficiency measurement techniques

Performance measurement is a topical issue in any public or private organisation. Profit is used as a common performance measurement indicator for a for-profit organisation. Profit or other financial indicators indicate the outcome of the performance rather than a comprehensive measure to evaluate the performance itself (Fried, Lovell & Schmidt 2008). Performance is concerned with doing the right things using the appropriate operation processes. Measuring performance using an efficiency-oriented approach can overcome the narrow perspective of using profit or financial indicators. Efficiency measurement can be achieved by comparing observed performance with optimal performance defined by a production frontier. The relevant frontier is an empirical approximation which is often known as the *best practice* frontier (Fried, Lovell & Schmidt 2008). Production analysis often highlights the process of optimisation in production activities. The objectives of optimisation can be maximum production frontier, minimum cost frontier, maximum profit frontier or revenue frontier. Studies of production frontiers create various interests, especially ones originating from a policy setting perspective. It is important to know the distance between production frontiers (best practices) and observed production activities and therefore the type and level of inefficiency (Fare, Grosskopf & Lovell 1994).

A production frontier can be constructed using a parametric (econometric) or non-parametric (linear programming) approach. Parametric approaches present smooth parametric frontiers whereas linear programming approaches show piece-wise non-parametric frontiers (Fried, Lovell & Schmidt 2008). Parametric approaches use a specific functional form for the relationship between inputs and outputs. When the functional form is specified, the unknown parameters of the function need to be estimated using econometric techniques. These requirements make parametric approaches technically demanding (Coelli et al. 2006). Further, it is difficult to implement parametric approaches in a multi-input multi-output setting because of the complexities arising in the specification (Favero & Papi 1995). The common parametric approaches available for constructing efficiency frontiers include the stochastic frontier, thick frontier and the distribution-free approaches (Bauer et al. 1995).

Stochastic frontier is the principal econometric approach for estimating efficiency. This approach can incorporate statistical noises such as measurement errors and inefficiency into the model. The disadvantage is that it requires a predetermination of distributional and independence assumptions. Efficiencies are assumed to have an asymmetric distribution (half-normal), while measurement errors are assumed to follow a symmetric distribution (standard normal). Measurement errors and inefficiency are assumed to be distributed independently of each other and of inputs. Unfortunately, it is unknown whether the condition of independent distribution is satisfied as neither measurement errors nor inefficiency are observed. Distributional assumptions imposed arbitrarily could lead to errors in estimating efficiency of individual firms and therefore, the shape of the production frontier (Bauer et al. 1995; Fried, Lovell & Schmidt 2008; Greene 2008).

By contrast, non-parametric approaches use linear programming in the analysis of problems, in which a linear function of a number of variables is maximised or minimised when the variables are subject to a number of restraints (Dorfman, Samuelson & Solow 1986). Non-parametric methods do not require a functional form and therefore impose little restriction on the structure of the efficiency frontier. There is no requirement to specify parameters for the function, and therefore there is no concern about possible specification errors that may occur while using parametric methods (Bauer et al. 1995; Fried, Lovell & Schmidt 2008). DEA and Free Disposal Hull are two major programming techniques for estimating efficiency frontiers. DEA, one of the research methods in this study, is discussed in detail in the following section.

Notwithstanding the on-going discussions on the best frontier approaches, efficiency measurement and productivity analysis using both parametric and non-parametric models have recently been used in many industries in both government and private for-profit and not-for-profit sectors. Frontier efficiency is considered an effective alternative to the standard financial ratios derived from accounting data commonly used by regulators and industry practitioners to assess performance. This is because frontier efficiency is estimated by programming techniques that are not limited to financial performance and financial data, and the effect of differences in prices as well as other external factors on performance (Bauer et al. 1995). The usefulness of frontier efficiency has been evidenced in empirical studies. For instance, in a short period of three years from 2003–5, efficiency and productivity analysis were found in a significant number of research papers representing over fifty sectors, ranging from financial and legal services (accounting, legal firms, banks) to military and municipal services. The popularity of frontier efficiency studies has demonstrated the need for improving efficiency and productivity in various social and economic activities (Fried, Lovell & Schmidt 2008).

3.3 Data envelopment analysis (DEA)

The DEA concept was first introduced by Farrell (1957) to estimate the efficiency of the US agricultural industry. The article unfortunately did not generate great interest. For the two decades that followed Farrell’s proposal, the DEA concept was considered by only a few researchers (Afriat 1972; Boles 1966; Sheppard 1970). It is only when Charnes, Cooper and Rhodes (1978) proposed a similar model to measure the efficiency of public programs that the DEA concept received full attention and appreciation. Since 1978, DEA has been widely used in many industries, in particular, the services industries (Coelli et al. 2006).

DEA employs the use of linear programming methods to estimate non-parametric piece-wise frontiers over the data. Efficiency measurements are estimated subsequently relative to the frontiers. The term DEA was first mentioned in Charnes, Cooper and Rhodes' article (Coelli et al. 2006). As the name indicates, DEA does *envelop* a data set (illustrated in Figure 3.6), although the envelopment is not as tight as a stochastic frontier since DEA makes no accommodation for statistical noise (Fried, Lovell & Schmidt 2008).

3.3.1 Farrell's proposed efficiency

Farrell's proposed efficiency frontier is constructed from observed inputs and outputs for a number of firms (Figure 3.6). Each firm is represented by a point in the diagram. The observed firms will create a scatter of points. The efficiency function is represented by line SS', a piece-wise convex isoquant. The technical efficiency of a firm is estimated by comparing it with a hypothetical efficient firm which uses x and y factors in the same proportions and lies on the isoquant (Farrell 1957). Researchers developed Farrell's concept to extend the application of the DEA concept using different assumptions, as discussed in sections 3.3.2 and 3.3.3.

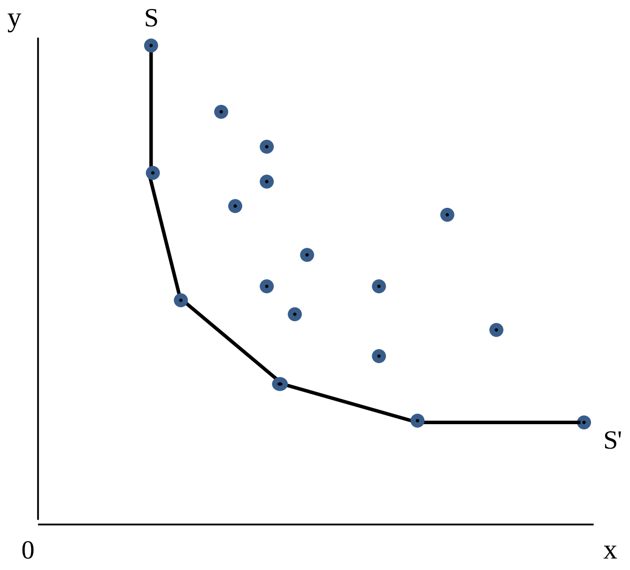


Figure 3.6. Efficiency frontier represented by a piece-wise isoquant enveloping inefficient points

Source: Farrell (1957)

3.3.2 Constant return to scale (CRS) DEA

The first DEA model developed by Charnes, Cooper and Rhodes in 1978 was named after the authors, and is often referred to as the CCR model in the literature. The CCR model proposes an input orientation, minimum inputs for a given number of outputs, and assumes a CRS technology, when all firms operate at an optimal scale without any social, financial or economic constraints. The input oriented CCR (CRS) model was the first to be widely applied and Charnes, Cooper and Rhodes are often referred to as the pioneers of the DEA model in empirical studies (Coelli et al. 2006; Fried, Lovell & Schmidt 2008).

DEA can be used in either direction: input-oriented (minimum input for each given level of output) or output-oriented (maximum output for each given level of input), depending on the objective of the research. Input-oriented and output-oriented DEA models estimate the same production frontiers. In other words, input-oriented and output-oriented approaches identify the same set of efficient firms in the sample.

However, efficiency measures related to the inefficient firms may differ between the two methods (Coelli et al. 2006).

3.3.2.1 The CCR (CRS) input-oriented DEA model

In the CCR (CRS) model, a ratio of all outputs over all inputs is obtained such as *uy / vx*, where *y* and *x* are respectively outputs and inputs used, *u* is output weight and *v* is input weight. The optimal weights are estimated by solving the following linear programming problem:

Equation 3.1: CCR (CRS) DEA model

$$max\, h_0 = \frac{\sum_{r=1}^{s} u_r\, y_{r0}}{\sum_{i=1}^{m} v_i\, x_{i0}}$$

Subject to:

$$\frac{\sum_{r=1}^{s} u_r\, y_{rj}}{\sum_{i=1}^{m} v_i\, x_{ij}} \leq 1 \qquad j = 1,2, \dots, n$$

$$u_{r,} v_i \geq 0$$

$$r = 1,2,\dots,s$$

$$i = 1,2,\dots,m$$

Source: Charnes, Cooper and Rhodes (1978)

The variables y_{rj} and x_{ij} are respectively output and input observations. The variable weights $u_{r,}$ and v_i are unknown and can be determined by solving the programming problem using all DMUs as a data set (Charnes, Cooper & Rhodes 1978). As the CCR (CRS) multiplier model is a linear programming function, it has a dual envelopment equivalent (Coelli et al. 2006). The dual input-oriented CCR (CRS) model can be written as follows:

Equation 3.2. Dual input-oriented CCR (CRS) model

Multiplier form	*Envelopment form*
$max_{u,v}\ (u,y_i)$	$min_{\theta,\lambda}\ \theta$
subject to:	*subject to:*
$vx_i = 1$	$-y_i + Y\lambda \geq 0$
$uy_j - vx_j \leq 0$	$\theta x_i - X\lambda \geq 0$
$u,v \geq 0$	$\lambda \geq 0$
$j=1,2,\ldots I$	

Source: Coelli et al. (2006); Fried, Lovell and Schmidt (2008)

The CCR (CRS) envelopment model has θ as a scalar and λ as a *Ix1* vector of constants (Coelli et al. 2006). *I* represents the number of DMUs in the data set. *X* and *Y* represent data for all *I* DMUs. The value of λ indicates input or output weights. The value of θ represents the efficiency score for the i^{th} DMU. The value of θ is equal or less than 1, with a value of 1 referring to a point on the efficiency frontier and, therefore, a technically efficient DMU, and a value of less than 1 referring to a point off the efficiency frontier and a technically inefficient DMU. The linear programming problem needs to be solved *I* times, once for each DMU in the data set to get a value θ for that DMU. In other words, to determine the efficiency score of the i^{th} DMU, the problem seeks to radially reduce input vector x_i as much as possible within the boundary of the feasible input set. The boundary is represented by the piece-wise linear isoquant (re-visit Figure 3.6). The radial reduction of the input vector x_i produces a projected point ($X\lambda$, $Y\lambda$) for each firm on the frontier. The constraints imposed on the model ensure that the projected point is *enveloped*, or does not lie outside the feasible input set. The envelopment option is generally preferred in practice as it contains fewer constraints than the multiplier option (Coelli et al. 2006).

3.3.2.2 The CCR (CRS) output-oriented DEA model

Both Farrell (1957) and subsequently Charnes, Cooper and Rhodes (1978) proposed an input-based DEA model which estimates technical inefficiency as a radial proportional reduction of inputs used, given a constant level of outputs. The CCR (CRS) DEA model however can be applied using an output-oriented approach. The dual output-oriented CCR (CRS) model is written as follows:

Equation 3.3. Dual output-oriented CCR (CRS) programme

Multiplier	Envelopment
$\min_{u,v} (vx_i)$	$\max_{\phi,\lambda} \phi$
subject to:	subject to:
$uy_i = 1$	$x_i - X\lambda \geq 0$
$uy_j - vx_j \leq 0$	$-\phi x_i + Y\lambda \geq 0$
$u,v \geq 0$	$\lambda \geq 0$
$j=1,2,\ldots I$	

Source: Coelli et al. (2006); Fried, Lovell and Schmidt (2008)

The input-oriented and output-oriented DEA models estimate the same frontier and therefore, the same set of efficient DMUs. Further, the choice of input-orientation or output-orientation approach is not critical in linear programming as it is in the case of econometric estimation, as linear programming is not exposed to simultaneous equation bias (Coelli et al. 2006).

3.3.3 Variable return to scale (VRS) DEA

The CRS assumption is only appropriate when all firms are operating at an optimal scale. However, government regulations, imperfect competition, and other issues created by the markets where firms are operating may cause them to operate at a sub-optimal scale. Using the CRS specification when firms are not operating at optimal scale results in measures of technical efficiency confounded by scale inefficiencies (Coelli et al. 2006).

Fare, Grosskopf and Logan (1983) and then Banker, Charnes and Cooper (1984) proposed a modification of the CRS model to accommodate situations where firms are operating in the VRS region. The CRS linear programming problem can be modified by adding a convexity constraint $I1'\lambda = 1$ to Equation 3.3 (envelopment input-oriented) to arrive at Equation 3.4. This approach is referred to as the VRS or BCC model, named after Banker, Charnes and Cooper. The BCC (VRS) approach produces a convex hull of intersecting facets that 'envelop the data points' more tightly than the CCR (CRS) hull (Coelli et al. 2006, p. 172). The BCC (VRS) model provides technical efficiency scores that are equal to or greater than those calculated under the CCR (CRS) model. As illustrated in Figure 3.7, a firm operating at point A is technically efficient under the VRS model. However, to be efficient under the CRS model, the firm needs to reduce its input from point A to point A' (Cook & Zhu 2008).

Equation 3.4. Input-oriented BCC (VRS) – envelopment model

$$\begin{aligned}
&\min_{\theta,\lambda} \theta \\
&\text{subject to:} \\
&-y_i + Y\lambda \geq 0 \\
&\theta x_i - X\lambda \geq 0 \\
&I1'\lambda = 1 \\
&\lambda \geq 0
\end{aligned}$$

Source: Coelli et al. (2006)

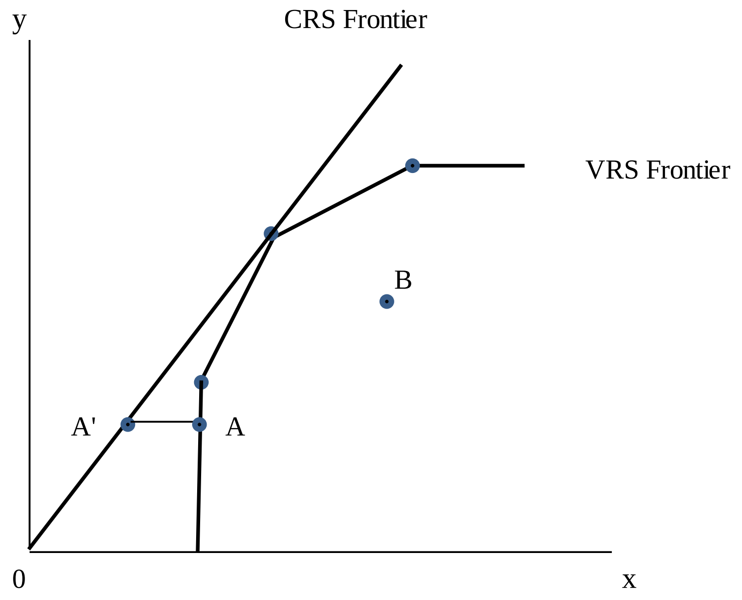


Figure 3.7. DEA CRS and VRS frontiers

Source: Cook and Zhu (2008)

3.3.4 Efficiency targets and efficiency reference groups

The linear programming problems presented in Equations 3.2, 3.3 and 3.4 need to be solved *I* times, once for each DMU. The best performing DMUs with efficiency scores of 1 are efficient and form the efficiency frontier. Inefficient DMUs are enveloped by this frontier. Each DMU in this group is compared to the efficiency frontier, whereby an efficiency score, an efficiency reference set (peer group) and an efficiency target value are obtained for this DMU (Cook & Zhu 2008).

Figure 3.8 presents an input-oriented efficiency frontier using the CCR (CRS) technology. DMU A is inefficient and its efficiency score is determined by the ratio 0A'/0A. Point A' represents a virtual efficient DMU, a DMU that does not necessarily exist but represent an efficiency target for DMU A. The efficiency target point for DMU A is A'. DMU A could reduce its inputs proportionally from A to A'. The efficiency target value for DMU A is the ratio A'A/0A. In other words, DMU A could reduce its inputs used by A'A/0A without reducing its outputs produced. Similarly, DMU B could reduce its inputs used by B’B/0B. The projected point A' on the efficiency frontier lies on a line that joins points C and D. DMU C and DMU D are referred to as *a reference group* or *peer group* of DMU A. DMU C and DMU D define a section on the efficiency frontier that is relevant to DMU A. Point A' is a linear combination of points C and D and the weights in the linear combination are the optimal weights belonging to DMU C and D (Cook & Zhu 2008).

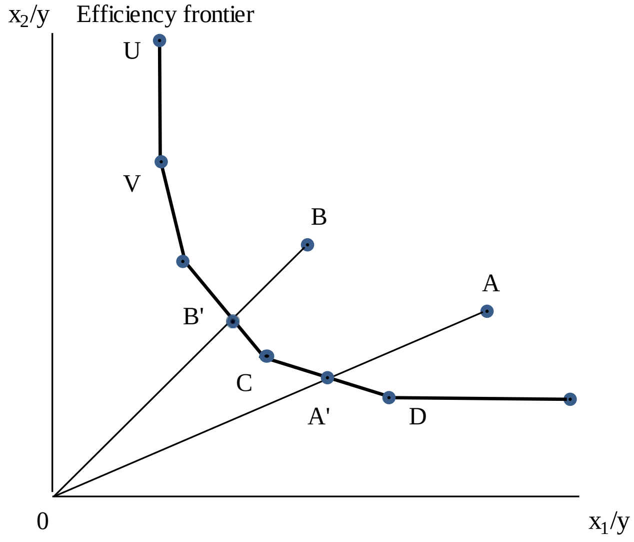


Figure 3.8. Input-oriented CCR (CRS) DEA

Source: adapted from Coelli et al. 2006; Cook and Zhu 2008

Similarly, Figure 3.9 presents an output-oriented efficiency frontier using the CCR (CRS) technology. DMU C could increase the output to point C’ without using more inputs. Point C’ is the virtual efficient target point for DMU C. Point D’ is the virtual efficient target point for DMU D. DMU D could increase its output to point D’ without additional inputs (Coelli et al. 2006; Cook & Zhu 2008).

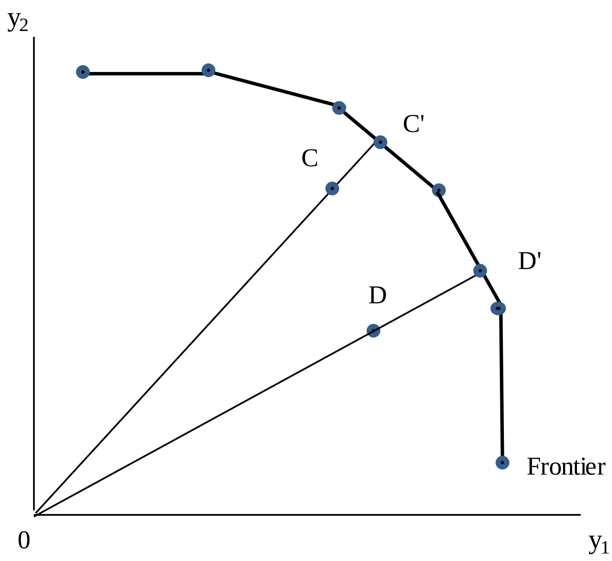


Figure 3.9. Output-oriented CCR (CRS) DEA

Source: Coelli et al. (2006); Cook and Zhu (2008)

3.3.5 Slacks

Debreu and Farrell's technical efficiency measure does not fully coincide with Koopman's strict definition of technical efficiency (Fried, Lovell and Schmidt 2008). Debreu and Farrell's technical efficiency is not sufficient for that of Koopman's due to the presence of *slacks*, which is inherent in the application of the non-parametric DEA model to construct a piece-wise efficiency frontier. Slacks arise when there are sections on the efficiency frontier that run parallel to the vertical and horizontal axes which normally do not occur when using parametric methods. In Figure 3.8, both DMU U and V lie on the efficiency frontier. Nevertheless, DMU U could possibly reduce its input x_2 to the same amount of input x_2 used by DMU V and still produce the same output. This is often referred to as *input slack* and DMU U is but *weakly efficient* (Coelli et al. 2006; Cook & Zhu 2008).

Much has been debated around the presence of slacks as a one of the major weaknesses of Debreu and Farrell's model. However, DEA experts are convinced that the problem is exaggerated. In practice, when the problem is seen as significant, it is possible to report slacks, re-score and produce a new efficiency score set for the DMUs in the data set (Fried, Lovell & Schmidt 2008).

3.3.6 Further analysis on strengths and weaknesses of the DEA model

The DEA model presents both strengths and weaknesses in empirical applications. Further analysis of these strengths and weaknesses is outlined below.

3.3.6.1 Strengths of the DEA model

One of the reasons for the popularity of DEA applications is that DEA provides researchers with an alternative for performance evaluation in situations where complex social and economic relationships exist. The model incorporates these relationships into a multiple input and output set-up, which accept different units of measurement and which are also the limitations of other approaches. DEA allows the inclusion of cost information as well as various types of ratios (Anderson et al. 2002; Cooper, Seiford & Tone 2007). DEA is computationally simpler to use and useful for situations where the relationship between input and output variables is not known in advance. DEA can be applied even when the algebraic form of the relationship between outputs and inputs is not pre-specified. The production frontier can be estimated without the knowledge of whether the output is a linear, quadratic, exponential or similar to some other function of inputs (Coelli et al. 2006). DEA can be chosen over the stochastic frontier as it makes the avoidance of the effects of misspecification of the functional form possible (Fried, Lovell & Schmidt 2008).

Another reason for the popular use of DEA lies in its ability to identify areas for improvement in business operations. DEA efficiency scores and efficiency targets provide a wealth of information. From a management point of view, efficiency targets are valuable insights which can be used as benchmarks for corrective methods and improvements of operating activities (Anderson et al. 2004; Premachandra, Powell & Shi 1998).

Finally, DEA is seen as superior to techniques such as regression or other traditional indexes in that DEA is a measure of relative performance, not average performance. DEA evaluates each DMU's performance compared to all other DMUs in the data set and scores the DMU based on the *best* performers. This is in contrast with regression where the *average* performer is identified and then individual DMUs are compared with the average performer. Benchmarking using best practice, not average practice, is the norm in the business world. DEA is therefore a powerful tool for practical endogenous benchmarking (Barros & Garcia 2006; Basso & Funari 2001; Fried, Lovell & Schmidt 2008; Seiford & Thrall 1990).

3.3.6.2 Weaknesses of the DEA model

A major disadvantage of DEA as a non-parametric frontier estimation method is that it does not take into account measurement errors and other type of statistical noise (Anderson et al. 2002). Deviations from the frontiers are considered to be the result of technical inefficiency (Coelli et al. 2006). Measurement errors can be problematic as when they exist, they change the shape of the efficiency frontier. Consequently, efficiency scores of individual DMUs will change accordingly (Berger & Humphrey 1997). Despite this drawback, in recent years, DEA researchers contend that it is not necessary to have a consensus on which is the single best frontier approach for measuring efficiency. Both parametric and non-parametric methods are robust despite their limits (specification errors for parametric and statistical noise for non-parametric methods). Studies by Cummins and Zi (1998) showed positive correlations between point estimates of efficiency when alternative econometric models were used, and indicated weaker but positive correlations among alternative econometric and programming models. Different approaches could show consistent results when applied to the same set of good quality data. The higher the quality of the data, the higher the positive correlations between the two sets of efficiency estimates (Fried, Lovell & Schmidt 2008).

Outlier identification and exclusion are often advocated in DEA applications. Nevertheless, the problems are not simple to resolve. If DMUs are heterogeneous, such as in the case of financial institutions, it is possible that the heterogeneity may cause DMUs that should be on the efficiency frontier to be classified as outliers and thus excluded from the dataset. The exclusion of these efficient DMUs may shift the frontier and the mean DEA score may be biased downwards. The exclusion of outliers may result in different frontiers, different individual efficiency scores estimates and possible loss of valuable data (Brown 2006).

3.4 Empirical applications of the DEA model

Non-parametric approaches such as DEA have not traditionally been as widely used as parametric approaches. Nevertheless, DEA remains a useful alternative way of modelling production activity. The popularity of the DEA method over the last thirty years (since Charnes, Cooper and Rhodes referred to the term 'DEA' in 1978) cannot be overstated. Extensive literature searches identified more than 4000 published journal articles and text book chapters from 1978–2008. If unpublished papers and dissertations, working papers and papers presented at conferences were included, the count would exceed 7000 items. Over 200 papers per year were published between 1995–2003. In the period 2003–06, the number increased to over 350 papers per year. DEA has been applied in various service industries including transport (railroads, airports), utility (water, electricity, telecommunication), education institutions (tertiary and secondary), health services, agriculture, not-for-profit sector, public programs and financial services (mainly banks) (Emrouznejad, Parker & Tavares 2008; Seiford 2005).

DEA has been applied to mutual funds since the 1990s, and became well-accepted after a paper was published by Murthi, Choi and Desai (1997), some of the pioneers in applying DEA to assess mutual fund performance. In their research, the authors used DEA to construct a DEA portfolio efficiency index (DPEI) and compared this index with the more commonly used Jensen's alpha and Sharpe's index. Unlike both Jensen's alpha and Sharpe's index, the DPEI incorporated transaction costs. The authors believed that the incorporation of transaction costs was important due to the strong correlation between fees and costs and portfolio performance evidenced in other studies.

Specifying and measuring relevant variables is an important issue and is subject to on-going discussion in the literature (Fried, Lovell & Schmidt 2008). It was suggested that it would be ideal to have a complete model to incorporate all the complexities including agency costs, information asymmetry, inadequate motivation, and incomplete contracts (Stigler 1976). So far there has been no such comprehensive model and thus it appears the researchers tend to concentrate on important issues where data are available. With regards to the DEA model, discussions on relevant inputs and outputs are often highlighted (Fried, Lovell & Schmidt 2008). Nevertheless, there has been no formal process or agreement among researchers regarding the selection of inputs or outputs (Callen 1991; Charnes, Cooper & Rhodes 1981; Cholos 1997; Watson, Wickramanayke & Premachandra 2011).

3.5 Summary

This chapter provided an overview of productivity and efficiency measures to evaluate an organisation’s performance. The chapter discussed productivity and efficiency concepts. The discussion included a distinction between productivity and efficiency, relative efficiency and construction of production frontiers using parametric and non-parametric methods. Finally, a deliberation on the DEA model was provided. This included an introduction of Farrell’s approach to efficiency measurement, the first DEA concept. CCR (CRS) and BBC (VRS) models were subsequently discussed. Various performance measurement benchmarks produced by the DEA model, its strength and weaknesses were further deliberated. The chapter concluded with an overview of empirical applications of the DEA model to evaluate performance of

DMUs including mutual funds. The following chapter, Chapter 4, will present an overview of the Australian superannuation system and the conceptual model for the study.

Chapter 4
THE AUSTRALIAN SUPERANNUATION SYSTEM

4.1 Introduction

This chapter vertically extends the global overview of pension markets presented in Chapter 2 by investigating the Australian superannuation system. The objective of the chapter is to explore the development and operational characteristics of the Australian superannuation system and its legislative framework. Current issues in the operation of the superannuation system, in particular, governance structure, fees, costs and investment activities are highlighted through the presentation of the SCP framework. Together with Chapter 2, this chapter forms the basis for the conceptual model of the study and the main research questions.

Chapter 4 consists of 9 sections. Section 4.2 presents an overview of the effect of demographic changes and government's responses to the ageing of the population. Section 4.3 introduces the Australian retirement income system. An investigation of the structure and operation of the superannuation system is presented in Section 4.4. Section 4.5 discusses the operation of the superannuation system. This section covers recent major issues in superannuation identified by the researchers from both academic and industry fields. Section 4.6 discusses the performance of superannuation funds from an investment return perspective, and Section 4.7 presents the SCP conceptual framework for the Australian superannuation system. Section 4.8 provides an account of Australian studies, identifies gaps in the literature and provides the conceptual model for this study. A summary of the chapter and guide to the contents of the next chapter are provided in the final section.

4.2 Demographic changes and legislative responses

The ageing of the population has become an increasingly significant issue in both major and emerging economies. Australia is no exception (Australian Government 2010). According to the Australian Bureau of Statistics (ABS), the dependency ratio, the proportion of people aged under 15 and over 65 to the working age population, was approximately 16.4% in 1989 and 20.5% in 2000. The dependency ratio was forecast to rise to 24.4% in 2011, 34% in 2021 and 44.7% in 2031 (Booth 2003). This distribution is mainly due to population ageing. The baby boom after World War II, together with an increase in life expectancy, has changed Australia's population distribution significantly. There were approximately 2.8 million Australians aged 65 and over in 2008. This number was forecast to rise to approximately 5.4 million in 2028, which is approximately 19% of the Australian population (Kelly 2009). This development has created challenges to the national economic growth and the funding of the social security system, in particular, the superannuation system (Edey 2005).

Since the late 1980s, it has been argued that Australia's taxpayer-funded pension system would not sustain this dramatic change in the demographic trends. Australians would need to save more for their own retirement through a robust superannuation scheme (Australian Government 2010). In light of this development, the government introduced the *Superannuation Guarantee Act (SG)* in 1992. The SG Act was followed by the *Superannuation Industry Supervision Act (SIS)* in 1993. The SIS Act defines the rules for the management of superannuation funds in Australia (APRA 2007a; Nielson 2010). The SG Act enforced a compulsory employer contribution of 3% from the financial year 1992–3. This level of contribution would gradually be increased to reach a maximum of 9% in 2002–3. In 2011, the government amended the SG scheme to increase compulsory employer contribution to 12% in 2019. The increase to 12% would be gradual. The first increase was 9.25%, effective on 1 July 2013. The second increase was 9.50%, effective on 1 July 2014 (Australian Government 2011a).

In 2000, an extensive reform of the financial services industry led to the passing of the *Financial Services Reform Act 2001* (FSRA). A revised Chapter 7 was inserted into the *Corporations Act 2001* which aimed at assisting Australians to select their providers on a more informed basis. FSRA required more extensive disclosures of financial products including fees, suppliers of the products, advisers and their alliances. Product disclosure statements were compulsory for superannuation, investment life insurance and other managed fund products (Beal, Delpachitra & Grundy 2005). In 2006, the Federal Government released further legislative changes to the Australian superannuation system. These measures were designed to improve the system by resolving tax complexities, giving greater flexibility to superannuation contributions, and exempting from tax all superannuation benefits for people over 60 years of age. It was anticipated that favourable tax treatments and simplified regulations would encourage a much higher level of superannuation contribution (APRA 2007a; Creedy & Guest 2008).

In the wake of the GFC, the Government announced the Super System Review, commonly known as the Cooper Review, which is a comprehensive assessment of the governance, operation, efficiency and structure of the Australian superannuation system including the SMSF sector. The review subsequently provided extensive recommendations on how to improve the system (Cooper et al. 2010a). Policy recommendations from the Super System Review (for example, My Super) have been legislated in the SIS Act (1993) (ComLaw Authoritative Act 2013).

4.3 Australian retirement income system

Similar to the schemes in several other developed countries, Australia maintains a three-pillar retirement income structure consisting of the public pension, private pension (through employers or self-arrangement) and other savings (Clark, Munnell & Orszag 2006a). The first pillar is the universal public pension, often referred to as the

Age Pension. The second pillar is the compulsory occupational superannuation guarantee. The third pillar is voluntary superannuation (see Table 4.1).

Table 4.1. Australian three-pillar retirement income system

Type	**Form of benefit**	**Level of benefit**	**Funding**	**Coverage**	**Coverage of longevity, investment and inflation risk**	**Residual value at death**
Age pension	Income	Depends on marital status and subject to means tests	Current tax payers	Universal for a resident subject to means tests	Payable for life with wage indexation	No
Superannuation guarantee	Asset convertible to income	Depends on salary/wage, investment returns, period in workforce	Employer contributions	Employees with upper cap.	Depends on account balance and benefit options (e.g. insurance)	Yes
Voluntary superannuation	Asset convertible to income	Depends on amount invested and returns	Personal and employer contributions. Government co-contribution if eligible	Work tests from 65 years of age. Contribution is capped.	Depends on account balance and benefit options (e.g. insurance)	Yes

Source: compiled from Henry (2009)

The public pension scheme (the Age Pension) in Australia was first introduced in 1908 by the Commonwealth government under the *Invalid and Old Age Pensions Act 1908* (Nielson 2010). Apart from the public pension scheme, there had been an absence, until recently, of any form of compulsory earnings-related pensions. The Age Pension served as the social insurance for the elderly and the major source of income for most retired people for nearly one century. Alongside the Age Pension, concessions had always existed for occupational retirement schemes, and participation was voluntary. The Australian government did not compel participation in a public earnings-related scheme as was typical in some other OECD countries. As a consequence, the introduction of compulsory occupational superannuation contributions in 1992 did not occasion the transitional problems which had occurred in countries with well-established public PAYG schemes. The Age Pension scheme remains the first pillar of the new multi-pillar system (Bateman & Piggott 1998).

The Age Pension aims at providing an additional retirement income source to Australians who cannot afford an adequate retirement income. The entitlement is based on age, residency status, marital status, and is means-tested although not on employment history (Henry 2009). The Age Pension is paid from general revenues funded by current tax-payers, and from the public pension reserve often known as the Future Fund (OECD 2012b). Public pension reserves are a pre-funding system. For some countries, the system commenced after the Great Depression of 1929–32 (as in the USA), or after World War II (as in the case of Sweden). For other countries, it is relatively new; in the Netherlands from 1997 and in France from 1999. In 2011, Australia's public pension reserves assets were equivalent to about 5% of the GDP. This is compared with some OECD countries where the public pension reserves were more than 25% of the GDP, as is the case in Korea, Sweden or Japan. Australia's public pension replacement rate for average earners was just over 15%, which was lower than the rate in most OECD countries (for example, Greece provided a replacement rate of 110%). The replacement rate is the percentage of a worker's pre-retirement income that is paid out by a pension plan upon retirement (OECD 2015). The limited and shrinking role of the Age Pension is in contrast with the growing importance of superannuation guarantee, as discussed below (OECD 2012a).

Superannuation guarantee represents the second pillar in the Australian retirement income system. With $1.6 billion of asset value as at June 2013, superannuation is the most important pillar for supporting Australian retirees (APRA 2014a). In 2012, superannuation assets were approximately 20 times more than the Age Pension reserves and accounted for about 95% of all retirement income (OECD 2013a). Although mandatory contribution (personal and occupational) is required in nine countries in the OECD system, Australia is the only country where an occupational mandatory contribution scheme is in place. Other countries only enforce personal mandatory schemes. While private pension plans covered more than 50% of the working population in OECD countries, the coverage rate of superannuation for the working population in Australia was the second highest, at 86%, behind only the Netherlands at 89%. Nevertheless, the net replacement rate in Australia when combined with the Age Pension was below 60% (OECD 2012a). This estimation however does not include the value of the family home in Australia. Since the 1970s, the home ownership rate in Australia has ranged between 65% and 70% (ABS 2015).

The third pillar in the retirement income system is voluntary superannuation which allows additional savings to be contributed into compulsory occupational superannuation plans. This pillar together with the first two pillars makes the Australian retirement income system unusual among OECD countries. Nevertheless, the system shows significant strengths in that it does not only enforce compulsory contributions to satisfy minimum retirement income needs, it also provides a mechanism to encourage individuals to enhance their retirement savings and to spread risk between individuals, private and public sectors (Henry 2009). Despite the strength of the three-pillar framework, there have been discussions on the optimal weight of each element. It has been argued that the expansion of superannuation assets by increasing superannuation guarantee rates could negatively affect low-salaried workers' pre-retirement income and government tax revenue (Henry 2009). A balanced mix of a public pension scheme and individual financial accounts could better share the risk between government and workers, such as in the Swedish pension system (Boeri et al. 2006; Palmer 2002; Pension Myndigheten 2011).

Reliance of one main pillar such as the private pension in defined contribution plans under the occupational compulsory contribution system could also be problematic due to the risk being confined in individual plans and not being shared by other participants. Investment risk is the greatest risk of defined contribution plans. This risk can only be covered by insurance in Australia, not by intergenerational risk-sharing and solidarity schemes as in other OECD countries. In an intergenerational risk-sharing or solidarity scheme, for a given level of benefit, older generations underpay while younger generations overpay to obtain the pension benefits. In Australia, due to the recent GFC, the superannuation balances of many older Australian workers who were close to retirement decreased dramatically which would take a number of years to recover. Without insurance, intergenerational risk-sharing or solidarity schemes, the retirement income of these participants would be negatively affected. Governments are believed to be the best facilitators of intergenerational risk-sharing schemes (Blommestein et al. 2008; Boeri et al. 2006; Cooper et al. 2010a; Dunnin 2012; Main 2012).

4.4 Structure of the Australian superannuation system

The Australian superannuation system has a long history. The construct of the system is complex, with a highly regulated market and tax regime. This section discusses the system characteristics from two different perspectives: operational and legislation frameworks.

4.4.1 Development of superannuation as retirement savings

In Australia, superannuation as a form of savings had existed since the middle of the 19^{th} century for white-collar employees in the financial services sector, before the introduction of the old age pension scheme by the federal government in 1908. The first superannuation fund was established in 1862 for the employees of the Bank of New South Wales. In 1869, AMP followed by opening a superannuation fund for its staff (Dunnin 2008). These superannuation schemes were small and restricted to a limited number of employees. Only in the 1970s were superannuation schemes more widely negotiated to be included in industrial awards (terms and conditions of employment) for new employees. According to the ABS's first national survey on superannuation in 1974, 24 % of employees in the private sector had superannuation coverage as compared to 58% in the public sector. Male superannuation coverage was 36% and female superannuation coverage was 15%. The *Hancock Inquiry* of 1976 established by the Whitlam Labor government proposed a partially contributory national pension system. This proposal was rejected by the Fraser Liberal government in 1979. However, the trend toward a compulsory national superannuation system appeared unstoppable with the elected Hawke Labor government expressing support toward an employee scheme in 1983 (Nielson 2010).

In 1985, institutionalisation of compulsory superannuation contribution was fully considered when the Australian Council of Trade Unions proposed a three percent employer superannuation contribution to be paid into an industry fund, as part of its National Wage Case claim with the Conciliation and Arbitration Commission. The government supported the claim as it aligned with the inflation control objectives at that time (Barrett & Chapman 2001). By 1986, the Commission announced that it would approve contributions up to three percent for accredited superannuation funds. These are generally multiple-employer industry funds. Many industrial awards were negotiated under the National Wage Case. In the four years that followed the Commission's decision, industry superannuation coverage increased from about 40% to 79%. Coverage in the private sector increased from 32% in 1987 to 68% in 1991 (APRA 2007b).

The award-based scheme, despite encouraging growth in superannuation coverage for employees, showed several disadvantages. Even though employees were entitled to superannuation coverage, not all of them had it, as the superannuation award could only be implemented through a laborious process with the Conciliation and Arbitration Commission. The superannuation award did not take into account a large number of employees who already had superannuation coverage as part of their employment contracts. Lastly, more than one-third of employees in the private sector were not covered by superannuation awards in 1991. The SG Act introduced in 1992 arguably removed most of these drawbacks. The SG Act provides broad definitions of employers and employees and allows few exceptions, thus, extending superannuation coverage to almost all workers within a defined age range (APRA 2007b).

4.4.2 Growth of superannuation assets, superannuation fund types and market structure

Legislative changes since the early 1990s have encouraged a significant growth of superannuation assets. When the SIS Act was introduced in 1993, total superannuation assets were approximately $183 billion (Cooper et al. 2010a). These assets amounted to $360 billion, or over 60% of Australia's GDP in 1998 (see Table 4.2). By June 2008, the total assets were approximately 96% of the GDP. It was projected that by 2035, the superannuation assets would be over 6 trillion dollars, or approximately 130% of the GDP (Cooper et al. 2010a).

Table 4.2. Growth of superannuation assets: 1998–2035

Category/Year	**1998**	**2000**	**2002**	**2004**	**2006**	**2008**	**2010**	**2012**	**2035***
Superannuation assets ($billion)	360	484	528	635	904	1,131	1,199	1,400	6,100
GDP ($billion)	589	663	755	860	995	1175	1292	1475	4,692
% of Australia's GDP	61	73	70	74	91	96	93	95	130

* Forecast

Sources: ABS (2012), APRA (2013a), APRA (2007a) and Cooper et al. (2010a)

From a global perspective, Australia was ranked fifth in the size of superannuation assets relative to the country's respective GDP, only after the Netherlands, Iceland, Switzerland and United Kingdom in 2012 (see Appendix 4.1). Australia has transformed superannuation earnings from a minor role to an important position in the national income mix. It was forecast that Australia's superannuation assets would be the second largest in the world by 2030 (APRA 2007a; Jimenez 2013).

In addition to an extraordinary asset growth, the superannuation market has also developed from a small industry servicing limited sectors to a professionally managed industry with members from all economic areas. From the first voluntarily managed industry funds in the mid-1860s, the superannuation industry has developed into an constitutionalised industry with five distinctive fund types including industry, corporate, retail, public sector and SMSFs (APRA 2007a). Public-sector funds cater for state and federal government employees. Corporate funds set up by a company or group of companies provide superannuation benefits to the company employees. Industry funds service members of specific industries. Retail funds provide superannuation services to individuals who are not eligible to join corporate, public sector or industry funds (APRA 2005; Liu & Arnold 2010).

Table 4.3 shows the increase and decrease in assets by fund types and their proportions in total superannuation assets from June 2004 to June 2012. Continuing the trend of the previous decade, corporate funds declined from 7.93% in 2004 to 4.01% in 2012. Conversely, industry funds grew from 14.75% to 19.08% (APRA 2013a). Superannuation benefits of many corporate funds have been moved to large-scale industry or retail funds as part of companies' strategy to reduce operation costs and superannuation liabilities (Australian Super 2013). The trend in Australia is consistent with the trend in many OECD countries, as discussed in Boeri et al. (2006). Corporate funds with defined benefit schemes have been shrinking and have been replaced by retail funds. Corporations have chosen to transfer superannuation benefit risks to their employees by contributing employee pension entitlements to independent retail funds with defined contribution schemes (Boeri et al. 2006).

Table 4.3. Asset growth by fund types, in billion dollars, 2004–12

Fund type	2004	2005	2006	2007	2008	2009	2010	2011	2012
Corporate									
Assets ($)	50.5	52.2	52.2	69.1	59.7	55.4	56.6	58.5	56.1
(%)	7.93	6.94	5.76	5.86	5.27	5.15	4.63	4.33	4.01
Industry									
Assets ($b)	94	119.4	150.3	197.4	201.3	191.8	226.2	250.7	267.3
(%)	14.75	15.86	16.59	16.75	17.77	17.84	18.49	18.56	19.08
Public sector									
Assets ($b)	112.1	129	152.7	177.6	170.6	151.9	172.9	210.6	222.7
(%)	17.59	17.14	16.85	15.07	15.06	14.12	14.13	15.59	15.90
Retail									
Assets ($b)	207.5	244.5	298.9	369.9	337.1	305.4	339.5	368.2	371.4
(%)	32.56	32.48	32.98	31.38	29.76	28.40	27.75	27.26	26.52
SMSF									
Assets ($b)	132.8	165.4	208.7	321.8	325.8	336.2	392.9	425.3	440.9
(%)	20.84	21.97	23.03	27.30	28.76	31.26	32.11	31.48	31.48
Others									
Assets ($b)	40.3	42.2	43.4	42.9	38.4	34.7	35.5	37.6	42.2
(%)	6.32	5.61	4.79	3.64	3.39	3.23	2.90	2.78	3.01
Total ($b)	637.2	752.7	906.2	1,178.7	1,132.9	1,075.4	1,223.6	1,350.9	1,400.6

Source: APRA (2013a)

The asset value of retail funds, the largest sector until 2008, has been slowly declining. The SMSF sector has been the fastest growing, increasing its share of total superannuation assets from 20.8% in 2004 to 31.5%% in 2012. When the compulsory superannuation contribution scheme was established in 1992–1993, the SMSF sector barely existed. The superannuation industry predominantly served industry and public sector members. SMSFs were the largest sector with over $440 million dollars of assets as at 30 June 2012. Members of the SMSF sector held the largest average account balance of approximately $480,000. Corporate fund members held $102,000 on average. Public sector fund members had an average account balance of $66,000. Retail and industry fund members had the smallest average account balance of approximately $24,000 and $23,000 respectively (APRA 2013a).

The number of member accounts grew from 26.7 million in June 2004 to 31.9 million in June 2012 (Table 4.4). The retail sector had the largest number of accounts, with

15.4 million accounts in 2012. The SMSF sector had the smallest number of accounts, with 0.9 million accounts (APRA 2013a). The number of member accounts has been consistent around 27–31 million accounts since 2004. The very high number of member accounts indicates that the same member may have more than one account (Cooper et al. 2010a).

