TECHNICAL EFFICIENCY OF PENSION SCHEMES AND PROVIDENT FUNDS IN KENYA: AN APPLICATION OF DATA ENVELOPMENT ANALYSIS

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(X50/71894/2008)

A Research Paper Submitted in Partial Fulfilment of the Requirements for the Degree of Masters of Arts in Economics of the University of Nairobi

2015

DECLARATION

This research paper is my original work and has not been presented for an award of a degree or diploma in any other university or institution.

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This research paper has been submitted for examination with our approval as university supervisors.

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DEDICATION

This research paper is dedicated to my parents, Mr and Mrs. Christopher Rotich, my spouse Ms. Brigid Kandie and Daughters.

ACKNOWLEDGMENT

I thank God the almighty for the gift of life, health, strength and protection that I have received throughout my studies. The success of this paper is a result of combined effort, support and cooperation from several people to whom I owe a lot of gratitude. For academic guidance and advice, I am most grateful to my supervisors, Dr. Anthony Wambugu and Dr. Moses Muriithi for their accessibility, unreserved support and insightful comments that have guided me through this process. I also wish to acknowledge the University of Nairobi's administration and community at large through whom I had a conducive learning environment.

I acknowledge the Retirement Benefits Authority, Pension Fund managers, administrators and all other stakeholders in the pension industry for their help in providing all the relevant materials and information required for my research paper. Finally, I acknowledge my family for their kind support during the development of this research paper. Thank you all.

ABSTRACT

Pension schemes and provident funds in Kenya have expanded in terms of members and contributions. However, little is known about their level of technical efficiency. The purpose of this study was to estimate technical efficiency of pension schemes and provident funds in Kenya and to identify the factors that are likely to influence their technical efficiency.

In this study, data from 161 pension funds and provident funds are sampled. Of the 161 pension schemes, 118 schemes are pension funds while 43 schemes are provident funds. Input oriented data envelopment analysis is used to calculate constant returns to scale and variable returns to scale technical efficiency scores. The study also estimated both Tobit model and liner model to identify the determinants of technical and scale efficiency of pension funds and provident funds in the second stage. In the second stage, regression is estimated having the technical and scale efficiency scores as dependent variables. The independent variables for the regression analysis are age, size, market share of the pension scheme or provident fund, employer contribution rate and the employee contribution rate to the pension scheme.

The results revealed that of the 118 pension funds only 4 were fully technically efficient with the majority (73 pension funds) having technical efficiency score of less than 50 per cent. Of the 43 provident funds ,15 had technical efficiency score of 70 per cent and above. The mean scale efficiency scores for pension funds was 83.9 per cent while for provident funds was 74.9 per cent. A scale efficiency score of less than 100 per cent implies that pension funds and provident funds in Kenya are not operating at optimal scale or size.

Market share and size was positively related to technical efficiency of pension funds while age, employer contribution rate and employee contribution rate were negatively related to

technical efficiency for pension funds. On the other hand, the newly formed pension funds were found to be technically efficient when compared to older pension funds. The higher the rate of contribution to a pension fund by the employer the less technically efficient will the pension fund operate. On scale efficiency, age and size of a pension fund were found to be negatively related to scale technical efficiency while market share, employer contribution rate, and employee contribution rate had a positive relationship.

For provident funds, market share and employer contribution rate had a positive relationship with technical efficiency while age, size, and employee contribution rate had a negative relationship. The implication of these results is that the higher the provident fund's market share is in the industry, the greater will be its technical efficiency. The higher is the employer contribution rate; the provident fund will tend to operate technically efficiently. On the other hand, older provident funds and tend to be less technically efficient. Further, the bigger the size of a provident fund, the less technical efficient it will be. On scale technical efficiency, age, size, and employer contribution rate had negative relationship with scale technical efficiency while market share had a positive relationship.

The low technical efficiency score reflects that a greater amount of inputs to the pension schemes is wasted. Pension schemes need to improve their technical efficiency since the levels observed are below the frontier. Further, the results of this study can heighten the awareness of policymakers in Kenya regarding the technical efficiency of the pension schemes in light of its primary objective of providing income at retirement.

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CSPS	Civil Servants Pension Scheme
CRS	Constant Returns to Scale
DB	Defined Benefits
DC	Defined Contribution
DEA	Data Envelopment Analysis
DEAP	Data Envelopment Analysis Program
DMU	Decision Making Units
ERBI	Employee Benefit Research Institute
FDH	Free Disposal Hull
GDP	Gross Domestic Product
GOK	Government of Kenya
IPS	Individual Pension Scheme
NSSF	National social Security Fund
OECD	Organization for Economic Co-operative and Development
OPS	Occupational Pension Scheme
PAYG	Pay As You Go
RBA	Retirement Benefits Authority
SFA	Stochastic Frontier Analysis
VRS	Variable Returns to Scale

CHAPTER ONE

INTRODUCTION

1.1 Background

An increasing number of African countries have initiated reform of their pension and social protection systems (Bonnet, Ehmke, and Hagemejer, 2013). Social protection encompasses programs geared towards; access to medical services; retirement and pension plans; and insurance against unemployment, bankruptcy, or loss of assets due to catastrophic events. Pension schemes help deal with uncertainties and risks in terms of health, aging, and unemployment that individuals experience (Ashok and Luca, 2014). Stewart and Yermo (2009) defined a pension scheme as a mechanism to collect contributions from members/participants, invest the contributions and make payments to retired members or their beneficiaries. Pension contributions to the scheme are made by either the employer or the employees or by both the employer and the employee.

Pension systems can either be a Defined Benefit (DB) system or a Defined Contribution (DC) system. In DB scheme, the retirement income is determined up front and based on a formula set out in the system while under DC scheme, the retirement income is determined by contributions and the investment performance over time. The DC system is also referred to as funded scheme as members make contributions and the scheme invests these contributions towards meeting pension benefits (Woodger, 2009). In both systems, the funds are controlled by an appointed pension administrator and fund manager.

Pension income depends on the type of pension scheme an individual joins. In a DB system, pension income depends on the employee's years of service and income level. In the DC retirement system, income depends on the amount contributed by both the employer and employee and the performance of the pension scheme. In a DB system, the employer ensures

there is sufficient funds to pay the retirees in future and bears the investment risk (Stewart and Yermo, 2009). The DB system is also referred to as non- funded scheme and is mainly provided by the Government in most countries. On the other hand, investment in the DC system mainly directed by the employee, while both employer and employee are encouraged to contribute. The DC offers more flexibility to the employee than the DB but puts all the investment risk directly to the employee.

Over the last decade, Kenya has undertaken major reforms of its pension system. The primary motivation for reform of pension systems in many countries worldwide has been to address the growing fiscal burden of pension liabilities (World Bank, 1994). In Kenya, the major driver for reform was to improve the governance, management and effectiveness of the existing pension system (RBA, 2010). A new Retirement Benefits Act was enacted in 1997 and a comprehensive framework of regulations was implemented three years later in 2000. A regulatory authority, the Retirement Benefits Authority (RBA) was established at the same time to regulate, supervise and promote retirement sector in Kenya (RBA, 2010). Kenya also has a separate pension plan for public service employees financed on pay as you go basis which is also part of the broader pension reform programme under consideration.

1.1.1 Importance of Pension Systems

Pension systems are important in the provision of basic income security and poverty alleviation especially to the elderly. Kakwani, Sun and Hinz (2006), points out that pension schemes contribute significantly to the reduction in old-age poverty since a large proportion of the income of retirees is derived from their previous pension arrangements (Kakwani, Sun and Hinz, 2006). According to World Bank (1994), pension systems functions as old age programs and helps alleviate poverty amongst the elderly.

Income from pension funds is important in the alleviation of poverty. (Stewart & Yermo, 2009) found that pension reduced the poverty gap ratio by 13 per cent in South Africa and increased the income of the poorest 50 per cent of the population by 50 per cent. Families receiving pension are 89 per cent less likely to be poor than those without pension in South Africa. According to (RBA, 2010) pensions increase older people's access to services such as health care and reduce their dependency on the younger generation.

Pension funds can promote financial market development (Davis, 2005). Such funds if invested offshore promote international financial markets and increased capital flow which could stabilize economies. In addition, pension schemes are often required by law to invest a share of their funds locally (RBA, 2010). Investing of pension funds locally boosts the local capital market and improves stock market liquidity. Pension schemes also increase savings in countries (Davis, Gaarder, Handa, and Yablonskei, 2012). In Chile for example, pension funds increased the ratio of domestic savings to GDP from 0.8 per cent to 4.6 per cent 2011.

1.1.2 Pension Schemes in Kenya

According to the Retirement Benefit Act (Government of Kenya, 2010), a pension scheme is either a pension fund or a provident fund. A provident fund is a scheme that pays retirement benefits in lump sum to the employee at retirement or to his or her dependants on death of the employee. In a pension fund, a proportion of the benefits are commuted as lump sum payment at the point of retirement with the remainder is paid out periodically. The Retirement Benefit Act, 1997 provides that the commuted amount will be equal to one quarter of the retirement benefits in non-contributory scheme and not more than one third in a contributory scheme.

In Kenya, the retirement benefits assets have increased over time, both in absolute terms and as a ratio of GDP (KNBS, 2014). The pension assets grew from Kshs.117.4 billion in 2002 to

Kshs.432.8 billion in 2011, translating to an average annual growth rate of 26.9 per cent over the period. As a share of GDP, the ratio improved over the period from a ratio of 11.5 per cent in 2002 to approximately 14.3 per cent in 2011 (RBA, 2012). The total industry assets grew by 15.5 per cent from Kshs. 548.7 billion in December, 2012 to Kshs. 633.5 billion as at June 2013 underscoring the centrality of pension funds in the country's economic development .

Kenya's pension system has four components. The components are; (i) National Social Security Fund (NSSF), (ii) Civil Servants Pension Scheme (CSPS), (iii) Occupational Pension Schemes (OPS), and (iv) Individual Pension Schemes (IPS). Overall, the system is estimated to cover 15 per cent of the labour force and to have accumulated assets of 14.3 per cent of the GDP in 2011 (Kipanga, 2012). The types and features of the pension system in Kenya are outlined in table 1.