Table 4.4. Number of member accounts (thousand), 2004–12

Fund type	2004	2005	2006	2007	2008	2009	2010	2011	2012
Corporate	774	697	605	665	661	662	623	594	551
Industry	8,946	9,270	9,948	10,629	11,266	11,551	11,516	11,449	11,664
Public sector	2,707	2,758	2,891	2,925	3,002	3,095	3,131	3,372	3,371
Retail	13,764	14,434	14,970	15,472	16,308	16,574	16,797	15,318	15,408
SMSF	535	569	603	676	720	766	798	851	918
Total	26,727	27,728	29,017	30,369	31,957	32,648	32,866	31,584	31,911

Source: APRA (2013a)

Over the nine year period of 2004–12, the number of institutional superannuation funds reduced dramatically, from 1928 to 419 entities (see Table 4.5). The number of all institutional funds decreased except for public sector funds. Corporate funds showed the greatest decrease, shrinking more than ten times. Consolidation of funds and changes of superannuation benefit schemes were the main drivers of this trend (APRA 2013a).

Table 4.5. Number of superannuation funds, 2004–12

Fund type	2004	2005	2006	2007	2008	2009	2010	2011	2012
Corporate	1,405	962	555	287	226	190	168	143	122
Industry	106	90	80	72	70	67	65	61	56
Public sector	42	43	45	40	40	40	39	39	39
Retail	232	228	192	176	169	166	154	143	135
Others	143	130	123	101	90	82	79	77	67
Sub-total	1,928	1,453	995	676	595	545	505	463	419
SMSF	279,584	296,813	315,924	356,309	381,413	404,131	418,928	446,597	481,538
Total	281,512	298,266	316,919	356,985	382,008	404,676	419,433	447,060	481,957

Source: APRA (2013a)

4.4.3 Superannuation market structure, sellers' and buyers' behaviour

From the sellers' perspective, the Australian superannuation industry consists of different fund types with various characteristics. Corporate, industry and public sector funds are mostly closed and mutually exclusive, and there is consequently no competition among these funds to win members. Retail funds remain fully open funds. As there is little differentiation between products offered, retail funds incur a sizeable cost in promoting them (Clements, Dale & Drew 2007). As compared to corporate, public sector and industry funds, retail funds offer the greatest number of investment choices to members which could reach over 200 options per fund (APRA 2013a). The observation in Clements, Dale and Drew (2007) does not agree well with Bain's (1968) classic theory which proposed that when there was little differentiation between products, there was no change in market conduct. Studies in international markets showed that products in financial services which are generally homogeneous tend to be commoditised, easily copied and modified. The outcome of this commoditisation is that homogeneous products encourage promotion of product options, competition and contestability. Possible price reductions might occur and consequently, lower profitability for participating financial services firms (Davis & Steil 2001). In Australia, high promotion costs are mostly borne by members of superannuation funds and negatively affect their investment returns (Clements, Dale & Drew 2007; Coleman, Esho & Wong 2006).

The Australian superannuation market is characterised by uniform and involuntary participation by employers and employees who represent buyers. This creates a constant supply of funds and demand for services. The market does not reflect the classic economic theory which assumes that competition in the market determines prices and allocates resources efficiently (Cooper et al. 2010a). Although voluntary contributions are encouraged and can be tax concessional, the number of employees engaged in voluntary contribution is limited. Many members choose not to take an active role in managing their superannuation fund and are generally uninterested in monitoring its performance. This feature has resulted in a non-engaging attitude and insensitivity to fund fees (fund fees are not direct out-of-pocket payments by members) and inelastic demand for the investment management services by most members (Clements, Dale & Drew 2007; Cooper et al. 2010a).

High fees and costs incurred by superannuation funds, in particular retail funds, negatively affect members' benefits especially during financial market turmoils and create inefficiency in the system. Fees and costs have been subject to increased scrutiny since the GFC. As a consequence of lower returns, cost reductions and industry consolidation have been expected (Main 2011). The number of SMSFs has been increasing steadily since 2009. By mid-2012, over one million members decided to manage their own funds due to fees and sub-optimal investment returns from institutional funds (Patten 2012). While the total number of member accounts increased by 1.0 % during the year to 31.9 million, the number of member accounts for small funds increased by 7.9%. These are members with high superannuation accounts whose balances have an average value of approximately $500,000. The number of SMSFs members is 4% of the total members in the superannuation industry, and the retail superannuation market is contestable and competitive mostly to this minority – to the members who have high superannuation balances. Due to the low engagement of the majority of members and several factors that affect competition and desired outcomes, it is believed that the government's intervention in managing superannuation assets is necessary (APRA 2013a; Clements, Dale & Drew 2007; Cooper et al. 2010a).

4.4.4 Structure of superannuation benefits

The decline of the defined benefit pension plan has been a worldwide trend since the early 1990s. This trend is in effect part of a much broader tendency in which public and private institutions, both non-profit and for-profit, attempt to de-risk their balance sheets. Through this process, more risks are transferred to the balance sheets of individual households. The traditional occupational defined benefit plan has been on the decrease as companies no longer wish to bear the risks of increased pension benefit liabilities of their employees. Companies prefer to focus on their core businesses. Workers do not stay with the same employers throughout their working life and companies want to avoid the complexities of pension transfers when workers change employment. Defined contributions plans with accumulation benefits managed by independent financial institutions are more suitable for a moving workforce on a global scale (Boeri et al. 2006). Workers' freedom in selecting funds and their responsibility in managing their own pension assets are also enhanced. Nevertheless, the rise of defined contribution plans exposes workers' pension assets to a number of risks, such as market risks or poor investment decisions. To manage these risks, many governments elect to strictly regulate the pension fund industry (Srinivas, Whitehouse & Yermo 2000).

Consistent with the global trend, Australia has also been on a long journey of shifting superannuation benefits from defined benefit to defined contribution plans. In 1982, more than 82 per cent of members were reported to be in defined benefit funds (APRA 2007a). This situation had been reversed in the course of the last thirty years. In 2013, 93.4% of total assets ($996 million) of entities with more than four members were allocated to defined contribution and hybrid schemes (combination of both defined contribution and benefit feature). See Appendix 4.2. Strictly defined benefit plans only held 6.6% of total superannuation assets (APRA 2014a). With public pension funding approximating 5% of Australia's GDP, the risk to retirement benefits has been shifted almost fully to individual members (Williams 2014).

4.4.5 Superannuation legislation

Australian superannuation funds operate under a trustee model established by the general law of equity (Cooper et al. 2009). A corporate trustee or a group of individual trustees plays a major role in the fund. The trustee manages the fund's assets, invests and distributes them for the benefit of their members and beneficiaries. The trustee is responsible for ensuring that the trust is administered in accordance with the trust deed and within the superannuation legislation framework. Each trustee has a fiduciary obligation to members and beneficiaries of that trust (ComLaw Authoritative Act 2013).

The superannuation legislation has become an ever expanding body of legislation which significantly increases in size and complexity every year. The legislation covers the SG scheme, which regulates superannuation contributions of individual members, and the SIS scheme, which regulates superannuation fund operation. The legislation also covers the resolution of complaints, the taxation of superannuation contributions, benefits and entities, and other laws impacting superannuation operations. Superannuation legislation is an extremely extensive and diverse legislative framework (CCH Australia 2013). The regulatory objectives for the Australian superannuation system are two-fold, aiming at member protection and efficiency (Donald 2009).

4.4.5.1 The Superannuation Guarantee Administration (SG) Act 1992

Partially mandatory superannuation contributions in Australia commenced in 1987. The compulsory superannuation contribution that an employer was required to provide on behalf of employees was constitutionalised by the *Superannuation Guarantee (Administration) Act* in 1992 (Nielson 2010). A major amendment to the SG scheme occurred in 2011 with an incremental increase in employer superannuation contribution from 9% to 9.5%, effective from July 2013. This increase has re-affirmed the government's commitment to shift the burden of funding for retirement almost completely to individual retirees (Australian Government 2011a; Jimenez 2013).

4.4.5.2 The Superannuation Industry Supervision (SIS) Act 1993

The introduction of the SG Act was accompanied by the SIS Act in 1993, and supporting regulations came into effect in 1994 (APRA 2007b). The SIS Act remains a major legislative instrument governing operation of superannuation funds and protecting superannuation fund members' interests. The SIS Act has been amended several times. One of the most extensive and significant reforms is related to the

Stronger Super reforms initiated by the government following the Super System Review in 2009–10 (CCH Australia 2013).

In Australia, as well as in many common law countries, the model of trusteeship is the basis for the establishment of superannuation legislation (Donald 2008). The trust law plays an important role in shaping the SIS Act. The principle-based nature of the trust law complements statutory rules. As superannuation funds are formed as trusts, the rights of the participants, in essence, the rights of members and trustees, are defined by the trust law governing rules. Fiduciary duties of trustees as well as trustees' qualifications and actions (that is, acting with due care, skill and diligence) are derived from the trust law (CCH Australia 2013; Donald 2009). Nevertheless, the superannuation legislation has acquired a compliance culture in which broader principles such as fiduciary duties can be diluted. This may create a dilemma in dealing with conflicts of interest imposed by the trust law (Mason 2005). This observation was supported in another study by Sy et al. (2008) where it was recorded that trustees spent over 50% of their time on non-critical tasks, of which 15–29% of time was on ensuring compliance with the legislation. Time spent on investment strategy and evaluation of investment performance as specified in the SIS Act were consequently greatly reduced (Donald 2009).

4.4.5.3 Other superannuation legislation

In addition to the SG Act and the SIS Act, the legislation of the Australian superannuation system can also be found in other major laws, in particular the *Corporations Act 2001*, the *Income Tax Assessment Act 1997*, the *Tax Administration Act 1953* and the *Family Law Act 1975*. The Corporations Act and SIS Act are the two key pieces of legislation governing superannuation funds. The Corporations Act and Income Tax Act define how superannuation is taxed (CCH Australia 2013).

The *Family Law Act* and its regulations shape the rules in relation to superannuation interests for member spouses, members in de facto relationships and dependants. A major reform in 2002 gave the Court the power to treat superannuation as property and to bind trustees to any order the Court would make regarding superannuation interests (CCH Australia 2013; Harrison 2002).

4.4.5.4 Stronger Super reforms

There are four tranches in the superannuation legislation amendments in response to the Cooper Review (CCH Australia 2013). The first tranche is *My Super Core Provision. My Super* is a simple and cost-effective investment product which replaces existing default options. This amendment was inserted into the SIS Act and was effective from January 2013. The second tranche relates to *Trustee Obligations and Prudential Standards*. This amendment highlights the principle of member protection. In Schedule 1 of the amendment, extensive changes were introduced into the SIS Act, such as duties of trustees in regards to default investment products. Provisions relating to conflict of interests were also included, such as giving priority to beneficiaries where a conflict exists. An insurance strategy needs to be formulated and executed for the benefits of the beneficiaries. Schedule 2 of the amendment empowers APRA to issue prudential standards for certain superannuation matters (CCH Australia 2013).

The third tranche of the superannuation legislation amendments is *Further My Super and Transparency Measures*. This amendment highlights the principle of efficiency. In a nutshell, the SIS Act sets criteria for fees, including re-defining fees for financial advice and banning entry fees. The SIS Act further requires publication of key information of superannuation funds to members (CCH Australia 2013). The fourth tranche is *Service Providers and Other Governance Measures* which amends legislation in relation to superannuation, corporations and first home saver accounts. In particular, the Act requires superannuation entity licensees to ensure adequate resources and risk management systems to be in place and also to empower APRA to issue infringements for a broader range of breaches to the Act. The requirement includes an establishment of a reserve fund (AUSTLII 2013).

In the aftermath of the GFC, many OECD countries have undertaken pension reforms. Nevertheless, Australia is the only country, apart from the UK, that has reformed the superannuation system across six out of seven areas as classified by the OECD. They are: adequacy, sustainability, work incentives, administrative efficacy, diversification and security, except for coverage, which refers to pension coverage for the working population (OECD 2012a).

4.4.6 Superannuation authorities

Following the Financial System Inquiry in 1997, the government re-structured regulatory bodies to oversee and administer the superannuation market. Superannuation is now the responsibility of three main bodies: *Australian Prudential Regulation Authority* (APRA), *Australian Investments and Securities Commissio*n (ASIC) and *Australian Tax Office* (ATO) (Australian Government 2013a; Barrett & Chapman 2001).

APRA is the prudential regulator for banks, credit unions, building societies, general insurance and reinsurance companies, life insurance, friendly societies and superannuation funds. APRA supervises regulated superannuation funds other than SMSFs, deposit funds and pooled superannuation trusts, and its major governing tool is the SIS Act (APRA 2013b). APRA is given authority by the SIS Act (section 34C) to issue prudential standards when appropriate (ComLaw Authoritative Act 2013).

ASIC oversees Australian financial markets. This regulatory body ensures fair and transparent operations of financial activities for consumers and investors and other financial market participants of which superannuation fund members are part. Certain aspects of superannuation fund regulation are therefore managed by ASIC, such as the relevant sections and related regulations of the *Superannuation (Resolution of Complaints) Act 1993* and the SIS Act (ASIC 2013).

The ATO oversees superannuation contributions as required by the SG Act and tax compliance in relation to superannuation matters. Essentially, employer superannuation guarantees and superannuation tax concessions as well as penalties are enforced through the ATO powers. The ATO also administers SMSFs of four or fewer members (APRA 2007b; Barrett & Chapman 2001).

4.4.7 Professional and industry associations

The Australian superannuation system hosts several prominent professional and industry associations. The *Association of Superannuation Funds of Australia* (ASFA) is the advocacy body for Australia's superannuation industry. ASFA membership includes superannuation funds from the corporate, industry, retail and public sectors, self-managed and small APRA funds representing over 90 per cent of Australians with superannuation (ASFA 2013).

There are other associations which focus on particular sectors of the superannuation industry. The *Australian Institute of Superannuation Trustees* (AIST) caters for the not-for-profit superannuation sectors. AIST's membership includes trustee directors and staff of corporate and public-sector funds (AIST 2013). The *SMSF Professionals' Association of Australia* (SPAA) is the organisation which supports SMSFs, SMSF consultants and member trustees (SPAA 2014).

4.4.8 Tax treatment of superannuation contributions and benefits

Taxation of superannuation is implemented throughout the three phases in the superannuation life cycle: contribution, investment and benefit. The contribution and investment phase comprise the accumulation stage which is distinguished from the benefit phase (de-accumulation stage) due to different tax treatments. Tax is concessional for contribution and investment income during the accumulation stage at a flat rate of 15%. Cash payments of superannuation benefits after a preservation age or retirement are mostly tax-free. With voluntary superannuation savings, tax ranges from 0% to 15% for contribution and remains flat for investment income at 15% (CCH Australia 2013; Henry 2009).

Like Australia, many OECD countries use tax incentives to encourage private pension savings. In some OECD countries, pension contributions are tax-deductible or exempt from taxation, investment income is exempt from taxation, and pension benefits are taxed. In other OECD countries, contributions and investment incomes are taxed, but at a preferential rate relative to other forms of savings (Yoo & De Serres 2004). In the first case, pensions are taxed on a cash flow basis. This system is referred to as *exempt*, *exempt* and *taxable* (EET) in the literature. With this system, the government delays the collection of the major part of pension tax until retirement to encourage the growth of pension assets during accumulation years (Boeri et al. 2006; Whitehouse 1999; Yoo & De Serres 2004).

The tax regime in Australia falls into the second case. Australia does not follow the cash-flow treatment principle. Most superannuation contributions are taxed upfront before generating income (Boeri et al. 2006). Investment income is taxed on a fixed rate basis. By contrast, superannuation benefits in the form of pension allowances (cash payments) are exempt from taxation. This tax treatment is referred to as *taxable*, *taxable* and *exempt* (TTE). The net present value of the tax revenue under both the EET and TTE regime is similar; however, the timing between the EET and TTE system is different. Tax revenues are deferred until retirement under the EET, but are received immediately when pension premiums (contributions) are contributed under the TTE. The TTE system may discourage pension saving as consumption may now be worth more than consumption in the future. Pension contributions are taxed before any investment income is generated (Whitehouse 1999).

From a public spending discipline perspective, not adhering to the cash-flow treatment principle has several disadvantages. Rather than reserving the tax revenues for higher future budgetary needs, politicians may use the additional current tax revenues to increase current spending or reduce current tax rates in other taxation areas (Boeri et al. 2006). These policies may be seen as favourable for re-elections but do not adhere to budget disciplines: ‘Once a government starts collecting taxes upfront, rather than waiting until a tax payer will have retired to collect them, [it] becomes “hooked” on the

[tax] drug' (Patten 2013, p. 45). By contrast, taxing pension benefits in retirement broadens the tax base when the ageing population puts more pressure on public spending. For instance, in the Netherlands, the additional personal income tax revenues from pension benefits could be large enough to finance more than half of the rise in public pension spending projected as a consequence of population ageing (Boeri et al. 2006). Expenditure tax as in the EET system is believed to be a more appropriate treatment of pension tax (Dilnot 1996).

4.5 Operation of superannuation funds

Operation of superannuation funds is an important area of the superannuation system analysis. In this section, operation characteristics as well as current issues of the system are deliberated. This section together with sections 4.4 and 4.6 form the basis for the SCP framework for the Australian superannuation system presented in section 4.7.

4.5.1 Governance and agency issues

Governance enables the organisation to operate in alignment with desired goals (Clark & Urwin 2008). Almost all issues surrounding the efficiency of the superannuation system identified in the Super System Review are somewhat related to governance, trustee policies and practices (Cooper et al. 2010a). Governance has been gradually gaining interest from many concerned parties as superannuation assets have been increasing in size. There has been a rapid shift from a defined benefit system where pension liabilities are born by corporate and state sponsors to a self-funded defined contribution system where individual members bear investment and retirement benefit risks (Boeri et al. 2006; Bryan, Ham & Rafferty 2008; Clark & Urwin 2008). Governance can be dissected into two perspectives: those of structure and mechanism. Governance structure covers underlying principles, processes, identification of a governing body and its responsibilities. The governance mechanism covers specific control and practice areas (OECD 2009). In Australia, the governing body of a superannuation fund is the trustee board. Trustees have fiduciary obligations under the general law of equity (Cooper et al. 2009). The SIS Act specifies trustees' obligations, which contribute to forming governing rules for all superannuation funds (Cooper et al. 2010a).

Superannuation funds have features of a multiple agency relationship. Apart from the trustee-member relationship, other relationships exist such as those between trustees and service providers, members and service providers, and among service providers themselves (Sy 2008). Trustees' intentions as well as service providers' activities are not easy to observe (Benson, Hutchinson & Sriram 2011; Clark 2004; Coleman, Esho & Wong 2006). Despite a legally bound relationship between trustees and members of the superannuation plan, there are no legal contracts between members and other service providers that trustees engage in to manage the superannuation plans. Superannuation assets are pooled and managed collectively, thus, the separation between ownership and control is even wider (Benson, Hutchinson & Sriram 2011).

Due to the nature of the superannuation fund structure which entrusts trustees to manage members' contributions, members have little or no control over how their superannuation plans are constructed and managed (Drew & Stanford 2003b; Nguyen, Tan & Cam 2012). Although members have choices in managing their superannuation plans, many of them are neither well-informed nor rational investors, which was a key assumption in the Financial System Inquiry (the 1997 Wallis Report) upon which the *Financial Services Reform Act 2001* was formulated. The financial literacy of the average adult Australian is low (Cooper et al. 2010a; Pearson 2008). Members of superannuation funds are non-expert principals. Thus, the power weighs heavily on trustees who are professional agents (see Figure 4.1). Members may lack both knowledge and information to be able to make rational and well-informed financial decisions for the benefit of their superannuation plans. The low involvement of members in selecting their superannuation funds despite member choice regulation in 2005 further reinforces members' non-engaging attitude in financial matters that only affect them in the future. This issue highlights the importance of a good governance framework (Benson, Hutchinson & Sriram 2011; Cooper et al. 2010a).

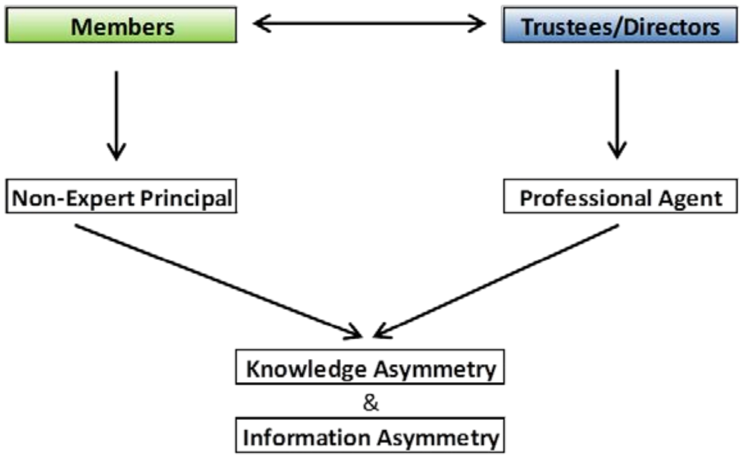


Figure 4.5.1. Relationship between members and trustees

Source: Adapted from Sharma (1997)

In Australia, the superannuation regulation framework supports a principle-based governance mechanism, not a prescriptive approach (ASFA 2010). Consequently, trustee policies and practices vary depending on the types of funds. There are arguably two models of governance and trustee practices. The first model prevails in non-profit funds such as for corporate, industry and public sector funds. The second model is used by trustees of for-profit retail funds. Non-profit superannuation funds are managed by trustees who fulfil their fiduciary duties as broadly guided by the SIS Act. For-profit superannuation funds are operated in a competitive commercial market where fund managers and financial advisors must sell superannuation products to fund members and beneficiaries (Sy 2008). This transition in the traditional trustee philosophy was termed a ‘mutation from stewardship to salesmanship’ by Bogle (2005, p. 118).

With regards to portfolio construction, trustees of non-profit funds take a more direct responsibility in asset management and selection of fund managers. By contrast, trustees of for-profit funds pass this responsibility onto related service providers. This practice has several implications. Additional fees may be incurred to retail fund members. Trustees face a double layer of conflict of interest. The principal-agent's conflict of interest involves a choice between acting in the best interest of fund members and for investment managers who are often executive directors on the board. There is also the principal-principal conflict of interest where trustees have to decide whether shareholders' benefits should take priority over fund members' benefits (Sy 2008). Agency costs among retail funds are perceived to be higher than those among other fund types (Coleman, Esho & Wong 2006; Bryan, Ham & Rafferty 2008). Given the complexity surrounding the nature of the relationship between trustees and members, and trustees and other service providers, good governance is of paramount importance (Ambachtsheer, Capelle & Lum 2008; Useem & Mitchell 2000).

4.5.2 Fees and costs

Fees and costs in investment funds are topical subjects. For investors, fees are prices paid for the management of the investment funds. For fund managers, fees represent fund revenues (Khorana, Servaes & Tufano 2008). Fees are important for both investors and managers. Higher fees lower investors' returns and increase fund income for fund managers (Carhart 1997). Thus, there is a fundamental conflict of interest between fund managers and investors. Some legal settlements in the United States highlighted fund trustees breaching duty of care due to excessive charges of fees to retail investors. In countries when governing rules surrounding conflicts of interest between investors and fund managers exist, fees tend to be lower (Khorana, Servaes & Tufano 2008).

From a global perspective, administrative costs and pension funds charges are a significant policy concern. Fees and charges including taxes can be up to 40% of pension contributions. The projected effect of fees on pension incomes is shown in Table 4.6. With 1.5% of fees as a percentage of assets, pension income could be reduced by 30% at retirement. Measures have been introduced to improve the situations in various countries (Australia, United Kingdom, Sweden, Chile and Estonia are some examples). Greece has reduced 133 pension institutions to 13 (OECD 2012a). One strategy to reduce fees and charges recommended by pension experts has been the creation of large private plans instead of many small funds competing with each other, with little freedom of choice from participants and great competition for asset management and other services (Boeri et al. 2006). These recommendations were also discussed in the Super System Review (Cooper et al. 2010b).

Table 4.6. Projected effect of fees on pension income

Fee as percentage of assets (%)	Reduction of pension in percentage (%)
0.05	1.20
0.15	3.60
0.25	5.90
0.50	11.40
0.75	16.50
1.00	21.30
1.50	29.90

Assumptions: 40-year accumulation period, contribution at 10% of average wages, nominal wage growth at 3.8% and average return of 7%

Source: OECD (2012a)

In Australia, fees and costs of managed funds in general and superannuation funds in particular have been subject to increased scrutiny since the GFC. Fund managers expect significant cost reductions, as a consequence of lower returns, higher investor expectations and industry consolidation (Main 2011). The number of SMSFs has been increasing steadily. Over one million members decided to manage their own funds due to fees and sub-optimal investment returns from institutional funds (Patten 2012). There have been layers of fees and costs, some directly attributed to the internal management and administration activities, others to third party service providers (APRA 2014b; Liu & Arnold 2010). A superannuation fund can have over 20 types of fees. Different funds do not follow a consistent structure for classifying fees, hence fee structures may not comparable between funds (The Future of Super 2012a).

During a year of low investment return for global share markets such as for the year 2011–12, expenses were very significant as compared to earnings. The ratio of total expenses to earnings before tax ranged between 25.1% for public sector funds and 161.1% for industry funds. Retail funds incurred a loss during 2011–12. Members nevertheless were still subject to both investment and operating expenses. In 2012–13, which was a year of very positive return in the share market, the ratio of total expenses to earnings before tax ranged between 3.8% for public sector funds and 7.3% for retail funds (APRA 2013a, 2014a).

Superannuation fees on average declined from 1.32% to 1.23% from 2007 to 2013. Nevertheless, the decline was deemed not to be attributable to changes in the governing rules of fund trustees to provide more benefits to members. Average fee reductions were due to members' changing fund choices (including establishing SMSFs) and negotiating better fund management packages. Wealth management funds responded by offering better products. Despite the fee decline, members paid approximately $20 billion in fees for 2013 (Toohey 2013). Superannuation assets are approximately the size of the GDP and fees were still largely set based on the account size in dollar terms (Teckchandani 2013).

Following the Super System Review recommendations, the government introduced *My Super* products under the superannuation amendment legislation. *My Super* scheme aims to provide default products at low costs and simplify investment choices for members. The fees which a member can be charged in *My Super* products include administration, investment, buying and selling of spreads, exit and switching fees. Many fees are limited to cost recovery only (Australian Government 2011b; CCH Australia 2013). Along with the superannuation amendment legislation, the government has implemented other measures to provide more transparency and mitigate the negative effect of fees on financial services customers, and superannuation fund members. The *Future of Financial Advice* reforms, incorporated in the *Corporations Act 2001*, banned conflicted remunerations, enforced best interest duty (of financial advisors to clients), more fee disclosures, and minimised asset-based and on-going fees

(Australian Government 2013b; Macquairie Group 2013). The newly-elected Liberal government, however, proposed a watered down version to mitigate the compliance costs and regulatory burden on the financial services sector (Australian Government 2015).

4.5.3 Outsourcing

Outsourcing is the use of a third party service provider by an organisation to perform activities on a continuing basis that would normally be undertaken by the organisation (BIS 2005). Outsourcing is used by both public and private organisations. Cost, strategy and politics are the three main motivations for outsourcing. While cost and strategy are two key drivers of outsourcing in private organisations, politics is believed to be one of the main reasons public organisations resort to outsourcing. An organisation may outsource in order to save costs. Nevertheless, there has been evidence that cost savings can be overestimated (Kremic, Tukel & Rom 2006). Outsourcing can also be due to strategic directions such as focusing on core competencies or creating flexibility (Elmuti & Kathawala 2000). Outsourcing is prevalent in financial services industries, in particular, mutual funds. A recent study by Chen et al. (2013) indicated that outsourcing mutual funds underperformed benchmarked returns.

Outsourcing is prevalent in the Australian superannuation industry (Cooper et al. 2010b). Outsourcing activities vary across several important functions, from actuarial services, asset allocation, and investment management to custody, legal, auditing and administration services (Liu & Arnold 2010). Funds differ greatly in the extent of outsourcing services (Bateman 2003). Outsourcing may lead to fees being incurred at more than one level (Cooper et al. 2010a). Outsourcing activities are greater for non-profit funds than for-profit funds. While non-profit funds tend to outsource most or all functions of superannuation management, for-profit funds tend to outsource fewer but do so to related party service providers (Drew & Stanford 2003b; Liu & Arnold 2010). Outsourcing activities and related party transactions which are not at an arm's length basis are arguably common practice in for-profit retail superannuation funds. Fees paid to related party service providers by retail funds are significantly higher than fees paid to independent third parties. By contrast, for non-profit funds, related party outsourcing or outsourcing to independent service providers appear to incur the same level of fee payments (Dunn 2011; Liu & Arnold 2010).

In a survey of 115 APRA-regulated funds, Liu and Arnold (2010) revealed that these funds resorted to eight types of services provided by external providers (Table 4.7). The highest number of contracts falls into the investment management category, applicable to all funds in the sample. The lowest number of contracts falls into the sales and marketing category.

Table 4.7. Outsourcing activities – 115 APRA-regulated funds, 2010

Type of outsourcing	Number of contracts
Administrative services	101
Asset allocation	81
Auditing	124
Custody	76
Actuarial services	49
Investment management	1026
Legal services	88
Sales and marketing	19

Source: Liu and Arnold (2010b)

4.5.4 System administration

According to the statistics provided in the Cooper Review (2010a), there were approximately 12 million members and over 30 million accounts in 2009. The latest statistics by APRA over a period of 10 years from 2004 to 2013 indicated that the number of member accounts averaged between 27 to 31 million (Table 4.8. These figures suggest that there is room for improvement in regards to system administration, especially the need for consolidating accounts of small value (Cooper et al. 2010a). Compared to its global counterparts in other OECD countries, the Australian superannuation system appears fragmented with many small funds of small account balances (see Appendix 4.3). The ATO recorded $ 18.1 billion in lost superannuation as at 30 June 2012 (BT Financial Group 2014).

Table 4.8. Number of member accounts ('000), as at June 30

Fund type	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Corporate	774	697	605	665	661	662	623	594	550	512
Industry	8,946	9,270	9,948	10,629	11,266	11,551	11,516	11,449	11,664	11,524
Public sector	2,707	2,758	2,891	2,925	3,002	3,095	3,131	3,374	3,372	3,337
Retail	13,764	14,434	14,970	15,472	16,308	16,574	16,797	15,312	15,334	14,395
Small	535	569	603	676	720	765	793	843	904	968
Total	26,727	27,728	29,017	30,369	31,957	32,648	32,861	31,572	31,823	30,736

Source: APRA (2014)

Another major issue of the system administration is accounting function and paper work or 'back office' activities. These activities are dominated by overlapping functions and manual transactions which may cost members much more than necessary. The system is in general outdated and unsuitable to cope with the rapid growth and the complexities of the superannuation industry (Cooper et al. 2010a). The issue of lost super and administration costs to members can be mitigated when 'back office' activities are improved. Within the *Superannuation Legislation Amendments* framework, the government proposed Super Stream which is a set of measures designed to improve back office activities. It is expected that, after implementation, the system will be more efficient and easier to use (Australian Government 2011b; Murray et al. 2014).

4.5.5 Investment activities

With superannuation assets approximately the size of the GDP and superannuation market highly regulated, the issue of how to invest these assets is of paramount importance (Cooper et al. 2010a). From a global perspective, there currently exist two forms of government policy for pension asset investment. The first form involves quantitative asset restrictions where the government imposes certain limitations in holding a particular class of asset. The second form is the prudent person rule (PPR) where no restrictions are required, however, asset managers should invest fund assets as prudently as though these assets were their own. The PPR mainly prevails in Anglo-Saxon countries and thus, is common practice in Australia (Hu, Stewart & Yermo 2007).

Most superannuation funds in Australia offer members default option strategies. Default option strategies, despite different names, are mostly alike between different funds (McDougall 2008). Within default strategies, approximately half of superannuation assets are held in equities, divided between Australian and international shares. Small portions of the assets are shared for other asset classes such as properties, Australian and international fixed interest, cash, and miscellaneous assets (APRA 2014a).

The majority of large superannuation funds offers investment choices to their members. Retail funds offer the greatest number of investment choices. For instance, in 2013, there was an average of 265 options per fund. Non-profit funds (industry, public sector and corporate) offers many fewer options (10 options per fund on average) (APRA 2014a). Investment choices are used as promotional tools by for-profit funds. For an international comparison, Swedish workers can choose their pension funds from a list of nearly 700 funds or stay with a default fund. However, contributions and fund choices are centrally administered by the Swedish Premium Pension Authority (Boeri et al. 2006).

As evidenced from both international and Australian studies, members are not interested in switching investment options, plans or funds. Most members stay in the default option of the same default fund (The Future of Super 2012b). This is partly due to bounded rationality often discussed in behavioural finance. Bounded rationality describes that when investors have to make complex decisions regarding investment choices, they often show inertia or procrastination which leads to poor choices and negatively affects investment returns (Gallery, Gallery & Brown 2004). However, when members are actively engaged in monitoring their investments, they often make choices that reduce performance returns or cause losses to investment assets (Tang et al. 2010). Further discussions on members' ability to make financial decisions are presented in the following section.

4.5.6 Financial literacy of superannuation fund members

Financial literacy has been defined broadly and variously in the literature. These definitions include financial knowledge and skills to manage financial resources, appropriate financial behaviour, and experience and the ability to make informed financial decisions. Recent studies have also included numeracy as a key financial literacy indicator (Cooper et al. 2010a; Hung, Parker & Yoong 2009; PACFL 2008).

Research indicated that Australians have a low level of numeracy and, consequently, a low level of financial literacy. The 1997 Wallis Report and subsequent *Financial Services Reform Act 2001* which enforced disclosure and other measures to protect customers from financial products had overestimated the ability of members of superannuation plans in regards to financial literacy (Cooper et al. 2010a). A growing body of research both internationally and in Australia demonstrated that members are not well equipped to make sound financial decisions when it comes to managing their pension assets. The intention of the government to develop superannuation as the primary source of retirement income where defined contribution plans dominate makes members more vulnerable to market movements and their own financial decisions. Australian trust law requires fund trustees to act with skill, care and diligence and the recent superannuation legislation amendments are expected to mitigate the issues surrounding members' financial literacy and enhance member protection (Cooper et al. 2010a; Donald 2008; Gallery, Gallery & Brown 2004; Tang et al. 2010).

4.6 Performance of superannuation funds

In the context of a superannuation fund, the term *performance* often encompasses investment return (Ellis, Tobin & Tracey 2008). APRA provides time-series statistical data annually (see Table 4.9). Negative return affects investment performance directly. The higher the number of years of negative investment return, the lower the overall long-term return. In the ten-year period to 2011, the number of years of negative investment return was four, and the average annual investment return is 3.8%. By contrast, in the ten year period to 2013, as the number of years of negative investment return was halved, the average investment return was as high as 6%. The volatility of investment return remains stably high, regardless of return during the period.

Table 4.9. Superannuation funds average return and volatility in three ten-year periods, 2002–11, 2003–12, 2004–13

Period	2002–11		2003–12		2004–13	
Type	Average return	Volatility	Average return	Volatility	Average return	Volatility
Corporate	4.3%	9.7%	4.8%	9.4%	6.5%	9.0%
Industry	4.5%	9.9%	5.1%	9.5%	6.7%	9.5%
Public sector	4.7%	10.4%	5.5%	9.7%	7.0%	9.7%
Retail	2.9%	9.6%	3.4%	9.3%	4.9%	9.4%
All entities	3.8%	9.9%	4.4%	9.4%	6.0%	9.5%
Negative return	4 years		3 years		2 years	

Source: adapted from APRA (2012), APRA (2013a), APRA (2014a)

When compared with the global counterparts in the OECD countries for a period of five years (2008–12), Australian superannuation funds average investment return is among the worst four countries (OECD 2013a). See Appendix 4.4. This result, coupled with high volatility of return, may be due to a high proportion of assets invested in Australian equities as compared to global counterparts (Main 2012).

4.7 SCP framework for the Australian superannuation system

The SCP framework, introduced by Mason (1939) and developed by Bain (1968), can be used to dissect an industry's performance given its structure and conduct. In empirical studies on commercial banks, the traditional SCP framework has been used to explain the collusion between firms, concentration of market powers and higher profits. With regards to mutual funds, a study by Otten and Schweitzer (2002) demonstrated that poor risk-adjusted performance is the direct result of specific structural and behavioural (conduct) characteristics, which may be generic or industry- and country-specific.

In this study, the SCP framework has been used to present an overview of the Australian superannuation system under three inter-related elements of structure, conduct and performance. The Australian superannuation system has unique characteristics. The superannuation market is highly regulated and operates under a complex legislative framework. Superannuation contribution is compulsory resulting in highly inelastic demand from members. The industry is protected with low competition, low efficiency and high fees with high profits for service providers and low benefits for members (Murray et al. 2014; Clements, Dale & Drew 2007; Toohey 2013).

Figure 4.2 presents the SCP framework for the Australian superannuation system using information presented in the previous sections of this chapter. The SCP framework allows the construction of a comprehensive view on the market structure, market participants' behaviour, and performance of the superannuation market. These elements set the foundation for the development of the independent explanatory variables presented in Chapter 7.

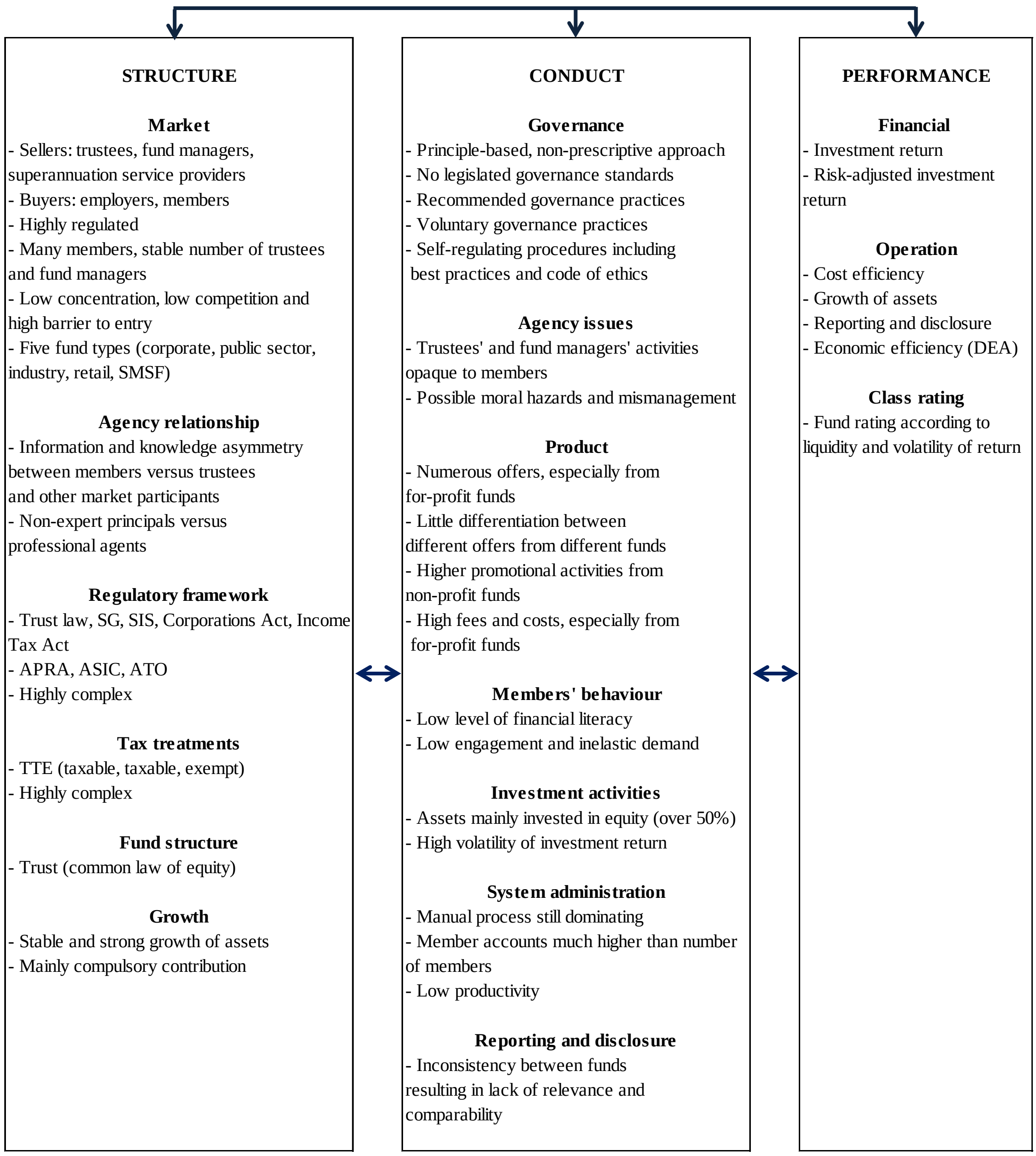


Figure 4.2. SCP framework for the Australian superannuation system

Source: APRA (2014a), Bain (1968), Benson, Hutchinson and Sriram (2011), Clements, Dale and Drew (2007), Cooper et al. (2010a), Davis & Steil (2001), Donald (2009), and Mason (1939)

Under the *structure* paradigm, the superannuation market features an industry of sellers which comprises trustees, fund managers and other superannuation services providers. The buyers of superannuation products include employers and members. The structure of Australian superannuation system also reflects the legislative framework, the potential growth of superannuation assets, and the fund structure guided by trust law.

Under the *conduct* paradigm, behaviour of market participants is emphasised. This includes governance and trustees' practices, investment activities and behaviour of members. Under the *performance* paradigm, a summary of various approaches to the performance of superannuation are presented. Performance is most often assessed from a risk-adjusted investment return perspective.

4.8 Australian studies, main research questions and conceptual model for the study

To the best knowledge of the thesis's author, few studies on Australian superannuation funds have used the SCP framework or the DEA model to dissect current issues in a comprehensive manner and to measure the economic efficiency of superannuation funds. From a global perspective, although DEA is widely used in the financial services sector, its application mainly concentrates on mutual funds. Pension funds receive less interest for research purposes due to having a lower level of transparency and disclosure than other types of mutual funds (Ambachtsheer, Capelle & Lum 2008). The same situation prevails in Australia. Recent research includes one study to measure the efficiency of Australia's retirement income system under the effects of financial reforms by Njie (2006).

The gaps in the literature therefore present an opportunity to explore the relative economic efficiency of superannuation funds using DEA and drivers of efficiency based on the SCP framework. In this context, the study aims to address two main research questions: 1) *To what extent do Australian superannuation funds operate efficiently* and *2) What are the drivers that influence this efficiency?*

The conceptual model of the study (Figure 4.3) is drawn from the comprehensive SCP framework for the Australian superannuation system presented in section 4.7. The study focuses on investigating three important areas of research interest. Under the *structure* paradigm, the trustee board structure is explored. Within the *conduct* paradigm, investment and risk management activities are investigated. The efficiency of superannuation funds belongs to the *performance* paradigm. The relationships between structure, conduct and performance are explored through investigating the effect of trustee board structure, investment activities and risk management tactics on the efficiency performance of superannuation funds. The conceptual model forms a basis and sets a boundary for the development of the drivers of efficiency represented by the independent exploratory variables.

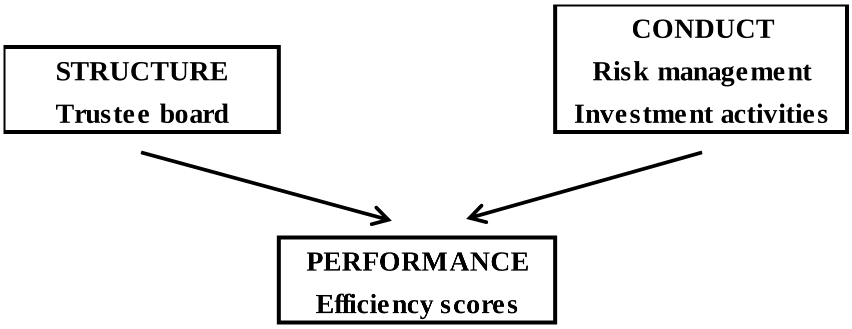


Figure 4.3. Conceptual model for the study – efficiency (performance) and drivers of efficiency (board structure, risk management and investment activities)

4.9 Summary

An overview of the Australian superannuation system, its strengths, weaknesses and current issues were presented in this chapter. The overview focused on the structure, operation and performance of the system. The chapter concluded with a presentation of the SCP framework for the Australian superannuation system, a panoramic overview of the inter-relationships between the structure of the superannuation market, its conduct and performance. Australian studies, gaps in the literature, the main research questions, and the conceptual model for the study were subsequently presented. The conceptual model is the basis for further investigations toward the performance of Australian superannuation funds from a relative economic efficiency perspective in Chapter 5 and 6, and the development of the independent exploratory variables in Chapter 7 and the respective results in Chapter 8.

Chapter 5
RESEARCH METHOD – THE FIRST PHASE

5.1 Introduction

This study was conducted in two phases comprising different methodologies. The first phase estimated efficiency scores of Australian superannuation funds using DEA. The second phase explored the relationship between efficiency scores and explanatory factors. The two-phase approaches have been commonly used in DEA studies (Coelli et al. 2006; Fried, Lovell & Vanden Eekaut 1993). This chapter presents the research method for the first phase. Chapter 6 discusses the results of the first phase. Chapters 7 and 8 present the research method for the second phase and discuss the results respectively.

This chapter unfolds as follows. Section 5.2 discusses the process of sample selection and sample size. Section 5.3 provides an overview of how inputs and outputs were selected in past DEA studies on investment, mutual and pension funds. Section 5.4 discusses input and output specifications. Section 5.5 presents the DEA mathematical programming problem used to estimate efficiency scores. Section 5.6 summarises the chapter.

5.2 Sample and data collection – the first phase

Superannuation fund data were retrieved from the APRA database and cross-checked with fund financial statements. DEA does not take into account measurement errors and other sources of statistical noise. All deviations from the efficiency frontier are assumed to be the result of technical inefficiency (Coelli et al. 2006; Fare, Grosskopf & Lovell 1994; Schmidt 1985).Therefore, measurement errors which exist may result in lower efficiency scores and more dispersion in the data (Bauer et al. 1995). Random checks are expected to mitigate measurement errors and enhance the level of accuracy for the data.

APRA prepared the data from the superannuation information submitted by fund trustees under the Financial Sector (Collection of Data) Act 2001 (APRA 2013c). The total number of funds selected for the DEA efficiency score estimates is 183. The selected funds had been active (see Table 5.1) and reported to APRA for a period of seven years, from 2005 to 2012. Active funds reported non-zero assets, contributions and expenses consistently over the seven year period of 2005–12. The number of selected funds is lower than the number of funds which were reported to APRA as at 30 June 2012 due to missing data across the years, and different reporting dates. The period 2005–12 is of significant interest as it covers the GFC and includes four years of positive and three years of negative investment returns. Due to mergers and consolidations, only funds which still existed as at 30 June 2012 were accounted toward the sample funds. The sample of 183 funds makes up about 79% of active funds that reported to APRA as at 30 June 2012. The 183 funds had approximately 27 million members, which is equivalent to about 93% of the total members in active funds. The total average net assets of the sample funds were $668 million, approximately 85% of the total average net assets of active funds (APRA 2013c).

Table 5.1. Number of active APRA-regulated funds as at 30 June, period 2005–12

Year	**2005–6**	**2006–7**	**2007–8**	**2008–9**	**2009–10**	**2010–11**	**2011–12**
Number of funds	423	382	351	322	291	254	231
Number of sample funds	183	183	183	183	183	183	183

Source: APRA (2013b)

Compared to global research on mutual funds, mostly done in the USA, and using the DEA model, this sample size is relatively small. Nevertheless, Australia is a smaller market and the sample is sufficiently robust. Several other studies on Australian managed funds (Galagedera & Silvapulle 2002) or pension systems (Njie 2006) using

DEA also had significantly smaller sample sizes (see Table 5.2 for examples of sample sizes).

5.3 Inputs and outputs used in DEA studies on mutual and pension funds

A most important task for researchers who use DEA to assess performance of a DMU is to select relevant input and output variables for the DEA mathematical programming functions (Morita & Avkiran 2009). Specifying relevant input and output variables for DEA analysis is subject to on-going discussions in the literature (Fried, Lovell & Schmidt 2008). In many situations, the performance model of a particular DMU is not well defined, thus, it is not simple to select the appropriate inputs and outputs. It appears that the researchers tend to concentrate on important issues where data are available (Morita & Avkiran 2009; Stigler 1976). With regards to mutual funds in general and pension funds in particular, the common approach to select inputs and outputs is to focus on expenses and investment returns respectively.

Table 5.2 presents a bibliography of selected research papers which used DEA to evaluate performance of investment funds in different countries and markets from 1997 to 2011 with highlights on input, output specifications, and sample size. The application of DEA to measure efficiency performance of investment funds was developed quite recently, in the late 1990s, despite the fact that the DEA concept was proposed by Farrell in the late 1950s and became popular after 1978 (re-visit Chapter 3 for a brief history of DEA). As per Table 5.2, mutual funds were featured strongly in these studies. This is not surprising given that data on mutual funds are more readily available, and the level of transparency and disclosure is more substantial than for pension funds (Klapper, Sulla & Vittas 2004). The US market was dominant in these studies. To the best knowledge of this thesis's author, studies on Australian superannuation funds were not found. Most of the studies used panel or pooled data and the sample size was reasonably large. The most commonly used input is the expense-related variable and the most commonly used output is the investment return-related variable.

Table 5.2. Inputs, outputs and sample sizes used in DEA to evaluate mutual funds, pension funds and other types of investment funds for selected markets, 1997–2011

Year	Authors	Sector, country and period	Sample size	Inputs	Outputs
1997	Murthi, Choi & Desai	Mutual funds, the US, 1993	731	- Expense ratio (operating costs including administration, advisory fees) - Turnover (monthly purchases or sales) - Loads (sales charges or redemption fees when investors buy or sell shares)	Gross return
1998	Premachandra, Powell & Shi	Mutual funds, 1975–92	16	- Amounts invested in risky vehicles - Amounts invested in risk-free assets	- Excess return
1999	Morey & Morey	Mutual funds, the US, 1985–95	26	- Multiple dimensions of risk	- Multiple dimensions of return
2001	Choi & Murthi	Mutual funds, the US, 1990–1993	731	- Costs - Standard deviation of return (proxy for risk) - Management skills	- Return
2001	Tarim & Karan	Investment portfolio, Turkey, 1998	22	Adaption of Murthi, Choi and Desai’s (1997) approach: - Expense ratio - Turnover ratio - Standard deviation of return	- Investment return (monthly change in market value)
2002	Anderson et al.	Real estate investment trust, the US, 1992–96	584	Total expenses (decomposed into interest expense, operating expense, general and administrative expense, and management fees)	Total assets (mortgage assets, equity assets, and other assets)
2003	Basso & Funari	Ethical mutual funds, Italy, 2001	50	- Subscription costs - Redemption costs - Risk measure (standard deviation of return) - Risk measure (beta coefficient)	- Excess return - Ethical indicator

Table continued

2004	Anderson et al.	Real estate mutual funds, the US, 1997–2001	348	- Total expense ratios (broken down marketing, distribution fees and 'other' expenses, which include general and administrative expenses, operating expenses, and advisory fees) - Standard deviation of the returns	Annual returns
2005	Barrientos & Boussofiane	Pension funds, Chile, 1982–99	61	- Marketing and sales costs - Office personnel and executive pay - Administration and computing costs	- Total revenue - Number of contributors (members)
2005	Daraio & Simar	Mutual funds, the US, 2001–02	3166	- Expense ratio - Loads - Turnover ratio - Market risk	- Return
2005	Gregoriou, Sedzro & Zhu	Hedge funds, the US, 1997–2001	168	- Lower mean monthly semi-skewness - Lower mean monthly semi-variance - Mean monthly lower return	- Upper mean monthly semi-skewness - Upper mean monthly semi-variance - Mean monthly upper return
2006	Barros & Garcia	Pension funds, Portugal, 1994–2003	120	- Number of full time equivalent workers, - Fixed assets - Contributions	- Number of funds - Value of funds - Pensions paid - Proxy for risk-pooling and risk-bearing functions
2006	Eling	Hedge funds, the US, 1996–2005	30	- Risk (standard deviation of return)	- Return
2006	Galagedera & Silvapulle	Mutual funds, Australia, 1995–99	257	- Standard deviation - Sales charges - Entry fees - Operating expenses (management expense ratio) - Minimum initial investment	- Short term gross performance - Medium term gross performance - Long term gross performance

Table continued

2006	Gregoriou	Mutual funds	75	- Monthly standard deviation - Monthly downside deviation (monthly loss) - Maximum drawdown (largest percentage drop from peak to trough)	- Average monthly return - Monthly percentage of profitable return
2006	Njie	Pension funds, Australia, 2000–05	n/a	- Sales charges - Initial investments	- Investment income - Total operating performance
2008	Lopes et al.	Share portfolios, Brazil, 2001–05	132	- Price to earnings ratio - Beta - Return volatility	- Earnings per share -12, 36, and 60 month return
2008a	Lozano & Gutierrez	Mutual funds, Spain, 2002–05	108	- Mean variance - Mean variance skewness	Monthly return
2008b	Lozano & Gutierrez	Fixed income mutual funds, Spain, 2002–2005	132	- Risk	- Return
2009	Soongswang & Sanohdontree	Equity mutual funds, Thailand, 2002–07	690	- Weighted fees and expenses - Systematic risk and total risk	- Returns (different time horizons) - Diversification - Manager
2011	Kerstens, Mounir & Van de Woestyne	Mutual funds, US and European market, 2004–09	1068	- Net expense ratio - Fund loads	- Daily (minimum, maximum and expected) returns
2011	Watson,Wickra-manayke & Premachandra	Mutual funds, 1990–2005	180	- Total risk - Market risk - Manager ability	- Monthly rate of return

As per Table 5.2, the key inputs used in mutual funds and other types of investment funds were operating and administration expenses, risk or volatility of return. Fees and costs as inputs were featured in more than half of the studies. Controlling fees and costs were seen as critical in evaluating fund managers. Choi and Murthi (2001) argued that even when returns are calculated after all fees have been deducted, fee analysis can still provide information about the fund manager's operation style and performance. There is a difference between the performance of a fund which achieves a net return of 5% and a gross return of 10% and a fund which has the same net return of 5% but a gross return of 20%. It is harder for the latter fund to maintain the same net return for the years when general markets do not generate high investment returns or generate negative returns.

Referring to Table 5.2, the key outputs used were investment return and total assets. Thus, the main indicators of efficiency performance measurement in mutual funds and investment funds are finance-related (expenses and revenues). With pension funds, the key inputs were also various finance-related metrics such as fund expenses (Barrientos & Boussofiane 2005; Njie 2006), investment returns and or revenues (Barrientos & Boussofiane 2005; Njie 2006), and total assets (Barros & Garcia 2006). Efficiency performance of these types of funds has been measured by minimising expenses, risk or volatility of return (inputs), and maximising investment returns (outputs).

In Australia, the managed fund industry comprises superannuation funds, life insurance offices, public unit trusts, cash management trusts, friendly societies, and common funds. Managed investment schemes refer to all major investment products for different investment purposes (Moodie & Ramsay 2003). From a legal perspective, there are two distinguishable systems: pension plans and other managed investment schemes. This is because the final benefits produced by the two systems are vastly different. An investment scheme aims to generate acceptable returns for investors. The purpose of a pension plan is to provide adequate retirement incomes for members. However, from an investment management perspective, regardless of fund characteristics, all these different fund types invest investors or members' assets with the same underlying objective of generating the optimal risk-adjusted returns. These funds may operate and compete for the same investment products in the same financial markets and be managed by the same fund managers (Davis & Steil 2001; Moodie & Ramsay 2003).

DEA can evaluate the performance of an investment fund by incorporating inputs and outputs of dissimilar measurement units *simultaneously* (Murthi, Choi & Desai 1997). Due to this flexibility, other non-financial performance indicators related to further operational characteristics of the funds can also be used as inputs and outputs. As per Table 5.2, these variables included qualitative factors such as management skills, number of employees as inputs, or the number of contributors or members as outputs. Nevertheless, these types of non-finance-related inputs and outputs were overshadowed by the use of finance-related metrics, traditionally used for the performance measurement of an investment fund.

5.4 Input and output specifications

There is no formal selection process agreed among researchers as to how input and output variables should be chosen in a DEA model. Popular variable selection methods that have been adopted in the past include expert judgement and accepted practice (Callen 1991; Charnes, Cooper & Rhodes 1981; Cholos 1997; Morita & Avkiran 2009). Another approach used is principal components analysis or step-wise approach (Adler & Golany 2001; Norman & Stoker 1991). The selection of variables can also be based on a particular theory, such as production versus intermediation approach in measuring bank efficiency performance (Morita & Avkiran 2009).

Principal component analysis is a process for variable reduction (Eling 2006). Principal component analysis uses linear combinations of variables to explain the variance structure of a matrix of data. This procedure reduces data to a few principal components which explain the amount of the variance in the data. If most of the sample variance can be explained by a few principal variables, these principal variables can replace original variables (presented in a much larger number) without a major loss of information. A smaller number of variables will avoid the generation of extreme results in DEA analysis (Adler & Golany 2001; Eling 2006).

The step-wise approach is a linear incremental search method which selects individual variables one at a time. Input variables may be removed at subsequent iterations. The step-wise approach is aimed at handling redundancy between variables. A variable may be selected initially due to high relevance, but is later found to be inferior to other variables, which only arises at a subsequent iteration. The initially selected input variable is now redundant, and can be removed in favour of the new variables (Kittelsen 1993; Norman & Stoker 1991).

The appropriate number of inputs and outputs are often discussed in the literature. While DEA can handle multiple inputs and outputs, it is observed that a very large number of inputs or outputs relative to the number of DMUs may clutter the analysis or result in a large number of efficient DMUs. Therefore, original inputs are occasionally aggregated in order to reach an appropriate number of adjusted inputs (Adler & Golany 2001; Gregoriou, Sedzro & Zhu 2005). Conversely, a very small number of inputs or outputs can result in a very low number of efficient DMUs. Morita and Avkiran (2009) proposed an approach to achieve the best combination in the number of inputs and outputs based on discriminant analysis, which is to select the relevant inputs and outputs to distinguish the best performing DMUs from the worst performing DMUs. Bowlin (1998) suggested that there should be a minimum of three inputs and three output variables. Bowlin (1998) did not discuss the maximum inputs and outputs allowed, however Eling (2006) exerted that there should be a limit as to the number of inputs and outputs used.

For this research, input and output variable selections were based on expert judgement and accepted practice, which is the most popular method. Inputs and outputs are performance measures, and thus, if correctly selected, can provide useful insights to managers and/or regulators. Within the context of the productivity concept and DEA model, efficiency is enhanced by reducing inputs while maintaining the current level of outputs, or increasing outputs while upholding the current level of inputs (Cooper, Seiford & Tone 2007). Current issues identified in the literature and analysis of operating characteristics determined how input and output were selected. Final input and output selection were based on data provided by APRA and were available in superannuation fund annual reports. A range between three and five input and output variables, which fall into the middle range of inputs and outputs often used for DEA estimates, were selected for this research. With a sample size of 183, the number of inputs and outputs is deemed appropriate following the accepted practice (re-visit Table 5.2). The inputs and outputs cover major financial and operating performance indicators and the rationale for the selection is provided below.

5.4.1 Input variable selection

Expenses (fees and costs) of investment and mutual funds including pension funds have been a topical issue. For instance, Khorana, Servaes and Tufano (2008) investigated the variations in mutual fund fee charges across eighteen countries. Bauer, Cremers and Frehen (2010) discussed the cost advantages of large scale pension funds in comparison with the liquidity advantages of small scale pension funds. Coleman, Esho and Wong (2006) discussed the relationship between risk, return and expenses, together with the effect of agency costs on for-profit superannuation fund performance. Nguyen, Tan and Cam (2012) explored the link between governance practices, fees and performance of corporate superannuation funds. Liu and Arnold (2010) contended that Australian superannuation funds incur many layers of fees and costs, some which are directly attributed to the internal management and administration activities, others to third party service providers.

Fees and costs are within the control of fund trustees. It is possible to implement cost reductions through increased scale (fund size), better fee negotiation, more direct investing, or less active management to enhance the benefits for members and beneficiaries (Sy & Liu 2010). This is in contrast with volatility of investment return which could relate to the systematic risk regardless of the skill of the fund trustees

(Gitman, Juchau & Flanagan 2011; Malhotra & McLeod 1997). Members could use fees as an important benchmark to select fund trustees (Sy & Liu 2010).

Table 5.4 shows that during a year of negative share market returns such as 2011–12, investment returns were correspondingly negative and expenses were very significant as compared to earnings (230% of earnings before tax on a total superannuation fund basis). By contrast, as shown in Table 5.3, in a year of positive share market return, due to positive investment returns, expenses were insignificant relative to earnings (10.2% of earning before tax on a total fund basis). Outsourcing activities and related party transactions which are not at an arm's length basis are arguably common practice in many retail superannuation funds (Dunn 2011; Liu & Arnold 2010). This supports the data presented in Tables 5.3 and 5.4 that retail funds incurred the largest operating expenses and thus, total expenses in both 2010–11 and 2011–12. According to APRA classification, investment expenses include investment management fees, custodian fees, property maintenance costs, asset consultant fees and miscellaneous investment expenses. Operating expenses include interest expenses, management fees, administration fees, actuary fees, director/trustee fees and expenses, audit fees and other operating expenses (APRA 2014b).

Table 5.3. Expenses as a percentage of earnings before tax, APRA-regulated funds, 2010–11

Category	Corporate	Industry	Public sector	Retail	Total
Net assets ($m)	57,134	244,762	199,707	368,322	869,926
Earnings before tax ($m)	4,362	20,681	16,193	21,658	62,894
Investment expenses ($m)	159	887	466	388	1,900
Operating expenses ($m)	185	1,164	442	2,732	4,523
Total expenses ($m)	344	2,051	908	3,120	6,423
Investment expenses (%)	*3.7*	*4.3*	*2.9*	*1.6*	*3.0*
Operating expenses (%)	*4.2*	*5.6*	*2.7*	*12.6*	*7.2*
Total expenses (%)	*7.9*	*9.9*	*5.6*	*14.2*	*10.2*

Source: APRA (2012)

Table 5.4. Expenses as a percentage of earnings before tax, APRA-regulated funds, 2011–12

Category	Corporate	Industry	Public sector	Retail	Total
Net assets ($m)	54,357	260,640	211,318	370,318	896,633
Earnings before tax ($m)	448	1,290	4,096	–2,982	2,852
Investment expenses ($m)	195	877	480	372	1,924
Operating expenses ($m)	160	1,202	549	2,733	4,644
Total expenses ($m)	355	2,079	1,029	3,105	6,568
Investment expenses (%)	*43.5*	*68.0*	*11.7*	*n/a*	*67.5*
Operating expenses (%)	*35.7*	*93.2*	*13.4*	*n/a*	*162.8*
Total expenses (%)	*79.2*	*161.1*	*25.1*	*n/a*	*230.3*

Source: APRA (2013a)

Given that expenses are important performance indicators, the first set of selected inputs is therefore *total expenses*, categorised into large expenses including *investment expenses*, *operating expenses*, *management*, *administration* and *director fees*. Representing expenses in sub-categories is necessary to assess the efficiency level in different areas of expenses.

Volatility or risk of investment return is one of the commonly used performance indicators of any investment funds including pension funds. Volatility of return is of significant concern to pension fund investors or members especially during years of poor investment returns (Antolín & Stewart 2009; O'Loughlin, Humpel & Kendig 2010). It is therefore often used as a benchmark for fund performance and to evaluate fund managers and trustees’ skills and performance. Well-known return measurement models such as Jensen’s alpha, Sharpe’s index and Treynor’s ratio all include the measurement of volatility of return (Jensen 1968; Sharpe 1966; Treynor 1965). The literature has documented a myriad of research studies on mutual and pension fund performance using risk-adjusted return approaches. Research studies distinguish between systematic and non-systematic risk and emphasise diversification to reduce volatility (Gitman, Juchau & Flanagan 2011). In the aftermath of the GFC, volatility of return has been a major issue in the investment return performance of Australian superannuation funds. That is because the majority of superannuation assets were allocated to highly volatile asset classes such as shares. There have been recommendations to balance the asset allocations toward more conservative assets, or to improve governance and risk management strategies (Antolín & Stewart 2009; Newell, Peng & De Francesco 2011).

In that context, the second input selected in this study is volatility or *SD of investment return* across the period of study, from 2005 to 2012. Annual returns for seven years were chosen due to the lack of monthly and quarterly investment return data. SD of return is, by nature, an output of investment activities, not an input. Researchers using DEA to evaluate efficiency of investment funds tend to classify the SD of return as an undesirable output and therefore include this variable in the input set (Anderson et al. 2004; Basso & Funari 2001; Daraio & Simar 2006; Eling 2006; Lopes et al. 2008). In this study, the classification of SD as an input has several benefits. Firstly, to operate efficiently, superannuation funds should attempt to control the SD of return. Therefore, the SD of return suits the input profile better than it does the output profile. Further, the DEA software selected to automate the DEA efficiency score estimates allows treating this undesirable output as an input. The DEA software can also calculate input efficiency targets for individual funds while holding outputs constant. Thus, by classifying SD of return as an input, SD efficiency targets (possible reductions of SD) for individual funds could be obtained. From a fund management perspective, controlling volatility of investment return is an important issue (Cooper et al. 2010a; OECD 2013b). Information regarding possible reductions of SD of return for individual funds could be useful for superannuation fund managers.

5.4.2 Output variable selection

The size of fund assets and its relation to investment returns has often been discussed in the literature. On the one hand, it is contended that when a fund gets larger, economies of scale increase, therefore, operating expenses may be reduced and enhance investment returns (Sy & Liu 2010). On the other hand, there may be a trade-off when a fund becomes too large as it may lose some advantages in liquidity and flexibility in investing in small companies. The fund may also become disadvantaged due to the complexity in the organisational structure. These factors have the potential to negatively affect investment returns (Bauer, Cremers & Frehen 2010; Chen et al. 2004). Assets relative to expenses are therefore one of the most common indicators of performance for mutual funds. Researchers often specify assets (Anderson et al. 2002; Davis & Steil 2001) or investor contributions (Barrientos & Boussofiane 2005; Barros & Garcia 2006) as output variables in DEA applications on pension funds. Given that asset size is an important factor in evaluating fund efficiency performance, the first output selected for the DEA estimates is *average net assets*, calculated by the average of beginning and ending net assets for the financial year as reported in the fund balance sheet.

The number of contributors, fund investors or members has been used as an output variable for the DEA efficiency score estimates (re-visit Table 5.2). The more members there are in a fund, the higher the potential administration costs (Barros & Garcia 2006). The number of member accounts of APRA-regulated fund during the period of 2005–12 is high, ranging between 28 and 33 million accounts. The number of member accounts is higher than the members themselves (APRA 2013a) and thus, it is very likely that a member may have several accounts. The number of member accounts relative to operating expenses is another indicator of performance. To be more efficient, fund managers should maximise member numbers while holding operating expenses constant or minimise operating expenses given the same member accounts. On that basis, the second output variable is the *number of member accounts*.

Investment return is the most commonly used performance indicator of a superannuation fund. Many studies on superannuation fund performance over the last decade have dealt with investment performance, either directly or indirectly (Clark-Murphy & Gerrans 2001; Coleman, Esho & Wong 2006; Cummins 2012; Drew & Stanford 2001; Ellis, Tobin & Tracey 2008; Sy & Liu 2009). As indicated in Table 5.5, during the ten-year period from 2003–12 which covers the GFC, APRA-regulated funds delivered low average returns (4.4%) despite high volatility (9.4%). The issue of investment return is more pressing during periods of negative returns (Main 2012).

Table 5.5. Average investment return and return volatility for APRA-regulated superannuation funds, 2003–12

Entities	Average Return %	Volatility %
Corporate	4.8	9.4
Industry	5.1	9.5
Public sector	5.5	9.7
Retail	3.4	9.3
All entities	4.4	9.4

Source: APRA (2013a)

The third variable selected for the output set is *investment return*, represented by annual and multiple period returns. Annual return was required for the DEA efficiency score estimates for individual years. Multiple-period returns were required for the DEA efficiency score estimates for the whole period of 2005–12 when the SD of investment return during an extended period of time (seven years) was taken into account. Return was calculated using earnings before tax as this research focuses on fund efficiency and management performance rather than ultimate benefits for members. Using after-tax earnings data where the tax rates might differ across funds could potentially render data poorly comparable and distort the information on management performance. Multiple-period returns were calculated using geometric averages. The seven-year period return was computed based on the following formula:

$$[(1+ROR_{t-6})\times(1+ROR_{t-5})\times(1+ROR_{t-4})\times(1+ROR_{t-3})\times(1+ROR_{t-2})\times(1+ROR_{t-1})\times(1+ROR_{t})]^{1/7}-1$$

The DEA model does not recognise negative variables. To deal with the issue of negative returns, an additional step often referred to as *translation invariance* is necessary. The transformation was done by adding an arbitrarily selected positive constant to the values of the variable set which contain negative data so that all negative data were transformed to positive data (Ali & Seiford 1990; Fried, Lovell &

Schmidt 2008; Lovell & Pastor 1995). This approach was used in the study to transform negative numbers into positive numbers, for the years when financial markets performed poorly and investment returns were negative. A new set of positive values was obtained by using an arbitrarily selected translation constant π_r, as presented in Equation 5.1.

Equation 5.1. Translated variable

$$\hat{y_{rj}} = y_{rj} + \pi_r$$

Where: $\hat{y_{rj}}$ original output data

π_r translation constant

$\hat{y_{rj}}$ translated output data

Sources: Coelli et al. (2006)

In summary, input and output variables selected for the study are presented in Table 5.6 below. The DEA efficiency score estimates are carried out in two stages, the first stage covers individual years, and the second stage covers the period of 2005–12. The second stage has an additional input variable, that is the SD of return.

Table 5.6. Input and output variables

Variable	Individual years, 2005–12	Period, 2005–12
Inputs	- Investment expenses	- Average investment expenses
	- Operating expenses	- Average operating expenses
	- Management, administration and director fees	- Average management, administration and director fees
	- Total expenses	- Average total expenses
		- Volatility/SD of investment return
Outputs	- Average net assets	- Average net assets
	- Member account number	- Average member account number
	- Investment return before tax	- Multiple period investment return

5.5 The DEA programming model

The input-oriented approach was used in this study to obtain efficiency scores for Australian superannuation funds. The input-oriented model was selected as expenses are areas over which managers have most control in comparison to investment returns, assets under management, and member accounts. The VRS model is necessary due to the application of the translation invariance. The VRS frontier remains the same when the original variables are replaced by the translated variables, which is not the case with the CRS model (Cook & Zhu 2008). The VRS model is also appropriate due to the large variations in fund sizes among the sample funds. Under the VRS model, funds are compared against those of a similar size (Coelli et al. 2006). Thus, the bias caused by very large funds or very small funds is controlled. As efficiency scores under CRS model are not applicable in situations with negative, translated input and output variables, scale efficiency and return to scale regions were not estimated in this study. The estimation of scale efficiency and return to scale regions requires that efficiency scores using the CRS model be calculated (Coelli et al. 2006).

Efficiency scores with slack calculations and efficiency targets were computed using the following programming problems:

Equation 5.2. DEA efficiency scores

$$\theta^* = \min \theta$$

subject to:

$$\sum_{j=1}^{n} \lambda_j x_{ij} \leq \theta x_{io} \qquad i = 1,2,\ldots,m$$

$$\sum_{j=1}^{n} \lambda_j y_{rj} \geq y_{ro} \qquad r = 1,2,\ldots,s$$

$$\sum_{j=1}^{n} \lambda_j = 1$$

$$\lambda_j \geq 0 \quad j = 1,2,\ldots,n$$

Sources: Coelli et al. (2006); Cook and Zhu (2008)

Equation 5.3. Slack calculations

$$\max \sum_{i=1}^{m} s_i^- + \sum_{i=1}^{r} s_r^+$$

subject to:

$$s_i^- = \theta^* x_{io} - \sum_{j=1}^{n} \lambda_j x_{ij} \qquad i = 1,2,\dots,m$$

$$s_r^+ = \sum_{j=1}^{n} \lambda_j y_{rj} - y_{ro} \qquad r = 1,2,\dots,s$$

$$\lambda_j \geq 0 \qquad j = 1,2,\dots,n$$

Sources: Coelli et al. (2006); Cook and Zhu (2008)

Equation 5.4. Efficiency targets

$$\hat{\boldsymbol{x}}_{io} = \boldsymbol{\theta}^* \boldsymbol{x}_{io} - \boldsymbol{s}_i^{*-} \quad i = 1,2,\dots,m$$

Sources: Coelli et al. (2006); Cook and Zhu (2008)

Where:

θ	*efficiency score*
ε	*optimisation involving slacks*
s_i^-	*input slack*
s_r^+	*output slack*
λ	*unknown input and output weight*
x	*input, denoted as* x_{ij}
y	*output, denoted as* y_{rj}
n	*total funds under evaluation*
m	*total inputs*
s	*total outputs*
j	*number of fund under evaluation, from 1 to n*
i	*number of input, from 1 to m*
r	*number of output, from 1 to s*

Under the VRS model, the convexity constraint $\sum_{j=1}^{n} \lambda_j = 1$ (Equation 5.2) added to the original CRS problem ensures that an inefficient fund is only compared against funds of the same scope. The estimated point for the inefficient firm on the DEA frontier is derived from a convex combination of all funds in the data set. This feature of the VRS model is in contrast with the CRS model where a fund may be compared against funds significantly larger (smaller) and thus, the sum of the λ weights can have a value of less than (greater than) 1 (Coelli et al. 2006).

With regards to the DEA efficiency score estimation process, efficiency scores with slack treatments and efficiency targets were obtained through two stages. In the first stage, efficiency scores were calculated with the assumption that maximum reduction of inputs should be achieved. The presence of slacks and of weakly efficient funds gave rise to multiple optimal solutions. In the second stage, the presence of slacks was corrected and efficiency scores were adjusted. Efficiency targets (input oriented) were also estimated in this stage, and indicated to what extent inefficient funds need to reduce all inputs so as to be on the efficiency frontier.

Efficiency scores were equal to or less than 1 but greater than zero. Efficient funds, where minimal inputs were used for a given level of outputs, were scored 1 and together formed the efficiency frontier. Inefficient funds (deviations from the efficiency frontier) were scored less than 1. The further the inefficient fund was away from the frontier, the smaller the score.

Efficiency scores were estimated twice for two sets of input and output variables as identified in Table 5.6. The first DEA estimation provided efficiency scores for individual years across all funds to identify trends over the period 2005–12. The second DEA estimation provided efficiency scores using average values of the seven year period, where the volatility of investment return was taken into account. For individual years, the linear programming problem was repeated for 183 funds by seven variables by seven years. For the whole period, the linear programming problem was repeated for 183 funds by eight variables. Solving the linear programming problems was facilitated with *DEAFrontier*.

There are two other methods in this stage of DEA analysis often used by DEA researchers: window analysis and bootstrapping technique. As the time period for this study only spans seven years, it is not necessary to apply window analysis which could be much more time consuming. According to Asmild et al. (2004) and Cooper, Seiford and Tone (2007), window analysis is often applied when the time length of the study is much longer, with a much smaller number of DMUs, and a higher number of inputs and outputs, where each DMU is regarded as a different DMU in each of the reporting dates. The bootstrapping DEA method which is often used to mitigate the deterministic effect of the original DEA model is not necessary in this study due to the application of a two-stage DEA analysis approach, where the second stage is regression-based (Fried et al. 2002; Moradi-Motlagh and Saleh 2014).

5.6 Summary

This chapter presented the research method for the first phase of this study, efficiency scores of Australian superannuation funds. The chapter provided an overview of the types of inputs and outputs commonly used in DEA analysis. The chapter subsequently discussed the rationale for the input and output variable selections, including the type and the number of inputs and outputs. The chapter presented the DEA programming problem and discussed stages in estimating efficiency scores; slack calculations for weakly efficient funds, efficiency scores adjustments incorporating slacks, and efficiency targets with possible reductions of inputs. The following chapter, Chapter 6, discusses the results of the first phase.

Chapter 6
RESULTS AND DISCUSSION – THE FIRST PHASE

6.1 Introduction

This chapter presents the results of the first phase, efficiency scores of Australian superannuation funds. Efficiency scores were estimated from various perspectives using different efficiency frontiers. The first set of efficiency frontiers was estimated using data pertaining to all the funds in the sample. The second set of efficiency frontiers was estimated using data pertaining to different fund types, namely, corporate, industry, public sector and retail funds.

The chapter is organised as follows. Section 6.2 presents the descriptive statistics of the sample funds being studied. Section 6.3 analyses the estimated efficiency scores based on the efficiency frontiers constructed using all fund data, where funds were benchmarked against all those in the sample. Section 6.4 analyses the estimated efficiency scores based on the efficiency frontiers constructed using fund type data, where funds were only benchmarked against those of the same fund type. Section 6.5 concludes the chapter.

6.2 Descriptive statistics

The descriptive statistics of the 183 sample funds are presented in Table 6.1. From 2005 to 2012, total net assets increased by 79%, and member accounts by 19%. The number of member accounts was high, ranging from 24 million to 27 million accounts. While the average fund size ranges between \$2 – 3.6 billion over the period, the smallest fund size ranged between \$1.3 – 1.6 million, as compared to the largest fund being \$32.5 – 51.6 billion. This indicates the large variations in fund asset values in the sample. Corporate funds accounted for 21.3% and industry funds accounted for 27.9% of the total funds in the sample. Retail funds had the highest proportion at 42.6%. Public sector funds had the smallest proportion at 8.2%. Public offers existed in 127 funds in the sample (69.4%). The benefit structure of the majority of sample funds was accumulation (68.3%), followed by hybrid (30.1%), with accumulation and defined benefit combined. Pure defined benefit structure only existed in three funds (1.6%). The benefit structure in Australian superannuation funds reflects the long-standing global trend to shift the risk of retirement income benefits from superannuation plan sponsors (defined benefit) to members and beneficiaries (defined contribution) (OECD 2013a).

Table 6.1. Descriptive statistics of the sample, the first phase, 2005–12

Measure	**2005–6**	**2006–7**	**2007–8**	**2008–9**	**2009–10**	**2010–11**	**2011–12**
Total net assets ($mil)	373,691.7	480,813.5	529,053.8	502,717.0	518,205.1	604,908.0	667,731.2
Mean ($mil)	2,042.0	2,627.4	2,891.0	2,747.1	2,831.7	3,305.5	3,648.8
Min ($mil)	1.3	1.4	1.3	1.3	1.5	1.6	1.6
Max ($mil)	32,535.3	40,801.5	43,798.1	40,661.7	40,958.3	47,312.1	51,626.3
Member accounts	23,903,779	23,903,779	25,759,487	26,312,490	26,799,538	26,409,527	26,851,523
Investment Return*(%)	12.37	13.59	–8.90	–12.78	7.85	6.89	–0.44
Total funds	183	100%		Public offer		127	
Corporate	39	21.3%		Non-public offer		56	
Industry	51	27.9%		Defined contribution		125	
Public sector	15	8.2%		Hybrid		55	
Retail – all	78	42.6%		Defined benefit		3	
Retail – normal	65	35.5%					
Retail – ERFs**	13	7.1%					

* Return over average net assets, unweighted to asset size of individual funds **Eligible rollover funds

6.3 Efficiency scores – all funds

Efficiency scores of individual superannuation funds in the sample were estimated under the VRS model where funds were benchmarked against funds of a similar size to avoid large fund bias. Efficiency scores were estimated twice for two sets of input and output variables. The first DEA estimation provided efficiency scores for individual years across all funds over the period 2005–12. The second DEA estimation provided efficiency scores using average values of the seven year period, where the SD of return was included as an input. Data on efficiency scores for individual funds are provided in Appendices 6.1 to 6.8. This section presents aggregate results.

6.3.1 Efficiency scores, individual years

Table 6.2 presents the efficiency scores under the VRS model when funds were benchmarked and scored against funds of a similar size. The results are self-explanatory. The number of efficient funds was highest in 2006–7 and 2009–10 with 32 funds (17.5%) being efficient. The number of efficient funds was lowest in 2007–8 and 2008–9, with 24 funds (13.1%) being efficient. Conversely, the number of inefficient funds was highest in the years 2007–8 and 2008–9 at 87% (159 funds), when the average investment returns of superannuation funds were significantly negative. The results reflect the developments in the financial markets. The two years 2007–8 and 2008–9 were particularly difficult for investors worldwide with the commencement of the subprime mortgage crisis in the USA, followed by the GFC after the collapse of Lehman Brothers (De Haas & Van Horen 2012).

Table 6.2. Efficiency scores for individual years, 2005–12

Measure / Year	05–06	06–07	07–08	08–09	09–10	10–11	11–12	Average
Efficient funds	27	32	24	24	32	30	27	28
Average asset ($million)	4,948	5,766	8,502	9,618	8,564	10,059	11,561	8,431
Inefficient funds	156	151	159	159	151	153	156	155
Average asset ($million)	1,539	1,962	2,044	1,710	1,617	1,981	2,279	1,876
Pearson correlation *r* *	0.3574	0.3298	0.4363	0.4874	0.4258	0.4104	0.5037	0.422
Mean	0.361	0.412	0.317	0.320	0.392	0.409	0.376	0.370
Median	0.247	0.301	0.174	0.180	0.271	0.265	0.248	0.241
SD	0.315	0.327	0.324	0.324	0.324	0.330	0.316	0.323
Min	0.039	0.049	0.028	0.026	0.033	0.022	0.040	0.034
Max	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

* Pearson correlation between efficiency scores and asset sizes, significant at p = 0.0001

The results in Table 6.2 further indicate that the average asset of efficient funds was higher than that of inefficient funds across the seven years. The asset size of efficient funds ranged from $4.9 billion to $11.6 billion whereas that of inefficient funds ranged from $1.5 billion to $2.3 billion. The Pearson correlation between efficiency scores and asset sizes was moderately positive, lowest at 0.398 in 2006–7 and highest at 0.5037 in 2011–12. Thus, there is some positive effect of fund size on efficiency scores. The mean score was 0.370/1, and the minimum score was 0.034/1. These results show that there is a wide variation of efficiency scores among the sample funds.

The following tables present a breakdown of efficiency scores of *inefficient* funds into quintiles. A quintile is a statistical data set that represents 20% of the sample. Quintile analysis has been used in the literature to classify values (Chapman 1998; Elton et al. 1993). In this study, the quintiles represent efficiency score values. The sample was divided into five subsets, from Quintile 1 to Quintile 5, as detailed in Table 6.3. As the asset sizes of the sample funds varied widely, from $1.3 million to $51.6 billion (re-visit Table 6.1), the quintile analysis of efficiency scores provides more detailed information on the performance of the *inefficient* funds when they were classified in their subsets.

Table 6.3. Classification of efficiency scores of inefficient funds into quintiles

Quintile	**Efficiency score**	
	From	**To**
Quintile 1	0.800	0.999
Quintile 2	0.600	0.799
Quintile 3	0.400	0.599
Quintile 4	0.200	0.399
Quintile 5	0.001	0.199

Figures 6.1 and 6.2 provide statistical snapshots of the number of inefficient funds and average net assets per quintile. As per Figure 6.1, the number of inefficient funds was extremely high in the lower quintiles, such as Quintiles 4 and 5. In particular, due to the effect of negative investment returns during the GFC, the number of inefficient funds was much higher in 2007–8 (99 funds) and 2008–9 (100 funds) as compared to the five remaining years. As per Figure 6.2, the average net assets were higher in the quintiles with high efficiency scores and lower in the quintiles with low efficiency scores. The Pearson correlation coefficient *r* between average net assets and efficiency scores was highly positive, at 0.707. Thus, there is a strongly positive effect of fund sizes on efficiency scores, the larger the fund, the higher the efficiency score.

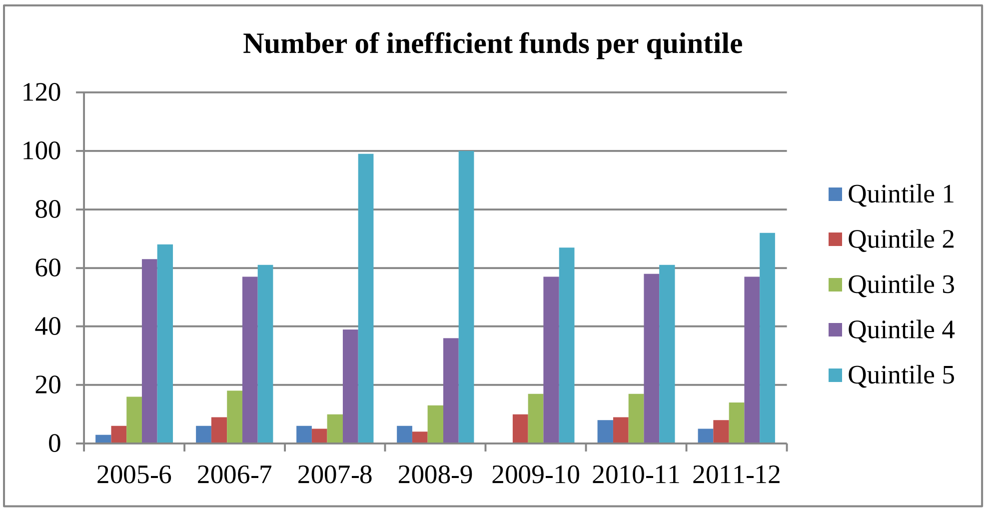


Figure 6.1. Number of inefficient funds per quintile, 2005–12

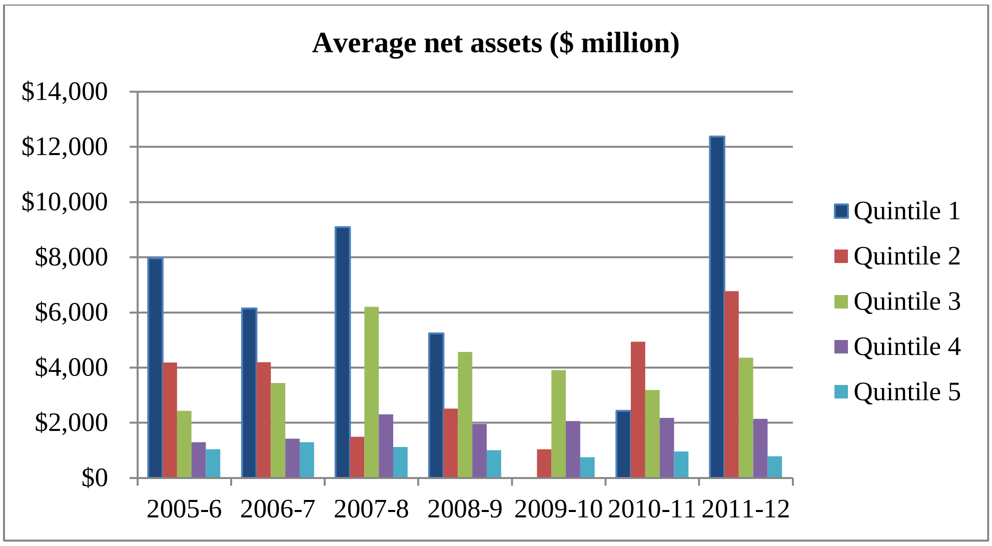


Figure 6.2. Average net assets ($ million) per quintile, 2005–12

It was noted that there was no fund classified into Quintile 1 (0.800 – 0.999) for the year 2009–10 (see Figures 6.1, 6.2 and Table 6.4). Verification indicated that there was no error in data recording and processing. The event probably happened randomly and did not conflict with other data. During the year 2009–10, the number of efficient funds was the highest, at 32 funds. Further, the number of funds which falls into Quintile 2 category in that year is also the highest. Consequently, efficiency scores were pushed either upward to the ‘efficient funds’ category (scored 1) or downward to Quintile 2.

An important indicator generated by DEA is input or output target(s) for inefficient funds. If the inefficient funds achieved these targets, they would be operating on the efficient frontier. While the efficiency targets may appear unrealistic as many funds were operating under certain constraints, the efficiency targets show that there are variations in fund efficiency performance and there is room for improvement of efficiency among the sample funds, which represent nearly 80% of APRA-regulated active funds as at 30 June 2012. For management purposes, the information on input targets is probably best interpreted against individual funds (see Appendices 6.1 to 6.8).

Table 6.4 provides some highlights in input reduction targets for the five quintiles. Quintile 1 (efficiency scores range from 0.800 to 0.999) had a total expense reduction target between 15.4% (0.154) in 2006–7 and 21.9% (0.21.9%) in 2011–12. Quintile 2 (efficiency scores range from 0.600 to 0.799) had a total expense reduction target between 28.9% (0.289) in 2008–9 and 39.9% (0.399) in 2006–7. The number of funds which fall into Quintile 1 and 2 are low. Quintile 3 had a range of total expense reduction target from 51% (0.510) to 56.7% (0.567). Quintile 4 (efficiency scores range from 0.200 to 0.399) held the second highest inefficient funds with a range of total expenses reduction target from 70.9% (0.709) to 73.9% (0.739). Quintile 5 (efficiency scores range from 0.001–0.199) held the highest inefficient funds across the years and had a range of total expenses reduction target between 87.9% (0.879) and 90% (0.900). Quintiles 4 and 5 which are low efficiency score quintiles together made up about 65% – 75% of all the funds across the seven years. Therefore, it is possible to conclude that the majority of the superannuation funds in the dataset were operating on a very low efficiency level as compared to the benchmark defined by efficient funds. The efficiency targets were consequently very challenging for most of the inefficient funds.