Table 1: Types and Features of Pension System in Kenya

	Civil Servants Pensions Scheme	**NSSF Scheme**	**Occupational Pension Scheme**	**Individual Pension Scheme**
Legal Structure (Establishing Statute)	Act of Parliament	Act of Parliament	Trust Deed	Trust Deed
Membership	Mandatory for all Civil Servants	Mandatory for all employers in the formal sector with over 5 employee	Formal employees with employers being the sponsors	Trust Deed
Type of Scheme	Defined benefit	Defined Contribution	Defined Contribution or defined Benefit	Defined Contribution or defined Benefit
Regulation	Exempt from Regulation	Under RBA Regulation	Under RBA Regulation	Under RBA Regulation
Proportion of membership in the year 2009	26%	69.2%	1.7%	15.8%

Source: RBA, 2014

According to Kipanga (2012), the low coverage of the pension system is attributable to the current pension laws which have established pension schemes largely for formal employees. A policy to initiate pension reforms which will extend coverage to majority of uncovered elderly poor by introducing a universal pension scheme will be ideal. In the meantime, National Social Security Fund Act, the Pensions Act and the Retirement Act have been amended to extend coverage to the informal sector.

The NSSF started as a public provident fund in 1989 under an Act of Parliament to cover both employed and self-employed persons. It provides social protection to in the formal and informal sector workers. It is mandatory for all employers with over five employees to register and make monthly contributions to the fund (Government of Kenya, 1989). Table 2 shows the details of registered employers, registered employees, annual contributions and benefits to members of NSSF.

Table 2: Trend in membership contributions and payments at NSSF, 2008-2012

Details	**2008**	**2009**	**2010**	**2011**	**2012**
Registered Employers (000)	61.4	72.6	72.6	84.2	92.1
Registered Employees (000)	3169.0	3395.4	3402.0	3665.2	3955.9
Annual Contributions (Kshs million)	3568.6	5341.0	5341.7	5990.6	6571.1
Annual Benefits paid (Kshs million)	2575.6	2773.4	2773.4	2357.1	2763.3

Source: Kenya National Bureau of Statistics (2013).

The private sector in Kenya operates the Occupational Pension Scheme (OPS) established by execution of a trust deed (Sundeep, 2008). A trust deed is a legal document biding an individual (trustee) who manages the assets of another person (beneficiary). The trustee is

obligated to safeguard the interest of the beneficiary. The OPS is set up by the employer to provide retirement benefits to its employees. The OPS either be a DB or DC arrangements.

Membership to an Occupational Pension Scheme is mandatory for covered employees and withdrawal of benefits is not allowed while one is still an employee of the sponsoring employer (Sundeep, 2008). There were 1379 OPS in Kenya by end of 2009 out of which 10.4 per cent were DB schemes and 89.6 per cent were DC schemes. The Individual Pension Schemes (IPS) are established by trust deeds and targets informal and self-employed workers. According to Sundeep (2008), the individual pension schemes are DC schemes and are mainly offered by insurance companies and fund managers. Since IPS targets unemployed members, contribution and withdrawal of benefits is flexible. By end of 2009, there were 23 IPS in Kenya.

The retirement sector in the Kenya has continued to register significant growth prospects. RBA, (2010) reported that the growth has been both quantitative and qualitative with increase in the number of sector players. The government plans to implement the contributory pension scheme for public servants by enacting the Public Service Superannuation Act, 2012 which enhance domestic savings and reduce government contingent liabilities, it will also expand the pension industry. The increase in the number of licensed sector players in the last several years has supported the industry‘s upward trend where by the end of 2013, the sector had reached a capitalization of Kshs. 633.5 billion.

1.1.3 Regulatory and Institutional Framework

Pension schemes in Kenya are subject to licensing and regulation. However, this was not always the case. Sundeep (2008) points out that before 1997; there was limited regulation of the pension industry in Kenya with the Income Tax Act and Trust Laws being the main reference documents. He adds that during this period, mismanagement of schemes’ funds;

underfunding of schemes; uncontrolled investment of funds without independent professional advice; and poor records and book keeping practices were major a challenge.

To address these challenges, the Retirement Benefits Authority (RBA) was established in 1997 by an Act of Parliament (Retirement Benefits Act, 1997) to regulate, supervise and promote retirement benefits schemes in Kenya. According to the Act, the main goal of establishing the RBA is to ensure an efficient pension industry (Government of Kenya, 2010).The Retirement Benefits Act, 1997 defines a scheme as *"an arrangement established by law or any instrument under which persons are entitled to benefits which are determined by age, length of service and amount of contribution or earning and payable upon retirement, death, termination of service or upon the occurrence of an event as may be specified by law"*.

The RBA actualizes its mission of developing and safeguarding the retirement benefits in Kenya through monitoring and licensing of pension industry players such as fund managers, fund administrators, custodians and corporate trustees (Sundeep, 2008). This ensures that the schemes established are able to meet the regulatory conditions set out in the RBA Act, 1997 (Government of Kenya, 2010), executed trust deeds and any regulations on governance and financial management.The success or failure of pension reform hinges on whether pension schemes are effective. In this context, RBA ensures that pension schemes ensure efficiency in managers' performance of key functions including: collecting workers' contributions into the pension funds; investing this fund in a range of financial assets; providing disability and survivor insurance; arranging pension benefits for those retiring; and providing a range of supporting services.

The Civil Service Pension Scheme is the only scheme which is not under supervision of the RBA. This is because it draws the member's benefits directly from government revenue and since it is not a DC scheme, it does not pool funds for investment (OECD, 2009). It does not

have a custodian as it does not invest and keep assets. The CSPS is managed by the National Treasury.

RBA (2010) points out that although RBA is a key institution in the regulatory frame work of the pension industry it faces many challenges. First, the savings rate in Kenya is low. Second, the rate of withdrawal of benefits by members before the mandatory retirement age is high. Third, the rate of compliance with the requirements of the RBA Act, 1997 especially on governance and investment is low. In particular, political interference especially on the NSSF scheme affects its governance.

1.2 Problem Statement

Retirement income accounts for 45 per cent of total income of retirees in Australia, 44 per cent in Austria and 80 per cent in France. In South Africa, pension income accounts for 75 per cent of the elderly pension income while in Kenya it accounts for 68 per cent (Kakwani et al., 2006). Therefore, since pension schemes are a key source of income for retirees, it should be efficient to ensure greater income and secuirity for retirees. Njuguna (2010) noted that the goal of government regulation of the pension industry is to enhance efficiency of schemes.

Despite increased importance of pension income to the retirees in Kenya and the increasing number of contributors, little research has been conducted on its technical efficiency. According to Bateman and Mitchell (2004), past studies of pension industry concur that rising technical efficiency is consistent with rapid growth in contributors, enabling pension schemes to exploit economies of size, to better utilize pension assets and branch network, and to distribute the large setup costs.

Although knowledge of the degree of efficiency of pension funds would inform government policy and other stakeholders to improve the competitiveness of the pension industry, there is

no empirical evidence on levels of technical efficiency of this industry in Kenya. Existing empirical studies on performance of pension schemes in Kenya focuses on financial ratio analysis and comparative returns with market indices (Njuguna, 2010). In particular, empirical evidence on technical efficiency of pension schemes is lacking not only in Kenya but Africa at large. The very few studies focus on Europe and Latin America. The purpose of this study was to gauge the level of technical efficiency among pension funds and provident funds in Kenya and to identify factors that are correlated with technical efficiency.

1.3 Objectives of the study

The general objective of the study was to examine the technical efficiency of pension schemes and provident funds in Kenya. Its specific objectives are:

i. To estimate technical efficiency of pension funds and provident funds in Kenya.
ii. To identify some of the factors that are likely to influence the technical efficiency of pension funds and provident funds in Kenya; and
iii. To draw implications for improving technical efficiency of pension funds and provident funds.

1.4 Justification of the study

Pension industry is an important component of the financial services sector to study because schemes are major sources of income for most people specifically on retirement and on termination of service and accounts for 68 percent of the total income of retirees in Kenya (Kakwani, et al., 2006). Bateman and Mitchell, (2004) argued that inefficiency of pension schemes leads to lower returns on investment, increased operation costs and could lead to erosion of funds. This can adversely affect level of income to pensioners, contribution of pension schemes to GDP and stability of the financial markets. In Kenya, the total industry assets grew by 15.5 percent from Kshs. 548.7 billion in December, 2012 to Kshs.633.5 billion

as at June 2013. It is therefore prudent to have information on the technical efficiency of pension scheme to enhance decision making.

Findings from the study will assist pension scheme members to gauge the viability of retirement saving through the pension schemes. The findings can also be used by pension fund managers and administrators as a basis for improving the efficiencies thereon. Policy makers will also gain from this study to guide them when formulating policies to guide the development of the industry.

Investigation of technical efficiency of pension schemes has received limited attention (Barrientos and Boussofiane, 2005). This study contributes to empirical literature concerning the efficiency of pension funds and schemes in Africa. Specifically it extends the literature to developing countries in Africa, by providing evidence from Kenya.

1.5 Organization of the Paper

The remainder of the research paper is organised as follows. Chapter two provides a review of theoretical and empirical literature of technical efficiency of pension schemes.The third chapter presents the methodology used to analyze technical efficiency. Specifically the Data Envelopment Analysis, Tobit model, data sources and types and variables definitions. Chapter four presents the findings and chapter five summarizes and concludes the study.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter provides a review of theory and previous studies on efficiency of pension schemes. The chapter starts with theoretical literature followed by empirical literature and ends with a summary.

2.2 Theoretical Literature

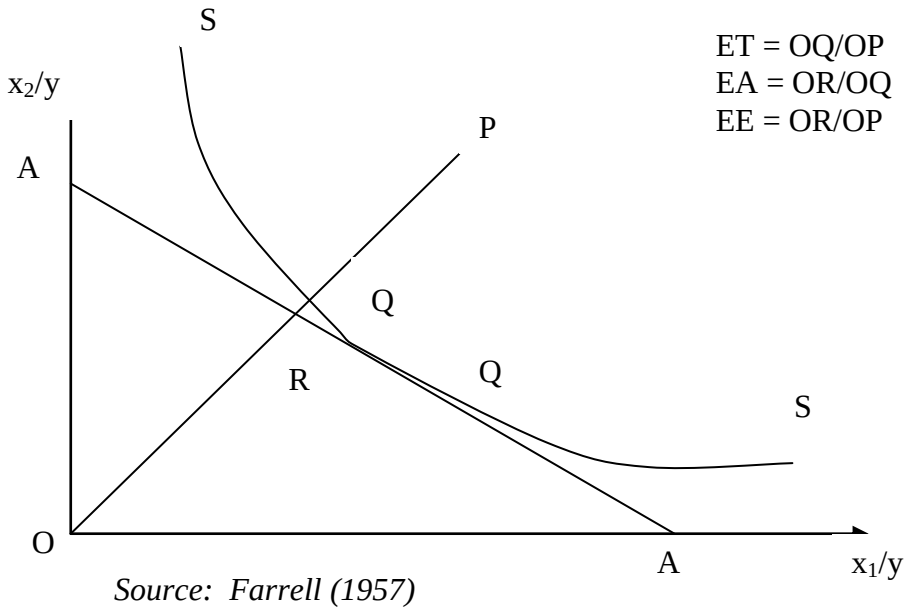
Productive or economic efficiency refers to the ability of a firm to produce a given output level using optimal combination of inputs (Coelli, 1996). Economic efficiency has two components: Technical efficiency is the ability of a firm to produce maximum output for a given inputs set. Allocative efficiency is the ability of a firm to use inputs in optimal quantities given the available technology.