Table 6.4. Quintile analysis of inefficient funds, 2005–12

Measure	2005–6	2006–7	2007–8	2008–9	2009–10	2010–11	2011–12
Quintile 1							
Number of funds	3	6	6	6	0	8	5
Average asset ($m)	7,962	6,147	9,094	5,241	n/a	2,431	12,379
Mean	0.904	0.893	0.897	0.906	n/a	0.901	0.847
Min	0.852	0.850	0.812	0.825	n/a	0.803	0.804
Max	0.992	0.941	0.970	0.998	n/a	0.994	0.909
Input target	–0.198	–0.154	–0.207	–0.199	n/a	–0.248	–0.219
Quintile 2							
Number of funds	6	9	5	4	10	9	8
Average asset ($m)	4,184	4,200	1,489	2,508	1,037	4,943	6,777
Mean	0.716	0.650	0.648	0.711	0.741	0.708	0.694
Min	0.668	0.601	0.610	0.631	0.647	0.602	0.619
Max	0.777	0.735	0.700	0.763	0.794	0.800	0.790
Input target	–0.348	–0.399	–0.352	–0.289	–0.327	–0.379	–0.308
Quintile 3							
Number of funds	16	18	10	13	17	17	14
Average asset ($m)	2,437	3,444	6,202	4,570	3,907	3,183	4,364
Mean	0.473	0.460	0.474	0.469	0.467	0.479	0.490
Min	0.404	0.402	0.416	0.401	0.410	0.415	0.412
Max	0.551	0.570	0.546	0.563	0.571	0.594	0.572
Input target	–0.532	–0.558	–0.537	–0.567	–0.562	–0.547	–0.510
Quintile 4							
Number of funds	63	57	39	36	57	58	57
Average asset ($m)	1,291	1,418	2,310	1,958	2,056	2,182	2,144
Mean	0.273	0.293	0.276	0.271	0.291	0.269	0.292
Min	0.201	0.202	0.204	0.203	0.201	0.203	0.203
Max	0.390	0.396	0.390	0.385	0.396	0.393	0.398
Input target	–0.728	–0.709	–0.724	–0.739	–0.724	–0.740	–0.709
Quintile 5							
Number of funds	68	61	99	100	67	61	72
Average asset ($m)	1,041	1,292	1,120	1,005	749	959	780
Mean	0.109	0.117	0.100	0.105	0.117	0.123	0.118
Min	0.039	0.049	0.028	0.026	0.033	0.022	0.040
Max	0.195	0.193	0.200	0.198	0.199	0.198	0.195
Input target	–0.891	–0.883	–0.900	–0.897	–0.887	–0.879	–0.882

6.3.2 Efficiency scores, period 2005–12

This section discusses the efficiency performance of the sample funds based on the DEA estimates using average values of expenses, SD of investment returns, investment returns, net assets and member accounts for the whole period of 2005–12. Multiple-period investment returns were calculated using geometric averages. SD of investment return was included as an additional input to assess the fluctuation of investment returns during the study period. As discussed in Chapters 4 and 5, the volatility of investment returns in the aftermath of the GFC was high and of concern to fund members, regulators, and other relevant market participants.

Table 6.5 shows the results on efficiency scores and input targets for the period 2005–12. The number of efficient funds was 27 (14.8%), falling into the result range for the individual years. Including the SD of return as an additional input did not change the efficiency scores dramatically. The average efficiency score was similarly low, at 0.405 for the whole period. The minimum score of 0.046 was only a little higher than the individual years' average of 0.034 (re-visit Table 6.2). The reduction targets for the total expenses ranged from 16.2% (0.162) for Quintile 1 to 82.9% (0.829) for Quintile 5. Apart from the total expenses reduction targets, this DEA estimation also provided reduction targets for the volatility of investment returns represented by the SD of return. The reduction targets for the volatility of investment returns were 33.7% (0.337) for Quintile 1 and 89.4% (0.894) for Quintile 5. The number of inefficient funds, again, concentrated highly in lower quintiles, such as Quintiles 4 and 5. As would be expected, these quintiles had challenging input reduction targets if they wished to be efficient. Higher reduction targets for volatility of investment returns, as compared to expenses, were present in all quintiles except for Quintile 2. While the input reduction targets may appear unrealistic for the majority of the sample funds, the findings again imply that most of inefficient funds operate at a very low efficiency level as per the benchmark determined by the efficiency frontier. For management purposes, input reduction targets are probably best to be interpreted against individual funds (see Appendices 6.1 to 6.8).

Table 6.5. Average efficiency scores and input targets, period 2005–12

Measure	**All funds**	**Quintile 1**	**Quintile 2**	**Quintile 3**	**Quintile 4**	**Quintile 5**
Efficient funds	27	0	0	0	0	0
Inefficient funds	156	10	4	26	49	67
Mean	0.405	0.903	0.703	0.494	0.278	0.132
Min	0.046	0.808	0.632	0.402	0.204	0.046
Max	1.000	0.983	0.787	0.578	0.386	0.198
Input targets						
SD of return	n/a	–0.337	–0.484	–0.656	–0.801	–0.894
Total expenses	n/a	–0.162	–0.607	–0.502	–0.754	–0.826

Table 6.6 and Figure 6.3 compare the average efficiency scores for individual years and the period. There was little difference in the average efficiency scores between individual years (without the SD of return) and period (with the SD of return). The average efficiency scores were similarly low for the period DEA estimates, in the range of 0.300 and 0.400 (Figure 6.3). The number of efficient funds was between 15–18% and the number of inefficient funds was more than 80% of the sample. The results of low efficiency scores are consistent with those found in mutual funds; see Galagedera and Silvapulle (2002) or Anderson et al. (2002) for a comparison.

Table 6.6. Efficient funds and average efficiency scores, individual years and period

Measure	**2005–6**	**2006–7**	**2007–8**	**2008–9**	**2009–10**	**2010–11**	**2011–12**	**Period**
Efficient funds	27	32	24	24	32	30	27	27
Percent	14.8%	17.5%	13.1%	13.1%	17.5%	16.4%	14.8%	14.8%
Efficiency score	0.361	0.412	0.317	0.320	0.392	0.409	0.376	0.405

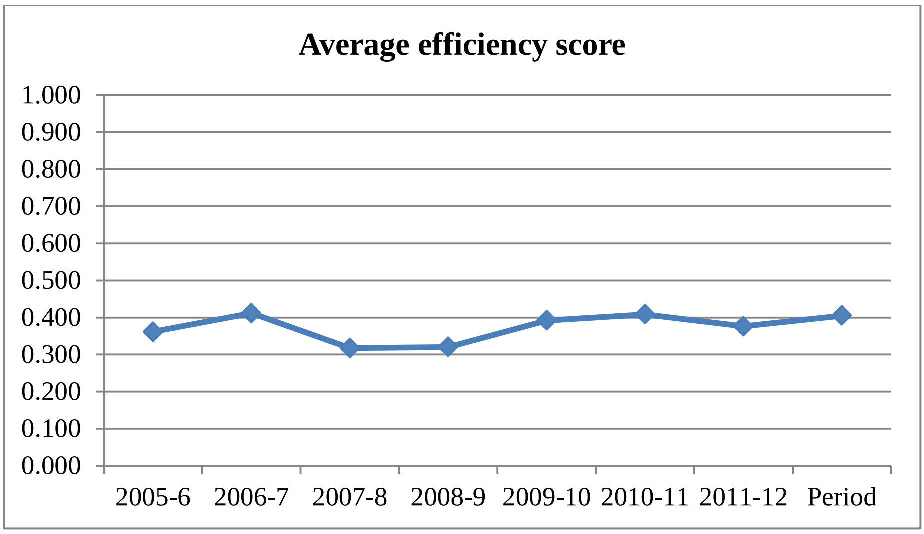


Figure 6.3. Average efficiency scores – individual years and period

6.3.3 Comparison of efficiency scores between fund types, individual years

This section is dedicated to fund type analysis, in particular, how the four fund types, corporate, industry, public sector and retail performed in efficiency using the VRS model. Table 6.7 presents the average efficiency scores and the SD of efficiency scores per fund type for individual years. Public sector funds had the highest average efficiency score on average (0.464), followed by corporate funds (0.409) and retail funds (0.381), while industry funds had the lowest (0.315). Nevertheless, there was no major difference in the average efficiency score between the four fund types. The SD of efficiency scores over the period ranged from 0.021 to 0.088. Retail funds had the lowest volatility (0.021) and corporate funds had the highest volatility (0.088) in efficiency scores. Industry funds and public sector funds had a similar level of volatility in efficiency scores (0.050 and 0.056 respectively).

Table 6.7. Average efficiency scores per fund type, individual years, 2005–12

Year / Fund type	05–06	06–07	07–08	08–09	09–10	10–11	11–12	Average	SD
Corporate	0.441	0.494	0.267	0.319	0.478	0.511	0.354	0.409	0.088
Industry	0.372	0.36	0.249	0.241	0.304	0.312	0.364	0.315	0.050
Public sector	0.379	0.531	0.43	0.446	0.45	0.453	0.557	0.464	0.056
Retail	0.361	0.381	0.365	0.349	0.399	0.412	0.397	0.381	0.021

The trend of efficiency scores across the seven-year period is illustrated graphically in Figure 6.4. Corporate funds experienced the most fluctuation in efficiency scores, which were lowest during the GFC (2007–8 and 2008–9). Corporate funds were managed by multinational companies or international fund managers and might have had more international investments and active asset allocations, which were severely affected by the subprime mortgage crisis and the GFC after the collapse of Lehman Brothers (De Haas & Van Horen 2012). Industry fund efficiency scores were also more negatively affected during 2007–8 and 2008–9. This might be due to a higher proportion of assets invested in highly volatile financial instruments such as shares.

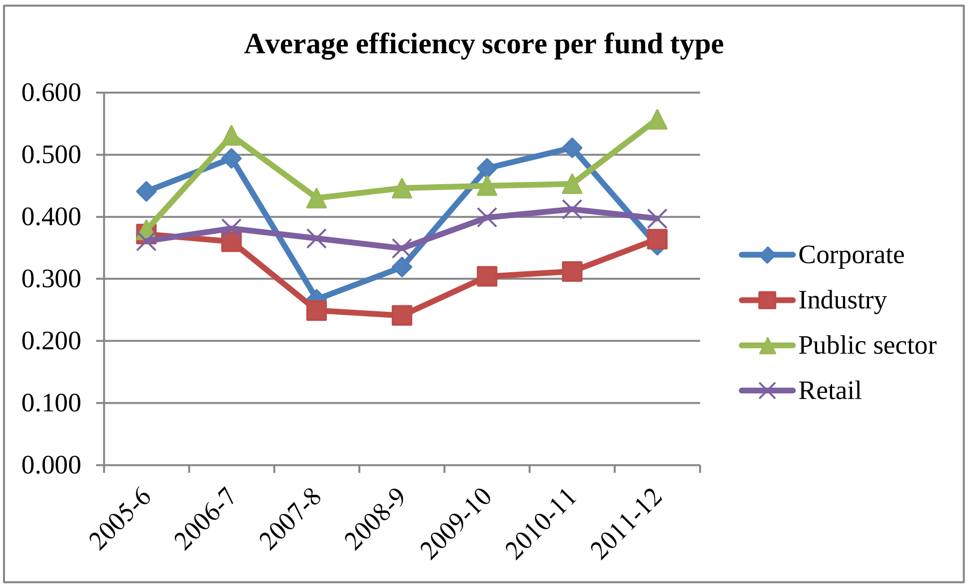


Figure 6.4. Average efficiency scores per fund type, 2005–12

Table 6.8 shows the percentage of efficient funds within their fund type. On average, 20.1% of retail funds were efficient as compared to 15.4% of corporate and 18.1% of public sector. Industry funds had the lowest number of efficient funds within their fund type with only 8% of the funds being efficient on average. Due to lack of publicly available data at the time the study was conducted, it was not possible to further examine the specific characteristics of different types and analyse them in relation to efficiency.

Table 6.8. Proportion of efficient funds per fund type, in percentage, individual years, 2005–12

Measure	2005–6	2006–7	2007–8	2008–9	2009–10	2010–11	2011–12	Average
Corporate	15.4	23.1	15.4	15.4	15.4	17.9	5.1	15.4
Industry	3.9	7.8	11.8	11.8	7.8	7.8	3.9	7.8
Public sector	6.7	6.7	6.7	26.7	26.7	20.0	33.3	18.1
Retail	23.1	23.1	14.1	14.1	23.1	20.5	23.1	20.1

A further breakdown of retail funds into normal retail funds and retail ERFs as shown in Table 6.9 indicates that retail ERFs had a much higher proportion of efficient funds as compared to retail funds (excluding retail ERFs) and other fund types (Table 6.8). Lower inputs and/or higher outputs result in higher efficiency scores. APRA did not provide operating and investment expense data on retail ERFs separately (as presented in Tables 5.3 and 5.4). Hence, it was not possible to investigate whether expenses contributed to higher efficiency scores. In relation to investment return, the reason for the better efficiency scores of ERFs could be explained by APRA data. Table 6.10 shows the average investment returns for APRA-regulated superannuation funds over the period 2008–12 (aggregate data from 2005–07 were not available). During the period 2008–12, retail ERFs was the only sector that reported a positive average investment return of 0.7%. All other fund types reported negative investment returns due to the effect of the GFC. Different from all other fund types, most retail ERF assets were invested in conservative asset classes such as infrastructure, fixed–term deposits and cash (see Australia's Unclaimed Super Fund Annual Report 2011–12 for example).

Retail ERFs employed passive investment strategies with only one investment option. This situation is in contrast with that found in normal retail funds which offered a few hundred investment options on average (APRA 2013a), and reported the lowest investment returns (–1.7%) during the 2008–12 period (Table 6.10).

Table 6.9. Proportion of efficient funds in percentage, retail funds versus retail ERFs, 2005–12

Measure	2005–6	2006–7	2007–8	2008–9	2009–10	2010–11	2011–12	Average
Retail–normal	15.4	16.9	20.0	13.8	15.4	15.4	15.4	16.0
Retail–ERF	61.5	53.8	46.2	38.5	61.5	46.2	61.5	52.7

Table 6.10. Average investment returns, 2008–12

Fund type	Average investment return (%)
Corporate	–0.4
Industry	–0.9
Public sector	–0.3
Retail–normal	–1.7
Retail ERFs	0.7
All funds	–0.9

Source: Compiled from APRA (2013d)

6.3.4 Comparison of efficiency scores between fund types, period 2005–12

Table 6.11 shows the average efficiency scores and proportion of efficient funds per fund type for the period DEA estimates with the SD of return being included as an additional input. The average scores were low, ranging from 0.326 to 0.504. Consistent with results of individual year DEA estimates where the SD of return was not taken into account, industry funds had the lowest average efficiency score (0.326), and public sector funds had the highest average efficiency score (0.504). Retail funds had the second highest efficiency score (0.451) and the highest proportion of efficient funds per fund type (21.8%). Subcategorising retail funds into retail – normal and retail – ERFs, it was seen that retail – ERFs had the highest proportion of efficient funds per fund type (46.2%) as presented in Table 6.12. In conclusion, the efficiency scores did not change dramatically, when calculated with the SD of return (period estimates) or without the SD of return (individual year estimates).

Table 6.11. Efficient funds per fund type, period 2005–12

Fund type	Average efficiency scores	Number of efficient funds	Efficient funds / fund type (%)
Corporate	0.378	4	10.3
Industry	0.326	3	5.9
Public sector	0.504	3	20.0
Retail – all	0.451	17	21.8

Table 6.12. Retail – normal versus retail ERFs, period 2005–12

Fund type	Average efficiency scores	Number of efficient funds	Efficient funds / fund type (%)
Retail – normal	0.379	11	16.9
Retail – ERF	0.811	6	46.2

6.4 Efficiency scores – fund types

This section presents the efficiency scores estimated for individual funds based on a *different* set of efficiency frontiers. These frontiers were constructed using the same input and output data as per section 6.3 and the same VRS model. However the sample funds were not the same. Four different sets of sample funds as per fund type were used: corporate, industry, public sector and retail funds. In these DEA efficiency score estimates, funds were scored and benchmarked against funds of the same type. As per Table 6.13, retail funds had the highest net assets across the seven-year period, followed by industry funds. Corporate and public sector funds held significantly smaller proportions in the total net assets across the seven years.

Table 6.13. Net assets of the sample funds by fund type, in thousand dollars, individual years, 2005–12

Fund type	2005–6	2006–7	2007–8	2008–9	2009–10	2010–11	2011–12
Corporate	29,975	34,900	36,097	33,046	33,310	37,031	39,023
Industry	114,819	155,351	178,169	177,290	189,603	224,019	251,097
Public sector	32,878	43,977	48,408	46,805	43,853	57,187	71,721
Retail – all	196,020	246,586	266,379	245,576	251,439	286,671	305,890
All funds	373,692	480,813	529,054	502,717	518,205	604,908	667,731

6.4.1 Corporate fund efficiency scores, individual years

Corporate funds were established by a company or group of companies to cater for corporate employees' superannuation requirements (APRA 2005, 2008). While corporate fund asset values had increased by 30%, from $30 billion in 2005–6 to $39 billion in 2011–12, the proportion of these assets relative to total net assets in the sample funds decreased approximately from 8% in 2005–6 to 5.8% in 2011–12 (Table 6.13). However, the number of funds reduced five times from 2005–6 to 2011–12 (APRA 2013a). This trend is consistent with the general trend of consolidation in the Australian superannuation system and the global trend of companies de-risking their pension liabilities by engaging independent pension funds to manage their employees' pension benefits (Boeri et al. 2006).

The number of corporate funds in the sample was 39. Table 6.14 presents efficiency scores based on the efficiency frontier set by the efficient funds in the corporate fund sample. When corporate funds were benchmarked against funds of the same type, the efficiency scores improved significantly. The number of efficient funds ranged between 13 funds (33.3%) in 2005–6 to 18 funds (46.2%) in 2007–8 and 2011–12. More efficient funds were recorded during the share market peak which took place in 2007 (Denning 2007). The average efficiency score was equally high, at 0.753. The general lower investment returns during the GFC of 2007–9 did not significantly affect efficiency scores. These findings are different from those in section 6.3 where corporate funds were benchmarked against all funds in the sample. The average efficiency score of corporate funds was only 0.409 when benchmarked against all the funds in the sample (re-visit Table 6.7). The minimum efficiency score on average was low (0.236); however this score was still much higher than the minimum efficiency core of all the sample funds (0.034 as in Table 6.2). This finding has an important implication. Using different benchmarks could result in contrasting results. Therefore, it is important to select an appropriate benchmark which can provide valuable information when estimating efficiency scores for DMUs.

Table 6.14. Corporate fund efficiency performance, 2005–12

Measure	2005–06	2006–07	2007–08	2008–09	2009–10	2010–11	2011–12	Average
Efficient funds	13	16	18	16	15	16	18	16
Inefficient funds	26	23	21	23	24	23	21	23
Average score	0.729	0.770	0.789	0.734	0.739	0.750	0.761	0.753
Min score	0.276	0.169	0.191	0.236	0.218	0.294	0.266	0.236

6.4.2 Industry fund efficiency scores, individual years

Industry funds catered for workers' superannuation requirements in a particular industry (APRA 2005). Industry funds experienced a significant growth in superannuation assets by 118.7% from $114.8 billion in 2005–6 to $251.1 billion in 2011–12 (Table 6.13). While the proportion of these assets in total net assets increased from 30.7% to 37.6%, the number of industry funds decreased by 43% from 2005–6 to 2011–12 due to merging and consolidation, consistent with the general trend in the Australian superannuation industry (APRA 2013a).

The number of industry funds in the sample was 51 over the period 2005–12. Table 6.15 presents the efficiency scores for industry funds, estimated based on the industry fund efficiency frontier. The number of efficient funds ranged from 17 funds (33%) in 2007–8 to 25 funds (49%) in 2006–7. As discussed in section 6.3, industry funds were more severely affected by the GFC and negative investment returns. The effect is shown in this DEA efficiency score estimate with the lowest number of efficient funds being in 2007–8 and the highest number of efficient funds being in 2006–7 around the time that the share markets peaked and a crash was looming (Denning 2007). The average efficiency score was 0.837, ranging from 0.788 in 2007–8 to 0.869 in 2006–7. The minimum score ranged from 0.314 in 2005–6 to 0.462 in 2011–12. Compared to corporate funds, industry funds performed more consistently when benchmarked against their peers (other industry funds) with a higher average score (0.837) and higher minimum score (0.399).

Table 6.15. Industry fund efficiency performance, 2005–12

Measure	2005–06	2006–07	2007–08	2008–09	2009–10	2010–11	2011–12	Average
Efficient funds	21	25	17	18	23	22	22	21
Inefficient funds	30	26	34	33	28	29	29	30
Average score	0.816	0.869	0.788	0.824	0.872	0.844	0.845	0.837
Min score	0.314	0.388	0.381	0.417	0.455	0.374	0.462	0.399

6.4.3 Public sector fund efficiency scores, individual years

Public sector funds manage superannuation assets for employees working for the federal and state governments (APRA 2005). This is the smallest sector in the four fund types in the sample as well as in the population (APRA 2013a). The number of public sector funds had only slightly reduced over the period 2005–12. The proportion of public sector fund assets in the sample slightly increased, from 8.8% in 2005–6 to 10.7% in 2011–12. However, consistent with the growth in the total superannuation assets, the public sector superannuation asset value increased more than 56.1% from $32.9 billion in 2005–6 to $71.7 billion in 2011–12 (Table 6.13).

The number of public sector funds in the sample data is 15 over the period 2005–12. Table 6.16 presents the efficiency scores of public sector funds, estimated based on the public sector fund efficiency frontier. The number of efficient funds ranged from 6 funds (40%) in 2008–9 and 2009–10 to 9 funds (60%) in 2007–8. The lower number of efficient funds was recorded during the GFC and the higher number of efficient funds was recorded around the peak period of the share markets. The efficiency scores ranged from 0.752 in 2007–8 to 0.836 in 2006–7 with an average score of 0.808. The minimum efficiency score ranged from 0.288 in 2009–10 to 0.422 in 2005–6 with an average minimum score of 0.355 for the period. Consistent with the findings for corporate and industry funds, public sector funds had much higher efficiency scores when rated against their peers. Public sector funds performed less consistently than industry funds, but more consistently than corporate funds.

Table 6.16. Public sector fund efficiency performance, individual years, 2005–12

Measure	2005–06	2006–07	2007–08	2008–09	2009–10	2010–11	2011–12	Average
Efficient funds	8	7	6	9	9	7	7	8
Inefficient funds	7	8	9	6	6	8	8	7
Average score	0.824	0.836	0.752	0.789	0.814	0.818	0.823	0.808
Min score	0.422	0.374	0.312	0.391	0.288	0.384	0.317	0.355

6.4.4 Retail fund efficiency scores, individual years

Retail funds offered superannuation services to the public on a commercial or 'for-profit' basis. Retail was the only classified 'for-profit' fund type in the sample. Retail funds were mostly managed by large financial institutions including major banks, insurance and investment companies. These financial institutions also provided a range of wealth management products (APRA 2005). The number of retail funds reduced by 42% from 2005–6 to 2011–12, consistent with the consolidation trend in APRA-regulated funds (APRA 2013a). Despite the asset growth in the superannuation market, the proportion of retail fund asset value in total superannuation assets reduced from 52.5% (2005–6) to 45.8% (2001–12), mostly due to members leaving institutional funds to establish SMSFs (APRA 2013a; Patten 2012).

Retail funds were the largest sector of the four fund types. The number of retail funds in the sample was 78 over the period 2005–12, of which 13 were ERFs. Table 6.16 presents the efficiency scores for retail funds. The number of efficient funds ranged from 16 funds (20.5%) in 2008–9 to 29 funds (37.2%) in 2005–6. Similar to the findings for most other fund types, the lower number of efficient funds was seen after the share market crash. Average retail fund efficiency scores ranged from 0.354 in 2008–9 to 0.545 in 2005–6 with an overall average efficiency score of 0.449. The findings show that retail funds were the only sector with low average efficiency scores, despite being benchmarked against peers (other retail funds). The average minimum score was extremely low, ranging from 0.022 in 2010–11 to 0.058 in 2006–7. These results indicate that the efficiency performance of retail funds varied widely despite being rated against peers. These findings are in contrast with those recorded for other not-for-profit fund types such as corporate, industry and public sector funds. It can be concluded that not-for-profit funds performed much more consistently than for-profit retail funds when rated against their peers.

Table 6.17. Retail fund efficiency performance, individual years, 2005–12

Measure	**05–06**	**06–07**	**07–08**	**08–09**	**09–10**	**10–11**	**11–12**	**Average**
Efficient funds	29	23	20	16	23	25	18	22
Inefficient funds	49	55	58	62	55	53	60	56
Average score	0.545	0.494	0.368	0.354	0.477	0.503	0.403	0.449
Min score	0.053	0.058	0.028	0.026	0.040	0.022	0.040	0.038

6.5 Summary

This chapter presented the efficiency performance of the sample funds. The analysis covered two sets of efficiency frontiers, one estimated for all funds in the sample and the other for funds in different fund types. The number of efficient funds was found to be low. Consequently, the average efficiency scores were low and efficiency targets for most funds were high. These findings show that the efficiency performance of the sample funds varies enormously. The findings have important implications for policy and practice which are deliberated in the last chapter, Chapter 9. The following chapter, Chapter 7, presents the research method for the second phase which aims to explore the relationship between efficiency scores and drivers of efficiency.

Chapter 7
RESEARCH METHOD – THE SECOND PHASE

7.1 Introduction

Chapters 5 and 6 presented the research method for the first phase of this study and the discussion of results, respectively. This chapter presents the research method for the second phase where the relationship between efficiency scores and explanatory factors pertaining to governance and operational characteristics were investigated. The second phase has been commonly used in DEA analysis. This phase aims to relate efficiency scores for a given group of DMUs to a number of exogenous variables that may influence the efficiency level using a prescribed regression model. The integration of the first and second phase is further guided by the conceptual model for the study proposed at the end of Chapter 4.

This chapter unfolds as follows. Section 7.2 presents alternative approaches to selecting the regression models for the second phase. Section 7.3 deliberates the regression models. Section 7.4 discusses the independent explanatory variable developments. Section 7.5 presents the comprehensive regression equation. Section 7.6 discusses the sample and data collection process. Sections 7.7 and 7.8 present the details of the data transposition and analysis process, respectively. Section 7.9 concludes the chapter.

7.2 Alternative approaches to selecting the regression models

The Tobit regression, originally developed by James Tobin (1958), is a common alternative approach to the ordinary least square regression (OLS) in the second phase of the DEA analysis (Hoff 2007). Tobit is applied when the dependent variable is limited from below, above or both by being truncated, censored or in a 'corner solution' situation. Truncation occurs when data for both the dependent and independent variables are lost and some observations are not in the sample. The sample data are drawn from a subset of a larger population, but the truncated sample is not representative of the population. Censoring occurs when only data on the dependent variable are lost or limited. Thus, the censored sample is representative of the population except that some observations for the dependent variable are not recorded at their real value as these values occur outside a predetermined interval. In censored situations, observations outside the interval are recorded at border values. For instance, if the interval is between *a* and *b*, an observed dependent variable *y* which is larger than *a* is recorded as $y = a$, and an observed *y* which is larger than *b* is recorded as $y = b$. In corner solution situations, the values of the observations are by nature limited from below or above or both with a positive probability at the interval ends ('corners') (Hoff 2007; Wooldridge 2010).

The dependent variable, DEA efficiency scores, is a continuous random variable with positive fractional values and a natural boundary of (0,1). DEA efficiency scores are not censored data as all the scores are included in the data set. DEA efficiency scores partly fit Woolridge's description of corner solution situations (Hoff 2007). While DEA efficiency scores can take the value of 1, they never take on the value of 0. There is a positive probability of taking on the value of 1 but the probability of taking on the value of 0 is zero percent. Hoff (2007) argued that the two-limit Tobit approach, often used to model corner solution data limited from both above and below is somewhat of a misspecification when applied to DEA efficiency scores. Thus, the first part of the likelihood function under Tobit where the probability of *y* obtaining a value of 0 should be omitted. In other words, it was considered more appropriate by Hoff (2007) to use the one-limit Tobit regression. By contrast, McDonald (2009) demonstrated that the maximum likelihood estimation (MLE) would be similar in both the two-limit and one-limit Tobit models, however the marginal effects under the two models are different. The two-limit Tobit model imposes a restriction that the observed *y* cannot be less than 0 while the one-limit model does not. DEA efficiency scores are positive values. It was therefore argued that using the two-limit Tobit model for DEA efficiency scores should not be considered a misspecification. The two-limit Tobit model uses more *a priori* (denoting reasoning which proceeds from theoretical deduction rather than from observation) information than the one-limit Tobit model does in calculating the marginal effects. Therefore, the two-limit model could be expected to be more asymptotically efficient (McDonald 2009). In this study, the two-limit Tobit model was applied.

In contrast to the Tobit regression, the OLS regression is a simpler approach in investigating the relationship between efficiency scores and exogenous (explanatory) factors. The fundamental difference between Tobit and OLS is that Tobit is a qualitative response or probability model applied to situations where the dependent variable is qualitative by nature, such as a category. In these situations, the objective is to find the *probability* of an event happening. By contrast, in situations where the dependent variable is quantitative with continuous random data, the objective is to find the expected or the *mean* value given the values of the independent variables (Gujarati & Porter 2009). The DEA efficiency scores have the characteristics of both qualitative and quantitative data. Although the efficiency scores fall between the range of 0 and 1, they strongly resemble quantitative data with continuous factional values. However, due to no limits being applied to the interval of 0 and 1, the OLS regression may predict scores outside 0 and 1 (McDonald 2009). Nevertheless, as evidenced in empirical studies, the regression coefficients estimated by the OLS method did not differ significantly from those predicted by the Tobit method (Bravo-Ureta et al. 2007). In some cases, the OLS regression even gave the best fit in the majority of the tests. The on-going question is whether it is necessary to apply the commonly used Tobit for the second phase of the DEA analysis, given the simplicity of use offered by the OLS regression (McDonald 2009).

Table 7.1 presents some examples of commonly used regression models in the second phase including the Logit, OLS and Tobit models. OLS and Tobit appear to be more commonly used than Logit. Some researchers used only the OLS regression (Anderson et al. 2002; Barrientos & Boussofiane 2005), some used only the Tobit regression (Chilingerian 1995; Fethi, Jackson & Weyman-Jones 2000; Latruffe et al. 2004), while others used both Tobit and OLS for comparative purposes (Bravo-Ureta et al. 2007; Hoff 2007; McDonald 2009). Tobit appeared in earlier studies whereas OLS was seen in later studies.

Table 7.1. Regression models used in the second phase

Year	Authors	Regression models	Industry/ sector	Explanatory variables
1995	Chilingerian	Tobit	Health care	Service fees, physician's accreditation, size of case load, diagnostics diversification, physician's age, proportion of high severity case
2000	Fethi, Jackson & Weyman-Jones	Tobit	Airlines	Proxies for competition, managerial and organisation characteristics, specialisation, public policies
2002	Anderson et al.	OLS	Real estate trusts	Leverage, diversification, type of management
2002	Chen	Logit	Banking	Financial crisis effect, ownership, staff, bank size (assets)
2002	Galagedera & Silvapulle	Logit	Managed funds	Fund size, fund type, investment objectives, asset allocations, tax structure
2004	Latruffe et al.	Tobit	Crop, livestock farms	Capital, land, labour, soil, education, market integration
2005	Barrientos & Boussofiane	OLS	Pension funds	Market share, sales, contribution ratio, revenue
2007	Bravo–Ureta et al.	OLS and Tobit	Farming	Region, crop characteristics, size

Table continued

2007	Hoff	OLS and Tobit	Fishing	Vessel age, vessel owner status, fraction of time spend fishing, gross tonnage and insurance value
2009	McDonald	OLS and Tobit	Agricultural estates	Urban, soil, size, crop mix, tenure

Chen (2002) and Galagedera and Silvapulle (2002) used the Logit model to regress the DEA efficiency scores against exogenous factors. Chen (2002) used a logistic probability function to regress the efficiency scores against bank size (assets), ownership status, staff level, and Asian financial crisis effect. Galagedera and Silvapulle (2002) tested the variation in relative efficiency using fund size, fund type, investment objectives, asset allocations, and tax structure as explanatory independent variables. The DEA efficiency scores were arranged into an index of efficiency where an efficient fund with a score of 1 was assigned a value of 1, and an inefficient fund with a score different from 0 was assigned a value of 0. Thus, the proportion of efficient funds plus the proportion of inefficient funds equalled 1, satisfying the condition of a binary logistic model. The Logit model has the dependent variable being the logarithm for the proportion of inefficient funds over the proportion of efficient funds and the independent explanatory variables being fund operating and investment characteristics. With a unit change in an independent explanatory variable, the coefficient corresponding to that independent explanatory variable explains the odds of changing the related efficiency score. By contrast, Anderson et al. (2002) and Barrientos and Boussofiane (2005) both used OLS. Chilingerian (1995), Fethi, Jackson and Weyman-Jones (2000), and Latruffe et al. (2004) used Tobit whereas Bravo-Ureta et al. (2007), Hoff (2007) and McDonald (2009) used both OLS and Tobit for comparative purposes. The features of the OLS and Tobit regression models were discussed in section 7.2.

As per Table 7.1, regardless of the regression models chosen, most of the explanatory independent variables represented focused on aspects of structure and operating activities of the organisation being studied. The structure and conduct of an organisation under the SCP framework (as deliberated in Chapters 2 and 4) affect the organisation's performance. The SCP framework is used as a basis for the selection of independent explanatory variables in the second phase of this study.

7.3 Regression models selected for the study

The Tobit and OLS regression models were employed for comparative purposes in this study. These two models were selected due to the DEA efficiency scores possessing characteristics of both qualitative and quantitative data.

7.3.1 Tobit regression

The general two-limit Tobit model used for DEA efficiency scores with an interval between 0 and 1 was applied in the second phase, described by Equation 7.1. If the observed *y* was of negative value, *y* would be recorded as zero. If the observed *y* was larger than 1, *y* would be recorded as 1. If *y* was between 0 and 1, *y* would be recorded at its observed value.

Equation 7.1. Two-limit Tobit model

$$
\begin{aligned}
y_i^* &= \beta x_i' + u_i \\
y_i &= 0 && \text{if } y_i^* \leq 0 \\
y_i &= 1 && \text{if } y_i^* \geq 1 \\
y_i &= y_i^* && 0 < y_i^* < 1
\end{aligned}
$$

Where:
$u \sim N(0,\delta)$, independent and identically normally distributed
$x = (x_1,\ldots,x_n)$, explanatory variables

Source: Greene (2003), Hoff (2007) and McDonald (2009)

The probability that an observed value y is equal to 0, 1 and between 0, and 1, is given in Equations 7.2, 7.3 and 7.4 respectively:

Equation 7.2. Tobit model – Probability for y to attain a value of 0

$$P\ (y=0) = F\ (-\sum \beta_k x_k | 0, \delta) = \frac{1}{\sqrt{2\pi\delta^2}} \int_{-\infty}^{-\sum \beta_k x_k} e^{-t^2/2\delta^2} dt$$

Where:

$F(x|\mu, \delta) = N(\mu, \delta)$ – density function

Source: Hoff (2007) and McDonald (2009)

Equation 7.3. Tobit model – Probability for y to obtain a value of 1

$$P\ (y=1) = F[-(1-\sum \beta_k x_k)|0, \delta] = \frac{1}{\sqrt{2\pi\delta^2}} \int_{-\infty}^{-(1-\sum \beta_k x_k)} e^{-t^2/2\delta^2} dt$$

Where:

$F(x|\mu, \delta) = N(\mu, \delta)$ – density function

Source: Hoff (2007) and McDonald (2009)

Equation 7.4. Tobit model – Probability for y to obtain a value between 0 and 1

$$\mathrm{P}(y_i|0<y_i < 1) = f\ (y_i - \sum \beta_k x_k | 0, \delta) = \frac{1}{\sqrt{2\pi\delta^2}} e^{-(y_i - \sum \beta_k x_k)^2/2\delta^2}$$

Where:

$f(x|\mu, \delta) = N(\mu, \delta)$ – normal density function

Source: Hoff (2007) and McDonald (2009)

The combined likelihood function for the censored dataset where y can obtain a value of 0, 1 or between 0 and 1, is given in Equation 7.5 below:

Equation 7. 5. Likelihood function for y to obtain a value of 0, 1 and between 0 and 1

$$L = \prod_{y_i=0} P(y_i = 0) \prod_{y_i=1} P(y_i = 1) \prod_{0<y_i<1} f(y_i)$$

Where:
P = probability
$f(y_i)$ = normal density function

Source: Hoff (2007) and McDonald (2009)

7.3.2 Ordinary least square (OLS) regression

In addition to the Tobit regression model, the multivariable OLS regression model was employed in parallel, as described in Equation 7.6.

Equation 7.6. Ordinary least square (OLS) model

$$E_{it} = \beta_0 + \beta_1 X_{1it} + \beta_2 X_{2it} + \ldots + \beta_n X_{nit} + u_{it}$$

Where:
E: efficiency score of i^{th} fund at t time period, $E \in (0,1)$
X: explanatory independent variables
β = *regression coefficient*
u = *residual (error) term*
$i = 1,2,\ldots,145$
$t = 1,2$

Source: format adapted from Gujarati and Porter (2009)

7.4 Independent explanatory variable selection

This section provides the rationale for the selection of independent explanatory variables for the regression analysis. Three areas presented in the SCP framework for the Australian superannuation system were identified as testable drivers of superannuation fund efficiency and consolidated in the conceptual model. They are governance mechanism and board structure, risk management and investment activities. Under these broad drivers, twelve independent explanatory variables were proposed.

7.4.1 Governance mechanism and board structure

Governance structure can have a negative or positive effect on performance. Good governance is increasingly recognised as an important aspect of an efficient pension system (Yermo & Stewart 2008). Good governance by fund trustees makes a significant incremental difference to the value creation of pension plans (Clark & Urwin 2008). The Australian superannuation market is defined by low competition, inelastic demand, and mostly non-engaging investors and members. The market is highly regulated with a complex legislative framework and taxation schemes. There are multiple agency relationships between key participants which lead to multiple conflicts of interest. The special characteristics of the Australian superannuation market emphasise the importance of a good governance structure, and an effective operating framework (Cooper et al. 2010a; Sy 2008).

Pension fund governance tends to exhibit the characteristics of governance models normally associated with corporate governance (Clark & Urwin 2009). As studies on corporate governance are more voluminous and readily available, the rationale for the selection of the independent explanatory variables has the theoretical support from both corporate governance and pension fund governance literature.

7.4.1.1 Board size

Board size is perceived an important element of the governance structure and mechanism. The effect of board size on organisation performance has been studied extensively, as indicated by the literature in the corporate sector as well as the fund management sector. Whether board size has a positive effect on performance appears to be a long debated matter as past studies on board size have produced inconsistent results. For instance, it was contended that the larger the board was, the better the governance a company exercised (Jensen 2000). Larger boards are better at replacing poor performing managers, leading to better performance for mutual funds (Ding & Wermers 2005). A larger corporate board was positively related to firm value and negatively associated with the variability in monthly stock return. Large boards took more time to reach consensus and thus the decisions could be less extreme (Beiner et al. 2006; Cheng 2008). Board size was also found to be positively related to investment return for superannuation funds (Benson, Hutchinson & Sriram 2011).

By contrast, other studies show that a smaller board size was positively associated with a higher market valuation of companies (Yermack 1996). A small board size appeared to be more efficient than a large board size in the fund management sector and a large board size appeared to have a positive effect on firm value in the corporate firm sector. Pension funds with smaller boards focused on tactical investing and outsourcing which resulted in higher performance (Useem & Mitchell 2000). A negative relationship between board size and financial performance was highlighted in Albrecht and Hingorani's (2004) study which indicates that smaller boards might make better investment decisions.

These studies indicate that board size has some effect on organisation performance, be it an organisation in the corporate sector or fund management sector. Board size may therefore have a relationship with efficiency. In that context, the first independent variable selected for the regression analysis is *the number of directors on the board* (board size).

Corporate sector regulators such as the Australian Stock Exchange (ASX) emphasise the importance of the corporate board composition (ASX 2011). Boards should have a diverse and balanced view to be effective (ICAA & Deloitte 2008). Academic literature is also replete with studies on the influence of board structure and characteristics on the performance of an organisation. Although a vast amount of literature exists on the relationship between board structure and organisation performance, it is empirically difficult to decide which characteristics of the board may have the dominant effect (Adams, Hermalin & Weisbach 2010). It is equally difficult to make a distinction between whether qualified board members add value to the firm or whether highly valued firms attract knowledgeable board members (Ahern & Dittmar 2014). Therefore, the results in many empirical studies on board characteristics and organisation performance are often inconsistent.

Dalton et al. (1998) showed that there was no clear association between board composition and financial performance. Recent studies in the pension fund management sector appeared to have similar results. In a study of over 70 US pension funds, Harper (2008) reported there was no significant relationship between board structure and investment performance measured by excess return. In this study, the trustee board composition was investigated by including three independent explanatory variables in the regression equation: the presence of employer-member representatives, female directors, and independent directors on the board. The rationale for these selections is provided in the following sections.

7.4.1.2 Employer-member representatives

It is common practice for many pension funds to have union (labour), employer and employee representatives on the board. The benefit of having board members with an inherent interest in the pension plan is a controversial issue (Verma & Weststar 2011). On the one hand, it is argued that employer, employee and union representatives are not often professional fund managers. Few of them have sufficient financial and investment expertise to guarantee acceptable investment returns. Consequently, the presence of employee representatives on pension boards has attracted some scrutiny of their role and effectiveness. Further, it was observed that employee representatives are not fully participative and, thus, often do not fulfil the expected role of a fully qualified pension fund trustee (Palacios 2002; Sayce, Weststar & Verma 2014; Verma &

Weststar 2011). Labour trustees made greater contributions to procedure-oriented processes regarding policies, policy interpretation and fewer contributions to technical matters such as investments or fund performance (Verma & Weststar 2011). In experiments that contrasted graduates with a self-selected group of pension trustees, Clark, Caerlewy-Smith and Marshall (2006, 2007) found that with regards to strategic investment decision making, the graduates were more consistent than the pension trustees. Union (labour) or employee representatives need advanced numeracy, quantitative skills and probabilistic reasoning to adequately monitor the actions of delegated agents.

On the other hand, as in the case of Australia, it has been contended that although for-profit funds are managed by professional trustee directors and fund managers, multiple conflicts of interest increase agency and administration costs, which result in sub-optimal investment returns (Coleman, Esho & Wong 2006; Sy 2008). Noticeably higher overall administration costs reported by for-profit funds have consistently been evident in APRA statistics over a period of time (APRA 2013a; 2014a). Although not all member-elected directors had the expertise to properly discharge their complex responsibilities, they were dedicated to their role and were best placed to understand superannuation fund members' requirements (ICAA & Deloitte 2008).

The appointment of trustees who represent members and beneficiaries' interests, yet are not professional fund managers, appear to present a strength as well as a constraint to fund performance. This study aims to explore the association of their appointment as representatives on the board on efficiency. Hence, the second independent explanatory variable selected for the regression analysis is *the presence of employer and member representatives on the board.* The presence of employer-member representatives was treated as *one* independent explanatory variable. The reason for this treatment is explained in section 7.6.2.

7.4.1.3 Female directors

The contribution of female directors to the performance of a modern organisation has been debated from various perspectives in the literature not only with regards to business management, board diversity and organisation performance, but also to politics (Kang, Cheng & Gray 2007; McCann & Wheeler 2011; Terjesen & Singh 2008). The perceived importance and presence of female trustees on the board have been referred to and investigated in various studies from operation efficiency, effectiveness and political perspectives (Sayce 2012). The proportion of companies with female director representation varied across countries. The proportion of companies with female directors on the board could be high, such as over 80% in the USA; nevertheless, few women were present on most corporate boards. The number of female directors on pension fund boards ranged from 3.8% on average in the Netherlands, 8.5% in the USA to 14.5% in Scandinavia (Swinkels & Ziesemer 2012). The answer to the question as to whether female directors were appointed as competent managers who would add value or only a token of board gender diversity remains elusive (Burgess & Tharenou 2002). Some studies showed positive effects of gender diversity on firm share value and higher profitability, while others showed no or negative effect of adding women to the board (Dobbin & Jung 2011). There was no significant relationship between firm performance as measured by Tobin's Q, the proxy for firm value, and female board representation (Rose 2007). Female and male directors did not differ significantly in terms of performance and risk management for fixed-income mutual funds (Atkinson, Baird & Frye 2003). There was no significant difference in the contribution between male and female pension fund trustees (Verma & Weststar 2011).

In contrast to the above studies, positive relationships were recorded between the fraction of women and minorities on the board and firm value (Carter, Simkins & Simpson 2003). Similarly, board diversities (gender and race) were found to be positively related to firm financial performance (Erhardt, Werbel & Shrader 2003).

Female directors could be more participative, have different educational backgrounds and experiences, and provide different insights and a broader range of contributions into the management process which resulted in better board decisions (Bear, Rahman & Post 2010). Women were more risk averse investors and consequently had a tendency to invest more in conservative assets such as fixed interest incomes and less in highly volatile assets such as shares, which would bring a balanced investment philosophy to the board (Hinz, McCarthy & Turner 1997). Given that the perceived importance of gender balance and the role of female directors in the board room are inconclusive in empirical studies, it is important to further investigate the matter in empirical studies. Thus, the fourth independent variable chosen for the regression analysis is *the proportion of female directors on the board.*

7.4.1.4 Independent directors

Best practice corporate governance often recommends the presence of independent directors on the board. Non-associated trustee directors who could influence the decision of the board were proposed to be present in all superannuation funds. The independence of the trustee board of directors is perceived to be necessary to reduce conflicts of interest and agency problems in superannuation funds (ASFA 2004). Agency problems in multiple-layered member-trustee-service provider relationships are critical issues in pension fund management, discussed in detail in Chapters 2 and 4.

Similar to the board size, female director, or employer-member representation, empirical studies on the effect of independent directors on firm performance produced various inconsistent results. Studies by Molz (1988), Fosberg (1989), Hermalin and Weisbach (1991), and Petra (2005) showed no positive effect of the presence of external independent directors on firm performance. Studies by Yermack (1996) and Beiner et al. (2004) indicated no association between the fraction of outside directors and firm performance for US and Swiss markets. There was a negative correlation between firm value and the presence of independent directors (Beiner et al. 2006). By contrast, Barnhart, Marr and Rosenstein (1994) found that the appointment of more external independents on the board had a positive effect on performance. The presence of independent directors is positively associated with lower fees charged to members for US open-ended funds (Tufano & Sevick 1997). With regards to pension funds, the independence of trustee directors was not recommended in the best-practice factors by Clark and Unwin (2008). Trustees' qualifications, and the quality and strategy of the investment committees were instead considered more critical (Clark & Urwin 2008). Non-independent trustees appointed by the pension plan sponsors could act in the interests of the plan sponsors and shareholders and not in the interests of plan members and beneficiaries (Cocco & Volpin 2007).

The independence of the directors on the board results in different effects on performance of an organisation in empirical studies, which guarantees further investigations. The fourth independent explanatory variable proposed is *the proportion of independent directors on the board.* There are various interpretations of trustee independence. For instance, superannuation fund trustee boards can be independent of the portfolio or asset managers and may not be independent of the plan sponsors (Benson, Hutchinson & Sriram 2011). Trustee board independence appears to be defined variously in pension research which include the method of appointment such as employers-sponsors (APRA 2008), regulator-appointed trustees (Albrecht & Hingorani 2004), or independence from the fund manager (Schneider & Damanpour 2002). In this study, the independence of the board was recorded at the nominal value, that is, as listed in the superannuation fund annual report without further investigations into the nature of the independence position.

7.4.2 Risk management

Risk management is a complex function within financial institutions. In pension funds, risk management involves the measurement and assessment of pension fund risks and the design, monitoring and revision of the fund parameters (contributions, investments and benefits) in order to address these risks in line with the fund objectives. The main risks to which pension fund members are exposed are investment, inflation and longevity risks. Risk management is directed at two goals: minimising the pension costs of contributors (employers), and minimising the benefit risks to members (beneficiaries). The goals involve trade-offs between contributions, asset allocations and risks. Plan sponsors (employers) are interested in minimising the funding costs. Plan members usually follow multiple goals that change over time. As active members, they are concerned with maximising their plan benefits. Retired members usually face higher emphasis on benefit security. This risk can be dealt with by pension insurance (Blome et al. 2007). Two aspects of risk management often referred to in superannuation fund management are insurance cover, operational and investment reserve (Cooper et al. 2010a).

7.4.2.1 Insurance

Insurance cover has been highlighted in the Super System Review as a crucial means to protect retirement benefits for members and beneficiaries (Cooper et al. 2010a). For instance, ASIC expects advice given by financial planners to superannuation fund members to include a detailed discussion on insurance before a SMSF fund is established (Wasiliev 2014). Australian institutional superannuation funds mostly offer insurance cover to members for three options: death, total permanent disability and income protection. Insurance schemes vary among funds (Cooper et al. 2010a). To the best knowledge of the thesis's author, no empirical studies have been conducted on the effect of insurance cover offered by superannuation funds on performance and performance rating. From a global perspective, insurance policies and covers receive little attention from policy makers and industry practitioners; see comprehensive works on pensions such as Clark, Munnell and Orszag (2006b), *OECD Pension Outlook* (2012a, 2013a, 2014), and *OECD Pension Market in Focus* (2012b, 2013b). In that context, this study aims to investigate the association between insurance covers offered to superannuation fund members and efficiency. Thus, the fifth independent exploratory variable is proposed as *insurance covers offered to members.*

7.4.2.2 Reserve

Effective fund management would command a sound mechanism of risk management to ensure that members are protected. Most Australian superannuation funds have a risk management strategy set up by the trustees. How effective these strategies are remains to be seen. There are mainly two types of reserve: operation (administration) reserve and investment reserve. Operation (administration) reserve is for taxation and operating expenses to ensure an equitable allocation of returns through the unit pricing process. Investment reserve is for smoothing investment return (FSC and ASFA 2011). The government has perceived the importance of institutional superannuation fund trustees maintaining an operational reserve as part of the risk management framework and required such a reserve to be established from July 2013 (Alcoa of Australia Retirement Plan 2013; AUSTLII 2013). The risk reserve can provide a source of financial relief for members in the event that an operational failure occurs and results in losses to members. Given that the data for this research cover up to the financial year 2011–12, it makes sense to explore the risk management practice in regards to maintaining reserve funds and its relationship with efficiency prior to the statutory requirement. The sixth independent exploratory variable is proposed as *reserves.*

7.4.3 Investment activities

Effective investment activities by pension funds are perceived to be critical to fund performance (Clark & Urwin 2008). In this study, investment activities of superannuation funds were investigated within three main areas: asset allocations, investment diversifications and investment options.

7.4.3.1 Domestic asset allocation

Most pension funds use a specialised asset management strategy which involves the asset managers carrying out security selection (choice of individual securities) and asset allocation (choice of markets and instruments) (Ang, Goetzmann & Schaefer

2009; Davis & Steil 2001). Data collection for the study showed that the specialised asset management strategy prevailed in Australian superannuation funds. In the wake of the GFC, it has been highlighted that lower returns generated by Australian superannuation funds as compared to the average returns of pension funds in other OECD countries were due to a higher proportion of assets invested in equities, especially in Australian equities (Basu & Drew 2010; OECD 2012b; OECD 2013a). There had been industry and media pressures regarding the negative effect of significant investments in equities, in particular, for the members who were close to retirement (Main 2012). Australian interest rates during the period 2010–11 and 2011–12 had been much higher than those in other developed countries (Lowe 2012; RBA 2015). The SMSF sector which mainly invested in conservative asset classes such as fixed term deposits and cash accounts yielded better investment returns than APRA-regulated funds in the period 2010–11 and 2011–12 (ATO 2013). Thus, it might be reasonable to expect that a higher proportion of superannuation assets allocated to Australian fixed interest investments and cash would result in higher investment returns during the GFC and thus, enhance fund investment performance. The seventh, eighth and ninth independent explanatory variables are therefore proposed as *the proportion of assets invested in Australian fixed interest schemes, the proportion of assets invested in Australian equities,* and *the proportion of assets held in cash.*

7.4.3.2 International diversification

When investors hold a diversified portfolio of assets, they can eliminate the unsystematic risk resulting from the different performance of individual firms and industries (Gitman, Juchau & Flanagan 2011). Despite an integrated world capital market, systematic risk could be minimised by holding the global portfolio. The improvement in the risk-return position from diversification would more than compensate for the additional element of volatility arising from currency movements. Despite the correlations between different markets, international risk diversification was proven beneficial to institutional investors (Solnik 1988, 1998; Solnik, Boucrelle

& Le Fur 1996). In a study by Jorion and Goetzman (1999) on the international equity investments by mutual funds over the period 1921–96, it was argued that diversification showed a major reduction in risk or volatility of investment returns. Useem and Mitchell (2000) who investigated the investment strategies including equity and international investing for US pension funds in 1992 and 1993 also concluded that investments in international assets affected pension fund performance positively. In this context, the tenth and eleventh independent explanatory variables are proposed as *the proportion of assets invested in international fixed interest schemes* and *the proportion of assets invested in international equities.*

7.4.3.3 Investment option

It is common practice that Australian superannuation funds outsource asset consultants and delegate the investment tasks to fund managers (Liu & Arnold 2010). The more fund managers there were, the more likely the high number of investment options. Agency costs in Australian retail superannuation funds were high due to a myriad of investment options offered to members (Coleman, Esho & Wong 2006). Passive asset management, simple product offers and costs, among other factors, are arguably believed to be the most beneficial for pension fund members (Boeri et al. 2006; Cooper et al. 2010a).

It has also been debated that the more investment choices there are, the more administration costs are incurred. When the number of asset consultants and fund managers engaged in investment activities increase, it is likely that the overall costs to members also increase. Nevertheless, it is unclear whether a higher number of asset consultants and fund managers will result in higher gross investment return for members (Nguyen, Tan & Cam 2012). In addition, the more choices members made, the worse the performance return was (Tang 2009; Tang et al. 2010). The preferred scheme as proposed by pension experts was large plans with little freedom of choice for fund members (Boeri et al. 2006). In this study, manual data collection from annual reports showed that the number of investment options ranges from one to over two hundred options. The issue of investment options offered to members, especially in the retail fund sector, was raised in various industry reports and academic literature (APRA 2014a, 2014b; Coleman, Esho & Wong 2006; Cooper et al. 2010a). In that context, the twelfth independent variable is proposed as *the number of investment options*.

7.5 Regression equation – the second phase

The comprehensive regression equation for the study incorporating all independent explanatory variables proposed in section 7.4 is presented in Equation 7.7.

Equation 7.7. Comprehensive regression model

$$E_{it} = \beta_0 + \beta_1 Dir + \beta_2 EmpMem + \beta_3 FemDir + \beta_4 IndDir + \beta_5 InsMem + \beta_6 Reserve + \beta_7 AusFixInt + \beta_8 AusShare + \beta_9 Cash + \beta_{10} IntFixInt + \beta_{11} IntShare + \beta_{12} InvOpt + u_{it}$$

Where:

E	= DEA efficiency scores
Dir	= number of directors on the board (board size)
EmpMem	= employer-member representative(s)
FemDir	= the proportion of female directors
IndDir	= proportion of independent directors
InsMem	= insurance scheme(s) and offer(s) to members
Reserve	= reserve(s)
AusFixInt	= proportion of superannuation assets invested in Australian fixed interest schemes
AusShare	= proportion of assets invested in Australian shares
Cash	= proportion of assets held in cash
IntFixInt	= proportion of assets invested in international fixed interest schemes
IntShare	= proportion of assets invested in international shares
InvOpt	= number of investment options offered to fund members
u	= error (residual) term
i	= 1,2,…,145
t	= 1,2

7.6 Sample and data collection – the second phase

Data for the second phase of this study were collected from the APRA database and annual reports of superannuation funds. Fund websites and other documents were used to verify and clarify the information provided in the annual reports and APRA database. The annual reports of 183 superannuation funds presented in the DEA estimates in Chapter 6 were manually collected from publicly available resources. There had been no financial market data service suppliers who maintained these data for a seven-year period during the time the data were collected. The downloading task was time-consuming, thanks to the inconsistencies in financial reporting and disclosure practices used by superannuation funds. Due to time and data availability constraints, the second phase only covers the financial years 2010–11 and 2011–12. The number of valid superannuation funds was reduced from 183 in the first phase (Chapters 5 and 6) to 145 funds for the second phase (Chapters 7 and 8). As data were pooled across the two financial years 2010–11 and 2011–12, the total observations made were 290.

7.7 Data transposition

The second phase explored the association between efficiency scores and explanatory factors. Data for the independent explanatory variables were transposed and prepared for the regression analysis, as detailed below.

7.7.1 Efficiency scores

As the number of valid superannuation funds for the second phase was reduced from 183 to 145, DEA efficiency scores were re-estimated for the new data set. This process was required as DEA efficiency scores would change depending on the number of DMUs present in the sample (Cooper, Seiford & Tone 2007).

7.7.2 Explanatory variables

To collect data on most independent explanatory variables, websites and annual reports of superannuation funds were screened manually. The independent explanatory variables present a mixture of quantitative and qualitative data. Table 7.2 shows the types of data and methods for collection.

Table 7.2. Explanatory variables – classification, collection and transposition

Description	Type	Data Collection	Data Recording/ Transposition
Board structure			
Directors	Quantitative	Count	Number
Employer-member representatives*	Qualitative	Count	0,1
Female directors	Quantitative	Count	Number/Percentage
Independent directors	Quantitative	Count	Number/Percentage
Risk management mechanism			
Insurance	Qualitative	Ranking	0,1,2
Reserves	Qualitative	Ranking	0,1,2
Investment activities			
Australian fixed interest	Quantitative	Record	Percentage
Australian shares	Quantitative	Record	Percentage
Cash	Quantitative	Record	Percentage
International fixed interest	Quantitative	Record	Percentage
International shares	Quantitative	Record	Percentage
Investment options	Quantitative	Record	Logarithm

* It was consistently observed for all the sample funds that if the fund had employer representatives, it also had member representatives on the board. Therefore the employer-member representative was treated as one independent explanatory variable.

Quantitative data were recorded directly. Qualitative data were transposed using a rating scale. The number of directors on the board (or board size) was counted and recorded. A similar approach was used for the collection of data relating to female and independent directors. The presence of employers and member representatives on the board was recorded as a dummy variable. It was observed that all the superannuation funds in the sample had either *both* employer and member representatives or had *no* employer and member representatives on the board. Therefore the employer-member representative variable was treated as *one* independent explanatory variable. Insurance covers offered to members and the number of reserves were ranked. Zero (0) indicates no insurance covers offered to members or no reserves established. Insurance covers were ranked in three scales (0–2) ranging from no insurance cover, death and permanent disability benefits to income protection. Reserves were ranked in three scales (0–2) with the highest rank of 2 indicating that the fund had two types of reserves (investment and operation). Logarithm of investment options was taken due to the high variation of options recorded which ranged from 1 to more than 200 options.

7.8 Data analysis

This section discusses the process selected for the regression analysis. Data were analysed for 2010–11 and 2011–12 separately, and then analysed when pooled (2010–12), using a dummy variable to distinguish between 2011 and 2012. *Eviews* was used for the regression analysis.

7.8.1 Regression model assessment – a step-wise approach

Three panels of independent explanatory variables were identified in section 7.4: governance or board structure, risk management and investment activities. A modified step-wise approach was used in this study to assess the strength of influence from the three panels of independent explanatory variables on efficiency. The step-wise approach has commonly been used in regression analysis. The validity of this method has been debated in the literature and likened to data mining. On the one hand, it is not advisable to build a model step-wise, that is, expanding the model by introducing independent variables one by one and testing their fitness using t– and F–tests. Researchers may use data mining to develop the best model after conducting diagnostic tests so that the final model is good and proper with estimated coefficients having the right signs and being statistically significant on the basis of both the t– and F–tests. A danger is that the normal levels of significance α such as 1%, 5%, or 10% may not the true levels of significance. The level of significance can be much higher than the true level (and may fall out of the conventional levels of 1%, 5% or 10%) if certain valid independent variables are omitted to ascertain the strength and goodness-of-fit of the condensed model (Gujarati & Porter 2009; Lovell 1983).

On the other hand, data mining has been increasingly recognised as an acceptable method among applied econometricians. The difficulties in dealing with real data imply that an anti-data mining approach is neither practical nor desirable. It is not practical because hypotheses are often weakly supported by theories. Consequently, it is rare that a theory fully agrees with a unique model. It is not desirable as researchers need to learn from and explore data to see which models are supported (Zaman 1996). This study aims to examine if a panel or panels of independent explanatory variables fit the model well and add to the statistical strength of the model. The modified step-wise approach thus enriches the regression analysis process. The comprehensive regression model presented in Equation 7.7 was tested using OLS and Tobit in three steps: regression model 1 covers the board structure and risk management mechanism; regression model 2 covers investment activities; and regression model 3 is a combination of the first two models.

7.8.2 Robustness tests

To ensure that the OLS multiple regression models are robust and thus, the estimated coefficients are meaningful and contain reliable predictive values, several assumptions are often discussed in the literature and robustness tests are recommended (Gujarati & Porter 2009; Oakshott 2012; Selvanathan et al. 2004). The assumptions (Gujarati & Porter 2009, p. 189) are as follows:

1. Linearity in the parameters
2. Independent variable values being fixed
3. Zero mean value of the error (disturbance) term u_i
4. Homo–scedasticity or constant variance of u_i

5. No autocorrelation, or serial correlation between the disturbances
6. The number of observations *n* must be greater than the number of parameters (coefficients) to be estimated
7. Variation in the values of the independent variables
8. No exact collinearity between independent variables
9. No specification bias, or the model is correctly specified

In this study, the sample size is sufficiently large and thus Assumptions 6 and 7 are relaxed. Assumptions 1 and 9 are relaxed due to two regression models OLS and Tobit being used for comparative purposes. Time constraint and data availability issues restricted the exploration of explanatory factors to only selected elements in governance and operation of superannuation funds. Assumption 3 relates to the intercept (β_0) which is of little value in empirical studies. Assumption 2 is often relaxed in empirical studies as it does not severely affect the estimated coefficients (Gujarati & Porter 2009). Therefore, it is unnecessary to have a comprehensive list of tests. It is common that researchers who explored the relationship between the efficiency scores and explanatory factors using comparative models did not emphasise the robustness tests as a key component in the regression process. See Bravo-Ureta (2007), Hoff (2007), and McDonald (2009) for example. Nevertheless, three common tests were conducted for the OLS model in this study and presented in Chapter 8. They are the White's test to detect hetero-scedasticity (Assumption 4), the Durbin-Watson test to detect the auto-correlation problem (Assumption 5), and the variance inflation factor (VIF) test to assess whether multi-collinearity would be an issue (Assumption 8).

7.9 Summary

This chapter detailed the research method for the second phase which aimed to explore the association between efficiency and explanatory factors pertaining to several critical areas in the structure and conduct of superannuation funds. The selection and rationale for the OLS and Tobit models were discussed in detail. The independent explanatory variables were developed, and the comprehensive regression equation was then presented. The process of collecting samples, data recording, transposition and analysis were also deliberated. The following chapter (Chapter 8) presents the regression results in the second phase.

Chapter 8
RESULTS AND DISCUSSION – THE SECOND PHASE

8.1 Introduction

This research comprises two phases, commonly used in DEA studies. The research method and discussion of major findings in the first phase were presented in Chapters 5 and 6 respectively. The research method for the second phase was presented in Chapter 7. This chapter discusses major findings obtained from the regression analysis for the second phase using OLS and Tobit. The results obtained from both regression approaches were analysed, compared and conclusions were drawn. Standard robustness tests were carried out to ensure that the econometric properties of the OLS regression results did not violate the commonly agreed OLS regression assumptions.

The chapter begins with section 8.2 providing a descriptive statistics of the sample. In section 8.3, correlation analysis of the dependent and independent variables is presented. Section 8.4 provides the results of the regression analysis using OLS and Tobit and discusses the results. Three regression models were tested. Regression model 1 explored the effect of trustee board structure and risk management activities on efficiency. Regression model 2 investigated the effect of investment activities (asset allocations and investment options) on efficiency. Regression model 3 is comprehensive and investigated the effect of board structure, risk management and investment activities on efficiency. Section 8.5 summarises the chapter.

8.2 Descriptive statistics

The descriptive statistics of the sample are presented in Table 8.1. As outlined in Chapter 7, the sample size of the second phase was reduced to 145 superannuation funds. The 145 funds represent 63% of APRA-regulated active funds as at 30 June 2012. This sample has balanced representatives of all five different fund types (Table 8.1). The total net assets of the sample are significant as compared to the population, approximately $494 and $553 billion in 2010–11 and 2011–12 respectively (APRA-regulated funds total net assets are $826 and $882 billion in 2011 and 2012 respectively). Average fund size for 2010–12 ranges from $3.3 to 3.8 billion, with the smallest fund value being $1.6 million and the largest fund value being $51.6 billion. While 2010–11 experienced a moderate average investment return (6.98%), 2011–12 showed a small negative average investment return (–0.56%).

Table 8.1. Descriptive statistics of the sample, the second phase, 2010–12

Description	**2010–11**	**2011–12**
Total net assets ($mil)	493,939.4	553,224.9
Average fund size ($mil)	3,406.5	3,815.3
Min ($mil)	1.6	1.6
Max ($mil)	47,312.1	51,626.3
Member accounts (mil)	24.0	24.5
Return (%)	6.98	–0.56
Total funds	145	100%
Corporate	31	21.4%
Industry	49	33.8%
Public Sector	14	9.7%
Retail – normal	40	27.6%
Retail – ERF	11	7.6%

8.3 Correlation analysis

The correlation analysis which is routine in the regression process may provide some indication of the relationships between the variables. The correlation analysis is also used to provide initial information regarding the existence of serious multi-collinearity which affects the precision of the coefficient estimates (Gujarati & Porter 2009). Table 8.2 shows the Pearson correlation matrix between the dependent variable (efficiency score) and independent exploratory variables with pooled data. Efficiency scores (Efficiency) are weakly positively correlated to Australian fixed interest (AusFixInt), Australian shares (AusShare), cash (Cash), female directors (FemDir), independent directors (IndDir) and international shares (IntShare). Efficiency scores are weakly negatively correlated to directors (Dir), employer-member representatives (EmpMem), insurance (InsMem), investment options (InvOpt) and reserves (Reserve). Efficiency scores have no correlation (r = 0.007) with international fixed interest (IntFixInt). Female directors (FemDir) has the highest positive correlation coefficient (r = 0.135) with efficiency scores whereas directors (Dir) has the highest negative correlation coefficient (r = –0.189).

It is commonly agreed that, when the pair-wise correlation coefficient between the two regressors is in excess of 0.8, multi-collinearity may be a serious problem (Gujarati & Porter 2009). The correlations between independent variables, regardless of signs, are weak to moderate (lower than 0.500). The level of positive correlations appears to be lower. The results from this pooled data set indicate that serious collinearity between independent variables is unlikely for the multivariate regressions in this study.

Table 8.2. Correlation matrix between the dependent and independent variables, n=290, 2010–12

Variable	Efficiency	AusFixInt	AusShare	Cash	Dir	EmpMem	FemDir	IndDir	InsMem	IntFixInt	IntShare	InvOpt	Reserve
Efficiency	1.000	0.064	0.017	0.028	–0.189	–0.062	0.135	0.017	–0.279	0.007	0.062	–0.189	–0.073
AusFixInt	0.064	1.000	–0.300	0.064	–0.272	–0.234	–0.011	–0.050	–0.357	–0.154	–0.404	–0.077	–0.282
AusShare	0.017	–0.300	1.000	–0.442	–0.034	0.056	0.162	0.066	0.150	–0.238	0.099	–0.031	0.024
Cash	0.028	0.064	–0.442	1.000	–0.192	–0.207	–0.060	–0.034	–0.169	–0.082	–0.529	0.081	–0.222
Dir	–0.189	–0.272	–0.034	–0.192	1.000	0.352	0.020	–0.108	0.311	–0.074	0.146	–0.017	0.356
EmpMem	–0.062	–0.234	0.056	–0.207	0.352	1.000	–0.072	–0.144	0.295	–0.082	0.156	–0.200	0.292
FemDir	0.135	–0.011	0.162	–0.060	0.020	–0.072	1.000	0.140	0.047	–0.116	0.065	0.190	–0.168
IndDir	0.017	–0.050	0.066	–0.034	–0.108	–0.144	0.140	1.000	–0.165	0.163	–0.072	0.122	–0.063
InsMem	–0.279	–0.357	0.150	–0.169	0.311	0.295	0.047	–0.165	1.000	–0.065	0.204	0.150	0.333
IntFixInt	0.007	–0.154	–0.238	–0.082	–0.074	–0.082	–0.116	0.163	–0.065	1.000	0.221	0.050	–0.017
IntShare	0.062	–0.404	0.099	–0.529	0.146	0.156	0.065	–0.072	0.204	0.221	1.000	0.094	0.241
InvOpt	–0.189	–0.077	–0.031	0.081	–0.017	–0.200	0.190	0.122	0.150	0.050	0.094	1.000	–0.059
Reserve	–0.073	–0.282	0.024	–0.222	0.356	0.292	–0.168	–0.063	0.333	–0.017	0.241	–0.059	1.000

8.4 Discussion of the regression results

The modified step-wise regression analysis using Tobit and OLS in this study was carried out using three regression models. Model 1 covers board structure and risk management mechanism. Model 2 covers investment activities. Model 3 is comprehensive and includes all the independent variables, to cover board structure, risk management and investment activities. The list of independent explanatory variables selected in Chapter 7 is re-produced in Table 8.3.

Table 8.3. Description of the independent variables

Board structure
Directors (Dir)
Employer-member representatives (EmpMem)
Female directors (FemDir)
Independent directors (IndDir)
Risk management mechanism
Insurance (InsMem)
Reserves (Reserve)
Investment activities
Australian fixed interest (AusFixInt)
Australian shares (AusShare)
Cash (Cash)
International fixed interest (IntFixInt)
International shares (IntShare)
Investment options (InvOpt)

8.4.1 Model 1 – Board structure and risk management mechanism

The board structure and risk management regression model 1 (Equation 8.1) aims to analyse the effect of board structure and risk management framework on efficiency. Data for two years 2010–11 and 2011–12 were pooled and a dummy variable was added to distinguish between the two years.

Equation 8.1. Effect of board structure and risk management mechanism on efficiency

$$E_{it} = \beta_0 + \beta_1 Dir + \beta_2 EmpMem + \beta_3 FemDir + \beta_4 IndDir + \beta_5 InsMem + \beta_6 Reserve + \beta_7 Year + u_{it}$$

Where:

E	= DEA efficiency score
Dir	= number of directors on the board
EmpMem	= employer–member representative(s)
FemDir	= proportion of female directors
IndDir	= proportion of independent directors
InsMem	= insurance scheme(s) and offer(s) to members
Reserve	= reserve(s)
Year	= dummy variable, 0 for 2010–11, 1 for 2011–12
u	= residual (error) term
i	= 1,2,…,145
t	= 1,2

Three sets of regression tests were run for both financial years with the year (dummy) variable as specified in Equation 8.1, and for financial years 2010–11 and 2011–12 separately. In this section, the results of pooled data across the two years are presented. The results of separate regression runs for 2010–11 and 2011–12 are shown in Appendices 8.1 and 8.2. The combination of the time series and cross-sectional observations, or pooled data, is believed to provide more informative results, more variability and fewer violations of the multiple regression assumptions (Gujarati & Porter 2009).

Efficiency scores were regressed on six independent explanatory variables which represent the trustee board structure and the proxies for the risk management mechanism. For the board structure, the independent variables are the number of directors, the presence of employer-member representatives, the proportion of female directors, and the proportion of independent directors on the board. For the risk management mechanism, the independent variables are insurance provisions offered to members and reserve funds.

Table 8.4 presents the regression results for model 1 (Equation 8.1). The findings from this regression model with pooled data are similar to those revealed when the years were examined separately (see results in Appendices 8.1 and 8.2). The level of statistical robustness in regards to the t–statistics for separate independent variables and F–statistic for the overall model when the two year data were pooled are higher. This finding is consistent with the argument on the advantage of panel (pooled) data (Gujarati & Porter 2009). The interpretation of the Tobit-estimated coefficients have attracted contrary views. On the one hand, researchers contended that the Tobit coefficients or marginal effects could be interpreted normally like other regression coefficients, from a theoretical discussion (Gujarati & Porter 2009), or from a practical application perspective (Bravo-Ureta et al. 2007; Chilingerian 1995; Njie 2006). On the other hand, it was argued that in limited dependent variable models such as the Tobit model with values falling into the range of 0 and 1, the estimated coefficients do not have a direct interpretation. A change in censored regression models have two effects: an effect on the mean of the variable being observed, and an effect on the probability of being observed (Greene 2003). In this study, the first approach to interpreting the estimated coefficients was adopted as efficiency scores are continuous data and uncensored. This is the interpretation approach taken in the Bravo-Ureta et al.'s (2007) or Njie's (2006) studies.

As per Table 8.4, the results obtained under both OLS and Tobit models have the same coefficient values with the normal distribution of the residual term assumed for Tobit. The results under both OLS and Tobit models have similar p–value ranges and the same statistical significance levels. These findings are consistent with those reported in Bravo-Ureta et al.'s (2007) study. These findings are also consistent with Hoff's (2007) and McDonald's (2009) studies where the marginal effects between the two models were found not to be significantly different. Thus, there is little difference in the outcomes of the regression analysis under OLS and Tobit, except that the Tobit z–values are marginally more robust than OLS t–values, as shown in Table 8.4.

Table 8.4. Effect of board structure and risk management mechanism on efficiency, 2010–12

Independent variable	OLS				Tobit			
	Estimated coefficient	t–statistic	p–value		Estimated coefficient	z–statistic	p–value	
Constant	0.556	10.487	0.000	***	0.556	10.635	0	***
Directors	–0.016	–2.538	0.012	**	–0.016	–2.574	0.010	**
Employer/member	0.019	0.960	0.338		0.019	0.973	0.331	
Female directors	0.283	3.113	0.002	***	0.283	3.157	0.002	***
Independent directors	–0.087	–1.041	0.299		–0.087	–1.056	0.291	
Insurance	–0.087	–4.731	0.000	***	–0.087	–4.798	0	***
Reserve	0.044	1.446	0.149		0.044	1.467	0.143	
Year	–0.001	–0.034	0.973		–0.001	–0.034	0.973	
R–squared	0.125				Left censored		0	
Adjusted R–squared	0.107				Right censored		0	
F–statistic	6.766				Unsensored		290	
Prob(F–statistic)	0.000				Total observations		290	
Durbin–Watson stat	1.287							
Total observations	290							

* significant at the 10% level, ** significant at the 5% level, *** significant at the 1% level

When the data were not pooled, that is, when the 2010–11 and 2011–12 data were assessed separately, the results obtained under the Tobit regression for the year 2011–12 were more robust with more significant variables (see Appendix 8.2). However, when the data were pooled and thus, the number of observations doubled (290 observations), the variations in results obtained under the OLS and Tobit models reduced quite dramatically. This result may be due to a sample size twice as large (290 versus 145 observations). The result provides further evidence in regards to the advantages of larger sample sizes.

The F–statistic (6.766) for the OLS regression is significant at the 1% level (p–value = 0.000). This result implies that the overall multivariate OLS regression model is robust and statistically significant. The R–squared value of 12.5%, adjusted to 10.7% to take into account the number of independent variables, indicates that about 12.5% (10.7%

after adjustment) of the variation in the efficiency score of a superannuation fund can be explained by the board structure and risk management mechanism.

The dummy variable year is not statistically significant with a p–value of 97.3% and a coefficient of –0.001, suggesting there is no difference between 2010–11 and 2011–12 data. Employer/member representatives (EmpMem), independent directors (IndDir), and reserve (Reserve) are not statistically significant under both the OLS and Tobit regression. By contrast, directors (Dir) is significant at the 5% level, female directors (FemDir), and insurance (InsMem) are significant at the 1% level.

The number of directors on the board has a weakly negative association (coefficient of –0.016) with efficiency. The result is consistent with the various findings in the literature on the effect of board size on organisation performance (Albrecht & Hingorani 2004; Yermack 1996). Although large boards may have a positive effect on certain aspects of performance (depending on what is studied), it is also debated that it is the quality of directors on the board, their conduct and other endogenous factors, which are not often observed, and not the number of board members, that influence the performance of an organisation (Adams, Hermalin & Weisbach 2010; Adler & Golany 2001).

Similar to the result on board size, insurance offered to members has a weakly negative relationship with efficiency (–0.087). Thus, insurance covers do not affect fund efficiency performance positively. It might be possible that the more insurance covers there are, the higher the operating expenses and consequently lower efficiency performance. One of the current issues discussed in the literature is the complexity of pension (superannuation) product offers to members and, consequently, the increase of operating costs (Boeri et al. 2006; Cooper et al. 2010b). To the best knowledge of the thesis's author, the effect of insurance covers on performance of superannuation funds has not been studied. Protection of member benefits through insurance has been offered mostly on a default basis to working members, nevertheless, the quality of the insurance services and their effect on operating costs have not been scrutinised in empirical studies.

In contrast to the results on the board size and insurance, female directors (FemDir) has a positive relationship with efficiency with an estimated coefficient of 0.283. Previous empirical studies provided various results on the contribution of female directors to an organisation's performance. This finding supports the results found in studies by Carter, Simkins and Simpson (2003), Erhardt, Werbel and Shreider (2003), and Bear, Rahman and Post (2010).

The three remaining explanatory variables, employer-member representatives (EmpMem), independent directors (IndDir) and reserves (Reserve) are not statistically significant in both the OLS and Tobit regressions at the conventional levels of significance (1%, 5% or 10%). Not taking into account the level of statistical significance, employer-member, independent directors and reserves only have a very slightly negative or positive effect on efficiency with coefficients of 0.019, –0.087 and 0.044 respectively. Previous empirical studies produced inconsistent results in regards to the influence of independent directors on performance. See works by Beiner et al. (2006), Barnhart, Marr and Rosenstein (1994), (Tufano & Sevick 1997) in the corporate sector; or Clark and Unwin (2008) and Cocco and Volpin (2007) in the pension fund sector. Further, the appointment of employer-member representatives and their contribution to fund performance have attracted different views from both proponents and opponents (Palacios 2002; Yermo & Stewart 2008).

Three standard robustness tests were carried out to assess if key assumptions pertaining to the OLS multiple regression model were satisfied: the Durbin-Watson test to detect autocorrelation between the residual (error) terms, the VIF test to assess the possibility of serious correlations between independent variables, and the White test to detect hetero-scedasticity.

When there is a presence of autocorrelation between the residual terms, the coefficients remain consistent and asymptotically normally distributed. However, the variance of the coefficients is much larger and thus, the prediction values are less precise. The Durbin-Watson values range from 0 to 4. As a rule of thumb, if the parameter *d* in the Durbin-Watson test is found to be 2 in an application, then it can be assumed that there is no autocorrelation between the residual term, either positive or negative. By contrast, if the parameter *d* in the Durbin-Watson test is close to 0 or 4, it can be assumed that the model suffers from serious positive or negative correlations of the residual terms, respectively (Gujarati & Porter 2009). At a Durbin-Watson value of 1.287 (Table 8.4), it is unlikely that the residual term of the regression model presented in Equation 8.1 suffers from serious autocorrelations.

Multi-collinearity is almost always present in data collected in most social sciences when a large number of independent variables is present in the model (Gujarati & Porter 2009). Multi-collinearity is therefore a question of degree, not of presence or absence. When multi-collinearity is present, unbiased consistent estimates can still be achieved. Nevertheless, it is harder to obtain coefficient estimates with small standard errors (Achen 1982). There is no unique method of detecting it or measuring its magnitude. Two common warning signs are (1) high R-squared but few significant t–values and (2) high pair–wise or zero–order correlation coefficient between the independent variables. Common detection approaches are: (1) examination of partial correlation, (2) obtaining auxiliary regression and (3) obtaining eigenvalues, tolerance/VIF, condition index or scatterplot (Gujarati & Porter 2009).

The regression model has a low R-squared value (Table 8.4). Therefore, it is not a warning sign in regards to the presence of multi-collinear independent variables. The VIF test provided more evidence of multi-collinearity. The VIF shows the extent to which the variance of a coefficient estimate of an independent variable is inflated due to collinearity with other independent variables. As a rule of thumb, if the VIF of a variable is higher than 10, that variable is highly collinear. Two forms of VIF for the OLS regression model, centred and uncentred were provided by *Eviews*. The *centred*

VIF is the ratio between the variance of the coefficient estimate from the original equation and the variance from a coefficient estimate from an equation with that regressor and *a constant*. The *un-centred* VIF is the ratio between the variance of the coefficient estimate from the original equation and the variance of a coefficient estimate from an equation with that regressor and *no constant* (IHS Global 2013). In this study, the *centred* VIF values are more appropriate as all the regression models contain a *constant*. As per Table 8.5, most of the centred VIFs are low, therefore, it is very unlikely that the OLS regression model suffers from serious collinearity between the independent variables.

Table 8.5. Regression model 1
Variance Inflation Factors (VIFs) between independent variables, 2010–12

Independent Variable	Coefficient Variance	Un-centred VIF	Centred VIF
Constant	0.003	12.313	NA
Directors	0.000	10.495	1.288
Employer/member	0.000	1.971	1.233
Female directors	0.008	2.945	1.075
Independent directors	0.007	1.347	1.065
Insurance levels	0.000	6.854	1.253
Reserves	0.001	3.517	1.300

As in the case of autocorrelation, the presence of hetero-scedasticity of the residual variance results in the estimated coefficients being inefficient or less precise (Gujarati & Porter 2009). Table 8.6 shows the corrected standard errors and levels of covariance using the White test. There are few differences between the uncorrected standard errors and White's standard errors. The White p–values for the significant variables are mostly within the same range as for the uncorrected version. Therefore, it could be concluded that the variance of the residual term does not suffer from hetero-scedasticity.

Table 8.6. Regression model 1
White heteroscedasticity–consistent standard errors and covariances, 2010–12

Independent Variable	Uncorrected OLS Std. Error	White's Std. Error	White's t–value	White's p–value	
Constant	0.053	0.058	9.518	0.000	
Directors	0.006	0.005	–3.285	0.001	***
Employer/member	0.020	0.015	1.251	0.212	
Female directors	0.091	0.094	3.005	0.003	***
Independent directors	0.084	0.101	–0.865	0.388	
Insurance	0.018	0.020	–4.316	0.000	***
Reserve	0.030	0.031	1.406	0.161	
Year	0.029	0.030	–0.033	0.973	

* significant at the 10% level, ** significant at the 5% level, *** significant at the 1% level

8.4.2 Model 2 – Investment activities

Equation 8.2 expresses the relationship between efficiency and investment activities which include asset allocations and investment options offered to superannuation fund members. Similar to the regression analysis for regression model 1, three sets of data, financial years 2010–11, 2011–12 and pooled data for both financial years 2010–12 were analysed. This section discusses the results from the pooled data set of 2010–12. The results from the separate regression runs, which are not significantly different from the pooled data results, are shown in Appendices 8.3 and 8.4.

Equation 8.2. Effect of investment activities on efficiency

$E_{it} = \beta_0 + + \beta_1 AusFixInt + \beta_2 AusShare + \beta_3 Cash + \beta_4 IntFixInt + \beta_5 IntShare + \beta_6 InvOpt + \beta_7 Year + u_{it}$

Where:

E	= DEA efficiency score
AusFixInt	= proportion of assets invested in Australian fixed interest schemes
AusShare	= proportion of assets invested in Australian shares
Cash	= proportion of assets held in cash
IntFixInt	= proportion of assets invested in international fixed interest schemes
IntShare	= proportion of assets invested in international shares
InvOpt	= number of investment options offered to fund members
Year	= dummy variable, 0 for 2010–11, 1 for 2011–12
u	= residual (error) term
i	= 1,2,…,145
t	= 1,2

Table 8.7 presents the regression results for model 2 (Equation 8.2). Apart from international fixed interest (IntFixInt), all other variables are statistically significant at p–values of 1% and 5%. The overall multiple regression model is statistically significant with the F–statistic of 3.518 (p–value = 0.001). Although most of the independent variables are statistically significant, the R–squared and adjusted R–squared values are low, at 8% and 5.7% respectively. That is, after the adjustment of the number of independent variables, only 5.7% of the variation in efficiency scores is explained by investment activities. The finding is not surprising as efficiency performance of a superannuation fund should depend on a wider range of factors, of which investment activities are a part. The Durbin-Watson test provided a *d*-value as high as 1.316. Therefore, autocorrelations between the residual terms are not a major issue for model 2.

Table 8.7. Effect of investment activities on efficiency, 2010–12

Independent variable	OLS				Tobit			
	Estimated coefficient	t–statistic	p–value		Estimated coefficient	z–statistic	p–value	
Constant	0.035	0.282	0.778		0.035	0.286	0.775	
AusFixInt	0.420	2.725	0.007	***	0.420	2.764	0.006	***
AusShare	0.386	2.173	0.031	**	0.386	2.203	0.028	**
Cash	0.493	2.995	0.003	***	0.493	3.037	0.002	***
IntFixInt	0.229	0.782	0.435		0.229	0.793	0.428	
IntShare	0.880	3.305	0.001	***	0.880	3.352	0.001	***
InvOpt	–0.036	–3.719	0.000	***	–0.036	–3.771	0.000	***
Year	–0.001	–0.019	0.985		–0.001	–0.019	0.985	
R–squared		0.080			Left censored		0	
Adjusted R–squared		0.057			Right censored		0	
F–statistic		3.518			Uncensored		290	
Prob(F–statistic)		0.001			Total observations		290	
Durbin–Watson stat		1.316						
Total observations		290						

* significant at the 10% level, ** significant at the 5% level, *** significant at the 1% level

Despite the low R–squared value, five out of six independent explanatory variables were predicted as affecting efficiency scores at the 1% and 5% significance level in both the OLS and Tobit regressions. Australian fixed interest (AusFixInt), Australian shares (AusShare), cash (Cash), international fixed interest (IntFixInt), and international shares (IntShare) have positive associations with efficiency. Investment options (InvOpt) has a weakly negative association with efficiency.

International shares (IntShare) has the highest positive coefficient of 0.880, significant at a p–value of 0.001, followed by cash (Cash) with a coefficient of 0.493, significant at a p–value of 0.003. Both periods 2010–11 and 2011–12 produced poor investment returns for the Australian share market (S&P Dow Jones & ASX 2014). The average investment return for Australian APRA-regulated superannuation funds in 2011–12 was below the historical averages (APRA 2013a). These facts may explain why holding cash is better for investment returns and thus efficiency scores. The research finding indicates that global diversifications may contribute to improving investment returns, mitigating risk and thus, improving efficiency of the sample funds. The findings support previous studies by Jorion and Goetzmann (1999), Solnik, Boucrelle and Le Fur (1996), and Useem and Mitchell (2000).

Investment options (InvOpt) is the only independent explanatory variable that has a negative coefficient (–0.036). This finding predicts that the more investment options there are, the less efficient a fund becomes. The result is consistent with the literature discussed in Chapter 7. It has been argued that a very high number of investment options could increase overall costs, or lead members to choose inefficient investment options and reduce investment returns (Coleman, Esho & Wong 2006; Tang et al. 2010). The dummy variable representing the years is not statistically significant (p–value = 0.985 and coefficient = 0.001). Thus, there are empirically no differences between 2010–11 and 2011–12 data.

Tables 8.8 and 8.9 present the results on the robustness tests to assess the risk of multi-collinearity between the independent variables and hetero-scedasticity in the variance of the residual terms. As the VIFs are low, it is unlikely that the OLS regression model suffers from serious multi-collinearity (Table 8.8). Likewise, there are no major differences between the uncorrected OLS standard errors and the White adjusted standard errors. The number of statistically significant independent variables based on the White estimators have the same significance levels (Table 8.9).

Table 8.8. Regression model 2
Variance Inflation Factors (VIFs) between independent variables, 2010–12

Variable	Coefficient Variance	Uncentred VIF	Centered VIF
Constant	0.015	67.587	NA
AusFixInt	0.024	3.579	1.596
AusShare	0.032	14.914	1.789
Cash	0.027	3.580	2.171
IntFixInt	0.086	2.376	1.200
IntShare	0.071	15.686	2.014
InvOpt	0.000	3.192	1.036
Year	0.001	2.006	1.003

Table 8.9. White’s hetero-scedasticity–consistent standard errors and covariances, 2010–12

Independent Variable	Uncorrected OLS Std. Error	White's Std. Error	White's t–value	White's p–value	
Constant	0.123	0.103	0.336	0.737	
AusFixInt	0.154	0.151	2.787	0.006	***
AusShare	0.178	0.152	2.535	0.012	**
Cash	0.164	0.151	3.253	0.001	***
IntFixInt	0.293	0.307	0.746	0.456	
IntShare	0.266	0.241	3.643	0.000	***
InvOpt	0.010	0.011	–3.363	0.001	***
Year	0.030	0.030	–0.019	0.985	

* significant at the 10% level, ** significant at the 5% level, *** significant at the 1% level

8.4.3 Model 3 – Board structure, risk management and investment activities

Regression model 3 (Equation 8.3 overleaf, which is a re-statement of Equation 7.7) includes all the independent explanatory variables developed in Chapter 7. This comprehensive model aims to assess the effect of board structure, risk management mechanism, and investment activities on the efficiency score of a superannuation fund. The process to analyse data in model 3 is similar to that used for models 1 and 2. Regression results for the pooled data covering two years with 290 observations are presented in this section. Regression results for individual years 2010–11 and 2011–12 are provided in Appendices 8.5 and 8.6.