The concept of economic efficiency developed by Farrell (1957) using two inputs based on ($X_1$and X_2) in the production of one output under constant returns to scale is shown in figure 1. The curve SS' represents a unit isoquant. It depicts the minimum combinations of inputs X_1 and X_2 that a fully efficient firm may use to produce one unit of output. For example a firm at point P is technically inefficient while a firm at point Q is fully efficient. The two firms produce same level of output. However, the firm at point Q uses only a part (OQ/OP) as much of each input as used by the firm at P.

Technical inefficiency of a firm can be measured by the distance QP, between the observed input combination at P and the fully technically efficient input combination at Q. The distance shows extent by which inputs can be cut without reducing output. This is an input-oriented or input-saving measure of technical efficiency. The technical efficiency of a firm at

point P can be measured by the ratio OQ/OP. It lies between zero and one. A value of one implying that the firm is fully technically efficient and zero for a completely inefficient firm.

Figure 1: Technical and Allocative Efficiencies



Source: Farrell (1957)

The curve AA' represents the isocost. An isocost depicts all combinations of inputs which cost the same total amount. The distance RQ measures the decrease in the production costs if production was to occur at point $Q^{'}$ which is allocatively and technically efficient point, and not at point Q^{1}as opposed to point Q. Allocative efficiency of a firm is usually measured by the ratio OR/OQ. The product of technical efficiency and allocative efficiency is measured by the ratio OR/OP. This is the ratio of potential input level to actual input level.

The output-oriented or output- increasing measure is an alternative to the input- oriented technical efficiency. It addresses the question of *"by how much can the output quantities be proportionally expanded without altering the input quantities"* (Coelli, 1996).

2.3 Empirical Literature

In the literature there are two approaches that have been widely used in the measurement of efficiency; parametric and non-parametric approaches. The main parametric approach is

Stochastic Frontier Analysis (SFA). Both approaches have a common goal which is to construct a best practice frontier against which each firm can be assessed (Barros, Caporale, and Silvestre (2007).Studies that uses Stochastic Frontier Analysis employ either stochastic production frontier or stochastic cost frontier or both. Where it is assumed a firm's objective is to maximize output, then studies employ the production frontier.

The non-parametric approaches are the Data Envelopment Analysis (DEA) and the Free Disposal Hull (FDH). This model was created by Farrell (1957) and advanced by Charnes, Cooper, and Rhodes (1978). The model was developed to analyse technical efficiency of public and non-profit making firms by Charnes et al., (1978). Its advantages in efficiency measure includes (i) it enables more than one input and output measurement of efficiency for homogeneous samples, (ii) does not require functional relation between input-outputs, and (iii) it enables expression of input and outputs in different unit values. In DEA, linear programming procedure is applied to construct a non-parametric piecewise best frontier over the data. Technical efficiency is calculated in relation to this frontier.

FDH on the other hand is a unique case of the DEA model where the points linking the DEA vertices are not included in the frontier. In contrast to the parametric approaches, the non-parametric approaches do not assume any functional form and they do not involve random error (Sharma, Leung, and Zaleski, 1999). DEA is used to calculate the technical efficiency of a set of firms called Decision Making Units (Pension scheme) that convert inputs into outputs.

2.3.1 Studies using Stochastic Frontier Analysis

Barros et el., (2007) applied SFA to examine the technical efficiency in a panel of twelve Portuguese pension funds Management Companies. The cost frontier was estimated using

cost of labour and capital as inputs, while profits, the existence of closed and open funds and the number of members were used as outputs. The data were for the period 1994 to 2003.

The point estimates of the cost frontier indicated that increased with the price of labour, price of capital, profit, merger and acquisition and market share. Mean efficiency was 87.8% for the 12 companies. This means it is possible for these companies to reduce their costs by 12.2% without decreasing their inputs. As far as economies of scale are concerned, the estimated scale was 1.528 with a standard deviation of 0.012. This means that increasing costs increases output but at a low rate. The estimated parameter of economies of scope was -0.231 therefore costs were found to decrease with output.

The cost frontier approach was also used by Keum-Rok (2002) to evaluate the efficiency of three Korean public pension schemes. The study used translog stochastic cost frontier and panel data for the period 1988 to 1999.The number of insured persons and number of beneficiaries were used as outputs while the price of labour (personnel expenses divided by the number of employees) and price of capital (overhead expenses divided by the net tangible fixed assets) were the inputs. The empirical results showed that the overall cost efficiency of the three public pension schemes is 52.6%, which means that their inefficiency amounts to 47.4%, and that there is a great difference between the operational efficiency of the three pensions with their respective cost efficiency estimates of 32.6%, 78.9%, and 92.2%. This implies that fundamental reforms to improve the operating system of public pension systems should be carried out in a consistent and urgent way.

Instead of annual data, Barros, Ferro, and Romero (2008) used quarterly data to estimate the cost frontier for 10 Argentina pension funds management companies. Price of labour (measured by dividing total wages by the number of workers) and price of capital (measured

by dividing the fixed and variable commissions by the value of the pension funds under management) were used as inputs. Involvement of the companies in merger and acquisitions was taken into account. In addition, the study took into account two types of heterogeneity in the model; observed heterogeneity relating to observed attributes of pension funds management companies and the unobserved heterogeneity relating to unobserved attributes.

The mean efficiency score was 94.6% and 88.1% for heterogeneous and homogeneous respectively. This means it is possible for these companies to reduce their output costs by 5.4% and 11.9% respectively without decreasing their inputs. For Argentinean pension fund management companies to be technically efficient, they should control the prices of inputs and output because they significantly increase costs (Barros et al., (2008).

2.4.1Studies using Data Envelopment Analysis

DEA is a non-parametric approach. Unlike SFA it does not require functional form assumptions. Barrientos and Boussofiane (2005) used DEA to evaluate the technical efficiency of pension fund management companies in Chile using data for the period 1982 to 1999.Output was measured by total revenue and number of contributors while the inputs were measured by marketing and sales costs, office personnel and executive pay and administration and computing costs.

In the period 1982 to 1989 (first phase) average technical efficiency levels increased from 42.7% to 78.5%. The increase in efficiency score in the first phase was attributed to rapid growth in number of contributors, better utilization of capital equipment and branch networks and ability of the companies to distribute set up costs widely. In the second phase (1990 to 1994) there was a decline in average technical efficiency score to 43%. The study attributed this decline to rise in sales and marketing costs and increase in the number of fund management companies. The third phase (1995 to 1999) showed a steady improvement in

average technical efficiency to 65% which was consistent with reduction in administration and sales cost experienced after the second phase (Barrientos and Boussofiane, 2005).

The study also investigated the determinants of technical efficiency. The variables, market share, regulations and market segmentation were regressed on efficiency scores. Market share was measured as the percentage of total contributions to the market value of fund managers while regulation is proxies by two variables; the ratio of contributions to affiliates, and a measure of spending per contributor. The regression results showed that larger market share is associated with higher technical efficiency scores.

Njie (2006) applied the DEA-based Malmquist Productivity Index to measure the technical efficiency levels in Australia's retirement income system over the period 2000-2005. In the study inputs was measured by sales charges and the initial investments while output was measured by investment income and operating performance. Tobit regression analysis was then used with the DEA scores was the dependent variable while the explanatory variables employed were government intervention index, investment incomes, total assets and financial reform dummy. This dummy variable for financial reforms took a value of 1 for the period after one of the key reform programs was implemented and 0 otherwise. The dummy variable for government intervention took the value of 1 when government intervenes in the retirement income system in Australia through regulation and supervision and 0 otherwise.

The results of the study showed that technical efficiency increased by 1.1 percent from 0.977 in 2001 to 0.988 in 2005. The increase in technical efficiency translated into increased in total factor productivity index from 0.92 in 2001 to 1.042 in 2005.Therefore, reforms had efficiency and productivity enhancing effects on the retirement income system. The mean technical efficiency score was 0.989.Tobit regression results showed that there was a

statistically significant positive relationship between the level government intervention, investment incomes, total asset size of pension funds and financial reforms with efficiency.

Data Envelopment Analysis was used as a measurement method in the study by Kurtaran, Karakaya, and Dagli (2013) to analyze Improvement of Private Pension System in Turkey and Measurement of Its Efficiency with DEA. The analysis period of the study was from the years 2004 to 2011. Data was obtained from reports about Insurance and Private Pension Activities in Turkey as published in the web site of the Republic of Turkey Prime Ministry under Secretariat of Treasury. Two inputs and two outputs were used. The inputs were the number of employees representing the labor force and total assets representing capital. The outputs were the total premiums collections representing the income obtained by the company and the number of contracts to represent the number of participants.

Before DEA was conducted, the study analyzed the compatibility of inputs and output variables. Average size of assets of pension companies sector was 8 billion TRY and premiums collected was 952 million TRY. The number of employees working in the sector was 6,680 people while the number of contacts was 367,292. It was shown that correlation between input variables and output variables were position and statistically significant.

Under the assumption of CRS and VRS, the efficiency of private pension companies was calculated from 2004 to 2011 using DEA. It was observed that while under CRS, total efficiency score was at 0.85 levels in 2004, it dropped to 0.28 levels in 2005 and increased in the following year to 0.70 and then had a course around 0.70. The efficiency score did not reach the 0.85 level of 2004. A similar improvement was also shown under VRS assumption. The results therefore of the study were that the number of active companies in the system was

at its lowest level in 2005 and improved constantly until 2011. The efficiency increased horizontally from 2006 and hit 0.80 score.

In this study, Data Envelopment Analysis was used to estimate technical efficiency scores for each pension scheme or provident fund. Data Envelopment Analysis (DEA) is a linear programming methodology to measure the efficiency of multiple decision-making units (DMU) when the production process presents a structure of multiple inputs and outputs (Coelli, 1996).The concept of DEA was developed by Charnes et al., (1978) to calculate efficiency of decision making units using a variety of inputs and outputs. The method enables measurement of relative efficiency of decision making units by comparing more than one input and outputs or those that were measured with varying scales and have different units (Kurtaran et al., 2013).

A decision making unit (DMU) is considered efficient if there is no other decision making unit, or combination of other decision making units that can produce at least the same amounts of all outputs, with less of some resource input and no more of any other resource. DEA is therefore a technique that can be used to benchmark the performance of DMUs. In the present study, pension schemes or provident funds are such DMUs.