Equation 8.3. Effect of board structure, risk management and investment activities on efficiency, 2010–12

$$E_{it} = \beta_0 + \beta_1 Dir + \beta_2 EmpMem + \beta_3 FemDir + \beta_4 IndDir + \beta_5 InsMem + \beta_6 Reserve + \beta_7 AusFixInt + \beta_8 AusShare + \beta_9 Cash + \beta_{10} IntFixInt + \beta_{11} IntShare + \beta_{12} InvOpt + u_{it}$$

Where:

E	= DEA efficiency score
Dir	= board size represented by the number of directors on the board
EmpMem	= employer-member representative(s)
FemDir	= proportion of female directors
IndDir	= proportion of independent directors
InsMem	= insurance scheme(s) and offer(s) to members
Reserve	= reserve(s)
AusFixInt	= proportion of assets invested in Australian fixed interest schemes
AusShare	= proportion of assets invested in Australian shares
Cash	= proportion of assets held in cash
IntFixInt	= proportion of assets invested in international fixed interest schemes
IntShare	= proportion of assets invested in international shares
InvOpt	= number of investment options offered to fund members
u	= residual (error) term
i	= 1,2,…,145
t	= 1,2

The regression results for the comprehensive model using pooled data are shown in Table 8.10. These results are more robust than when efficiency scores were regressed against independent explanatory variables for 2010–11 and 2011–12 separately (see Appendices 8.5 and 8.6). The overall model is statistically sound with an F–statistic of 4.528 at a p–value of 0.000. The R–squared values are the highest as compared to those in models 1 and 2, at 17.6% (13.7% after adjustment for the number of independent variables). This finding indicates that regression model 3 may be the best regression model for exploring the relationship between efficiency and explanatory factors in this study.

Table 8.10. Effect of board structure, risk management and investment activities on efficiency, 2010–12

Independent variable	OLS				Tobit			
	Estimated coefficients	t–statistic	p–value		Estimated coefficient	z–statistic	p–value	
Constant	0.382	2.408	0.017	**	0.382	2.468	0.014	***
AusFixInt	0.074	0.424	0.672		0.074	0.435	0.664	
AusShare	0.153	0.822	0.412		0.153	0.842	0.400	
Cash	0.266	1.526	0.128		0.266	1.564	0.118	
Dir	–0.014	–2.094	0.037	**	–0.014	–2.146	0.032	**
EmpMem	0.005	0.243	0.808		0.005	0.249	0.803	
FemDir	0.297	3.208	0.002	***	0.297	3.288	0.001	***
IndDir	–0.029	–0.338	0.736		–0.029	–0.346	0.729	
InsMem	–0.077	–3.973	0.000	***	–0.077	–4.073	0.000	***
IntFixInt	0.025	0.082	0.935		0.025	0.084	0.933	
IntShare	0.659	2.484	0.014	**	0.659	2.546	0.011	**
InvOpt	–0.034	–3.425	0.001	***	–0.034	–3.511	0.000	***
Reserve	0.032	1.042	0.299		0.032	1.068	0.286	
Year	0.000	–0.009	0.993		0.000	–0.009	0.993	
R–squared		0.176			Left censored		0	
Adjusted R–squared		0.137			Right censored		0	
F–statistic		4.528			Uncensored		290	
Prob(F–statistic)		0.000			Total observations		290	
Durbin–Watson stat		1.327						
Total observations		290						

* significant at the 10% level, ** significant at the 5% level, *** significant at the 1% level

The findings presented in Table 8.10 are consistent with those found in models 1 and 2. That is, the independent variables which were found to be statistically significant in the comprehensive model (Equation 8.3) were also statistically significant in models 1 (Equation 8.1) and 2 (Equation 8.2).

In regards to the board structure and risk management mechanism, Directors (Dir) shows a weakly negative association with efficiency (coefficient of –0.014), significant at the 5% level (p–value = 0.037). Female directors (FemDir) is statistically significant at the 1% level (p–value = 0.002) with a positive coefficient of 0.297. This finding indicates that the presence of female directors on the board has a positive effect on efficiency. Insurance (InsMem) is significant at 1% level (p–value = 0.000) with a negative coefficient of –0.077. The result shows that insurance covers offered to members has a weakly negative association with efficiency.

In regards to investment activities, international shares (IntShare) is statistically significant at the 5% level (p–value = 0.014) with a coefficient of 0.659. The finding indicates that investments in international shares have a strong positive effect on efficiency. Investment options (InvOpt) has a negative coefficient (–0.034) and is statistically significant at the 1% level (p–value = 0.001), which indicates that there is a weakly negative association between investment options and efficiency. Cash (Cash) is not significant at the conventional significance levels (1%, 5% or 10%). However, with a p–value of 0.128 and coefficient of 0.266, cash holdings show a positive effect on efficiency. This result implies that investing in conservative asset classes such as cash may improve efficiency performance of superannuation funds during financial crises. The SMSF sector which mainly invested in conservative asset classes showed better investment performance than APRA-regulated funds during the GFC (ATO 2013).

In regards to robustness tests, the Durbin-Watson test shows a *d*–value of 1.327. Thus, there is no serious auto-correlation between the residual terms. The results of two standard regression tests to assess the level of multi-collinearity between the independent variables and of hetero-scedasticity in the variance of the error terms are shown in Tables 8.11 and 8.12 respectively. Similar to previous tests conducted for models 1 and 2, the results indicate that the risk of multi-collinearity is low with all centred VIFs found being below 3.

Table 8. 11. Regression model 3
Variance Inflation Factors (VIFs) between independent variables, 2010–12

Variable	Coefficient Variance	Un-centred VIF	Centred VIF
Constant	0.025	122.649	NA
AusFixInt	0.030	4.955	2.210
AusShare	0.034	17.784	2.133
Cash	0.030	4.401	2.670
Dir	0.000	11.805	1.449
EmpMem	0.000	2.161	1.352
FemDir	0.009	3.182	1.162
IndDir	0.007	1.490	1.177
InsMem	0.000	7.823	1.430
IntFixInt	0.089	2.700	1.364
IntShare	0.070	17.016	2.184
InvOpt	0.000	3.654	1.186
Reserve	0.001	3.740	1.383
Year	0.001	2.021	1.010

Table 8.12. Regression model 3
Variance Inflation Factors (VIFs) between independent variables, 2010–12

Independent Variable	Uncorrected OLS Std. Error	White's Std. Error	White's t–value	White's p–value	
Constant	0.159	0.147	2.605	0.010	***
AusFixInt	0.173	0.177	0.415	0.679	
AusShare	0.186	0.160	0.956	0.340	
Cash	0.175	0.156	1.702	0.090	*
Dir	0.007	0.005	–2.530	0.012	**
EmpMem	0.020	0.010	0.495	0.621	
FemDir	0.093	0.092	3.229	0.001	***
IndDir	0.086	0.096	–0.303	0.762	
InsMem	0.019	0.019	–3.994	0.000	***
IntFixInt	0.299	0.277	0.089	0.929	
IntShare	0.265	0.231	2.858	0.005	***
InvOpt	0.010	0.011	–3.271	0.001	***
Reserve	0.031	0.032	0.999	0.319	
Year	0.029	0.029	–0.009	0.993	

* significant at the 10% level, ** significant at the 5% level, *** significant at the 1% level

The robust standard errors obtained under the White test (Table 8.12) are not significantly different from the uncorrected standard errors (Table 8.10). In effect, the number of significant independent variables increases slightly under the White test (Cash is now significantly at the 10% level) and the p–value of international shares (IntShare) has been improved.

To conclude this section, a summary of the regression results for regression model 3, the most comprehensive model, is presented below (Table 8.13). Five independent explanatory variables are statistically significant. The number of directors on the board (board size), insurance covers offered to members and the number of investment options are negatively related to efficiency. These findings indicate that simplified board structure and reduction of board size may be more beneficial to superannuation fund members. Similarly, simplified low-cost insurance offers, as well as fewer investment options, may enhance efficiency performance of superannuation funds. By contrast, the proportion of female directors on the board and the proportion of superannuation assets invested in international equities are positively related to efficiency. These results show that diversification of board structure by including more female trustee directors and diversification of investments into selected global financial markets may improve efficiency.

Table 8.13. Regression model 3 results

Explanatory variable	**Significance level**		**Result**
	OLS	**Tobit**	
Australian fixed interest			Inconclusive
Australian shares			Inconclusive
Cash			Inconclusive
Directors	**	**	Marginally negative relationship
Employer–member			Inconclusive
Female directors	***	***	Positive relationship
Independent directors			Inconclusive
Insurance	***	***	Marginally negative relationship
International fixed interest			Inconclusive
International shares	**	**	Positive relationship
Investment options	***	***	Marginally negative relationship
Reserves			Inconclusive

* significant at the 10% level, ** significant at the 5% level, *** significant at the 1% level

8.5 Summary

This chapter presented and discussed the regression results for three regression models. The regression analysis aimed to explore the relationship between efficiency and explanatory factors which comprise board structure, risk management mechanism, and investment activities of the sample superannuation funds. The final chapter (Chapter 9) summarises the findings in both the first phase and second phase (Chapters 6 and 8 respectively), and discusses the implications of the research results in regards to theory, policy and practice. The chapter also outlines several limitations of the study and possible avenues for future research.

Chapter 9
SUMMARY AND CONCLUSIONS

9.1 Introduction

This research examined the relative economic efficiency of Australian superannuation funds. The study covers two main research issues: relative economic efficiency, and the drivers that influence efficiency. The thesis comprises nine chapters. Chapter 1 introduced the motivations, objectives, main research questions of the study, and the structure of the thesis. The literature review was presented over three chapters. Chapter 2 provided an overview of the global pension market in light of the SCP framework. Chapter 3 extended the overview of performance of pension funds from an investment return perspective presented in Chapter 2, to a theoretical discussion on approaches to performance measurement of mutual and pension funds. Chapter 3 introduced productivity and efficiency concepts and the measurement of efficiency as an alternative approach. Chapter 4 presented an overview of the Australian superannuation system together with an analysis of its strengths, weaknesses and current issues. Chapter 4 outlined the SCP framework for the Australian superannuation system and concluded with a discussion of the gaps in the literature and the conceptual model for the study. The research design comprised two phases. Chapters 5 and 6 presented the research method for the first phase and the results respectively. Chapters 7 and 8 presented the research method for the second phase and the results respectively.

This chapter aims to provide a summary of the major findings, conclusions and implications of the research. In addition, the chapter discusses the contributions of the research to theory, policy and practice. Finally, it outlines several limitations of the study and possible avenues for future research.

9.2 Re-statement of the main research questions

The two main research questions explored in this study are:

1) To what extent do Australian superannuation funds operate efficiently, and

2) What are the drivers that influence this efficiency?

The two main research questions were addressed through two phases in the research design. The first phase estimated the efficiency scores of superannuation funds for the period 2005–12. The second phase explored the relationship between efficiency scores and independent explanatory variables which pertain to board structure, risk management and investment activities for the period 2010–12. The second phase aimed at dissecting governance and operational factors that contributed to the efficiency performance of superannuation funds.

9.3 Summary of main findings and conclusions

Five objectives of the study presented in Chapter 1 have been addressed systematically from Chapter 2 through to Chapter 8. This section summarises the main findings obtained from the first and second phases of the study. In the first phase, efficiency scores were estimated for individual years and for the whole period of 2005–12. The DEA linear programming model was applied in this phase. In the second phase, OLS and Tobit regressions were used in parallel to investigate the effect of governance and operational characteristics on efficiency scores. Due to data availability issues, only data for two years (2010–12) were included in this phase. Efficiency scores of superannuation funds were re-estimated to match with the new data set.

9.3.1 The first phase – Efficiency scores of superannuation funds

The sample size in the first phase was 183 funds, representing approximately 79% of 231 active funds as at 30 June 2012. The VRS DEA model was used where funds were benchmarked against funds of the same size. As per Table 9.1, the average number of efficient funds was found to be 28 (15.3%) in the individual year DEA estimates. There were 27 efficient funds (14.8%) in the period estimates where the volatility of investment return (the SD of investment return variable) was included as an additional input. The results obtained from the individual year estimates appear consistent with those obtained from the period estimates. There was little change in efficiency scores when the SD of return was added. The average efficiency score in the individual year estimates was 0.370, while the average efficiency score in the period estimates was slightly improved, to 0.405. The SD values of efficiency scores were high, at 0.323 and 0.320 for the individual year and period estimates respectively. The low proportion of efficient DMUs and low average efficiency scores obtained for the sample are not unusual in DEA studies on investment and mutual funds. When the sample size increases, the average efficiency score may decrease. This is possibly due to the larger variations in fund characteristics, which may be inherent within investment funds. Similar results were found in studies by Anderson et al. (2004), Gregoriou (2006), and Galagedera and Silvapulle (2002).

Table 9.1. Efficient funds, average net assets and efficiency scores, individual years and period, 2005–12

Measure	Individual year average	Period average
Efficient funds	28	27
Average net assets ($m)	$8,431	$7,342
Inefficient funds	155	156
Average net assets ($m)	$1,876	$2,097
Mean score	0.370	0.405
Median score	0.241	0.268
SD	0.323	0.320
Min. score	0.034	0.046
Max score	1.000	1.000

In both individual year and period DEA estimates, it was observed that the average net assets of efficient funds were much higher than those of inefficient funds. In the individual year estimates, the average net assets of efficient funds were $8,431 million, compared to $1,876 million of inefficient funds. In the period estimates, the average net assets of efficient funds were $7,342 million and those of inefficient funds were

$2,097 million. This finding indicates that the efficiency performance of large funds was found to be better than that of small funds. Thus, there are benefits in scale economies. These findings are consistent with the literature which supports larger fund size and scale economies to reduce operation costs (Cooper et al. 2010a). The average minimum efficiency scores in both individual year and period estimates ranged between 0.034 and 0.046. As the maximum efficiency score is 1, very low minimum scores indicate that the performance quality in regards to relative economic efficiency varied enormously among the sample funds.

Input reduction targets were calculated for inefficient funds and presented in a quintile analysis in Chapter 6. Most of the inefficient funds had very low efficiency scores and were classified into lower quintiles such as Quintiles 4 (scored 0.200–0.399) and 5 (scored 0.001–0.199). Consequently, input reduction targets were significantly higher for these two quintiles. Similar results were found under the period DEA estimates. To be efficient, Quintile 4 funds needed to reduce total expenses by an average of 75% and volatility of return by 80%. Quintile 5 funds needed to reduce total expenses by, on average, 83%, and volatility of return by 89%. These targets would be extremely difficult, if not impossible, for inefficient funds to achieve in practice.

As the VRS model was applied to estimating efficiency scores and funds were scored against those of the same size, overall low efficiency scores for the majority of the sample funds indicate that there is room for improvement in the efficiency performance of these sample funds. The efficiency could be improved by effectively reducing overall costs and controlling the volatility of investment returns. For the majority of the sample funds, there are opportunities for reducing both operating and investment expenses as well as adjusting asset allocation to avoid severe negative investment returns during financial crises. The issue of Australian superannuation funds concentrating the majority of fund assets in the Australian share market has been in the spotlight in the aftermath of the GFC. There have been proposals to better diversify superannuation assets in asset classes other than Australian shares (Cooper et al. 2010a; Newell, Peng & De Francesco 2011).

Retail ERFs, a special case, had the highest efficiency scores (0.717) on average in the individual year estimates. Retail ERFs had only one investment option, and the majority of the fund assets were invested in conservative asset classes, ready to be liquidated or transferred to a more permanent fund (APRA 2013c). The study period of 2005–12 recorded three years of negative investment returns for the Australian share market. The effect of passive and simple investment strategies in the management of investment funds has been discussed at length in the literature. It has been debated that for long term investments, active investment strategies and complex investment portfolio structures add little value. By contrast, passive investments are more cost effective and yield higher returns (Ang, Goetzmann & Schaefer 2009; Malkiel 2003). This result supports government policies for the establishment of the low-cost, simplified superannuation option *My Super* proposed in the Super System Review. This result is also consistent with the finding obtained in the second phase where the number of investment options was found to be negatively related to efficiency (see Chapter 8).

9.3.2 The second phase – Efficiency scores and explanatory factors

The sample size in the second phase was 145 funds, representing 63% of the active funds as at 30 June 2012. Efficiency scores were regressed against 12 independent explanatory variables in three regression models using OLS and Tobit. Regression model 1 contains six independent variables representing the trustee board structure and risk management mechanism. Regression model 2 contains six independent variables representing the investment activities in regards to asset allocations and investment options. Regression model 3 contains all the independent variables.

Five independent variables were statistically significant in all three regression models. These variables are the number of directors on the board (board size), the proportion of female directors, insurance covers offered to members, the proportion of assets invested in international equities and the number of investment options. Table 9.2 summarises the regression results for the statistically significant independent variables. Female directors and investments in international equities have positive relationships with efficiency. Board size, insurance cover and investment options, by contrast, have weakly negative relationships with efficiency.

The findings indicate that the appointment of female trustee directors on the board contributes positively to superannuation fund efficiency. Likewise, the diversification of superannuation asset investments into international equities enhances efficiency. These findings are consistent with the literature which contends that board diversity and female directors on the board positively influence organisation performance (Bear, Rahman & Post 2010; Carter, Simkins & Simpson 2003; Erhardt, Werbel & Shrader 2003), and that investments in international equities are beneficial for both pension fund members and mutual fund investors (Useem & Mitchell 2000; Solnik 1988; Solnik, Boucrelle & Le Fur 1996).

Table 9.2. Statistically significant explanatory factors

Independent explanatory variable	Significance level	Conclusion
Number of directors on the board	p-value < 5%	Marginally negative relationship
Proportion of female directors on the board	p-value < 1%	Positive relationship
Insurance covers offered to members	p-value < 1%	Marginally negative relationship
Proportion of assets invested in international equities	p-value < 5%	Positive relationship
Investment options	p-value < 1%	Marginally negative relationship

The number of directors on the board, insurance covers offered to members, and the number of investment options negatively affect efficiency scores. Studies on board size show various results in the literature, as discussed in detail in Chapter 7. The result on investment options supports the research findings in the first phase (Chapter 6), where retail ERFs recorded the highest efficiency scores on average among all fund types, and normal retail funds had the lowest efficiency scores on average. Retails ERFs had one investment option and retail funds excluding ERFs could have over 200 investment options. The finding on investment options is also consistent with studies by Coleman, Esho and Wong (2006) and Tang et al. (2010). The higher the number of investment options, the higher the agency costs (Coleman, Esho & Wong 2006). The more choices members made, the worse the investment returns (Tang et al. 2010). A high number of investment options therefore would not be beneficial for fund members.

9.4 Implications and contributions

The study has important implications and contributes to theory, policy and practice in several dimensions. These implications and contributions are detailed below.

9.4.1 Contributions to theory and the literature

The study contributes to the literature on the SCP framework, in particular, to the application of the framework to superannuation funds. Several critical areas identified in the SCP of the Australian superannuation system were used to form the conceptual model for the study, to narrow the research areas of this study, and to establish testable independent explanatory variables. A consistent flow from a broad overview of the existing superannuation system to highlighted current issues could therefore be systematically established. The SCP framework for the Australian superannuation system also assisted in identifying other avenues for future research, as discussed in more detail in section 9.5.

The study extended the application of the DEA linear programming technique, commonly used in other financial services sectors, in particular the banking sector, to Australian superannuation funds. The study contributes to and enriches the DEA literature. Further, as superannuation assets approximate Australia's GDP and have been continuously growing, the superannuation industry is a very important part of the national income mix (APRA 2007a; Cooper et al. 2010a; Murray et al. 2014). As the government has been shifting the pension funding burden to individual member accounts, improving the efficiency performance and enhancing members' benefits are increasingly critical for the sustainability of the superannuation system. The importance of empirical studies on superannuation therefore cannot be overstated. The study explored the relative economic efficiency of superannuation funds and explanatory factors and, thus, contributes to the literature on superannuation.

Another contribution of the study relates to the research methodology used for the DEA analysis. As outlined in Chapter 7, OLS and Tobit regressions have been commonly used in the second phase of the DEA analysis. The study used both models in the investigation of the effect of explanatory factors on efficiency scores for comparative purposes. Efficiency scores were not censored (as in the case of the pure Tobit model) and were fed as they were into the regression equations. The regression results from both the OLS and Tobit regressions models were only marginally different and the statistical conclusions from both models were the same. Therefore, from the findings in this study, it could be concluded that OLS and Tobit estimators are comparable for the second phase. The Tobit model appears to be researchers' preferred method in this phase. Tobit may have been chosen possibly due to the marginally more robust regression results and the justification of the unique characteristic of efficiency scores which are continuous data but fall within the range of 0 and 1 (revisit Chapter 7).

9.4.2 Implications for policy and practice

The study has practical contributions to and implications for policy. Efficiency scores were lowest in the years 2007–8 and 2008–9, when the average investment returns of most superannuation funds were significantly negative (APRA 2012). The results reflected the developments in the financial markets. The two years 2007–8 and 2008–9 were particularly difficult for investors worldwide with the effect of the GFC (De Haas & Van Horen 2012). Thus, with a relevant selection of inputs and outputs, not only does DEA serve as an internal benchmarking tool, it can also indirectly reflect financial market movements, a key factor in determining member benefits and timing for switching member investment options. The findings contribute important information to superannuation industry practitioners and members.

Productivity and efficiency are critical issues in government policies relating to various aspects of the economy including superannuation (Cooper et al. 2010a; Murray et al. 2014). Despite the strength of the Australian superannuation system, lack of efficiency has been raised as an issue and an area for improvement in both the Super System Review 2010 and the Financial System Inquiry 2014 reports (Cooper et al. 2010a; Murray et al. 2014). The third tranche of the superannuation legislation amendments, *Further My Super and Transparency Measures*, following the recommendations of the Super System Review, emphasises the need to improve efficiency where criteria on fees were legislated (AUSTLII 2013). Studies on efficiency therefore fit within the government's strategic direction. This study was partially funded by APRA and RBA under the Brian Gray Scholarship. The results from the first phase of the study have been approved by APRA. Its corresponding research report published on the APRA website is now in the permanent APRA archives, accessible to academic and industry researchers. The study has merits and its results provide useful information for policy developers and superannuation regulators.

The results of the DEA estimates show that the efficiency scores of the sample funds, which make up more than three quarters of APRA-regulated active funds, vary widely. These findings have important implications. From a practical perspective, it is necessary to narrow the gap in efficiency scores and the variations in efficiency performance between Australian superannuation funds. This improvement could be achieved by reducing the operating and investment expenses, and the volatility of investment returns. While investment returns could be harder to control as they may be part of the systematic risk prevailing in the financial markets, overall expenses and, ultimately, fees charged to fund members are more of an internal fund management issue and thus, may be better managed by trustee directors. The findings and policy discussions are consistent with and support the government legislation and regulation in regards to ensuring low-cost, simplified superannuation product offers to fund members (CCH Australia 2013).

Under the DEA model, efficient funds that formed the efficiency frontier were identified individually (see Appendices 6.1 to 6.8). Based on these results, 'best practices' exercised by efficient funds may be investigated and promoted in the superannuation industry. As discussed in Chapter 6, highly positive correlations were found between efficiency scores and fund asset sizes. These results support the argument on the benefits of scale economies and fund consolidations. Operating expenses, which represent a very large proportion of total expenses of superannuation funds, could be reduced if very small superannuation funds were consolidated. Costs and transparency of costs have been topical issues in the superannuation fund literature (Australian Government 2014; Bateman 2001; Bateman & Mitchell 2004; Coleman, Eshoo & Wong 2006; Cooper et al. 2010a; Gallery & Gallery 2003, 2006). The findings on individual year DEA estimates indicate that most funds were inefficient due to high expenses. Thus, mandatory disclosure of fees and charges in a comparable manner for all superannuation funds may be necessary to justify fee payments and to address the transparency and accountability issue.

APRA superannuation bulletins and several research bodies such as Super Ratings have been ranking the performance of Australian superannuation funds from an investment return perspective (APRA 2014a; Super Ratings 2014). Efficiency studies using frontier approaches and incorporating critical operating characteristics such as cost-return issues have not been regularly conducted. This study pioneers further efficiency studies on Australian superannuation funds. Efficiency scores using DEA, rankings, trends and shifts in the efficiency frontiers could be obtained for Australian superannuation funds on an on-going basis.

9.5 Limitations

As is common with any empirical research, this study has limitations. The analysis in both phases of the study was based on secondary data provided by the APRA and collected through fund annual reports. The data might have been subject to measurement and recording errors experienced in financial accounting. Some data in the second phase of the study were qualitative and were collected using a ranking scale. Consequently, subjectivity and misjudgements might have occurred which could alter the research outcomes.

A few of the study's limitations are related to the research methods used. Limitations and assumptions in regards to using regression models were discussed in Chapter 7. The strengths and weaknesses of the DEA model were discussed in detail in Chapters 3 and 5. DEA efficiency scores are an internal benchmarking tool. The efficiency scores are relative to other DMUs' scores in the same sample. Therefore, the benchmarks created from one sample have little value when compared with benchmarks obtained from a different sample. Likewise, each time the sample size is changed, DEA efficiency scores need to be re-estimated. This limitation makes it difficult to carry out comparisons of efficiency scores from different sets of data or international comparisons.

9.6 Implications for future research

The research study and its findings have revealed possible avenues for further research. Efficiency studies on superannuation funds could be extended to other critical areas identified in the SCP framework for the Australian superannuation system such as studying the efficiency of superannuation legislation reforms or of the tax regime, or investigating the effect of multiple agency relationships on efficiency. The second phase of this study could be extended over a longer period and shifts in the efficiency frontiers over a period of time could be examined. Future studies on efficiency could also re-explore the unsupported independent explanatory variables. Other important areas such as the trustee codes of ethics, self-regulations or trustee qualifications could be investigated. An on-going superannuation fund ranking and benchmarking system using DEA could also be established.

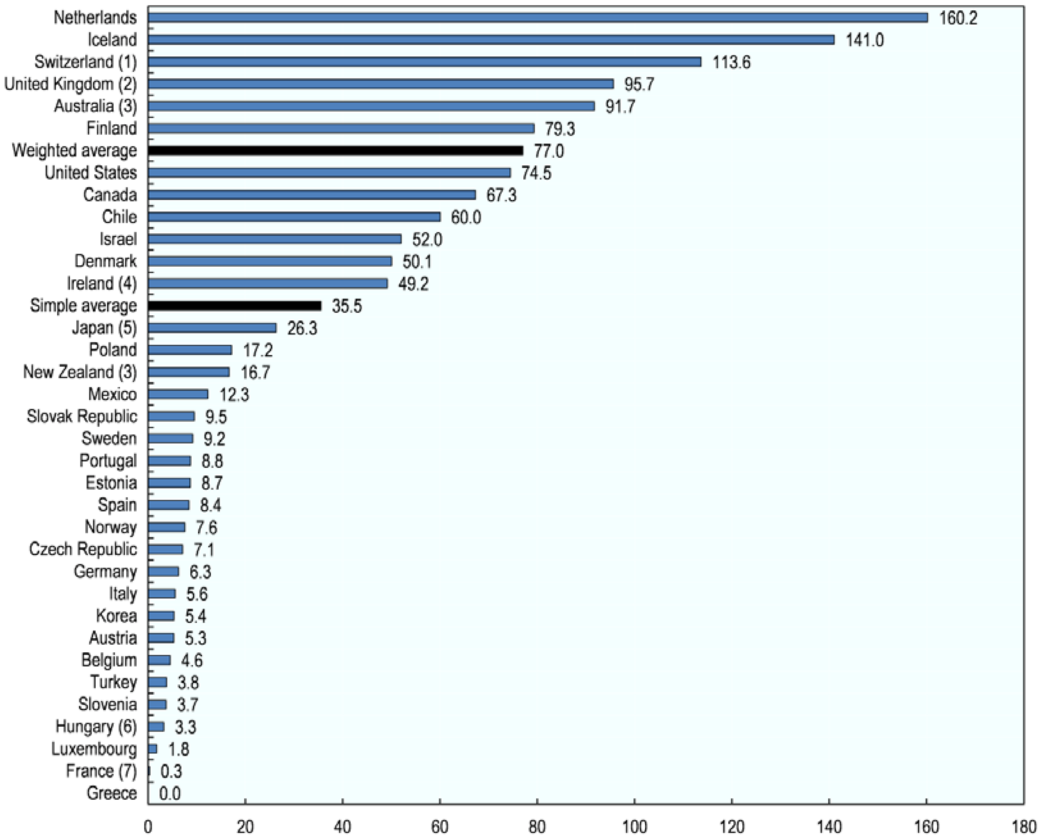
9.7 Concluding remarks

This research study was carried out during a time when there were many changes being made in the Australian superannuation legislation framework. Efficiency of the superannuation system is a critical issue, especially after the GFC. This study is unique in that it provides a conceptual framework of the structure, conduct and performance of the Australian superannuation system. Under the SCP framework, critical inputs and outputs for the estimation of the relative economic efficiency of Australian superannuation funds and factors affecting efficiency are identified. This study is also unique in that it applies two commonly used regression models for the second phase for comparative purposes. This research project contributes to theory, policy and practice, and pioneers further efficiency studies on the Australian superannuation system.

APPENDICES

Appendix 4.1

Size of pension assets relative to their respective countries' GDP, in percentage, 2012



Source: OECD (2013b)

Appendix 4.2

Structure of retirement benefits in 2013

Fund type	Classification	Defined Contribution	Defined Benefit	Hybrid	Total
Total	Entities	194	30	101	325
	Members account ('000)	14,927	610	14,231	29,768
	Assets ($m)	398,747	70,042	596,818	1,065,607
Corporate	Entities	34	15	59	108
	Member accounts ('000)	38	9	465	512
	Assets ($m)	1,818	594	58,887	61,300
Industry	Entities	39	0	13	52
	Members account ('000)	5,348	0	6,176	11,524
	Assets ($m)	132,821	0	191,846	324,668
Public sector	Entities	8	14	16	38
	Members account ('000)	457	600	2,280	3,337
	Assets ($m)	24,495	69,420	162,949	256,864
Retail	Entities	113	1	13	127
	Members account ('000)	9,084	1	5,310	14,395
	Assets ($m)	239,612	28	183,136	422,777

Source: APRA (2014a)

Appendix 4.3

Number of pension funds in selected OECD countries, 2003–2012

Country	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Australia*	264,614	290,917	306,553	324,789	363,687	389,813	406,781	417,272	446,524	446,983
Austria	20	21	20	21	20	19	19	17	17	17
Belgium	268	267	..	258	258	251	232	172	224	217
Canada	3,193	3,816	3,816	5,036	5,036	7,192	7,192	7,192	7,870	7,870
Chile	6	6	6	6	6	5	5	6	6	6
Czech Republic	12	11	11	11	10	10	10	10	9	9
Denmark	53	50	50	47	39	40	39	33	..	..
Estonia	21	22	15	15	15	19	22	23	23	23
Finland	144	153	174	129	122	119	117	..	..	..
Germany	177	182	178	175	178	180	182	183	179	177
Greece	..	..	..	..	3	3	3	8	6	6
Hungary	100	93	90	88	87	86	82	78	70	..
Iceland	50	48	46	41	38	37	37	33	33	32
Israel	42	43	30	32	32	34	33	32	33	33
Italy	484	431	432	431	418	393	370	353	343	332
Korea	116	116	138	..	..	..	..	..	..	..
Luxembourg	..	3	16	18	17	18	19	19	19	18
Mexico	12	26	1,331	1,342	1,062	1,091	1,050	1,042	1,037	..
Netherlands	877	841	802	769	714	531	484	455	393	..
Norway	135	125	119	122	109	108	105	100	95	85
Poland	..	..	..	20	20	19	..	19	19	28
Portugal	231	221	223	227	224	230	236	237	229	228
Slovak Republic	5	..	8	12	11	11	11	11	10	10
Slovenia	5	7	7	7	7	7	7	7	7	7
Spain	919	1,163	1,255	1,340	1,353	1,374	1,420	1,504	1,570	1,681
Switzerland	3,050	2,934	2,770	2,667	2,543	2,435	2,351	2,265	2,191	..
Turkey	..	..	..	..	..	14	15	15	14	17
UK	..	94,535	91,674	..	78,932	63,523	..	..	..	..

* includes SMSFs

Source: OECD (2013a)

Appendix 4.4

Pension fund nominal and real 5–year (geometric) average annual returns in selected OECD countries over 2008–12

Country	5–year average return	
	Nominal	Real
Turkey	11.6	3.4
Denmark	8.5	6.1
Mexico	7.7	3.2
Netherlands	5.6	3.5
Iceland	4.2	–2.9
Hungary	4.1	–0.4
Germany	3.9	2.4
Norway	3.6	0.9
Korea	3.2	0.1
Slovenia	2.7	0.6
Chile	2.7	0.1
New Zealand	2.7	–0.1
Canada	2.7	1.1
Italy	2.6	0.4
Czech Republic	2.2	–0.1
Finland	2.0	–0.2
Luxembourg	1.9	–0.3
United Kingdom	1.7	–1.5
Belgium	1.5	–0.8
Greece	1.3	–1.3
Spain	1.1	–0.9
Switzerland	1.1	1.0
Poland	1.0	–2.3
Austria	0.9	–1.2
Slovak Republic	0.4	–2.3
Australia	0.1	–2.6
Portugal	0.1	–1.6
Japan	–1.1	–0.7
Estonia	–1.8	–5.2

Source: OECD (2013a)

Appendix 6.1

Efficiency scores – VRS model, 2005–6

Inputs	Investments expenses Operating expenses Management, administration and director fees Total expenses
Outputs	Average net assets Number of member accounts Annual investment return

No	Name	Nets assets ($000)	Efficiency score
1	ACP Retirement Fund	62,999	0.247
2	Advance Retirement Savings Account	119,990	0.700
3	Advance Retirement Suite	286,620	0.992
4	Alcoa of Australia Retirement Plan	970,474	0.528
5	AMG Universal Super	50,150	0.154
6	AMP Superannuation Savings Trust	32,535,346	1.000
7	Aon Eligible Rollover Fund	81,881	0.078
8	AON Master Trust	1,266,460	0.096
9	ASC Superannuation Fund	63,348	0.271
10	ASGARD Independence Plan Division Four	107,781	0.050
11	ASGARD Independence Plan Division One	111,333	0.042
12	ASGARD Independence Plan Division Two	10,956,177	0.091
13	AusBev Superannuation Fund	278,103	0.192
14	Auscoal Superannuation Fund	3,845,766	0.540
15	Australia Post Superannuation Scheme	5,343,342	0.692
16	Australian Catholic Superannuation and Retirement Fund	2,526,090	0.299
17	Australian Christian Superannuation Fund	36,586	0.302
18	Australian Eligible Rollover Fund	991,922	1.000
19	Australian Ethical Retail Superannuation Fund	181,719	0.065
20	Australian Government Employees Superannuation Trust	1,346,213	0.312
21	Australian Meat Industry Superannuation Trust	574,174	0.284
22	Australian Superannuation Savings Employment Trust - Asset Super	1,080,485	0.223
23	Australian YMCA Superannuation Fund	43,443	0.220
24	AustralianSuper	13,961,897	1.000
25	Australia's Unclaimed Super Fund	571,898	1.000
26	Austsafe Superannuation Fund	603,240	0.453
27	Avanteos Superannuation Trust	412,421	0.064
28	AvSuper Fund	863,938	0.224
29	Bankwest Staff Superannuation Plan	268,078	0.310
30	Betros Bros Superannuation Fund No 2	5,841	1.000
31	BHP Billiton Superannuation Fund	1,807,605	0.536
32	Bluescope Steel Superannuation Fund	1,449,701	0.668
33	Boc Gases Superannuation Fund	477,848	0.308
34	Bookmakers Superannuation Fund	122,705	0.164
35	BT Classic Lifetime	652,455	0.059
36	BT Lifetime Super	2,745,006	0.120
37	BT Superannuation Savings Fund	16,594	1.000
38	Building Unions Superannuation Scheme (Queensland)	939,285	0.292
39	Canegrowers Retirement Fund	57,942	0.172
40	Care Super	2,388,884	0.285
41	Catholic Superannuation Fund	1,933,671	0.386

42	Christian Super	340,636	0.194
43	Clough Superannuation Fund	87,938	0.288
44	Club Plus Superannuation Scheme	909,105	0.390
45	Club Super	186,948	0.161
46	Coal Industry Superannuation Fund	116,556	0.274
47	Colonial First State FirstChoice Superannuation Trust	14,286,584	0.260
48	Colonial First State Rollover & Superannuation Fund	6,038,637	0.158
49	Colonial Super Retirement Fund	5,929,418	0.125
50	Commerce Industry Superannuation Fund	7,682	0.226
51	Commonwealth Life Personal Superannuation Fund	5,820,331	1.000
52	Concept One Superannuation Plan	128,254	0.148
53	Construction & Building Unions Superannuation	7,996,051	0.406
54	DBP Master Superannuation Plan	22,364	0.746
55	DPM Retirement Service	78,212	0.056
56	EmPlus Superannuation Fund	6,001	0.144
57	Energy Industries Superannuation Scheme-Pool A	446,635	0.111
58	Energy Industries Superannuation Scheme-Pool B	1,722,767	0.227
59	Energy Super	2,117,788	0.523
60	equipsuper	3,293,977	0.300
61	EquitySuper	327,071	0.071
62	ExxonMobil Superannuation Plan	680,939	0.201
63	Fiducian Superannuation Fund	629,966	0.053
64	Fire and Emergency Services Superannuation Fund	293,713	0.404
65	First Quest Retirement Service	229,003	0.043
66	First State Superannuation Scheme	10,250,457	0.852
67	First Super	433,145	0.168
68	Freedom of Choice Superannuation Masterfund	122,990	0.091
69	General Retirement Plan	73,559	0.079
70	Goldman Sachs & JBWere Superannuation Fund	192,090	1.000
71	Greater Staff Superannuation Fund	32,869	1.000
72	Grosvenor Pirie Master Superannuation Fund Series 2	18,978	0.333
73	Grow Super	33,450	0.132
74	Guild Retirement Fund	171,039	0.052
75	Harwood Superannuation Fund	1,130,444	0.289
76	Health Employees Superannuation Trust Australia	8,449,593	0.714
77	Health Industry Plan	399,711	0.167
78	Holden Employees Superannuation Fund	667,324	0.307
79	HOSTPLUS Superannuation Fund	4,328,611	0.350
80	IAG & NRMA Superannuation Plan	867,175	0.424
81	Intrust Super Fund	650,113	0.253
82	IOOF Portfolio Service Superannuation Fund	2,262,805	0.055
83	IRIS Superannuation Fund	338,688	0.072
84	Kellogg Retirement Fund	69,431	0.184
85	Labour Union Co-Operative Retirement Fund	1,673,062	0.139
86	Law Employees Superannuation Fund	54,098	0.214
87	legalsuper	659,087	0.245
88	Lifefocus Superannuation Fund	233,622	0.088
89	Lifetime Superannuation Fund	602,204	0.217
90	Local Authorities Superannuation Fund	3,203,239	0.232
91	Local Government Superannuation Scheme	1,131,901	0.298
92	Local Government Superannuation Scheme	1,131,901	0.298
93	Local Government Superannuation Scheme - Pool A	1,690,853	0.141
94	Local Government Superannuation Scheme - Pool B	3,092,426	0.251
95	MacMahon Employees Superannuation Fund	23,363	0.262
96	Macquarie ADF Superannuation Fund	947,558	1.000
97	Macquarie Superannuation Plan	4,898,564	0.118
98	Managed Australian Retirement Fund	45,099	0.210

99	Map Superannuation Plan	247,870	0.088
100	Maritime Super	1,413,689	0.211
101	Meat Industry Employees Superannuation Fund	414,326	0.250
102	Media Super	1,217,167	0.287
103	Mercer Portfolio Service Superannuation Plan	1,651,287	0.078
104	Mercer Super Trust	9,567,712	1.000
105	Mercy Super	270,887	0.347
106	Military Superannuation & Benefits Fund No 1	1,982,662	0.462
107	Millennium Master Trust	41,644	0.082
108	MLC Superannuation Fund	5,932,174	1.000
109	MTAA Superannuation Fund	3,318,941	0.312
110	National Australia Bank Group Superannuation Fund A	2,543,360	1.000
111	National Preservation Trust	338,307	1.000
112	Nationwide Superannuation Fund	312,827	0.127
113	Netwealth Superannuation Master Fund	221,829	0.054
114	New South Wales Electrical Superannuation Scheme	226,676	0.220
115	Newcastle Permanent Superannuation Plan	207,900	1.000
116	NGS Super	1,678,137	0.274
117	Nufarm Employees Superannuation Trust	61,636	0.466
118	Oasis Superannuation Master Trust	2,332,513	0.044
119	O-I Australia Superannuation Fund	140,628	0.334
120	OnePath Masterfund	13,349,742	0.867
121	Oracle Superannuation Plan	56,903	1.000
122	Perpetual WealthFocus Superannuation Fund	1,993,502	0.344
123	Perpetual's Select Superannuation Fund	1,251,158	0.440
124	Pitcher Retirement Plan	30,749	0.222
125	Plan B Eligible Rollover Fund	16,533	1.000
126	Plan B Superannuation Fund	118,617	1.000
127	Plum Superannuation Fund	6,014,753	0.369
128	Premiumchoice Retirement Service	176,604	0.039
129	Prime Superannuation Fund	829,343	0.218
130	Professional Associations Superannuation Fund	730,891	0.161
131	Public Eligible Rollover Fund	1,319	1.000
132	Qantas Superannuation Plan	5,304,357	1.000
133	Quadrant Superannuation Scheme	308,310	0.086
134	Queensland Independent Education & Care Superannuation Trust	319,643	0.189
135	Rei Super	507,177	0.226
136	Reserve Bank of Australia Officers Superannuation Fund	748,301	1.000
137	Retail Employees Superannuation Trust	9,719,843	0.777
138	Retirement Portfolio Service	1,313,418	0.070
139	Rio Tinto Staff Superannuation Fund	1,834,357	0.377
140	Russell Supersolution Master Trust	2,350,892	0.227
141	Smartsave 'Member's Choice' Superannuation Master Plan	98,400	0.039
142	SMF Eligible Rollover Fund	100,836	0.138
143	State Super Fixed Term Pension Plan	57,454	0.190
144	State Super Retirement Fund	5,140,509	0.073
145	Statewide Superannuation Trust	1,378,869	0.134
146	Suncorp Master Trust	270,609	0.202
147	Sunsuper Superannuation Fund	7,716,376	0.431
148	Super Eligible Rollover Fund	17,835	0.142
149	Super Safeguard Fund	17,366	1.000
150	Super Synergy Fund	30,975	0.146
151	SuperTrace Eligible Rollover Fund	1,441,805	1.000
152	Symetry Personal Retirement Fund	1,113,886	0.052
153	Synergy Superannuation Master Fund	1,040,023	0.052
154	Tasplan Superannuation Fund	802,258	0.249

155	Taxi Industry Superannuation Fund	17,677	0.139
156	Telstra Superannuation Scheme	8,647,337	0.551
157	The Allied Unions Superannuation Trust (Queensland)	118,403	0.177
158	The Bendigo Superannuation Plan	241,390	0.125
159	The Employees Productivity Award Superannuation Trust	21,292	0.251
160	The Executive Superannuation Fund	217,719	0.154
161	The Flexible Benefits Super Fund	649,831	0.407
162	The Industry Superannuation Fund	86,910	0.115
163	The ISPF Eligible Rollover Fund	9,022	0.381
164	The Portfolio Service Retirement Fund	3,983,331	0.056
165	The Retirement Plan	2,919,024	0.061
166	The State Bank Supersafe Approved Deposit Fund	70,148	0.078
167	The Super Money Eligible Rollover Fund (SMERF)	15,112	1.000
168	The Transport Industry Superannuation Fund	57,567	0.108
169	The Universal Super Scheme	28,496,240	1.000
170	Toyota Australia Superannuation Plan	140,199	0.195
171	Toyota Employees Superannuation Trust	241,038	0.201
172	TWU Superannuation Fund	1,592,240	0.241
173	Unisuper	17,220,007	1.000
174	United Technologies Corporation Retirement Plan	266,278	0.234
175	Victorian Superannuation Fund	3,781,779	0.270
176	Virgin Superannuation	50,072	0.201
177	WA Local Government Superannuation Plan	859,379	0.213
178	Water Corporation Superannuation Plan	84,919	0.367
179	Westpac Mastertrust – Superannuation Division	6,491,705	1.000
180	Westpac Personal Superannuation Fund	691,197	0.264
181	William Adams Employees Superannuation Fund	29,292	0.445
182	Worsley Alumina Superannuation Fund	143,995	0.547
183	Zurich Master Superannuation Fund	2,507,436	0.115

Appendix 6.2

Efficiency scores – VRS model, 2006–7

Inputs	Investments expenses Operating expenses Management, administration and director fees Total expenses
Outputs	Average net assets Number of member accounts Annual investment return

No	Name	Assets ($000)	Efficiency score
1	ACP Retirement Fund	70,372	0.386
2	Advance Retirement Savings Account	258,544	0.088
3	Advance Retirement Suite	582,882	0.570
4	Alcoa of Australia Retirement Plan	1,146,536	0.450
5	AMG Universal Super	81,927	0.147
6	AMP Superannuation Savings Trust	40,801,492	1.000
7	Aon Eligible Rollover Fund	86,509	0.088
8	AON Master Trust	1,555,448	0.094
9	ASC Superannuation Fund	78,477	0.384
10	ASGARD Independence Plan Division Four	94,600	0.094
11	ASGARD Independence Plan Division One	103,945	0.067
12	ASGARD Independence Plan Division Two	14,222,024	0.100
13	AusBev Superannuation Fund	304,661	0.165
14	Auscoal Superannuation Fund	4,581,536	0.617
15	Australia Post Superannuation Scheme	6,152,030	0.852
16	Australian Catholic Superannuation and Retirement Fund	3,182,108	0.353
17	Australian Christian Superannuation Fund	46,312	0.293
18	Australian Eligible Rollover Fund	1,088,400	1.000
19	Australian Ethical Retail Superannuation Fund	255,275	0.089
20	Australian Government Employees Superannuation Trust	2,052,458	0.449
21	Australian Meat Industry Superannuation Trust	726,149	0.301
22	Australian Superannuation Savings Employment Trust - Asset Super	1,359,034	0.307
23	Australian YMCA Superannuation Fund	56,647	0.390
24	AustralianSuper	24,656,732	1.000
25	Australia's Unclaimed Super Fund	607,581	1.000
26	Austsafe Superannuation Fund	762,566	0.385
27	Avanteos Superannuation Trust	669,256	0.083
28	AvSuper Fund	1,017,048	0.264
29	Bankwest Staff Superannuation Plan	318,393	0.385
30	Betros Bros Superannuation Fund No 2	6,673	1.000
31	BHP Billiton Superannuation Fund	2,123,258	0.404
32	Bluescope Steel Superannuation Fund	1,689,721	0.615
33	Boc Gases Superannuation Fund	549,129	0.354
34	Bookmakers Superannuation Fund	232,019	0.511
35	BT Classic Lifetime	623,618	0.057
36	BT Lifetime Super	3,037,575	0.139
37	BT Superannuation Savings Fund	15,604	1.000
38	Building Unions Superannuation Scheme (Queensland)	1,266,267	0.622
39	Canegrowers Retirement Fund	75,889	0.188
40	Care Super	3,077,909	0.364

41	Catholic Superannuation Fund	2,436,062	1.000
42	Christian Super	431,011	0.152
43	Clough Superannuation Fund	109,245	1.000
44	Club Plus Superannuation Scheme	1,095,282	0.503
45	Club Super	237,942	0.184
46	Coal Industry Superannuation Fund	139,292	0.459
47	Colonial First State FirstChoice Superannuation Trust	23,533,847	0.325
48	Colonial First State Rollover & Superannuation Fund	6,232,919	0.160
49	Colonial Super Retirement Fund	5,049,311	0.100
50	Commerce Industry Superannuation Fund	8,214	0.232
51	Commonwealth Life Personal Superannuation Fund	5,781,012	1.000
52	Concept One Superannuation Plan	149,932	0.181
53	Construction & Building Unions Superannuation	10,563,053	0.447
54	DBP Master Superannuation Plan	28,150	1.000
55	DPM Retirement Service	132,309	0.080
56	EmPlus Superannuation Fund	22,202	0.147
57	Energy Industries Superannuation Scheme-Pool A	622,248	0.100
58	Energy Industries Superannuation Scheme-Pool B	2,003,793	0.218
59	Energy Super	2,529,514	0.484
60	equipsuper	3,986,836	0.372
61	EquitySuper	393,292	0.076
62	ExxonMobil Superannuation Plan	737,631	0.099
63	Fiducian Superannuation Fund	794,922	0.059
64	Fire and Emergency Services Superannuation Fund	347,675	0.354
65	First Quest Retirement Service	270,716	0.058
66	First State Superannuation Scheme	13,214,769	0.941
67	First Super	546,733	0.170
68	Freedom of Choice Superannuation Masterfund	144,767	0.121
69	General Retirement Plan	85,083	0.102
70	Goldman Sachs & JBWere Superannuation Fund	233,873	1.000
71	Greater Staff Superannuation Fund	40,709	1.000
72	Grosvenor Pirie Master Superannuation Fund Series 2	28,652	1.000
73	Grow Super	39,992	0.140
74	Guild Retirement Fund	387,309	0.075
75	Harwood Superannuation Fund	1,304,672	0.316
76	Health Employees Superannuation Trust Australia	11,287,750	0.850
77	Health Industry Plan	491,996	0.173
78	Holden Employees Superannuation Fund	708,592	0.328
79	HOSTPLUS Superannuation Fund	5,694,732	0.407
80	IAG & NRMA Superannuation Plan	993,122	0.309
81	Intrust Super Fund	831,340	0.292
82	IOOF Portfolio Service Superannuation Fund	2,802,198	0.072
83	IRIS Superannuation Fund	533,182	0.089
84	Kellogg Retirement Fund	78,714	0.149
85	Labour Union Co-Operative Retirement Fund	2,112,430	0.236
86	Law Employees Superannuation Fund	63,893	0.173
87	legalsuper	853,954	0.308
88	Lifefocus Superannuation Fund	366,995	0.050
89	Lifetime Superannuation Fund	775,005	0.325
90	Local Authorities Superannuation Fund	3,772,921	0.337
91	Local Government Superannuation Scheme	3,333,083	0.663
92	Local Government Superannuation Scheme	3,333,083	0.663
93	Local Government Superannuation Scheme - Pool A	2,148,208	0.268
94	Local Government Superannuation Scheme - Pool B	3,466,096	0.931
95	MacMahon Employees Superannuation Fund	37,232	0.166
96	Macquarie ADF Superannuation Fund	1,133,339	1.000
97	Macquarie Superannuation Plan	6,869,677	0.176

98	Managed Australian Retirement Fund	50,546	0.205
99	Map Superannuation Plan	305,260	0.136
100	Maritime Super	1,713,342	0.224
101	Meat Industry Employees Superannuation Fund	485,271	0.206
102	Media Super	1,477,583	0.334
103	Mercer Portfolio Service Superannuation Plan	1,934,678	0.301
104	Mercer Super Trust	12,089,151	1.000
105	Mercy Super	346,551	0.376
106	Military Superannuation & Benefits Fund No 1	2,494,919	0.725
107	Millennium Master Trust	52,257	0.115
108	MLC Superannuation Fund	7,725,584	1.000
109	MTAA Superannuation Fund	4,627,375	0.434
110	National Australia Bank Group Superannuation Fund A	3,036,420	1.000
111	National Preservation Trust	359,282	0.873
112	Nationwide Superannuation Fund	381,261	0.162
113	Netwealth Superannuation Master Fund	417,147	0.049
114	New South Wales Electrical Superannuation Scheme	278,632	0.212
115	Newcastle Permanent Superannuation Plan	194,960	0.320
116	NGS Super	2,531,240	0.292
117	Nufarm Employees Superannuation Trust	75,148	1.000
118	Oasis Superannuation Master Trust	3,222,620	0.057
119	O-I Australia Superannuation Fund	161,421	0.374
120	OnePath Masterfund	20,897,764	0.735
121	Oracle Superannuation Plan	73,144	1.000
122	Perpetual WealthFocus Superannuation Fund	2,404,880	0.913
123	Perpetual's Select Superannuation Fund	1,474,036	1.000
124	Pitcher Retirement Plan	38,109	0.257
125	Plan B Eligible Rollover Fund	18,471	1.000
126	Plan B Superannuation Fund	121,250	1.000
127	Plum Superannuation Fund	7,311,038	0.433
128	Premiumchoice Retirement Service	274,953	0.057
129	Prime Superannuation Fund	997,931	0.213
130	Professional Associations Superannuation Fund	1,132,968	0.218
131	Public Eligible Rollover Fund	1,376	1.000
132	Qantas Superannuation Plan	5,976,851	1.000
133	Quadrant Superannuation Scheme	402,262	0.095
134	Queensland Independent Education & Care Superannuation Trust	417,304	0.230
135	Rei Super	640,344	0.250
136	Reserve Bank of Australia Officers Superannuation Fund	860,710	1.000
137	Retail Employees Superannuation Trust	12,477,802	1.000
138	Retirement Portfolio Service	1,397,935	0.086
139	Rio Tinto Staff Superannuation Fund	2,241,630	0.461
140	Russell Supersolution Master Trust	3,177,035	0.264
141	Smartsave 'Member's Choice' Superannuation Master Plan	200,519	0.065
142	SMF Eligible Rollover Fund	104,403	0.164
143	State Super Fixed Term Pension Plan	53,648	0.257
144	State Super Retirement Fund	6,299,748	0.101
145	Statewide Superannuation Trust	1,818,635	0.166
146	Suncorp Master Trust	281,923	0.265
147	Sunsuper Superannuation Fund	10,683,811	0.437
148	Super Eligible Rollover Fund	20,158	0.182
149	Super Safeguard Fund	20,074	1.000
150	Super Synergy Fund	35,879	0.161
151	SuperTrace Eligible Rollover Fund	1,528,406	1.000
152	Symetry Personal Retirement Fund	1,331,486	0.060
153	Synergy Superannuation Master Fund	1,213,962	0.065
154	Tasplan Superannuation Fund	1,005,766	0.276

155	Taxi Industry Superannuation Fund	19,485	0.204
156	Telstra Superannuation Scheme	10,156,927	0.558
157	The Allied Unions Superannuation Trust (Queensland)	151,720	0.238
158	The Bendigo Superannuation Plan	294,956	0.241
159	The Employees Productivity Award Superannuation Trust	23,403	0.273
160	The Executive Superannuation Fund	283,667	0.162
161	The Flexible Benefits Super Fund	685,994	0.429
162	The Industry Superannuation Fund	103,313	0.167
163	The ISPF Eligible Rollover Fund	11,709	0.439
164	The Portfolio Service Retirement Fund	4,756,938	0.084
165	The Retirement Plan	3,810,752	0.078
166	The State Bank Supersafe Approved Deposit Fund	59,276	0.146
167	The Super Money Eligible Rollover Fund (SMERF)	30,084	1.000
168	The Transport Industry Superannuation Fund	71,512	0.202
169	The Universal Super Scheme	33,619,915	1.000
170	Toyota Australia Superannuation Plan	175,521	0.305
171	Toyota Employees Superannuation Trust	288,425	0.234
172	TWU Superannuation Fund	1,998,044	0.292
173	Unisuper	21,403,784	1.000
174	United Technologies Corporation Retirement Plan	293,027	0.213
175	Victorian Superannuation Fund	5,065,572	0.366
176	Virgin Superannuation	157,048	0.396
177	WA Local Government Superannuation Plan	1,071,162	0.193
178	Water Corporation Superannuation Plan	114,355	0.402
179	Westpac Mastertrust - Superannuation Division	7,000,227	1.000
180	Westpac Personal Superannuation Fund	716,807	0.287
181	William Adams Employees Superannuation Fund	35,040	0.605
182	Worsley Alumina Superannuation Fund	170,575	0.601
183	Zurich Master Superannuation Fund	2,380,333	0.116

Appendix 6.3

Efficiency scores – VRS model, 2007–8

Inputs	Investments expenses Operating expenses Management, administration and director fees Total expenses
Outputs	Average net assets Number of member accounts Annual investment return

No	Name	Assets ($000)	Efficiency score
1	ACP Retirement Fund	66,539	0.148
2	Advance Retirement Savings Account	253,319	0.258
3	Advance Retirement Suite	539,030	0.285
4	Alcoa of Australia Retirement Plan	1,184,815	0.287
5	AMG Universal Super	103,806	0.062
6	AMP Superannuation Savings Trust	43,798,125	1.000
7	Aon Eligible Rollover Fund	85,327	0.077
8	AON Master Trust	1,629,349	0.058
9	ASC Superannuation Fund	84,181	0.152
10	ASGARD Independence Plan Division Four	73,596	0.056
11	ASGARD Independence Plan Division One	88,220	0.047
12	ASGARD Independence Plan Division Two	15,737,625	0.124
13	AusBev Superannuation Fund	306,621	0.121
14	Auscoal Superannuation Fund	4,941,422	0.464
15	Australia Post Superannuation Scheme	6,681,209	0.970
16	Australian Catholic Superannuation and Retirement Fund	3,568,812	0.290
17	Australian Christian Superannuation Fund	51,634	0.087
18	Australian Eligible Rollover Fund	1,044,233	0.372
19	Australian Ethical Retail Superannuation Fund	304,115	0.054
20	Australian Government Employees Superannuation Trust	2,744,036	0.313
21	Australian Meat Industry Superannuation Trust	820,596	0.171
22	Australian Superannuation Savings Employment Trust - Asset Super	1,457,098	0.181
23	Australian YMCA Superannuation Fund	61,638	0.137
24	AustralianSuper	28,499,657	1.000
25	Australia's Unclaimed Super Fund	599,444	1.000
26	Austsafe Superannuation Fund	852,863	0.222
27	Avanteos Superannuation Trust	902,406	0.039
28	AvSuper Fund	1,073,468	0.127
29	Bankwest Staff Superannuation Plan	343,554	0.174
30	Betros Bros Superannuation Fund No 2	7,110	0.515
31	BHP Billiton Superannuation Fund	2,227,401	0.252
32	Bluescope Steel Superannuation Fund	1,734,726	0.390
33	Boc Gases Superannuation Fund	551,489	0.268
34	Bookmakers Superannuation Fund	292,588	0.051
35	BT Classic Lifetime	526,675	0.032
36	BT Lifetime Super	2,985,702	0.119
37	BT Superannuation Savings Fund	14,999	1.000
38	Building Unions Superannuation Scheme (Queensland)	1,500,594	0.226
39	Canegrowers Retirement Fund	83,313	0.094

40	Care Super	3,511,976	0.267
41	Catholic Superannuation Fund	2,748,766	0.333
42	Christian Super	481,261	0.101
43	Clough Superannuation Fund	118,204	0.157
44	Club Plus Superannuation Scheme	1,203,902	0.327
45	Club Super	264,741	0.090
46	Coal Industry Superannuation Fund	146,119	0.218
47	Colonial First State FirstChoice Superannuation Trust	29,486,422	0.446
48	Colonial First State Rollover & Superannuation Fund	5,510,811	0.114
49	Colonial Super Retirement Fund	4,070,837	0.086
50	Commerce Industry Superannuation Fund	8,497	0.141
51	Commonwealth Life Personal Superannuation Fund	5,233,490	1.000
52	Concept One Superannuation Plan	157,533	0.111
53	Construction & Building Unions Superannuation	12,368,332	0.435
54	DBP Master Superannuation Plan	30,321	0.289
55	DPM Retirement Service	157,566	0.039
56	EmPlus Superannuation Fund	42,928	0.068
57	Energy Industries Superannuation Scheme-Pool A	771,535	0.061
58	Energy Industries Superannuation Scheme-Pool B	2,028,206	0.187
59	Energy Super	2,730,862	0.334
60	equipsuper	4,215,310	0.279
61	EquitySuper	419,566	0.047
62	ExxonMobil Superannuation Plan	705,065	0.037
63	Fiducian Superannuation Fund	843,304	0.030
64	Fire and Emergency Services Superannuation Fund	367,855	0.200
65	First Quest Retirement Service	281,942	0.028
66	First State Superannuation Scheme	15,212,388	0.882
67	First Super	1,025,177	0.147
68	Freedom of Choice Superannuation Masterfund	146,438	0.044
69	General Retirement Plan	87,058	0.081
70	Goldman Sachs & JBWere Superannuation Fund	242,055	0.279
71	Greater Staff Superannuation Fund	42,915	0.700
72	Grosvenor Pirie Master Superannuation Fund Series 2	38,066	0.144
73	Grow Super	40,881	0.069
74	Guild Retirement Fund	427,792	0.043
75	Harwood Superannuation Fund	1,300,179	0.241
76	Health Employees Superannuation Trust Australia	13,167,526	0.812
77	Health Industry Plan	537,989	0.098
78	Holden Employees Superannuation Fund	713,802	0.169
79	HOSTPLUS Superannuation Fund	6,686,484	0.319
80	IAG & NRMA Superannuation Plan	1,022,526	0.168
81	Intrust Super Fund	942,446	0.127
82	IOOF Portfolio Service Superannuation Fund	3,047,961	0.060
83	IRIS Superannuation Fund	702,935	0.040
84	Kellogg Retirement Fund	78,440	0.066
85	Labour Union Co-Operative Retirement Fund	2,364,347	0.157
86	Law Employees Superannuation Fund	67,525	0.095
87	legalsuper	986,518	0.108
88	Lifefocus Superannuation Fund	437,336	0.028
89	Lifetime Superannuation Fund	865,501	0.420
90	Local Authorities Superannuation Fund	4,026,419	0.275
91	Local Government Superannuation Scheme	3,636,245	0.610
92	Local Government Superannuation Scheme	3,636,245	0.610
93	Local Government Superannuation Scheme - Pool A	2,440,870	0.119
94	Local Government Superannuation Scheme - Pool B	3,402,291	0.209
95	MacMahon Employees Superannuation Fund	48,118	0.091
96	Macquarie ADF Superannuation Fund	1,066,480	1.000

97	Macquarie Superannuation Plan	8,111,331	0.168
98	Managed Australian Retirement Fund	51,529	0.072
99	Map Superannuation Plan	319,319	0.051
100	Maritime Super	1,797,890	0.126
101	Meat Industry Employees Superannuation Fund	521,520	0.157
102	Media Super	1,601,443	0.147
103	Mercer Portfolio Service Superannuation Plan	2,000,421	0.248
104	Mercer Super Trust	12,976,383	1.000
105	Mercy Super	395,381	0.164
106	Military Superannuation & Benefits Fund No 1	2,854,301	0.885
107	Millennium Master Trust	55,155	0.054
108	MLC Superannuation Fund	8,638,090	1.000
109	MTAA Superannuation Fund	5,783,685	0.312
110	National Australia Bank Group Superannuation Fund A	3,176,070	1.000
111	National Preservation Trust	373,490	1.000
112	Nationwide Superannuation Fund	396,103	0.093
113	Netwealth Superannuation Master Fund	588,943	0.028
114	New South Wales Electrical Superannuation Scheme	307,462	0.130
115	Newcastle Permanent Superannuation Plan	190,539	0.280
116	NGS Super	2,833,803	0.266
117	Nufarm Employees Superannuation Trust	75,184	0.267
118	Oasis Superannuation Master Trust	3,587,141	0.048
119	O-I Australia Superannuation Fund	159,892	0.216
120	OnePath Masterfund	24,274,199	1.000
121	Oracle Superannuation Plan	83,883	0.327
122	Perpetual WealthFocus Superannuation Fund	2,356,186	0.895
123	Perpetual's Select Superannuation Fund	1,509,660	0.210
124	Pitcher Retirement Plan	42,216	0.109
125	Plan B Eligible Rollover Fund	18,337	1.000
126	Plan B Superannuation Fund	115,639	1.000
127	Plum Superannuation Fund	7,611,241	0.323
128	Premiumchoice Retirement Service	327,603	0.029
129	Prime Superannuation Fund	1,073,658	0.111
130	Professional Associations Superannuation Fund	1,316,089	0.518
131	Public Eligible Rollover Fund	1,339	1.000
132	Qantas Superannuation Plan	6,034,544	1.000
133	Quadrant Superannuation Scheme	459,702	0.055
134	Queensland Independent Education & Care Superannuation Trust	479,259	0.113
135	Rei Super	695,462	0.107
136	Reserve Bank of Australia Officers Superannuation Fund	916,172	1.000
137	Retail Employees Superannuation Trust	14,293,301	0.937
138	Retirement Portfolio Service	1,290,949	0.048
139	Rio Tinto Staff Superannuation Fund	2,426,154	0.416
140	Russell Supersolution Master Trust	3,466,791	0.210
141	Smartsave 'Member's Choice' Superannuation Master Plan	269,631	0.034
142	SMF Eligible Rollover Fund	107,176	0.651
143	State Super Fixed Term Pension Plan	49,273	1.000
144	State Super Retirement Fund	6,929,971	0.117
145	Statewide Superannuation Trust	2,106,888	0.115
146	Suncorp Master Trust	1,838,124	1.000
147	Sunsuper Superannuation Fund	12,726,772	0.386
148	Super Eligible Rollover Fund	20,135	0.155
149	Super Safeguard Fund	20,819	0.670
150	Super Synergy Fund	37,332	0.072
151	SuperTrace Eligible Rollover Fund	1,552,851	1.000
152	Symetry Personal Retirement Fund	1,427,981	0.038
153	Synergy Superannuation Master Fund	1,264,789	0.034

154	Tasplan Superannuation Fund	1,128,240	0.155
155	Taxi Industry Superannuation Fund	19,765	0.087
156	Telstra Superannuation Scheme	10,548,331	0.546
157	The Allied Unions Superannuation Trust (Queensland)	171,447	0.100
158	The Bendigo Superannuation Plan	312,293	0.186
159	The Employees Productivity Award Superannuation Trust	27,012	1.000
160	The Executive Superannuation Fund	320,561	0.097
161	The Flexible Benefits Super Fund	673,351	0.237
162	The Industry Superannuation Fund	113,737	0.106
163	The ISPF Eligible Rollover Fund	12,729	0.484
164	The Portfolio Service Retirement Fund	5,010,842	0.059
165	The Retirement Plan	4,168,368	0.069
166	The State Bank Supersafe Approved Deposit Fund	50,814	0.499
167	The Super Money Eligible Rollover Fund (SMERF)	29,081	1.000
168	The Transport Industry Superannuation Fund	77,675	0.082
169	The Universal Super Scheme	34,670,388	1.000
170	Toyota Australia Superannuation Plan	194,725	0.241
171	Toyota Employees Superannuation Trust	315,589	0.183
172	TWU Superannuation Fund	2,227,141	0.154
173	Unisuper	23,469,443	1.000
174	United Technologies Corporation Retirement Plan	288,563	0.129
175	Victorian Superannuation Fund	6,010,531	0.266
176	Virgin Superannuation	228,947	0.086
177	WA Local Government Superannuation Plan	1,214,997	0.104
178	Water Corporation Superannuation Plan	135,642	0.204
179	Westpac Mastertrust - Superannuation Division	6,671,063	1.000
180	Westpac Personal Superannuation Fund	669,449	0.177
181	William Adams Employees Superannuation Fund	38,366	0.198
182	Worsley Alumina Superannuation Fund	180,144	0.254
183	Zurich Master Superannuation Fund	1,967,812	0.101

Appendix 6.4

Efficiency scores – VRS model, 2008–9

Inputs	Investments expenses Operating expenses Management, administration and director fees Total expenses
Outputs	Average net assets Number of member accounts Annual investment return

No	Name	Assets ($000)	Efficiency score
1	ACP Retirement Fund	54,970	0.152
2	Advance Retirement Savings Account	225,316	0.222
3	Advance Retirement Suite	439,099	0.525
4	Alcoa of Australia Retirement Plan	1,102,017	0.282
5	AMG Universal Super	104,511	0.070
6	AMP Superannuation Savings Trust	40,661,691	1.000
7	Aon Eligible Rollover Fund	81,923	0.094
8	AON Master Trust	1,500,820	0.063
9	ASC Superannuation Fund	77,619	0.169
10	ASGARD Independence Plan Division Four	50,794	0.071
11	ASGARD Independence Plan Division One	69,570	0.060
12	ASGARD Independence Plan Division Two	14,495,900	0.180
13	AusBev Superannuation Fund	300,994	0.108
14	Auscoal Superannuation Fund	4,719,245	0.315
15	Australia Post Superannuation Scheme	6,247,977	1.000
16	Australian Catholic Superannuation and Retirement Fund	3,455,892	0.255
17	Australian Christian Superannuation Fund	52,278	0.068
18	Australian Eligible Rollover Fund	891,522	1.000
19	Australian Ethical Retail Superannuation Fund	308,620	0.070
20	Australian Government Employees Superannuation Trust	3,044,207	0.350
21	Australian Meat Industry Superannuation Trust	794,159	0.161
22	Australian Superannuation Savings Employment Trust - Asset Super	1,350,224	0.185
23	Australian YMCA Superannuation Fund	59,496	0.134
24	AustralianSuper	28,186,031	1.000
25	Australia's Unclaimed Super Fund	534,631	1.000
26	Austsafe Superannuation Fund	855,328	0.183
27	Avanteos Superannuation Trust	1,005,706	0.080
28	AvSuper Fund	986,855	0.193
29	Bankwest Staff Superannuation Plan	334,369	0.208
30	Betros Bros Superannuation Fund No 2	7,009	0.499
31	BHP Billiton Superannuation Fund	2,095,490	0.269
32	Bluescope Steel Superannuation Fund	1,576,610	0.416
33	Boc Gases Superannuation Fund	469,304	0.217
34	Bookmakers Superannuation Fund	225,803	0.054
35	BT Classic Lifetime	388,725	0.055
36	BT Lifetime Super	2,603,109	0.123
37	BT Superannuation Savings Fund	14,243	1.000
38	Building Unions Superannuation Scheme (Queensland)	1,516,936	0.224
39	Canegrowers Retirement Fund	75,640	0.111

40	Care Super	3,489,703	0.277
41	Catholic Superannuation Fund	2,662,146	0.310
42	Christian Super	463,037	0.089
43	Clough Superannuation Fund	107,756	0.115
44	Club Plus Superannuation Scheme	1,166,234	0.266
45	Club Super	247,288	0.057
46	Coal Industry Superannuation Fund	132,380	0.185
47	Colonial First State FirstChoice Superannuation Trust	29,366,480	1.000
48	Colonial First State Rollover & Superannuation Fund	4,166,171	0.113
49	Colonial Super Retirement Fund	3,338,371	0.123
50	Commerce Industry Superannuation Fund	8,442	0.136
51	Commonwealth Life Personal Superannuation Fund	4,187,661	1.000
52	Concept One Superannuation Plan	151,934	0.107
53	Construction & Building Unions Superannuation	12,427,758	0.435
54	DBP Master Superannuation Plan	27,837	0.302
55	DPM Retirement Service	147,119	0.071
56	EmPlus Superannuation Fund	60,178	0.053
57	Energy Industries Superannuation Scheme-Pool A	830,996	0.080
58	Energy Industries Superannuation Scheme-Pool B	1,759,346	0.218
59	Energy Super	2,592,539	0.286
60	equipsuper	3,977,716	0.270
61	EquitySuper	392,690	0.046
62	ExxonMobil Superannuation Plan	632,173	0.033
63	Fiducian Superannuation Fund	734,622	0.036
64	Fire and Emergency Services Superannuation Fund	340,518	0.193
65	First Quest Retirement Service	242,484	0.048
66	First State Superannuation Scheme	15,672,144	1.000
67	First Super	1,366,856	0.154
68	Freedom of Choice Superannuation Masterfund	136,280	0.048
69	General Retirement Plan	79,854	0.092
70	Goldman Sachs & JBWere Superannuation Fund	215,447	1.000
71	Greater Staff Superannuation Fund	38,326	0.825
72	Grosvenor Pirie Master Superannuation Fund Series 2	36,476	0.133
73	Grow Super	37,346	0.078
74	Guild Retirement Fund	414,665	0.064
75	Harwood Superannuation Fund	1,138,549	0.235
76	Health Employees Superannuation Trust Australia	13,128,874	0.873
77	Health Industry Plan	505,694	0.085
78	Holden Employees Superannuation Fund	664,854	0.475
79	HOSTPLUS Superannuation Fund	6,737,947	0.267
80	IAG & NRMA Superannuation Plan	945,854	0.122
81	Intrust Super Fund	912,487	0.126
82	IOOF Portfolio Service Superannuation Fund	2,878,854	0.066
83	IRIS Superannuation Fund	687,270	0.105
84	Kellogg Retirement Fund	76,811	0.085
85	Labour Union Co-Operative Retirement Fund	2,289,713	0.114
86	Law Employees Superannuation Fund	63,711	0.097
87	legalsuper	1,067,427	0.130
88	Lifefocus Superannuation Fund	400,624	0.026
89	Lifetime Superannuation Fund	794,932	0.119
90	Local Authorities Superannuation Fund	3,740,752	0.267
91	Local Government Superannuation Scheme	3,490,646	0.563
92	Local Government Superannuation Scheme	3,490,646	0.563
93	Local Government Superannuation Scheme - Pool A	2,394,826	0.126
94	Local Government Superannuation Scheme - Pool B	2,832,606	0.188
95	MacMahon Employees Superannuation Fund	52,246	0.087
96	Macquarie ADF Superannuation Fund	763,017	1.000

97	Macquarie Superannuation Plan	7,792,924	0.410
98	Managed Australian Retirement Fund	43,834	0.072
99	Map Superannuation Plan	277,710	0.088
100	Maritime Super	2,124,400	0.175
101	Meat Industry Employees Superannuation Fund	492,017	0.152
102	Media Super	1,959,892	0.242
103	Mercer Portfolio Service Superannuation Plan	1,746,097	0.306
104	Mercer Super Trust	12,513,952	0.998
105	Mercy Super	389,596	0.151
106	Military Superannuation & Benefits Fund No 1	2,872,662	1.000
107	Millennium Master Trust	49,843	0.048
108	MLC Superannuation Fund	8,090,998	0.763
109	MTAA Superannuation Fund	5,645,826	0.385
110	National Australia Bank Group Superannuation Fund A	2,860,438	1.000
111	National Preservation Trust	358,288	0.924
112	Nationwide Superannuation Fund	354,044	0.098
113	Netwealth Superannuation Master Fund	661,469	0.053
114	New South Wales Electrical Superannuation Scheme	298,384	0.109
115	Newcastle Permanent Superannuation Plan	193,929	0.173
116	NGS Super	2,764,798	0.255
117	Nufarm Employees Superannuation Trust	61,989	0.360
118	Oasis Superannuation Master Trust	3,194,857	0.047
119	O-I Australia Superannuation Fund	138,665	0.215
120	OnePath Masterfund	22,770,116	1.000
121	Oracle Superannuation Plan	81,254	0.406
122	Perpetual WealthFocus Superannuation Fund	1,907,268	0.717
123	Perpetual's Select Superannuation Fund	1,309,630	0.196
124	Pitcher Retirement Plan	41,575	1.000
125	Plan B Eligible Rollover Fund	17,961	1.000
126	Plan B Superannuation Fund	102,268	0.281
127	Plum Superannuation Fund	6,847,395	0.401
128	Premiumchoice Retirement Service	307,891	0.057
129	Prime Superannuation Fund	999,862	0.122
130	Professional Associations Superannuation Fund	1,298,257	0.109
131	Public Eligible Rollover Fund	1,328	0.924
132	Qantas Superannuation Plan	5,407,784	0.890
133	Quadrant Superannuation Scheme	433,814	0.047
134	Queensland Independent Education & Care Superannuation Trust	475,323	0.091
135	Rei Super	650,380	0.111
136	Reserve Bank of Australia Officers Superannuation Fund	834,862	1.000
137	Retail Employees Superannuation Trust	14,562,968	1.000
138	Retirement Portfolio Service	1,039,202	0.096
139	Rio Tinto Staff Superannuation Fund	2,369,995	0.365
140	Russell Supersolution Master Trust	3,259,355	0.203
141	Smartsave 'Member's Choice' Superannuation Master Plan	242,915	0.028
142	SMF Eligible Rollover Fund	106,337	0.436
143	State Super Fixed Term Pension Plan	46,440	1.000
144	State Super Retirement Fund	6,712,624	0.172
145	Statewide Superannuation Trust	2,027,132	0.110
146	Suncorp Master Trust	3,166,389	0.098
147	Sunsuper Superannuation Fund	12,929,322	0.417
148	Super Eligible Rollover Fund	17,994	0.124
149	Super Safeguard Fund	20,023	0.733
150	Super Synergy Fund	34,257	0.106
151	SuperTrace Eligible Rollover Fund	1,524,156	1.000
152	Symetry Personal Retirement Fund	1,305,923	0.059
153	Synergy Superannuation Master Fund	1,105,095	0.058

154	Tasplan Superannuation Fund	1,135,403	0.157
155	Taxi Industry Superannuation Fund	18,033	0.093
156	Telstra Superannuation Scheme	9,559,872	0.556
157	The Allied Unions Superannuation Trust (Queensland)	162,679	0.100
158	The Bendigo Superannuation Plan	275,804	0.243
159	The Employees Productivity Award Superannuation Trust	24,401	0.105
160	The Executive Superannuation Fund	307,196	0.103
161	The Flexible Benefits Super Fund	629,499	0.294
162	The Industry Superannuation Fund	113,584	0.084
163	The ISPF Eligible Rollover Fund	14,775	0.631
164	The Portfolio Service Retirement Fund	4,531,552	0.069
165	The Retirement Plan	3,755,503	0.072
166	The State Bank Supersafe Approved Deposit Fund	45,141	0.244
167	The Super Money Eligible Rollover Fund (SMERF)	28,094	1.000
168	The Transport Industry Superannuation Fund	71,674	0.068
169	The Universal Super Scheme	30,323,941	1.000
170	Toyota Australia Superannuation Plan	188,294	0.208
171	Toyota Employees Superannuation Trust	297,869	0.198
172	TWU Superannuation Fund	2,137,373	0.150
173	Unisuper	22,646,322	1.000
174	United Technologies Corporation Retirement Plan	252,784	0.159
175	Victorian Superannuation Fund	6,153,364	0.342
176	Virgin Superannuation	243,399	0.093
177	WA Local Government Superannuation Plan	1,178,088	0.115
178	Water Corporation Superannuation Plan	143,726	0.218
179	Westpac Mastertrust - Superannuation Division	5,551,475	1.000
180	Westpac Personal Superannuation Fund	563,089	0.295
181	William Adams Employees Superannuation Fund	35,629	0.150
182	Worsley Alumina Superannuation Fund	169,581	0.277
183	Zurich Master Superannuation Fund	1,641,292	0.117

Appendix 6.5

Efficiency scores – VRS model, 2009–10

Inputs	Investments expenses Operating expenses Management, administration and director fees Total expenses
Outputs	Average net assets Number of member accounts Annual investment return

No	Name	Assets ($000)	Efficiency score
1	ACP Retirement Fund	53,864	0.418
2	Advance Retirement Savings Account	1,163,422	0.266
3	Advance Retirement Suite	81,225	0.385
4	Alcoa of Australia Retirement Plan	326,369	0.272
5	AMG Universal Super	4,884,379	0.374
6	AMP Superannuation Savings Trust	3,611,362	0.346
7	Aon Eligible Rollover Fund	55,691	0.065
8	AON Master Trust	3,439,544	0.445
9	ASC Superannuation Fund	816,180	0.260
10	ASGARD Independence Plan Division Four	1,389,459	0.343
11	ASGARD Independence Plan Division One	67,420	0.768
12	ASGARD Independence Plan Division Two	30,107,259	1.000
13	AusBev Superannuation Fund	925,866	0.303
14	Auscoal Superannuation Fund	340,980	0.294
15	Australia Post Superannuation Scheme	7,457	1.000
16	Australian Catholic Superannuation and Retirement Fund	2,153,395	0.437
17	Australian Christian Superannuation Fund	1,545,848	0.737
18	Australian Eligible Rollover Fund	443,276	0.357
19	Australian Ethical Retail Superannuation Fund	1,618,847	0.373
20	Australian Government Employees Superannuation Trust	3,690,339	0.416
21	Australian Meat Industry Superannuation Trust	3,134,159	0.565
22	Australian Superannuation Savings Employment Trust - Asset Super	111,296	0.296
23	Australian YMCA Superannuation Fund	1,210,882	0.287
24	AustralianSuper	13,211,506	0.386
25	Australia's Unclaimed Super Fund	27,687	0.742
26	Austsafe Superannuation Fund	2,666,967	0.363
27	Avanteos Superannuation Trust	4,089,236	0.271
28	AvSuper Fund	701,908	0.124
29	Bankwest Staff Superannuation Plan	1,389,902	0.375
30	Betros Bros Superannuation Fund No 2	79,250	0.441
31	BHP Billiton Superannuation Fund	218,479	1.000
32	Bluescope Steel Superannuation Fund	37,880	1.000
33	Boc Gases Superannuation Fund	38,653	0.363
34	Bookmakers Superannuation Fund	1,110,707	0.469
35	BT Classic Lifetime	14,193,258	1.000
36	BT Lifetime Super	627,333	0.784
37	BT Superannuation Savings Fund	7,233,863	0.312
38	Building Unions Superannuation Scheme (Queensland)	971,863	0.211
39	Canegrowers Retirement Fund	945,674	0.201

40	Care Super	605,799	0.159
41	Catholic Superannuation Fund	79,863	0.143
42	Christian Super	2,368,454	0.182
43	Clough Superannuation Fund	64,694	0.198
44	Club Plus Superannuation Scheme	1,237,051	0.212
45	Club Super	55,279	0.158
46	Coal Industry Superannuation Fund	2,728,133	0.215
47	Colonial First State FirstChoice Superannuation Trust	2,486,256	0.440
48	Colonial First State Rollover & Superannuation Fund	421,523	0.172
49	Colonial Super Retirement Fund	5,429,553	0.410
50	Commerce Industry Superannuation Fund	2,807,323	1.000
51	Commonwealth Life Personal Superannuation Fund	2,940,197	0.307
52	Concept One Superannuation Plan	61,835	1.000
53	Construction & Building Unions Superannuation	137,925	0.250
54	DBP Master Superannuation Plan	90,439	1.000
55	DPM Retirement Service	43,258	0.271
56	EmPlus Superannuation Fund	989,381	0.154
57	Energy Industries Superannuation Scheme-Pool A	5,244,051	0.731
58	Energy Industries Superannuation Scheme-Pool B	681,332	0.279
59	Energy Super	16,085,553	1.000
60	equipsuper	2,570,703	0.534
61	EquitySuper	14,269,998	0.493
62	ExxonMobil Superannuation Plan	1,234,907	0.240
63	Fiducian Superannuation Fund	9,611,954	0.507
64	Fire and Emergency Services Superannuation Fund	319,217	0.133
65	First Quest Retirement Service	628,719	0.423
66	First State Superannuation Scheme	195,269	0.331
67	First Super	301,302	0.313
68	Freedom of Choice Superannuation Masterfund	2,202,239	0.199
69	General Retirement Plan	23,827,580	1.000
70	Goldman Sachs & JBWere Superannuation Fund	242,226	0.336
71	Greater Staff Superannuation Fund	6,662,811	0.464
72	Grosvenor Pirie Master Superannuation Fund Series 2	165,631	0.269
73	Grow Super	36,133	0.794
74	Guild Retirement Fund	172,033	0.212
75	Harwood Superannuation Fund	2,051,913	0.145
76	Health Employees Superannuation Trust Australia	488,053	0.133
77	Health Industry Plan	76,320	0.131
78	Holden Employees Superannuation Fund	1,390,809	0.125
79	HOSTPLUS Superannuation Fund	510,404	0.116
80	IAG & NRMA Superannuation Plan	510,441	0.115
81	Intrust Super Fund	159,541	0.110
82	IOOF Portfolio Service Superannuation Fund	8,431	0.109
83	IRIS Superannuation Fund	163,707	0.106
84	Kellogg Retirement Fund	308,795	0.104
85	Labour Union Co-Operative Retirement Fund	120,965	0.088
86	Law Employees Superannuation Fund	71,680	0.080
87	legalsuper	482,380	0.071
88	Lifefocus Superannuation Fund	252,919	0.069
89	Lifetime Superannuation Fund	441,454	0.048
90	Local Authorities Superannuation Fund	153,895	0.033
91	Local Government Superannuation Scheme	5,798,943	1.000
92	Local Government Superannuation Scheme	17,275,984	1.000
93	Local Government Superannuation Scheme - Pool A	3,019,411	1.000
94	Local Government Superannuation Scheme - Pool B	809,757	1.000
95	MacMahon Employees Superannuation Fund	3,712,122	0.335
96	Macquarie ADF Superannuation Fund	133,411	0.306

97	Macquarie Superannuation Plan	1,372,122	0.252
98	Managed Australian Retirement Fund	1,372,122	0.252
99	Map Superannuation Plan	2,552,212	0.242
100	Maritime Super	1,696,774	0.240
101	Meat Industry Employees Superannuation Fund	2,616,467	0.222
102	Media Super	991,380	0.185
103	Mercer Portfolio Service Superannuation Plan	1,210,771	0.149
104	Mercer Super Trust	337,245	0.142
105	Mercy Super	954,222	0.135
106	Military Superannuation & Benefits Fund No 1	40,958,323	1.000
107	Millennium Master Trust	13,661	1.000
108	MLC Superannuation Fund	32,018,465	1.000
109	MTAA Superannuation Fund	3,513,358	1.000
110	National Australia Bank Group Superannuation Fund A	687,430	1.000
111	National Preservation Trust	13,024,426	1.000
112	Nationwide Superannuation Fund	8,168,452	1.000
113	Netwealth Superannuation Master Fund	23,457,780	1.000
114	New South Wales Electrical Superannuation Scheme	29,292,551	1.000
115	Newcastle Permanent Superannuation Plan	5,247,876	1.000
116	NGS Super	393,899	0.738
117	Nufarm Employees Superannuation Trust	1,796,301	0.704
118	Oasis Superannuation Master Trust	525,739	0.647
119	O-I Australia Superannuation Fund	7,044,376	0.571
120	OnePath Masterfund	3,799,101	0.465
121	Oracle Superannuation Plan	260,114	0.432
122	Perpetual WealthFocus Superannuation Fund	43,584	0.390
123	Perpetual's Select Superannuation Fund	19,303	0.380
124	Pitcher Retirement Plan	34,840	0.355
125	Plan B Eligible Rollover Fund	1,609,265	0.296
126	Plan B Superannuation Fund	272,305	0.282
127	Plum Superannuation Fund	7,115,418	0.279
128	Premiumchoice Retirement Service	481,997	0.268
129	Prime Superannuation Fund	14,353,246	0.264
130	Professional Associations Superannuation Fund	7,978,751	0.252
131	Public Eligible Rollover Fund	1,276,098	0.251
132	Qantas Superannuation Plan	2,990,846	0.248
133	Quadrant Superannuation Scheme	5,992,117	0.248
134	Queensland Independent Education & Care Superannuation Trust	3,652,602	0.223
135	Rei Super	96,887	0.211
136	Reserve Bank of Australia Officers Superannuation Fund	40,165	0.209
137	Retail Employees Superannuation Trust	191,666	0.193
138	Retirement Portfolio Service	1,524,783	0.189
139	Rio Tinto Staff Superannuation Fund	61,632	0.188
140	Russell Supersolution Master Trust	41,120	0.172
141	Smartsave 'Member's Choice' Superannuation Master Plan	17,849	0.167
142	SMF Eligible Rollover Fund	766,911	0.162
143	State Super Fixed Term Pension Plan	40,993	0.160
144	State Super Retirement Fund	2,548,007	0.153
145	Statewide Superannuation Trust	35,028	0.152
146	Suncorp Master Trust	821,842	0.136
147	Sunsuper Superannuation Fund	971,916	0.135
148	Super Eligible Rollover Fund	260,124	0.134
149	Super Safeguard Fund	361,365	0.129
150	Super Synergy Fund	4,105,812	0.123
151	SuperTrace Eligible Rollover Fund	4,440,069	0.116
152	Symetry Personal Retirement Fund	136,786	0.105
153	Synergy Superannuation Master Fund	1,286,476	0.102

154	Tasplan Superannuation Fund	3,668,652	0.101
155	Taxi Industry Superannuation Fund	1,532,015	0.095
156	Telstra Superannuation Scheme	324,943	0.089
157	The Allied Unions Superannuation Trust (Queensland)	120,923	0.085
158	The Bendigo Superannuation Plan	77,840	0.085
159	The Employees Productivity Award Superannuation Trust	1,263,982	0.083
160	The Executive Superannuation Fund	310,397	0.082
161	The Flexible Benefits Super Fund	228,134	0.081
162	The Industry Superannuation Fund	48,822	0.079
163	The ISPF Eligible Rollover Fund	142,754	0.079
164	The Portfolio Service Retirement Fund	1,031,445	0.075
165	The Retirement Plan	387,652	0.071
166	The State Bank Supersafe Approved Deposit Fund	3,143,380	0.062
167	The Super Money Eligible Rollover Fund (SMERF)	705,111	0.057
168	The Transport Industry Superannuation Fund	226,345	0.049
169	The Universal Super Scheme	328,051	0.042
170	Toyota Australia Superannuation Plan	350,662	0.040
171	Toyota Employees Superannuation Trust	840,704	1.000
172	TWU Superannuation Fund	532,230	1.000
173	Unisuper	344,499	1.000
174	United Technologies Corporation Retirement Plan	19,200	1.000
175	Victorian Superannuation Fund	1,452	1.000
176	Virgin Superannuation	25,597	1.000
177	WA Local Government Superannuation Plan	1,546,537	1.000
178	Water Corporation Superannuation Plan	29,817	1.000
179	Westpac Mastertrust - Superannuation Division	104,128	0.763
180	Westpac Personal Superannuation Fund	16,626	0.396
181	William Adams Employees Superannuation Fund	213,257	0.313
182	Worsley Alumina Superannuation Fund	21,000	0.123
183	Zurich Master Superannuation Fund	81,355	0.058