Sharma et al., (1999) suggests that the main strengths of using DEA are its ability to accommodate multiple inputs and outputs, no requirement to explicitly specify a mathematical form for the production function and allows decision-making units to specify their own weights to maximize their efficiency values. DEA was chosen due to its capability to handle small data sizes, numerous inputs and outputs, and the fact that it does not need price information. As put forward by Cooper, Seiford, Tone, Zhu (2007), it provides positive information of peers, which are inefficient firms of alike input-output composition with fully

efficient firms and generates collaboration between the policymakers and stakeholders in the selection of inputs and outputs. The limitations of DEA as pointed out by Kurtaran et al., (2013) are that its results are sensitive to the selection of inputs and outputs and its inability to test for the best specification.

2.4.2 Conclusion

This chapter has reviewed the limited literature available on technical efficiency of pension industry. The approaches used to measure technical efficiency are DEA and SFA. Other than Keum-Rok (2002), all the other literature focused on technical efficiency of pension fund management companies. Some of the inputs measured were cost of labour, cost of capital, marketing and sales costs, and value of initial investment while the output measure were profit, number of contributors/membership and value of funds under management. The level of technical efficiency varied from a low of 52.6 per cent in Korean public pension schemes to a high of 98.8 per cent in Australian retirement system.

The limitation of most of the studies reviewed is that they did not identify the factors influencing technical efficiency. However, literature by Njie (2006) identified reforms, government intervention, and investment income and asset size to have positive influence on technical efficiency in Australian retirement system. Barros et al., (2007) and Keum-Rok (2002) identified market share to be positively related to efficiency. Tobit regression model was used to identify the above factors (Njie, 2006).

Although these studies add to the literature on economic performance of pension schemes, they do not answer the question of how technically efficient individual pension schemes are as they concentrated mainly of pension management companies and not the schemes. The present study evaluates the technical efficiency of pension schemes in an African country, Kenya. To the best of the author's knowledge no empirical study exits on technical efficiency

levels of pension schemes in Kenya. This is a significant knowledge gap. Knowledge of the level of technical efficiency helps the stakeholders to know whether the current inputs are optimally employed and to be able to gauge the divergence from the efficient frontier. This knowledge will guide policy direction.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter explains the methods that were used to carry out the research. Aspects that will be included in this chapter include: Research design, analytical framework, data and measurement of variables; Source of data, input and output, variables used in regression model and data analysis.

3.2 Research design

The research design that will be employed in this study is quantitative survey. Quantitative survey research portrays an accurate profile of events or situations, a study in which data is collected without changing the environment. This kind of study was appropriate for this study as the status quo of events will remain the same after and during the study.

3.3 Analytical framework

3.3.1 Data Envelopment Analysis

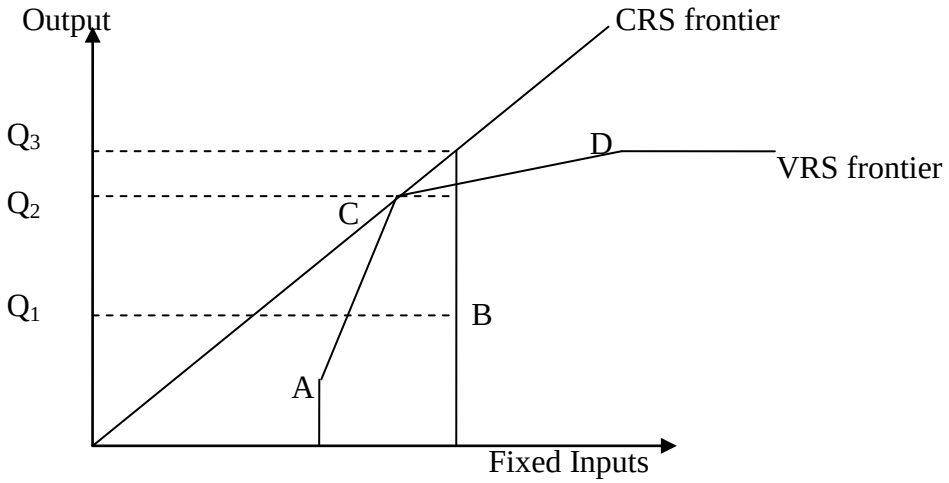
Data Envelopment Analysis (DEA) is a decision making tool based on linear programming for measuring the relative efficiency of a set of comparable units. Besides the identification of relatively efficient and inefficient units, DEA identifies the sources and level of inefficiency for each of the inputs and outputs.

DEA is a technique of mathematical programming that enables the determination of a unit's efficiency based on its inputs and outputs, and compares it to other units involved in the analysis. DEA is especially useful where the presence of multiple inputs and outputs makes conventional, ratio based comparisons difficult. It does not require any judgment as to the

relative importance of inputs and outputs. It has received significant attention from academia in recent years with over 1,200 publications in existence. The DEA frame work is illustrated in figure 2 under constant returns to scale (CRS) and variable returns to scale (VRS). The latter can be either increasing returns to scale (IRS) or decreasing returns to scale (DRS). A production function exhibits CRS if changing all inputs by a positive proportional factor has the effect of increasing outputs by that factor. If an increase in inputs does not result in a proportional change in the outputs, then the function exhibits VRS.

Under IRS, changing inputs by a given proportion changes output by a larger proportion. Under DRS, changing inputs by a given proportion changes output by a smaller proportion. The data points A, B, C and D in figure 2 represent pension schemes. Under CRS, the pension scheme C is a technically efficient scheme. While pension schemes A, B and D are below the frontier indicating technical inefficiency. On the other hand, under the VRS efficient frontier pension schemes A, C and D are technically efficient. The pension scheme B lies below the efficient frontier, and is therefore inefficient.

Figure 2: CRS and VRS frontiers



Source: Cooper, Seiford, and Tone (2000)

Following Charnes et al., (1978) who assumed constant returns to scale (CRS), the efficiency of pension scheme/provident fund is obtained by solving the following equation;

$$\max h_o \sum_{r=1}^{m} u_r y_{rt} - u_0$$

$$s.t. \sum_{r=1}^{m} u_r y_{rj} - \sum_{i=1}^{n} v_i x_{ij} - u_0 \le 0; (j = 1, 2, ..., N); \quad \text{.....(1)}$$

$$\sum_{i=1}^{m} v_i x_{it} = 1;$$

$$u_r, v_i \ge 0; (r = 1, 2, ..., m; i = 1, 2, ..., n); u_0 \text{ free}.$$

This is equivalent to

$$\max h_o \frac{\sum_{r=1}^{m} u_r y_{rt} - u_0}{\sum_{i=1}^{n} v_i x_{it}}$$

$$s.t. \frac{\sum_{r=1}^{m} u_r y_{rj} - u_0}{\sum_{i=1}^{n} v_i x_{ij}} \le 1: (j = 1, 2, ..., N); \quad \text{.....(2)}$$

$$u_r, v_i \ge 0; (r = 1, 2, ..., m; i = 1, 2, ..., n): u_0 \text{ free}.$$

A pension scheme/provident fund that employs i inputs to produce r output seeks to maximize the technical efficiency score h. Where h_0 is the solution from the linear programming problem.

The constraint $\frac{\sum_{r=1}^{m} u_r y_{rj} - u_0}{\sum_{i=1}^{n} v_i x_{ij}} \le 1$ indicates that the weighted sum of inputs for the particular pension scheme equal one which ensures that no scheme will have more than 100 per cent efficiency score. Pension schemes are on or below the frontier and ensure that the value of the coefficients is positive and non- zero. The weights are treated as unknowns and are obtained in the linear programming solution.

The use of CRS specification is applicable only when pension schemes are operating at an optimal scale. However, if pension schemes are operating at non-optimal scale, technical efficiency should be separated from scale efficiency. The removal of the effects of scale efficiency is by the use of DEA model with VRS version developed by Banker et al., (1984).

The input-oriented measure of technical efficiency of any *t* (pension scheme) under VRS requires the solution of the following LP problem due to Banker, Charnes, and Cooper (BCC): The linear program problem to be solved under the assumption of VRS is:

$$\min \theta$$

$$\begin{aligned} &\text{s.t.} \sum_{j=1}^{N} \lambda_j x^j \le \theta x^t; \\ &\sum_{j=1}^{N} \lambda_j y^j \ge y^t; \\ &\sum_{j=1}^{N} \lambda_j = 1; \\ &\lambda_j \ge 0 \ (j = 1, 2, ..., N). \end{aligned} \qquad \text{.....(3)}$$

Let $(\theta^*; \lambda_1^*, \lambda_2^*, ..., \lambda_n^*)$ be the optimal solution. Define $x_*^t = \sum_{j=1}^{N} \lambda_j^* x^j = \theta^* x^t$. Then (x_*^t, y^t) is the efficient input-oriented projection of (x^t, y^t) onto the frontier and

$$TE_I^V(x^t, y^t) = \theta^*. \qquad \text{.....(4)}$$

The output-oriented measure of technical efficiency is obtained from the solution of the following program:

$$\max \phi$$

$$\text{s.t.} \sum_{j=1}^{N} \lambda_j x^j \le x^t;$$

$$\sum_{j=1}^{N} \lambda_j y^j \ge \phi y^t; \quad \text{.....(5)}$$

$$\sum_{j=1}^{N} \lambda_j = 1;$$

$$\lambda_j \ge 0 \ (j = 1, 2, ..., N).$$

Again, define $\sum_{j=1}^{N} \lambda_j^* y^j = \phi^* y^t = y_*^t$. Now (x^t, y_*^t) is the efficient output-oriented projection of (x^t, y^t) and

$$TE_O^V(x^t, y^t) = \frac{1}{\phi^*} \text{.....(6)}$$

All convex combinations of the observed input-output bundles are feasible by assumption. Thus, the input –output bundle $(\bar{x} = \sum_{j=1}^{N} \lambda_j x^j, \bar{y} = \sum_{j=1}^{N} \lambda_j y^j)$ is feasible when $\sum_{j=1}^{N} \lambda_j = 1$.

The notations are similar with those of liner programming under CRS. From this model it is possible to derive scale efficiency.

Technical and scale efficiency score in this study were estimated using, Data Envelopment Analysis (Computer) Program (DEAP) developed at the Centre for Efficiency and Productivity Analysis, University of New England, Australia. Detailed instructions on how to use DEAP software are available in a user guide (Coelli, 1996). DEA was chosen as it can readily incorporate multiple inputs and outputs and to calculate technical efficiency, it only requires information on output and input quantities and not prices. This attribute makes is suitable for analyzing technical efficiency of pension scheme service providers, as it is difficult to assign prices for such services. Further, DEA identifies 'peers" for firms and provides a set of role models that other firm can emulate.