Appendix 6.6

Efficiency scores – VRS model, 2010–11

Inputs	Investments expenses Operating expenses Management, administration and director fees Total expenses
Outputs	Average net assets Number of member accounts Annual investment return

No	Name	Assets ($000)	Efficiency score
1	ACP Retirement Fund	58,759	0.320
2	Advance Retirement Savings Account	200,932	0.276
3	Advance Retirement Suite	390,954	0.852
4	Alcoa of Australia Retirement Plan	1,328,385	0.278
5	AMG Universal Super	153,579	0.068
6	AMP Superannuation Savings Trust	47,312,119	1.000
7	Aon Eligible Rollover Fund	82,023	0.109
8	AON Master Trust	1,829,772	0.106
9	ASC Superannuation Fund	94,184	0.301
10	ASGARD Independence Plan Division Four	36,553	0.181
11	ASGARD Independence Plan Division One	57,947	0.078
12	ASGARD Independence Plan Division Two	15,449,509	0.279
13	AusBev Superannuation Fund	356,859	0.258
14	Auscoal Superannuation Fund	5,601,486	0.374
15	Australia Post Superannuation Scheme	5,972,848	1.000
16	Australian Catholic Superannuation and Retirement Fund	4,148,184	0.226
17	Australian Christian Superannuation Fund	57,415	0.068
18	Australian Eligible Rollover Fund	874,277	1.000
19	Australian Ethical Retail Superannuation Fund	364,405	0.058
20	Australian Government Employees Superannuation Trust	4,091,377	0.462
21	Australian Meat Industry Superannuation Trust	931,968	0.245
22	Australian Superannuation Savings Employment Trust - Asset Super	1,567,822	0.246
23	Australian YMCA Superannuation Fund	79,861	0.806
24	AustralianSuper	37,847,214	1.000
25	Australia's Unclaimed Super Fund	543,958	1.000
26	Austsafe Superannuation Fund	1,061,243	0.262
27	Avanteos Superannuation Trust	1,947,780	0.116
28	AvSuper Fund	1,121,999	0.198
29	Bankwest Staff Superannuation Plan	372,246	0.415
30	Betros Bros Superannuation Fund No 2	8,579	1.000
31	BHP Billiton Superannuation Fund	2,393,723	0.451
32	Bluescope Steel Superannuation Fund	1,659,613	0.786
33	Boc Gases Superannuation Fund	477,925	0.287
34	Bookmakers Superannuation Fund	118,784	0.041
35	BT Classic Lifetime	302,546	0.106
36	BT Lifetime Super	2,661,130	0.178
37	BT Superannuation Savings Fund	13,197	1.000

38	Building Unions Superannuation Scheme (Queensland)	1,884,527	0.421
39	Canegrowers Retirement Fund	84,063	0.127
40	Care Super	4,252,342	0.498
41	Catholic Superannuation Fund	3,973,222	0.616
42	Christian Super	555,966	0.116
43	Clough Superannuation Fund	129,762	0.186
44	Club Plus Superannuation Scheme	1,364,326	0.246
45	Club Super	290,049	0.083
46	Coal Industry Superannuation Fund	149,559	0.276
47	Colonial First State FirstChoice Superannuation Trust	38,150,894	1.000
48	Colonial First State Rollover & Superannuation Fund	3,593,249	0.181
49	Colonial Super Retirement Fund	2,887,376	0.248
50	Commerce Industry Superannuation Fund	8,942	0.097
51	Commonwealth Life Personal Superannuation Fund	3,115,361	1.000
52	Concept One Superannuation Plan	174,684	0.082
53	Construction & Building Unions Superannuation	15,823,486	0.343
54	DBP Master Superannuation Plan	30,589	1.000
55	DPM Retirement Service	124,562	0.119
56	EmPlus Superannuation Fund	94,294	0.082
57	Energy Industries Superannuation Scheme-Pool A	1,204,664	0.205
58	Energy Industries Superannuation Scheme-Pool B	1,876,968	0.221
59	Energy Super	3,347,534	0.273
60	equipsuper	4,564,735	0.254
61	EquitySuper	558,517	0.116
62	ExxonMobil Superannuation Plan	774,333	0.207
63	Fiducian Superannuation Fund	742,121	0.054
64	Fire and Emergency Services Superannuation Fund	370,408	0.180
65	First Quest Retirement Service	229,608	0.085
66	First State Superannuation Scheme	24,985,838	1.000
67	First Super	1,564,945	0.203
68	Freedom of Choice Superannuation Masterfund	157,283	0.061
69	General Retirement Plan	83,364	0.359
70	Goldman Sachs & JBWere Superannuation Fund	246,501	0.535
71	Greater Staff Superannuation Fund	42,136	1.000
72	Grosvenor Pirie Master Superannuation Fund Series 2	38,870	0.152
73	Grow Super	41,616	0.276
74	Guild Retirement Fund	611,327	0.228
75	Harwood Superannuation Fund	1,208,469	0.443
76	Health Employees Superannuation Trust Australia	16,852,122	1.000
77	Health Industry Plan	577,005	0.192
78	Holden Employees Superannuation Fund	655,668	1.000
79	HOSTPLUS Superannuation Fund	8,631,146	0.434
80	IAG & NRMA Superannuation Plan	1,081,720	0.241
81	Intrust Super Fund	1,080,916	0.245
82	IOOF Portfolio Service Superannuation Fund	11,231,601	0.304
83	IRIS Superannuation Fund	596,303	0.179
84	Kellogg Retirement Fund	81,544	0.393
85	Labour Union Co-Operative Retirement Fund	2,719,285	0.207
86	Law Employees Superannuation Fund	71,091	0.247
87	legalsuper	1,444,849	0.257
88	Lifefocus Superannuation Fund	318,133	0.022
89	Lifetime Superannuation Fund	794,038	1.000
90	Local Authorities Superannuation Fund	4,131,268	0.560
91	Local Government Superannuation Scheme	4,174,975	0.905
92	Local Government Superannuation Scheme	1,564,867	0.265
93	Local Government Superannuation Scheme - Pool A	3,057,129	0.180
94	Local Government Superannuation Scheme - Pool B	2,812,297	0.179

95	MacMahon Employees Superannuation Fund	61,606	0.105
96	Macquarie ADF Superannuation Fund	616,675	1.000
97	Macquarie Superannuation Plan	8,875,808	0.271
98	Managed Australian Retirement Fund	42,076	0.099
99	Map Superannuation Plan	271,513	0.160
100	Maritime Super	3,099,780	0.213
101	Meat Industry Employees Superannuation Fund	530,678	0.197
102	Media Super	2,767,448	0.305
103	Mercer Portfolio Service Superannuation Plan	1,617,007	0.289
104	Mercer Super Trust	14,542,924	0.803
105	Mercy Super	504,233	0.215
106	Military Superannuation & Benefits Fund No 1	3,482,892	0.433
107	Millennium Master Trust	50,187	0.093
108	MLC Superannuation Fund	8,811,392	1.000
109	MTAA Superannuation Fund	5,858,234	0.305
110	National Australia Bank Group Superannuation Fund A	3,072,382	1.000
111	National Preservation Trust	334,492	1.000
112	Nationwide Superannuation Fund	406,274	0.103
113	Netwealth Superannuation Master Fund	1,135,274	0.132
114	New South Wales Electrical Superannuation Scheme	348,895	0.329
115	Newcastle Permanent Superannuation Plan	182,970	0.180
116	NGS Super	3,605,631	0.321
117	Nufarm Employees Superannuation Trust	69,937	1.000
118	Oasis Superannuation Master Trust	3,895,405	0.102
119	O-I Australia Superannuation Fund	151,293	0.243
120	OnePath Masterfund	25,865,685	1.000
121	Oracle Superannuation Plan	123,272	0.870
122	Perpetual WealthFocus Superannuation Fund	1,871,088	0.505
123	Perpetual's Select Superannuation Fund	1,452,133	0.243
124	Pitcher Retirement Plan	46,102	0.320
125	Plan B Eligible Rollover Fund	20,500	1.000
126	Plan B Superannuation Fund	98,751	0.257
127	Plum Superannuation Fund	9,019,104	0.760
128	Premiumchoice Retirement Service	326,792	0.091
129	Prime Superannuation Fund	1,114,127	0.180
130	Professional Associations Superannuation Fund	1,656,274	0.175
131	Public Eligible Rollover Fund	1,607	0.987
132	Qantas Superannuation Plan	5,650,800	0.737
133	Quadrant Superannuation Scheme	500,420	0.063
134	Queensland Independent Education & Care Superannuation Trust	608,090	0.151
135	Rei Super	781,193	0.237
136	Reserve Bank of Australia Officers Superannuation Fund	880,904	1.000
137	Retail Employees Superannuation Trust	19,012,886	1.000
138	Retirement Portfolio Service	1,006,588	0.117
139	Rio Tinto Staff Superannuation Fund	2,996,227	0.421
140	Russell Supersolution Master Trust	4,713,374	0.800
141	Smartsave 'Member's Choice' Superannuation Master Plan	223,804	0.039
142	SMF Eligible Rollover Fund	103,522	0.994
143	State Super Fixed Term Pension Plan	39,952	0.289
144	State Super Retirement Fund	8,311,611	0.313
145	Statewide Superannuation Trust	2,300,224	0.177
146	Suncorp Master Trust	5,630,951	0.174
147	Sunsuper Superannuation Fund	17,039,446	0.594
148	Super Eligible Rollover Fund	24,666	0.089
149	Super Safeguard Fund	32,520	0.992
150	Super Synergy Fund	38,114	0.253
151	SuperTrace Eligible Rollover Fund	1,616,969	1.000

152	Symetry Personal Retirement Fund	1,291,541	0.094
153	Synergy Superannuation Master Fund	1,028,417	0.084
154	Tasplan Superannuation Fund	1,453,406	0.233
155	Taxi Industry Superannuation Fund	19,003	0.195
156	Telstra Superannuation Scheme	10,816,063	0.640
157	The Allied Unions Superannuation Trust (Queensland)	181,824	0.097
158	The Bendigo Superannuation Plan	262,112	0.449
159	The Employees Productivity Award Superannuation Trust	17,366	0.325
160	The Executive Superannuation Fund	365,228	0.233
161	The Flexible Benefits Super Fund	689,859	0.536
162	The Industry Superannuation Fund	137,441	0.101
163	The ISPF Eligible Rollover Fund	13,815	0.211
164	The Portfolio Service Retirement Fund	4,742,124	0.139
165	The Retirement Plan	3,901,192	0.138
166	The State Bank Supersafe Approved Deposit Fund	34,899	0.242
167	The Super Money Eligible Rollover Fund (SMERF)	32,652	1.000
168	The Transport Industry Superannuation Fund	79,900	0.083
169	The Universal Super Scheme	31,441,567	1.000
170	Toyota Australia Superannuation Plan	219,774	0.460
171	Toyota Employees Superannuation Trust	342,799	0.519
172	TWU Superannuation Fund	2,520,416	0.168
173	Unisuper	27,277,376	1.000
174	United Technologies Corporation Retirement Plan	259,465	0.692
175	Victorian Superannuation Fund	7,873,796	0.735
176	Virgin Superannuation	329,049	0.290
177	WA Local Government Superannuation Plan	1,400,125	0.186
178	Water Corporation Superannuation Plan	204,784	0.278
179	Westpac Mastertrust - Superannuation Division	5,474,692	1.000
180	Westpac Personal Superannuation Fund	529,493	0.602
181	William Adams Employees Superannuation Fund	41,406	1.000
182	Worsley Alumina Superannuation Fund	194,385	0.312
183	Zurich Master Superannuation Fund	1,505,736	0.203

Appendix 6.7

Efficiency scores – VRS model, 2011–12

Inputs	Investments expenses Operating expenses Management, administration and director fees Total expenses
Outputs	Average net assets Number of member accounts Annual investment return

No	Name	Assets ($000)	Efficiency score
1	ACP Retirement Fund	59,490	0.147
2	Advance Retirement Savings Account	193,087	0.136
3	Advance Retirement Suite	354,783	0.619
4	Alcoa of Australia Retirement Plan	1,439,321	0.339
5	AMG Universal Super	184,376	0.072
6	AMP Superannuation Savings Trust	51,626,318	1.000
7	Aon Eligible Rollover Fund	83,399	0.310
8	AON Master Trust	2,058,228	0.108
9	ASC Superannuation Fund	101,992	0.225
10	ASGARD Independence Plan Division Four	31,401	0.083
11	ASGARD Independence Plan Division One	52,017	0.068
12	ASGARD Independence Plan Division Two	15,842,530	0.317
13	AusBev Superannuation Fund	365,268	0.210
14	Auscoal Superannuation Fund	6,152,378	0.452
15	Australia Post Superannuation Scheme	6,165,024	1.000
16	Australian Catholic Superannuation and Retirement Fund	4,503,659	0.369
17	Australian Christian Superannuation Fund	56,028	0.077
18	Australian Eligible Rollover Fund	882,055	1.000
19	Australian Ethical Retail Superannuation Fund	390,982	0.065
20	Australian Government Employees Superannuation Trust	4,582,397	0.658
21	Australian Meat Industry Superannuation Trust	1,009,976	0.232
22	Australian Superannuation Savings Employment Trust - Asset Super	1,661,413	0.237
23	Australian YMCA Superannuation Fund	86,438	0.567
24	AustralianSuper	44,952,610	1.000
25	Australia's Unclaimed Super Fund	535,301	1.000
26	Austsafe Superannuation Fund	1,156,471	0.256
27	Avanteos Superannuation Trust	2,791,284	0.115
28	AvSuper Fund	1,208,259	0.195
29	Bankwest Staff Superannuation Plan	388,322	0.348
30	Betros Bros Superannuation Fund No 2	9,456	0.339
31	BHP Billiton Superannuation Fund	2,603,017	0.344
32	Bluescope Steel Superannuation Fund	1,601,948	0.572
33	Boc Gases Superannuation Fund	488,599	0.354
34	Bookmakers Superannuation Fund	84,784	0.060
35	BT Classic Lifetime	260,956	0.071
36	BT Lifetime Super	2,531,525	0.147
37	BT Superannuation Savings Fund	12,954	1.000
38	Building Unions Superannuation Scheme (Queensland)	2,088,037	0.286

39	Canegrowers Retirement Fund	89,496	0.111
40	Care Super	4,722,012	0.386
41	Catholic Superannuation Fund	4,353,858	0.442
42	Christian Super	611,638	0.098
43	Clough Superannuation Fund	142,873	0.142
44	Club Plus Superannuation Scheme	1,460,573	0.236
45	Club Super	310,848	0.113
46	Coal Industry Superannuation Fund	158,005	0.181
47	Colonial First State FirstChoice Superannuation Trust	42,062,500	1.000
48	Colonial First State Rollover & Superannuation Fund	3,198,118	0.179
49	Colonial Super Retirement Fund	2,663,222	0.248
50	Commerce Industry Superannuation Fund	9,657	0.063
51	Commonwealth Life Personal Superannuation Fund	2,684,548	1.000
52	Concept One Superannuation Plan	180,695	0.098
53	Construction & Building Unions Superannuation	18,067,467	0.790
54	DBP Master Superannuation Plan	31,953	0.259
55	DPM Retirement Service	107,015	0.089
56	EmPlus Superannuation Fund	102,009	0.098
57	Energy Industries Superannuation Scheme-Pool A	1,426,226	0.206
58	Energy Industries Superannuation Scheme-Pool B	1,966,022	0.244
59	Energy Super	3,923,262	0.342
60	equipsuper	4,843,694	0.327
61	EquitySuper	712,200	0.094
62	ExxonMobil Superannuation Plan	820,878	0.244
63	Fiducian Superannuation Fund	706,306	0.054
64	Fire and Emergency Services Superannuation Fund	391,328	0.169
65	First Quest Retirement Service	208,405	0.074
66	First State Superannuation Scheme	32,313,367	1.000
67	First Super	1,658,897	0.234
68	Freedom of Choice Superannuation Masterfund	171,221	0.080
69	General Retirement Plan	83,977	0.193
70	Goldman Sachs & JBWere Superannuation Fund	254,859	0.305
71	Greater Staff Superannuation Fund	45,132	0.520
72	Grosvenor Pirie Master Superannuation Fund Series 2	41,814	0.133
73	Grow Super	41,808	0.192
74	Guild Retirement Fund	697,735	0.130
75	Harwood Superannuation Fund	1,238,683	0.333
76	Health Employees Superannuation Trust Australia	18,945,387	0.824
77	Health Industry Plan	617,127	0.113
78	Holden Employees Superannuation Fund	689,488	0.510
79	HOSTPLUS Superannuation Fund	9,804,567	0.413
80	IAG & NRMA Superannuation Plan	1,144,610	0.203
81	Intrust Super Fund	1,163,901	0.240
82	IOOF Portfolio Service Superannuation Fund	13,081,152	0.412
83	IRIS Superannuation Fund	566,480	0.166
84	Kellogg Retirement Fund	83,298	0.099
85	Labour Union Co-Operative Retirement Fund	3,021,389	0.193
86	Law Employees Superannuation Fund	73,694	0.084
87	legalsuper	1,588,441	0.236
88	Lifefocus Superannuation Fund	280,320	0.048
89	Lifetime Superannuation Fund	716,220	0.121
90	Local Authorities Superannuation Fund	4,619,121	1.000
91	Local Government Superannuation Scheme	5,417,317	0.772
92	Local Government Superannuation Scheme	5,417,317	0.772
93	Local Government Superannuation Scheme - Pool A	3,463,297	0.348
94	Local Government Superannuation Scheme - Pool B	2,815,571	0.308
95	MacMahon Employees Superannuation Fund	70,296	0.115

96	Macquarie ADF Superannuation Fund	549,266	1.000
97	Macquarie Superannuation Plan	9,445,821	0.322
98	Managed Australian Retirement Fund	40,664	0.085
99	Map Superannuation Plan	271,847	0.111
100	Maritime Super	3,318,606	0.398
101	Meat Industry Employees Superannuation Fund	548,923	0.182
102	Media Super	2,954,694	0.211
103	Mercer Portfolio Service Superannuation Plan	1,514,430	0.272
104	Mercer Super Trust	15,444,548	1.000
105	Mercy Super	569,471	0.133
106	Military Superannuation & Benefits Fund No 1	3,874,847	1.000
107	Millennium Master Trust	47,455	0.075
108	MLC Superannuation Fund	11,112,585	0.867
109	MTAA Superannuation Fund	6,052,458	0.363
110	National Australia Bank Group Superannuation Fund A	3,182,519	1.000
111	National Preservation Trust	323,473	1.000
112	Nationwide Superannuation Fund	427,399	0.124
113	Netwealth Superannuation Master Fund	1,438,574	0.070
114	New South Wales Electrical Superannuation Scheme	379,433	0.222
115	Newcastle Permanent Superannuation Plan	182,537	0.286
116	NGS Super	4,281,390	0.302
117	Nufarm Employees Superannuation Trust	71,064	0.463
118	Oasis Superannuation Master Trust	4,340,709	0.129
119	O-I Australia Superannuation Fund	143,935	0.263
120	OnePath Masterfund	26,248,258	1.000
121	Oracle Superannuation Plan	152,729	0.804
122	Perpetual WealthFocus Superannuation Fund	1,802,686	0.364
123	Perpetual's Select Superannuation Fund	1,512,927	0.322
124	Pitcher Retirement Plan	49,663	0.146
125	Plan B Eligible Rollover Fund	21,258	1.000
126	Plan B Superannuation Fund	96,372	0.264
127	Plum Superannuation Fund	10,465,502	0.834
128	Premiumchoice Retirement Service	314,570	0.081
129	Prime Superannuation Fund	1,228,752	0.187
130	Professional Associations Superannuation Fund	1,897,491	0.213
131	Public Eligible Rollover Fund	1,635	0.621
132	Qantas Superannuation Plan	5,812,311	1.000
133	Quadrant Superannuation Scheme	540,287	0.061
134	Queensland Independent Education & Care Superannuation Trust	688,213	0.127
135	Rei Super	842,399	0.182
136	Reserve Bank of Australia Officers Superannuation Fund	921,282	1.000
137	Retail Employees Superannuation Trust	21,217,824	0.909
138	Retirement Portfolio Service	989,624	0.109
139	Rio Tinto Staff Superannuation Fund	3,331,422	0.357
140	Russell Supersolution Master Trust	4,934,717	0.492
141	Smartsave 'Member's Choice' Superannuation Master Plan	215,338	0.040
142	SMF Eligible Rollover Fund	98,761	0.482
143	State Super Fixed Term Pension Plan	36,190	1.000
144	State Super Retirement Fund	9,279,624	0.375
145	Statewide Superannuation Trust	2,471,727	0.159
146	Suncorp Master Trust	5,833,332	0.231
147	Sunsuper Superannuation Fund	19,038,875	0.542
148	Super Eligible Rollover Fund	24,236	0.311
149	Super Safeguard Fund	32,314	1.000
150	Super Synergy Fund	41,703	0.095
151	SuperTrace Eligible Rollover Fund	1,632,002	1.000
152	Symetry Personal Retirement Fund	1,292,073	0.088

153	Synergy Superannuation Master Fund	921,599	0.077
154	Tasplan Superannuation Fund	1,614,616	0.238
155	Taxi Industry Superannuation Fund	18,982	0.081
156	Telstra Superannuation Scheme	11,514,120	0.646
157	The Allied Unions Superannuation Trust (Queensland)	191,145	0.117
158	The Bendigo Superannuation Plan	263,730	0.349
159	The Employees Productivity Award Superannuation Trust	14,459	0.098
160	The Executive Superannuation Fund	403,268	0.188
161	The Flexible Benefits Super Fund	638,046	0.468
162	The Industry Superannuation Fund	149,429	0.100
163	The ISPF Eligible Rollover Fund	11,000	1.000
164	The Portfolio Service Retirement Fund	4,945,226	0.175
165	The Retirement Plan	3,706,367	0.147
166	The State Bank Supersafe Approved Deposit Fund	30,425	0.229
167	The Super Money Eligible Rollover Fund (SMERF)	34,810	1.000
168	The Transport Industry Superannuation Fund	84,992	0.077
169	The Universal Super Scheme	33,019,403	1.000
170	Toyota Australia Superannuation Plan	230,819	0.324
171	Toyota Employees Superannuation Trust	347,359	0.347
172	TWU Superannuation Fund	2,744,607	0.165
173	Unisuper	29,741,153	1.000
174	United Technologies Corporation Retirement Plan	271,736	0.369
175	Victorian Superannuation Fund	8,863,660	0.674
176	Virgin Superannuation	367,924	0.179
177	WA Local Government Superannuation Plan	1,564,471	0.162
178	Water Corporation Superannuation Plan	239,546	0.262
179	Westpac Mastertrust - Superannuation Division	5,402,432	1.000
180	Westpac Personal Superannuation Fund	501,853	0.524
181	William Adams Employees Superannuation Fund	43,895	0.237
182	Worsley Alumina Superannuation Fund	215,056	0.348
183	Zurich Master Superannuation Fund	1,374,994	0.183

Appendix 6.8

Efficiency scores – VRS model, period 2005–12

Inputs	Investments expenses Operating expenses Management, administration and director fees Total expenses Volatility (SD) of investment return
Outputs	Average net asset Member account Multiple period investment return

No	Name	Efficiency score	Expense target	SD target
1	ACP Retirement Fund	0.247	–0.818	–0.927
2	Advance Retirement Savings Account	0.700	–0.296	0.000
3	Advance Retirement Suite	0.992	–0.368	–0.844
4	Alcoa of Australia Retirement Plan	0.528	–0.826	–0.891
5	AMG Universal Super	0.154	–0.926	–0.935
6	AMP Superannuation Savings Trust	1.000	0.000	0.000
7	Aon Eligible Rollover Fund	0.078	–0.841	–0.689
8	AON Master Trust	0.096	–0.923	–0.788
9	ASC Superannuation Fund	0.271	–0.835	–0.929
10	ASGARD Independence Plan Division Four	0.050	–0.912	–0.906
11	ASGARD Independence Plan Division One	0.042	–0.933	–0.827
12	ASGARD Independence Plan Division Two	0.091	–0.783	–0.482
13	AusBev Superannuation Fund	0.192	–0.855	–0.935
14	Auscoal Superannuation Fund	0.540	–0.720	–0.188
15	Australia Post Superannuation Scheme	0.692	0.000	0.000
16	Australian Catholic Superannuation and Retirement Fund	0.299	–0.836	–0.463
17	Australian Christian Superannuation Fund	0.302	–0.918	–0.884
18	Australian Eligible Rollover Fund	0.983	–0.069	–0.078
19	Australian Ethical Retail Superannuation Fund	0.065	–0.954	–0.925
20	Australian Government Employees Superannuation Trust	0.312	–0.734	–0.472
21	Australian Meat Industry Superannuation Trust	0.284	–0.827	–0.895
22	Australian Superannuation Savings Employment Trust - Asset Super	0.223	-0.830	-0.820
23	Australian YMCA Superannuation Fund	0.220	-0.826	-0.863
24	AustralianSuper	1.000	0.000	0.000
25	Australia's Unclaimed Super Fund	1.000	0.000	0.000
26	Austsafe Superannuation Fund	0.453	–0.791	–0.883
27	Avanteos Superannuation Trust	0.064	–0.911	–0.743
28	AvSuper Fund	0.224	–0.894	–0.918
29	Bankwest Staff Superannuation Plan	0.310	–0.729	–0.879
30	Betros Bros Superannuation Fund No 2	1.000	0.000	0.000
31	BHP Billiton Superannuation Fund	0.536	–0.683	–0.608
32	Bluescope Steel Superannuation Fund	0.668	–0.504	–0.740
33	Boc Gases Superannuation Fund	0.308	–0.810	–0.949
34	Bookmakers Superannuation Fund	0.164	–0.939	–0.954
35	BT Classic Lifetime	0.059	–0.929	–0.873
36	BT Lifetime Super	0.120	–0.857	–0.618

37	BT Superannuation Savings Fund	1.000	0.000	0.000
38	Building Unions Superannuation Scheme (Queensland)	0.292	–0.738	–0.727
39	Canegrowers Retirement Fund	0.172	–0.889	–0.614
40	Care Super	0.285	–0.773	–0.295
41	Catholic Superannuation Fund	0.386	–0.807	–0.369
42	Christian Super	0.194	–0.929	–0.892
43	Clough Superannuation Fund	0.288	–0.866	–0.947
44	Club Plus Superannuation Scheme	0.390	–0.736	–0.770
45	Club Super	0.161	–0.869	–0.926
46	Coal Industry Superannuation Fund	0.274	–0.775	–0.935
47	Colonial First State FirstChoice Superannuation Trust	0.260	–0.597	–0.026
48	Colonial First State Rollover & Superannuation Fund	0.158	–0.870	–0.400
49	Colonial Super Retirement Fund	0.125	–0.804	–0.459
50	Commerce Industry Superannuation Fund	0.226	–0.882	–0.802
51	Commonwealth Life Personal Superannuation Fund	1.000	0.000	0.000
52	Concept One Superannuation Plan	0.148	–0.888	–0.776
53	Construction & Building Unions Superannuation	0.406	–0.574	–0.354
54	DBP Master Superannuation Plan	0.746	–0.729	–0.923
55	DPM Retirement Service	0.056	–0.922	–0.899
56	EmPlus Superannuation Fund	0.144	–0.914	–0.766
57	Energy Industries Superannuation Scheme–Pool A	0.111	–0.911	–0.932
58	Energy Industries Superannuation Scheme–Pool B	0.227	–0.857	–0.798
59	Energy Super	0.523	–0.801	–0.438
60	equipsuper	0.300	–0.850	–0.235
61	EquitySuper	0.071	–0.919	–0.929
62	ExxonMobil Superannuation Plan	0.201	–0.940	–0.950
63	Fiducian Superannuation Fund	0.053	–0.957	–0.953
64	Fire and Emergency Services Superannuation Fund	0.404	–0.874	–0.872
65	First Quest Retirement Service	0.043	–0.940	–0.905
66	First State Superannuation Scheme	0.852	0.000	0.000
67	First Super	0.168	–0.828	–0.820
68	Freedom of Choice Superannuation Masterfund	0.091	–0.939	–0.919
69	General Retirement Plan	0.079	–0.659	–0.867
70	Goldman Sachs & JBWere Superannuation Fund	1.000	0.000	0.000
71	Greater Staff Superannuation Fund	1.000	0.000	0.000
72	Grosvenor Pirie Master Superannuation Fund Series 2	0.333	–0.867	–0.882
73	Grow Super	0.132	–0.764	–0.902
74	Guild Retirement Fund	0.052	–0.823	–0.820
75	Harwood Superannuation Fund	0.289	–0.783	–0.867
76	Health Employees Superannuation Trust Australia	0.714	–0.363	–0.317
77	Health Industry Plan	0.167	–0.893	–0.942
78	Holden Employees Superannuation Fund	0.307	–0.645	–0.830
79	HOSTPLUS Superannuation Fund	0.350	–0.643	–0.588
80	IAG & NRMA Superannuation Plan	0.424	–0.864	–0.920
81	Intrust Super Fund	0.253	–0.848	–0.886
82	IOOF Portfolio Service Superannuation Fund	0.055	–0.729	–0.741
83	IRIS Superannuation Fund	0.072	–0.886	–0.809
84	Kellogg Retirement Fund	0.184	–0.894	–0.784
85	Labour Union Co–Operative Retirement Fund	0.139	–0.880	–0.618
86	Law Employees Superannuation Fund	0.214	–0.892	–0.908
87	legalsuper	0.245	–0.837	–0.884
88	Lifefocus Superannuation Fund	0.088	–0.962	–0.940
89	Lifetime Superannuation Fund	0.217	–0.890	–0.955
90	Local Authorities Superannuation Fund	0.232	–0.757	–0.261
91	Local Government Superannuation Scheme	0.298	–0.609	–0.378
92	Local Government Superannuation Scheme	0.298	–0.547	–0.311
93	Local Government Superannuation Scheme – Pool A	0.141	–0.875	–0.612

94	Local Government Superannuation Scheme – Pool B	0.251	–0.834	–0.634
95	MacMahon Employees Superannuation Fund	0.262	–0.912	–0.904
96	Macquarie ADF Superannuation Fund	1.000	0.000	0.000
97	Macquarie Superannuation Plan	0.118	–0.720	–0.693
98	Managed Australian Retirement Fund	0.210	–0.920	–0.924
99	Map Superannuation Plan	0.088	–0.893	–0.893
100	Maritime Super	0.211	–0.847	–0.515
101	Meat Industry Employees Superannuation Fund	0.250	–0.823	–0.923
102	Media Super	0.287	–0.811	–0.709
103	Mercer Portfolio Service Superannuation Plan	0.078	–0.916	–0.764
104	Mercer Super Trust	1.000	0.000	0.000
105	Mercy Super	0.347	–0.845	–0.919
106	Military Superannuation & Benefits Fund No 1	0.462	–0.526	–0.162
107	Millennium Master Trust	0.082	–0.928	–0.892
108	MLC Superannuation Fund	1.000	–0.245	–0.251
109	MTAA Superannuation Fund	0.312	–0.751	–0.516
110	National Australia Bank Group Superannuation Fund A	1.000	0.000	0.000
111	National Preservation Trust	1.000	0.000	0.000
112	Nationwide Superannuation Fund	0.127	–0.857	–0.917
113	Netwealth Superannuation Master Fund	0.054	–0.938	–0.818
114	New South Wales Electrical Superannuation Scheme	0.220	–0.855	–0.877
115	Newcastle Permanent Superannuation Plan	1.000	0.000	0.000
116	NGS Super	0.274	–0.823	–0.470
117	Nufarm Employees Superannuation Trust	0.466	–0.552	–0.940
118	Oasis Superannuation Master Trust	0.044	–0.864	–0.886
119	O–I Australia Superannuation Fund	0.334	–0.799	–0.945
120	OnePath Masterfund	0.867	–0.236	0.000
121	Oracle Superannuation Plan	0.526	–0.561	–0.948
122	Perpetual WealthFocus Superannuation Fund	0.344	–0.710	–0.775
123	Perpetual's Select Superannuation Fund	0.440	–0.836	–0.844
124	Pitcher Retirement Plan	0.222	–0.875	–0.912
125	Plan B Eligible Rollover Fund	1.000	0.000	0.000
126	Plan B Superannuation Fund	0.470	–0.607	–0.341
127	Plum Superannuation Fund	0.369	–0.500	–0.275
128	Premiumchoice Retirement Service	0.039	–0.936	–0.898
129	Prime Superannuation Fund	0.218	–0.863	–0.859
130	Professional Associations Superannuation Fund	0.161	–0.855	–0.649
131	Public Eligible Rollover Fund	0.787	–0.213	–0.905
132	Qantas Superannuation Plan	0.977	–0.434	–0.044
133	Quadrant Superannuation Scheme	0.086	–0.938	–0.942
134	Queensland Independent Education & Care Superannuation Trust	0.189	–0.866	–0.936
135	Rei Super	0.226	–0.836	–0.944
136	Reserve Bank of Australia Officers Superannuation Fund	1.000	0.000	0.000
137	Retail Employees Superannuation Trust	0.777	0.000	0.000
138	Retirement Portfolio Service	0.070	–0.912	–0.749
139	Rio Tinto Staff Superannuation Fund	0.377	–0.793	–0.648
140	Russell Supersolution Master Trust	0.227	–0.756	–0.372
141	Smartsave 'Member's Choice' Superannuation Master Plan	0.039	–0.952	–0.910
142	SMF Eligible Rollover Fund	0.138	0.000	–0.366
143	State Super Fixed Term Pension Plan	0.190	0.000	0.000
144	State Super Retirement Fund	0.073	–0.710	–0.625
145	Statewide Superannuation Trust	0.134	–0.878	–0.701
146	Suncorp Master Trust	0.202	–0.843	–0.269
147	Sunsuper Superannuation Fund	0.431	–0.567	–0.571
148	Super Eligible Rollover Fund	0.142	–0.880	–0.736
149	Super Safeguard Fund	1.000	0.000	0.000
150	Super Synergy Fund	0.146	–0.901	–0.910

151	SuperTrace Eligible Rollover Fund	1.000	0.000	0.000
152	Symetry Personal Retirement Fund	0.052	–0.933	–0.747
153	Synergy Superannuation Master Fund	0.052	–0.936	–0.785
154	Tasplan Superannuation Fund	0.249	–0.813	–0.802
155	Taxi Industry Superannuation Fund	0.139	–0.907	–0.903
156	Telstra Superannuation Scheme	0.551	–0.489	–0.320
157	The Allied Unions Superannuation Trust (Queensland)	0.177	–0.888	–0.839
158	The Bendigo Superannuation Plan	0.125	–0.786	–0.838
159	The Employees Productivity Award Superannuation Trust	0.251	0.000	0.000
160	The Executive Superannuation Fund	0.154	–0.870	–0.927
161	The Flexible Benefits Super Fund	0.407	–0.612	–0.842
162	The Industry Superannuation Fund	0.115	–0.896	–0.766
163	The ISPF Eligible Rollover Fund	0.381	–0.471	–0.410
164	The Portfolio Service Retirement Fund	0.056	–0.804	–0.771
165	The Retirement Plan	0.061	–0.770	–0.826
166	The State Bank Supersafe Approved Deposit Fund	0.078	0.000	0.000
167	The Super Money Eligible Rollover Fund (SMERF)	1.000	0.000	0.000
168	The Transport Industry Superannuation Fund	0.108	–0.929	–0.901
169	The Universal Super Scheme	1.000	0.000	0.000
170	Toyota Australia Superannuation Plan	0.195	–0.750	–0.925
171	Toyota Employees Superannuation Trust	0.201	–0.782	–0.922
172	TWU Superannuation Fund	0.241	–0.867	–0.664
173	Unisuper	1.000	0.000	0.000
174	United Technologies Corporation Retirement Plan	0.234	–0.681	–0.784
175	Victorian Superannuation Fund	0.270	–0.637	–0.170
176	Virgin Superannuation	0.201	–0.777	–0.903
177	WA Local Government Superannuation Plan	0.213	–0.876	–0.872
178	Water Corporation Superannuation Plan	0.367	–0.744	–0.925
179	Westpac Mastertrust – Superannuation Division	1.000	0.000	0.000
180	Westpac Personal Superannuation Fund	0.264	–0.531	–0.799
181	William Adams Employees Superannuation Fund	0.445	–0.782	–0.924
182	Worsley Alumina Superannuation Fund	0.547	–0.667	–0.469
183	Zurich Master Superannuation Fund	0.115	–0.850	–0.590

Appendix 7.1

Record sheet – independent explanatory variables

EXPLANATORY FACTORS
RECORD SHEET
FUND NAME ____

Variables	Abbreviations	Code	2010–11	2011–12	Note
Governance and board structure					
Director trustee no.	Dir	no.			
Employer-member rep.	EmpMem	1/0			
Female director no.	FemDir	no.			
Independent director no.	Inddir	no.			
Risk management mechanism					
Insurance	InsMem	2/1/0			
Reserve	Reserve	2/1/0			
Investment activities					
Australian shares	AusShare	%			
Australian fixed interest	AuxFixInt	%			
Cash	Cash	%			
International shares	IntShare	%			
International fixed interest	IntFixInt	%			
Investment option no	InvOpt	no.			

Notes
* No disclosure = remove the fund
** Cross-checked with annual report
*** Cross-checked with fund website

Appendix 8.1

Effect of board structure and risk management mechanism on efficiency, 2010–11

Independent variable	**OLS**				**Tobit**			
	Estimated coefficient	t–statistic	p–value		Estimated coefficient	z–statistic	p–value	
Constant	0.511	6.892	0.000	***	0.511	7.064	0.000	***
Director	–0.018	–2.047	0.043	**	–0.018	–2.098	0.036	**
Employer/member	0.010	0.429	0.668		0.010	0.440	0.660	
Female director	0.304	2.306	0.023	**	0.304	2.364	0.018	**
Independent director	–0.051	–0.414	0.679		–0.051	–0.425	0.671	
Insurance	–0.053	–1.937	0.055	*	–0.053	–1.986	0.047	*
Reserve	0.040	0.896	0.372		0.040	0.918	0.359	
R–squared		0.090			Left censored		0	
Adjusted R–squared		0.050			Right censored		0	
S.E. of regression		0.260			Unsensored		145	
F–statistic		2.265			Total observations		145	
Prob(F–statistic)		0.041						
Durbin–Watson stat.		1.993						
Total observations		145						

* significant at 10%, ** significant at 5%, *** significant at 1%

Appendix 8.2

Effect of board structure and risk management mechanism on efficiency, 2011–12

Independent variable	**OLS**				**Tobit**			
	Estimated coefficient	t–statistic	p–value		Estimated coefficient	z–statistic	p–value	
Constant	0.607	8.493	0.000	***	0.607	7.675	0.000	***
Director	–0.015	–1.633	0.105		–0.015	–2.096	0.036	**
Employer/member	0.059	1.373	0.172		0.059	1.787	0.074	*
Female director	0.255	2.032	0.044	**	0.255	2.062	0.039	**
Independent director	–0.118	–1.044	0.299		–0.118	–0.969	0.333	
Insurance	–0.125	–4.960	0.000	***	–0.125	–4.997	0.000	***
Reserve	0.042	1.026	0.307		0.042	1.042	0.298	
R–squared		0.192			Left censored		0	
Adjusted R–squared		0.157			Right censored		0	
S.E. of regression		0.238			Unsensored		145	
F–statistic		5.479			Total observations		145	
Prob(F–statistic)		0.000						
Durbin–Watson stat.		1.919						
Total observations		145						

* significant at 10%, ** significant at 5%, *** significant at 1%

Appendix 8.3

Effect of investment activities on efficiency, 2010–11

Independent variable	OLS				Tobit			
	Estimated coefficients	t–statistic	p–value		Estimated coefficient	z–statistic	p–value	
Constant	–0.081	–0.454	0.650		–0.081	–0.466	0.641	
AusFixInt	0.482	2.119	0.036	**	0.482	2.172	0.030	**
AusShare	0.523	2.016	0.046	**	0.523	2.066	0.039	**
Cash	0.697	2.705	0.008	***	0.697	2.773	0.006	***
IntFixInt	0.168	0.390	0.697		0.168	0.400	0.689	
IntShare	1.027	2.685	0.008	***	1.027	2.752	0.006	***
InvOpt	–0.029	–2.067	0.041	**	–0.029	–2.119	0.034	**
R-squared		0.084			Left censored		0	
Adjusted R-squared		0.045			Right censored		0	
F-statistic		2.123			Unsensored		145	
Prob(F-statistic)		0.054			Total observations		145	
Durbin-Watson stat.		2.011						
Total observations		145						

* significant at 10%, ** significant at 5%, *** significant at 1%

Appendix 8.4

Effect of investment activities on efficiency, 2011–12

Independent variable	OLS				Tobit			
	Estimated coefficients	t–statistic	p–value		Estimated coefficient	z–statistic	p–value	
Constant	0.144	0.850	0.397		0.144	0.872	0.383	
AusFixInt	0.333	1.549	0.124		0.333	1.588	0.112	
AusShare	0.251	1.010	0.314		0.251	1.035	0.301	
Cash	0.351	1.655	0.099	*	0.351	1.661	0.096	*
IntFixInt	0.279	0.687	0.493		0.279	0.704	0.481	
IntShare	0.736	1.950	0.053	*	0.736	1.999	0.046	**
InvOpt	–0.043	–3.085	0.003	***	–0.043	–3.163	0.002	***
R-squared		0.089			Left censored		0	
Adjusted R-squared		0.050			Right censored		0	
F-statistic		2.252			Unsensored		145	
Prob(F-statistic)		0.042			Total observations		145	
Durbin-Watson stat.		2.137						
Total observations		145						

* significant at 10%, ** significant at 5%, *** significant at 1%

Appendix 8.5

Effect of board structure, risk management and investment activities on efficiency, 2010–11

Independent variable	OLS				Tobit			
	Estimated coefficient	t–statistic	p–value		Estimated coefficient	z–statistic	p–value	
Constant	0.176	0.757	0.450		0.176	0.794	0.427	
AusFixInt	0.222	0.851	0.396		0.222	0.892	0.372	
AusShare	0.285	1.026	0.307		0.285	1.075	0.282	
Cash	0.541	1.954	0.053	*	0.541	2.048	0.041	**
Dir	–0.014	–1.479	0.142		–0.014	–1.550	0.121	
EmpMem	0.004	0.172	0.863		0.004	0.181	0.857	
FemDir	0.312	2.288	0.024	**	0.312	2.398	0.017	**
IndDir	0.015	0.114	0.910		0.015	0.119	0.905	
InsMem	–0.041	–1.376	0.171		–0.041	–1.442	0.149	
IntFixInt	–0.003	–0.008	0.994		–0.003	–0.008	0.994	
IntShare	0.824	2.084	0.039	**	0.824	2.184	0.029	**
InvOpt	–0.030	–2.025	0.045	**	–0.030	–2.123	0.034	**
Reserve	0.036	0.790	0.431		0.036	0.827	0.408	
R-squared		0.145			Left censored		0	
Adjusted R-squared		0.067			Right censored		0	
F-statistic		1.863			Unsensored		145	
Prob(F-statistic)		0.045			Total observations		145	
Durbin-Watson stat		2.043						
Total observations		145						

* significant at 10%, ** significant at 5%, *** significant at 1%

Appendix 8.6

Effect of board structure, risk management and investment activities on efficiency, 2011–12

Independent variable	OLS				Tobit			
	Estimated coefficient	t–statistic	p–value		Estimated coefficient	z–statistic	p–value	
Constant	0.570	2.454	0.015	**	0.570	2.572	0.010	**
AusFixInt	–0.097	–0.377	0.707		–0.097	–0.395	0.693	
AusShare	0.035	0.132	0.895		0.035	0.139	0.890	
Cash	0.066	0.275	0.784		0.066	0.288	0.773	
Dir	–0.012	–1.349	0.180		–0.012	–1.414	0.157	
EmpMem	0.010	0.202	0.840		0.010	0.212	0.832	
FemDir	0.274	2.145	0.034	**	0.274	2.248	0.025	**
IndDir	–0.084	–0.720	0.473		–0.084	–0.755	0.450	
InsMem	–0.116	–4.344	0.000	***	–0.116	–4.553	0.000	***
IntFixInt	0.108	0.252	0.802		0.108	0.264	0.792	
IntShare	0.529	1.439	0.153		0.529	1.508	0.132	
InvOpt	–0.038	–2.615	0.010	**	–0.038	–2.741	0.006	***
Reserve	0.027	0.664	0.508		0.027	0.696	0.487	
R-squared		0.252			Left censored		0	
Adjusted R-squared		0.184			Right censored		0	
F-statistic		3.704			Unsensored		145	
Prob(F-statistic)		0.000			Total observations		145	
Durbin-Watson stat		1.961						
Total observations		145						

* significant at 10%, ** significant at 5%, *** significant at 1%

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