3.3.2 Sources of Scale and Technical Efficiency

After estimation of technical efficiency scores the second objective was to examine the determinants of the technical efficiency. Kirigia and Asbu (2013) suggested that the Tobit model is an appropriate multivariate statistical model in the second stage. Tobit regression framework helps to determine the key factors that influence the technical efficiency of pension schemes. This further means that public policy can be directed at those factors that have strong effects at improving the overall efficiency of the pension industry.

The Tobit model is used to measure linear relationships between variables when dependent variables is censored either from left or right depending on some threshold (Dougherty, 2002). The Tobit model is used because that efficiency scores are bounded between 0 and 1. The two-limit Tobit model (Long, 1997) where 0 is lower limit and 1 is upper limit was applied. The model is defined as:

$$E_j^* = \beta_0 + \beta_1 \text{Mshare} + \beta_2 \text{Age} + \beta_3 \text{Size} + \beta_4 \text{Employerrate} + \beta_5 \text{Employeerate} + u_j \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (7)$$

$$E_j^* = \begin{cases} 1 & \text{if} \quad E_j^* \geq 1 \\ E_j^* & \text{if} \quad 0 \leq TE_j^* \\ 0 & \text{if} \quad E_j^* \leq 0 \end{cases} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (8)$$

Where

E_j^*	= is a the observed efficiency score of pension scheme j;
Mshare	= Market Share of a pension scheme;
Age	= Age in years of a pension scheme;
Size	= Size of a pension scheme measured in Kenyan Shillings
Employerrate	= Employer Contribution rate to a pension scheme;
Employeerate	= Employee Contribution rate to a pension scheme; and
u_j	= independently and normally distributed error term with mean zero and a constant variance σ^2.

Age of the pension scheme is the number of years a scheme has been in the industry. Age has been included as an explanatory variable so that to determine whether older schemes are more technically efficient than newly started schemes.

The second variable is the market share of the scheme. For each scheme, market share is calculated as a total asset size as proportion of the total industry pension asset value in Kenyan Shillings.

Size of the pension scheme is the third explanatory variable, which is the amount in Kenyan shillings of each pension scheme. The intention of including size is to find out whether the asset base of a scheme is contributes to level of its technical efficiency.

The employer and employee rate of contribution to a scheme is a percentage of the contribution to a scheme to the employee's basic pay. Since the contribution can either be from the employer or the employee, the rate is calculated from each source as a ratio of an employee's basic pay.

3.4 Data and Measurement of Variables

3.4.1 Source of data

The population for the study consisted of 1216 pension schemes in the RBA register as of 31 December, 2010. The data covered three years from 2008 to 2010. Due to unavailability of data or complete records for some pension funds, the sample size for the study was 161 schemes comprising of 118 pension funds and 43 provident funds. The data was obtained from annual reports prepared by RBA and annual financial reports prepared by Fund Managers and Administrators. These documents were accessed from RBA Library.

3.4.2 Inputs and Outputs

Barrientos and Boussofiane (2005) emphasized that the selection of inputs and outputs should be limited to only those that can be accurately measured. This study focused on two measures of output: revenue/returns realized of the pension scheme per year and the number of members in the schemes. Revenue refers to returns on investment earned by each scheme. It is the sum of total realized and accrued gains on investments, interest income and dividends. The duration of measurement of these outputs is three years, from year 2008 to 2010, and was used because they can be accurately measured. In addition, these outputs are routinely compiled and published by RBA and registered Fund Managers and Administrators.

The two inputs used in this study are pension schemes expenses and contributions received from its members. The scheme expenses are direct payments to service providers such as marketing, sales and administration costs. Payments to service providers are any expenses incurred by the schemes in activities directed at increasing its awareness and in acquiring new members (marketing) and expenses paid to the providers who include the custodians, administrators, auditors, trustees and fund managers. Contributions receives is the amounts of contributions received by the schemes from its members. The two inputs are measured in Kenyan Shilling and were selected as they can easily be measured and available in the RBA literature and reports in the pension industry.

The choice of the above mentioned inputs and outputs was also because they were employed in past studies. The inputs and outputs in this study were used in the study by Njie (2006) to measure technical efficiency levels in Australia's retirement income system over the period 2000 to 2005.Kurtaran et al., (2013) also applied the selected inputs and outputs to analyze private pension system in Turkey and measured its technical efficiency using DEA. Other

inputs and outputs that could be used but are not used due to difficulty in measurement and their availability include cost of labour, capital and profits of a scheme.

3.4.3 Variables used in regression model

The technical efficiency scores estimated through DEA model are the dependent variables which will be used to examine the determinants of technical efficiency. The determinants of technical efficiency are analyzed by regressing the explanatory variables which are market share of a pension scheme, Age of a pension scheme since its establishment, Size in terms of asset size of a pension scheme, Employer Contribution rate to a pension scheme, and employee Contribution rate to a pension scheme. Table 3 shows the variables used in the regression model.

Table 3: Variables used in regression model

VARIABLES	MEASUREMENT
Market Share of a pension scheme	Measured as a pension scheme asset base to the industry's total asset base.
Age of a scheme in years	Measured by the number of year since the formation of the pension scheme.
Size of a pension scheme	Measured by the amount of funds under a pension scheme management.
Employer contribution rate	Measured by percentage of premium subscription by the employer to the beneficiary basic pay.
Employee contribution rate	Measured by percentage of premium subscription by the employee to his/her basic pay.

3.5: Data Analysis

Data collected was first checked for completeness and errors. Analysis then followed once data preparation was complete. Data relating to the first objectives was analysed using Data Envelopment Analysis Program (DEAP). Detailed instructions on how to use DEAP software are available in a user guide by Coelli, 1996. Data was then subjected to Tobit and OLS regression analysis to identify some of the factors likely to influence the technical efficiency of pension funds and provident funds in Kenya. The software used to facilitate this analysis was STATA. Tables were used for presentation and comparison of the data variables.

CHAPTER FOUR
RESULTS AND INTERPRETATION

4.1 Introduction

This chapter presents results of data analysis. The first part present descriptive statistics while the second part presents estimates of technical efficiency and regression results to determine factors that influence technical efficiency of pension schemes in Kenya.

4.2 Descriptive Statistics

Table 4 and 5 presents the descriptive statistics (sum, minimum, maximum, mean and standard deviation) for outputs and outputs of both the pension funds and provident funds for the three years (2008 to 2010) under study. A total of 118 pension funds and 43 provident funds are analysed in this study. From the descriptive statistics in table 4 and 5, it is clear that there is wide variation in both outputs and inputs across the pension and provident funds.

In table 4, in terms of outputs, average revenue varied from a minimum of Kshs.0.0038 million in year 2010 to a maximum of Kshs.611.14 million in year 2009. Average number of members to a pension fund also varies from a minimum of 6 in year 2008 to a maximum of 6,386 in year 2009. For inputs, there was considerable variations: the average contributions per year varies from Kshs.0.117 million to Kshs.919.58 million while average fund expenses had a minimum of Kshs.0.0058 million in 2009 to a maximum of Kshs.120.49 million in year 2010.

Table 5 shows the descriptive statistics of provident funds. Like in the pension funds, there was wide variation in both outputs and inputs in the three years under study. The mean revenue per year varies from a low of Kshs.2.14 million in year 2008 to Kshs.4.23 million in year 2010 while average number of members in each provident fund varies from 398 in year

2008 to 473 in year 2010. In terms of inputs, average contributions per year varies from a mean of Kshs.11.66 million in year 2008 to Kshs.7.18 million in year 2010 while average fund expenses varies from a minimum of Kshs.0.0078 million in year 2008 and 2009 to a maximum of Kshs.51.03 in year 2010.

Table 4: Descriptive statistics of the inputs and outputs for pension funds

	Sum			Maximum			Minimum			Mean			Standard Deviation		
Year	2008	2009	2010	2008	2009	2010	2008	2009	2010	2008	2009	2010	2008	2009	2010
Output-Revenue per year (Kshs. Millions)	360.76	1,200.63	670.54	50.91	611.14	113.14	16.38	0.016	0.0038	3.06	10.17	5.68	7.43	60.93	13.13
Output-No. of Members	30,321	34,101	35,429	4,919	6,386	5,229	6	8	8	257	289	300	611	737	750
Input-Contributions per year (Kshs.Millions0	906.30	2,917.68	1,363.53	206.59	919.58	258.15	120.0	0.117	0.169	7.68	24.73	11.56	22.79	93.9	28.90
Input-Fund Expenses (Kshs. Millions)	193.22	187.65	310.08	44.07	35.32	120.49	0.006	0.0058	0.0074	1.64	1.59	2.63	5.62	4.65	11.64

Table 5 : Descriptive statistics of the inputs and outputs for provident funds

	Sum			Maximum			Minimum			Mean			Standard Deviation		
Year	2008	2009	2010	2008	2009	2010	2008	2009	2010	2008	2009	2010	2008	2009	2010
Output-Revenue per year (Kshs. Millions)	91.82	139.16	182.01	18.19	23.86	38.75	0.0065	0.0073	0.032	2.14	3.23	4.23	3.03	5.16	7.13
Output-No. of Members	17,126	17,510	20,353	11,462	11,906	13,774	9	4	3	398	407	473	1,737	1,804	2,088
Input-Contributions per year (Kshs.Millions0	684.66	501.47	308.66	481.40	112.58	60.28	0.16	0.16	0.22	15.92	11.66	7.18	72.96	20.53	12.06
Input- Fund Expenses (Kshs. Millions)	84.60	85.37	177.68	23.97	40.35	51.03	0.0078	0.0078	0.011	1.98	1.98	2.74	4.76	6.35	8.36

Table 6 shows the descriptive summary of each of the independent variable for both the pension fund and provident fund.

Table 6: Descriptive statistics of variables used in regression model

Pension funds		
Variable	**Mean**	**Std. Dev.**
Efficiency score	0.436	0.257
Age in years	18.862	10.148
Size of pension fund	3.16e+08	1.44e+09
Market share	0.0009	0.004
Employer contribution rate	8.305	4.924
Employee contribution rate	5.206	2.174
Provident funds		
Efficiency score	0.596	0.239
Age in years	18.525	15.520
Size of Provident fund	2.72e+08	8.27e+08
Market share	0.0008	0.002
Employer contribution rate	7.222	4.101
Employee contribution rate	6.216	4.719

The mean is the arithmetic average of the scores while the Standard deviation provides an indication of how far a variable deviates from the mean. Standard deviation shows the spread of the variable from the mean.

The mean efficiency score of the pension funds is 43.6 per cent with a standard deviation of 0.257 while that of provident funds is 59.6 per cent with a standard deviation of 0.239. This implies that on average, provident funds are more efficient than pension funds. Age in year has a mean of 18.862 year for pension funds while under provident funds the Age variable has a mean of 18.525 years. The standard deviation of Age for provident fund is larger than that for pension funds. The size of pension funds has a mean of Kshs.316 million while the

size of provident funds has a mean of Kshs.272 million. The size of a provident fund has a larger standard deviation of 8.27e+08 compared to the standard deviation of the size of a pension fund which is 1.44e+09.

The mean market share of pension funds is 0.0009 and that of provident fund is 0.0008. The standard deviation of pension scheme market share at 0.004 is bigger than the standard deviation of provident fund market share. The variable employer contribution rate has a mean of 8.305 for pension funds compared to 7.222 for provident fund. Employee contribution rate has a mean of 5.206 for pension funds and 6.216 for provident funds.

4.3 Estimates of Technical Efficiency

A pension fund or a provident fund is fully technically efficient when its technical efficiency score is 100 per cent. When a technical efficiency score is less than 100 per cent, it implies that the pension fund/provident fund is not fully technically efficient. The level of inefficiency is the distance between the technical efficiency score of 100 to the technical efficiency score attained.

A pension fund or a provident fund is scale efficient when its size of operations is optimal so that any modifications on its size will render the unit less efficient. A scale efficiency score of 100 per cent implies that the pension fund or the provident fund in question is operating at optimal scale or size. If the scale efficiency is less than 100 per cent, the pension fund or provident fund is either too small or too big relative to its optimal size.

The mean technical and scale efficiency scores for the pension funds and provident funds sampled for both pension and provident funds are summarised in table 7. The efficiency measures for individual pension funds and provident funds are in Appendix I,II,II and IV.

Table 7: Mean technical and scale efficiency of pension and provident funds

	CRSTE Scores	VRSTE Scores	Scale Efficiency
Pension Funds			
Mean	0.341	0.419	0.839
Standard Deviation	0.279	0.318	0.213
Provident Funds			
Mean	0.444	0.599	0.749
Standard Deviation	0.300	0.331	0.266

Note:
CRSTE = Technical efficiency from CRS DEA
VRSTE = Technical efficiency from VRS DEA
SCALE = Scale efficiency = CRSTE/VRSTE

Pension funds had a mean score of 34.1 per cent for CRSTE, 41.19 per cent for VRSTE, and 83.9 per cent for scale efficiency. From the technical efficiency scores, it can be interpreted that on average, pension funds are not technically efficient. The level of inefficiency being the distance from the optimal score of 100 per cent to the technical scores for the pension funds. Further, the scale efficiency score of 83.9 shows that pension funds are not scale efficient and either they are too big or too small relative to their optimal size.

Provident funds had a mean score of 44.4 per cent for CRS TE score, 59.9 per cent for VRS TE score, and 74.9 per cent for scale efficiency. Provident fund are not technically and scale efficient. The mean scale efficiency score of 74.9 per cent implies that the provident funds are either too big or too small for their optimal size, and there is need for modification of their size to be scale efficient.

The mean VRS technical efficiency scores are larger than the mean CRS technical efficiency scores. To test the significance of the difference between DEA technical efficiency estimates under CRS and those under VRS, paired sample t-test was employed. The t-test statistic with 117 degrees of freedom was -7.7786 (P-value=0.001). The null hypothesis of no difference in CRSTE and VRSTE can be rejected. This suggests that the production technology of pension funds and provident funds are characterised by variable returns to scale.

4.4 Econometric Analysis

In the second stage, regression analysis is used to identify the factors that influence technical efficiency of pension funds and provident funds in Kenya. The Tobit model is used when the dependent variable is constrained and the observations are clustered at the constraint (Dougherty, 2002). The Tobit model is estimated because the dependent variable (technical efficiency scores) are bound between 0 and 1. Applying the OLS to the entire sample may yield inconsistent parameter estimates.

4.4.1 Determinants of Technical and Scale Efficiency of Pension Funds

Table 8 presents the Tobit and OLS regression results on the determinants of VRS technical efficiency of pension funds in Kenya.

Table 8: Determinants of Technical Efficiency of pension schemes

	TOBIT				OLS			
VRSTE	**Coef**	**Std. Err**	**T**	**P>|t|**	**Coef**	**Std. Err**	**t**	**P>|t|**
Age	-0.053843	0.0035383	-1.52	0.131	-0.005219	0.0030992	-1.68	0.095
Size	0.0000544	0.0000255	2.13	0.035	0.0000494	0.0000223	2.21	0.029
Market Share	0.101041	0.770961	1.31	0.193	0.1077928	0.0680822	1.58	0.116
Employer rate	-0.009850	0.007454	-1.32	0.189	-0.008701	0.0065446	-1.33	0.186
Employee rate	-0.001284	0.0153764	-0.08	0.934	-0.001229	0.0135086	-0.09	0.928
_cons	0.605122	0.1139897	5.31	0.000	0.5699645	0.1000471	5.70	0.000
/sigma	0.3506711	0.0261045						
Log likelihood = -59.874835 Number of obs = 118 LR chi2(5) = 9.11 Prob > chi2 = 0.104 Pseudo R2 = 0.0707 Obs. summary: 0 left-censored observations 100 uncensored observations 18 right-censored observations at vrste>=1					Number of obs = 118 F(5,112) = 2.24 Prob > F = 0.0552 R-Squared = 0.0909			

The results in table 8 show that the coefficients of Age, Employer rate and Employee rate have a negative sign and do not have a significant effect on pension funds technical efficiency at the 5 per cent level of significance. Therefore, the Age of a pension fund, the

Employer and Employee rate of contribution to a pension fund do not have a significant effect of technical efficiency level. Further, the results on table 8, indicate that Market Share of the pension fund is positively related to its technical efficiency. The coefficient of market share is positive 0.101041 on tobit regression and positive 0.1077928 on OLS regression.

Size of a pension fund is positively related with technical efficiency though it is statistically insignificant at the 5 per cent level of significance. Size has a positive coefficient of 0.0000544 on Tobit regression and positive 0.0000494 on OLS regression.

Table 9 presents the Tobit and OLS regression results on the determinants of Scale technical efficiency of pension funds in Kenya.

Table 9: Determinants of Scale Technical Efficiency of pension schemes

	TOBIT				OLS			
SCALE	**Coef**	**Std. Err**	**t**	**P>|t|**	**Coef**	**Std. Err**	**t**	**P>|t|**
Age	-0.000170	0.002126	-0.08	0.936	-0.000132	0.0020324	-0.06	0.948
Size	-0.007135	0.0021803	-3.27	0.001	-0.006273	0.0020705	-3.03	0.003
Market Share	23.99403	7.3401043	3.27	0.001	21.09124	6.970592	3.03	0.003
Employer rate	0.0052415	0.0044913	1.17	0.246	0.0048039	0.0042672	1.13	0.263
Employee rate	0.0220979	0.0091625	2.41	0.017	0.0217819	0.0088278	2.47	0.015
_cons	0.7121635	0.678834	10.49	0.000	0.7035494	0.0650927	10.81	0.000
/sigma	0.2096698	0.0144222						
Log likelihood =6.485189 Number of obs = 118 LR chi2(5) = 17.39 Prob > chi2 = 0.0038 Pseudo R2 = 3.9333 Obs. summary: 0 left-censored observations 108 uncensored observations 10 right-censored observations at SCALE>=1					Number of obs = 118 F(5,112) = 3.48 Prob > F = 0.0058 R-Squared = 0.0959			

The results on table 9 show the Tobit and OLS results of scale efficiency scores regressed against the five independent variables (Age, Size, Market Share, Employer Contribution rate

and Employee Contribution rate). From table 9, Market Share, Employer contribution rate, and Employee Contribution rate are positively related to scale technical efficiency of pension funds. The coefficient of market share on Tobit regression is positive 23.99403 while on OLS regression, market share has a positive coefficient of 21.09124. These results imply that market share positively related to scale technical efficiency of pension funds and is statistically significant at 5 per cent level of significance.

Age and size have negative coefficient implying that these two explanatory variables are negatively related to scale technical efficiency of pension's funds. The coefficient of Age is -0.000170 on Tobit regression and -0.000132 on OLS regression. The coefficient of size is -0.007135 on Tobit regression and -0.006273 on OLS regression.

4.4.2 Determinants of Technical and Scale Efficiency of Provident Funds

Table 10 presents the Tobit and OLS regression results on the determinants VRS technical efficiency of provident funds in Kenya.

Table 10: Determinants of Technical Efficiency of provident funds

TOBIT					OLS			
VRSTE	**Coef**	**Std. Err**	**t**	**P>|t|**	**Coef**	**Std. Err**	**t**	**P>|t|**
Age	-0.009850	0.0041394	-2.38	0.022	-0.007198	0.0032272	-2.23	0.032
Size	-0.004781	0.0024907	-1.92	0.062	-0.000493	0.00056	-0.92	0.363
Market Share	1734.392	913.8181	1.90	0.065	146.6361	143.2033	1.02	0.312
Employer rate	0.107194	0.0176885	0.61	0.548	0.0077474	0.012736	0.61	0.547
Employee rate	-0.011705	0.137684	-0.85	0.401	-0.004657	0.0108547	-0.43	0.670
_cons	0.8430579	0.2071459	4.07	0.000	0.7101568	0.1529237	4.64	0.000
/sigma	0.3969728	0.0567076						
Log likelihood = -25.78647 Number of obs = 43 LR chi2(5) = 12.58 Prob > chi2 = 0.0276 Pseudo R2 = 0.1961 Obs. summary: 0 left-censored observations 29 uncensored observations 14 right-censored observations at vrste>=1					Number of obs = 43 F(5,37) = 1.58 Prob > F = 0.1890 R-Squared = 0.1762			

From the results in table 10, Age, Size, and Employee contribution rate are negatively related with technical efficiency of provident funds. The coefficients on Tobit regression are, Age is -0.009850, Size -0.004781, and employee contribution rate -0.011705. On OLS regression, the coefficients are, Age -0.007198 , Size -0.000493, and employee contribution rate -0.004657. Tables 10 show that market share and employer contribution rate as being positively related to technical efficiency of provident funds. The coefficient of market share is positive 1734.392 on Tobit regression and 146.6361 on OLS regression. The relationship

of market share to technical efficiency of provident funds is significant at the 5 per cent level of significance.

Table 11 presents the Tobit and OLS regression results on the determinants of Scale technical efficiency of provident funds in Kenya.

Table 11: Determinants of Scale Efficiency of provident funds

	TOBIT				OLS			
SCALE	**Coef**	**Std. Err**	**t**	**P>|t|**	**Coef**	**Std. Err**	**t**	**P>|t|**
Age	-0.001239	0.0020609	-0.60	0.551	-0.000359	0.0018803	-0.19	0.849
Size	-0.148576	0.96366	-1.54	0.131	-0.000364	0.0000906	-4.03	0.000
Market Share	49972.57	32445.22	1.54	0.132	65.36218	24.87107	2.63	0.012
Employer rate	-0.015340	0.0080114	-1.91	0.063	-0.009654	0.0074123	-1.30	0.201
Employee rate	-0.000524	0.0068854	-0.08	0.940	0.0004814	0.006323	0.08	0.940
_cons	0.9496147	0.999347	9.50	0.000	0.8913852	0.0891168	10.00	0.000
/sigma	0.2023594	0.0238148						
Log likelihood = 1.5712427 Number of obs = 43 LR chi2(5) = 15.13 Prob > chi2 = 0.0098 Pseudo R2 = 1.2623 Obs. summary: 0 left-censored observations 38 uncensored observations 5 right-censored observations at SCALE >=1					Number of obs = 43 F(5,37) = 4.88 Prob > F = 0.0016 R-Squared = 0.3975			

Table 11 indicates that Market Share of a provident fund is significantly related with its technical efficiency at 5 per cent significance level. The coefficient of market share is positive 49972.57 on Tobit regression and 65.36218 on OLS regression. Age, Size and employer contribution rate have a negative coefficient sign implying that they do not have a positively relationship with scale technical efficiency of provident funds. The coefficient of Age is -0.001239 on Tobit regression and -0.000359 on OLS regression. Size has a coefficient of -0.148576 on Tobit regression and -0.000364 on OLS regression, while employer rate has a coefficient of -0.000524 on Tobit regression and -0.009654 on OLS

regression. Further, the results show that the employee contribution rate has a negative coefficient on Tobit regression and a positive coefficient on OLS regression.

These results, for both pension funds and provident funds agree with those of Barrientos & Boussoffiane (2005) who found out that market share was positively related to the technical efficiency in Chile. The results on pension funds are also in line with the finding by Njie (2006) that size of pension fund is positively related with its technical efficiency in Austria.

CHAPTER FIVE
SUMMARY, CONCLUSION AND IMPLICATIONS

5.1 Introduction

This chapter presents the summary of the findings of this research paper. This paper analysed the technical efficiency of pension schemes and provident funds in Kenya. The first part of this chapter presents the summary of the findings while second part provides the conclusion and implication of the results.

5.2 Summary

This study examined the technical efficiency of pension schemes and provident funds in Kenya over the sampled period 2008 to 2010. The specific objective of this study was: To estimate technical efficiency of pension funds and provident funds in Kenya; identify some of the factors that are likely to influence the technical efficiency of pension funds and provident funds in Kenya; and draw implications for improving technical efficiency of pension funds and provident funds.

Pension funds and provident funds were analysed separately. The study used Data Envelopment Analysis program to estimate the technical efficiency of pension funds and provident funds. Two outputs and two inputs were used in the DEA analysis. The outputs were; Revenue realised by the pension funds and provident fund, and the number of members in each of the funds. The inputs were; fund expenses and contributions received from members of the funds.

Data from the year 2008 to 2010 of 118 pension funds were analysed using DEA. The efficiency scores under CRS, VRS, and Scale efficiency showed that on average pension

funds in Kenya were not operating optimally. The optimal score is 100 per cent. The mean technical efficiency scores realised from the analysis were 34.1 per cent, 41.9 per cent and 83.9 per cent under CRS, VRS and Scale efficiency respectively.

Forty three (43) provident funds were analysed and average technical efficiency scores under CRS and VRS realised were 44.4 per cent and 59.9 per cent respectively. Provident funds have a scale efficiency mean score of 74.9 per cent. The mean scale efficiency score of 74.9 per cent implies that the provident funds are either too big or too small for their optimal size, and there is need for modification of their size to be scale efficient at 100 per cent.

In order to identify the factors that are likely to influence technical efficiency of pension funds and provident funds in Kenya, the technical efficiency scores were regressed against five variables namely: Age, Size, market share, employer contribution rate, and employee contribution rate. Both linear regression model and Tobit model were estimated. For pension funds, Age, employer contribution rate and employee contribution rate was found to have a negative relationship with technical efficiency while market share had a significant positive relationship with technical efficiency. Size had a positive relationship with technical efficiency though statistically insignificant.

The tobit and OLS regression results on the determinant of Scale efficiency on pension funds in Kenya indicated that market share, employer contribution rate and the employee contribution rate to have positive relationship with scale technical efficiency of pension funds. Age and size has a negative relationship with scale technical efficiency of pension funds.

In the analysis of the factors that influence technical efficiency of provident funds, Market share and employer contribution rate was found to have positive relationship with technical efficiency of provident funds. Age, size, employer contribution had negative relationship with technical efficiency of provident funds.

The regression results on the determinant of Scale efficiency on provident funds indicated that market share as significant in its relationship with scale technical efficiency. The other variables: Age, Size and employer contribution rate had a negative relationship with scale technical efficiency. The Tobit regression results for relationship of employee contribution rate to scale technical efficiency was positive while it was negative under OLS regression.

5.3 Conclusion and Implications

The purpose of having a pension scheme is to ensure that at retirement, the retiree have stable income and are able to maintain their standard of living. Pension Schemes also invests in the financial markets thereby ensuring that there is market stability. The importance of pension arrangement therefore cannot be over emphasised and it is the interest of all stakeholders in the pension industry to ensure that pension schemes are technically efficient.

This study has shown that pension funds and provident funds in Kenya as performing poorly. The average technical efficiency score of less than 50 per cent implies that above 50 per cent of the inputs in the pension industry in Kenya are wasted and do not result in any output.

The production technology in Kenya Pension industry is characterised by variable returns to scale. The mean VRS technical efficiency scores were found to be larger than the mean CRS technical efficiency scores.

The scale efficiency score for pension funds was 83.9 per cent while for provident funds was 74.9 per cent. A scale efficiency score of less than 100 per cent implies that pension funds

and provident funds in Kenya are not operating at optimal scale or size. There is need for the stakeholders to modify the scale of the pension funds and provident funds in order to be scale efficient.

For pension funds, Market share and size was positively related to technical efficiency while age, employer contribution rate and employee contribution rate were negatively related to technical efficiency. This implies that the bigger the market share and size of assets of a pension fund, the greater will it operations be technically efficient. On the other hand, the newly formed pension funds were found to be technically efficient when compared to older pension funds. The higher the rate of contribution to a pension fund by the employer the less technically efficient will the pension fund operate. On scale efficiency, age and size of a pension fund were found to be negatively related to scale technical efficiency while market share, employer contribution rate, and employee contribution rate had a positive relationship.

For provident funds, market share and employer contribution rate had a positive relationship with technical efficiency while age, size, and employee contribution rate had a negative relationship. The implication of these results is that the higher the provident fund's market share is in the industry, the greater will be its technical efficiency. The higher is the employer contribution rate; the provident fund will tend to operate technically efficiently. On the other hand, older provident funds and tend to be less technically efficient. Further, the bigger the size of a provident fund, the less technical efficient it will be. On scale technical efficiency, age, size, and employer contribution rate had negative relationship with scale technical efficiency while market share had a positive relationship.

There is an urgent need to further interrogate the variables used in this study which has identified in both pension funds and provident funds, market share as positively related to

technical efficiency. Age of a pension fund and provident funds was found to be negatively related to its technical efficiency.

Policy makers in the industry and all the other stakeholders should therefore consider whether merging the smaller schemes, in order to increase the market share of the resultant scheme, is the direction to take in order to improve technical efficiency in Kenya. In addition, studies should be conducted to establish, and to add to literature the reason as to why older schemes are less efficient since this study has showed that age of the scheme has a negative relation to technical efficiency.

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APPENDIX

Appendix I: Technical Efficiency Scores for the Pension Funds and Variables (CRSTE)

CRSTE	Age	Size	Market share	Employer rate	Employee rate
0.43	19.99	31.57	0.009	5.0	5.0
0.17	13.90	241.89	0.072	7.5	5.0
0.07	20.99	211.79	0.063	5.0	5.0
0.21	4.93	15.32	0.005	5.0	5.0
0.20	15.91	41.99	0.012	5.0	5.0
0.14	18.99	128.21	0.038	10.0	5.0
0.22	11.99	13.90	0.004	5.0	5.0
0.39	11.97	36.68	0.011	5.0	5.0
1.00	11.96	57.63	0.017	5.0	5.0
0.16	26.99	7.08	0.002	15.0	5.0
0.06	15.94	323.75	0.096	10.0	5.0
0.34	11.90	72.69	0.022	10.0	7.5
0.60	20.99	1040.09	0.309	7.5	7.5
0.06	44.99	246.22	0.073	20.0	5.0
0.42	27.98	159.72	0.047	20.5	5.0
0.06	19.93	132.06	0.039	5.0	5.0
0.22	10.99	69.05	0.021	5.0	5.0
0.20	5.96	753.93	0.224	0.0	0.0
0.13	4.88	25.64	0.008	15.0	15.0
0.13	2.99	97.51	0.029	5.0	5.0
0.05	38.99	275.56	0.082	9.0	5.0
0.05	30.99	29.01	0.009	0.0	0.0
0.37	7.93	44.23	0.013	10.0	5.0
0.12	22.99	36.47	0.011	10.0	7.5

CRSTE	Age	Size	Market share	Employer rate	Employee rate
1.00	19.93	371.15	0.110	12.0	5.0
0.14	18.99	37.12	0.011	5.0	5.0
0.06	15.99	25.73	0.008	7.5	5.0
0.20	31.96	144.82	0.043	23.5	5.0
0.44	8.90	4.39	0.001	5.0	5.0
0.07	18.88	36.06	0.011	10.0	0.0
0.14	22.89	88.06	0.026	7.5	5.0
0.35	11.98	8.59	0.003	5.0	5.0
0.14	13.99	106.97	0.032	8.3	8.3
0.06	41.91	4694.97	1.394	10.0	3.0
0.05	35.93	407.75	0.121	7.5	7.5
0.14	19.93	77.91	0.023	7.5	7.5
0.21	9.96	56.07	0.017	9.0	5.0
0.21	18.99	67.70	0.020	12.5	10.0
0.26	9.91	82.33	0.024	10.0	5.0
0.45	14.97	9.28	0.003	5.0	5.0
0.78	37.89	56.75	0.017	10.0	5.0
0.19	22.99	646.24	0.192	0.0	5.0
1.00	9.97	52.47	0.016	5.0	5.0
1.00	10.93	57.52	0.017	7.8	7.5
0.54	12.99	9.56	0.003	10.0	7.5
0.07	3.92	41.84	0.012	7.5	7.5
0.34	10.99	61.07	0.018	5.0	7.5
0.06	19.89	433.03	0.129	15.0	0.0
0.24	22.99	94.46	0.028	15.0	5.0
0.50	14.88	16.74	0.005	7.5	7.5
0.51	24.91	127.67	0.038	21.6	5.0

CRSTE	Age	Size	Market share	Employer rate	Employee rate
0.52	41.93	14809.81	4.399	27.5	2.0
0.24	32.97	208.60	0.062	5.0	5.0
0.46	4.99	215.10	0.064	7.5	5.0
0.32	11.98	123.56	0.037	5.0	5.0
0.63	2.93	15.35	0.005	5.0	5.0
0.85	15.89	4.02	0.001	7.0	5.0
0.09	21.93	316.42	0.094	6.0	3.0
0.12	5.89	7.52	0.002	0.0	0.0
0.81	11.92	9.00	0.003	7.0	5.0
0.91	18.96	30.08	0.009	10.0	10.0
0.44	18.98	22.41	0.007	5.0	5.0
0.17	27.99	432.16	0.128	7.0	5.0
0.13	23.93	16.42	0.005	10.0	10.0
0.29	23.99	24.80	0.007	7.5	5.0
0.24	44.99	743.18	0.221	8.8	5.0
1.00	6.95	80.95	0.024	7.5	5.0
0.57	17.91	34.14	0.010	5.0	5.0
1.00	27.99	477.49	0.142	5.0	5.0
0.66	7.90	6.25	0.002	5.0	5.0
0.24	12.93	174.21	0.052	7.5	7.5
0.14	19.94	73.34	0.022	9.0	5.0
0.70	1.95	24.21	0.007	0.0	0.0
0.12	29.96	142.25	0.042	7.5	7.5
0.28	22.99	66.65	0.020	8.0	7.0
0.74	7.90	6.62	0.002	5.0	5.0
0.32	16.99	19.29	0.006	7.5	5.0
0.09	14.88	319.44	0.095	8.0	5.0

CRSTE	Age	Size	Market share	Employer rate	Employee rate
0.13	30.99	89.39	0.027	5.0	5.0
0.40	8.90	14.32	0.004	5.0	5.0
0.35	21.99	449.88	0.134	10.0	7.5
0.14	12.94	356.56	0.106	5.0	5.0
0.45	15.93	226.58	0.067	5.0	5.0
0.06	32.92	10.97	0.003	12.5	7.5
0.65	31.92	264.24	0.078	18.5	0.0
0.36	13.97	22.27	0.007	5.0	5.0
0.19	14.99	2.98	0.001	5.0	5.0
0.27	29.89	29.14	0.009	5.0	0.0
0.26	14.99	212.91	0.063	5.0	5.0
0.92	9.99	9.27	0.003	5.0	5.0
0.15	12.91	5.14	0.002	15.0	5.0
1.00	43.99	2815.44	0.836	15.0	5.0
0.40	15.99	14.71	0.004	5.0	5.0
0.40	17.95	10.22	0.003	5.0	5.0
0.27	5.94	2.94	0.001	5.0	5.0
0.25	18.94	7.99	0.002	10.0	5.0
1.00	15.91	34.67	0.010	5.0	5.0
0.46	13.97	772.67	0.229	5.0	5.0
0.46	16.91	270.65	0.080	7.5	7.5
0.35	15.99	28.77	0.009	10.0	10.0
0.33	14.93	47.42	0.014	15.0	5.0
0.05	17.93	305.43	0.091	19.0	5.0
0.18	14.99	77.17	0.023	25.0	0.0
0.06	12.99	37.63	0.011	5.0	5.0
0.12	21.93	49.74	0.015	10.0	6.0

CRSTE	Age	Size	Market share	Employer rate	Employee rate
0.06	16.90	33.50	0.010	12.0	5.0
0.05	30.92	28.60	0.008	5.0	5.0
0.04	12.93	42.54	0.013	10.0	5.0
0.21	50.99	140.31	0.042	6.0	5.0
0.12	19.93	79.45	0.024	10.0	5.0
0.59	8.94	10.59	0.003	7.5	7.5
1.00	23.95	36.33	0.011	5.0	5.0
0.27	25.99	51.66	0.015	10.0	5.0
0.11	13.99	88.95	0.026	10.0	5.0
0.11	15.99	17.98	0.005	7.5	5.0
0.25	16.94	111.21	0.033	5.0	5.0
0.30	41.89	96.06	0.029	5.0	5.0
0.51	9.90	22.91	0.007	7.0	5.0

Appendix II: Technical Efficiency Scores for the Pension Funds and Variables (VRSTE)

VRSTE	Age	Size	Market share	Employer rate	Employee rate
0.44	19.99	31.57	0.009	5.0	5.0
0.21	13.90	241.89	0.072	7.5	5.0
0.07	20.99	211.79	0.063	5.0	5.0
0.23	4.93	15.32	0.005	5.0	5.0
0.20	15.91	41.99	0.012	5.0	5.0
0.15	18.99	128.21	0.038	10.0	5.0
0.24	11.99	13.90	0.004	5.0	5.0
0.42	11.97	36.68	0.011	5.0	5.0
1.00	11.96	57.63	0.017	5.0	5.0
0.22	26.99	7.08	0.002	15.0	5.0
0.06	15.94	323.75	0.096	10.0	5.0
0.35	11.90	72.69	0.022	10.0	7.5
1.00	20.99	1040.09	0.309	7.5	7.5
0.06	44.99	246.22	0.073	20.0	5.0
0.42	27.98	159.72	0.047	20.5	5.0
0.06	19.93	132.06	0.039	5.0	5.0
0.24	10.99	69.05	0.021	5.0	5.0
0.56	5.96	753.93	0.224	0.0	0.0
0.13	4.88	25.64	0.008	15.0	15.0
0.13	2.99	97.51	0.029	5.0	5.0
0.06	38.99	275.56	0.082	9.0	5.0
0.10	30.99	29.01	0.009	0.0	0.0
0.37	7.93	44.23	0.013	10.0	5.0
0.13	22.99	36.47	0.011	10.0	7.5

VRSTE	Age	Size	Market share	Employer rate	Employee rate
1.00	19.93	371.15	0.110	12.0	5.0
0.15	18.99	37.12	0.011	5.0	5.0
0.29	15.99	25.73	0.008	7.5	5.0
0.23	31.96	144.82	0.043	23.5	5.0
1.00	8.90	4.39	0.001	5.0	5.0
0.23	18.88	36.06	0.011	10.0	0.0
0.14	22.89	88.06	0.026	7.5	5.0
0.54	11.98	8.59	0.003	5.0	5.0
0.14	13.99	106.97	0.032	8.3	8.3
1.00	41.91	4694.97	1.394	10.0	3.0
0.05	35.93	407.75	0.121	7.5	7.5
0.16	19.93	77.91	0.023	7.5	7.5
0.21	9.96	56.07	0.017	9.0	5.0
0.22	18.99	67.70	0.020	12.5	10.0
0.44	9.91	82.33	0.024	10.0	5.0
0.58	14.97	9.28	0.003	5.0	5.0
0.88	37.89	56.75	0.017	10.0	5.0
0.19	22.99	646.24	0.192	0.0	5.0
1.00	9.97	52.47	0.016	5.0	5.0
1.00	10.93	57.52	0.017	7.8	7.5
0.61	12.99	9.56	0.003	10.0	7.5
0.07	3.92	41.84	0.012	7.5	7.5
0.35	10.99	61.07	0.018	5.0	7.5
0.08	19.89	433.03	0.129	15.0	0.0
0.25	22.99	94.46	0.028	15.0	5.0
0.58	14.88	16.74	0.005	7.5	7.5
0.51	24.91	127.67	0.038	21.6	5.0

VRSTE	Age	Size	Market share	Employer rate	Employee rate
0.56	41.93	14809.81	4.399	27.5	2.0
0.24	32.97	208.60	0.062	5.0	5.0
0.46	4.99	215.10	0.064	7.5	5.0
0.33	11.98	123.56	0.037	5.0	5.0
0.65	2.93	15.35	0.005	5.0	5.0
1.00	15.89	4.02	0.001	7.0	5.0
0.09	21.93	316.42	0.094	6.0	3.0
0.44	5.89	7.52	0.002	0.0	0.0
1.00	11.92	9.00	0.003	7.0	5.0
0.91	18.96	30.08	0.009	10.0	10.0
0.46	18.98	22.41	0.007	5.0	5.0
0.17	27.99	432.16	0.128	7.0	5.0
0.43	23.93	16.42	0.005	10.0	10.0
0.32	23.99	24.80	0.007	7.5	5.0
0.25	44.99	743.18	0.221	8.8	5.0
1.00	6.95	80.95	0.024	7.5	5.0
0.59	17.91	34.14	0.010	5.0	5.0
1.00	27.99	477.49	0.142	5.0	5.0
0.80	7.90	6.25	0.002	5.0	5.0
0.24	12.93	174.21	0.052	7.5	7.5
0.15	19.94	73.34	0.022	9.0	5.0
0.71	1.95	24.21	0.007	0.0	0.0
0.15	29.96	142.25	0.042	7.5	7.5
0.29	22.99	66.65	0.020	8.0	7.0
0.89	7.90	6.62	0.002	5.0	5.0
0.34	16.99	19.29	0.006	7.5	5.0
0.10	14.88	319.44	0.095	8.0	5.0

VRSTE	Age	Size	Market share	Employer rate	Employee rate
0.14	30.99	89.39	0.027	5.0	5.0
0.93	8.90	14.32	0.004	5.0	5.0
0.36	21.99	449.88	0.134	10.0	7.5
0.14	12.94	356.56	0.106	5.0	5.0
0.54	15.93	226.58	0.067	5.0	5.0
0.12	32.92	10.97	0.003	12.5	7.5
1.00	31.92	264.24	0.078	18.5	0.0
0.38	13.97	22.27	0.007	5.0	5.0
0.34	14.99	2.98	0.001	5.0	5.0
0.28	29.89	29.14	0.009	5.0	0.0
0.26	14.99	212.91	0.063	5.0	5.0
1.00	9.99	9.27	0.003	5.0	5.0
0.25	12.91	5.14	0.002	15.0	5.0
1.00	43.99	2815.44	0.836	15.0	5.0
0.52	15.99	14.71	0.004	5.0	5.0
0.46	17.95	10.22	0.003	5.0	5.0
0.80	5.94	2.94	0.001	5.0	5.0
0.55	18.94	7.99	0.002	10.0	5.0
1.00	15.91	34.67	0.010	5.0	5.0
1.00	13.97	772.67	0.229	5.0	5.0
0.51	16.91	270.65	0.080	7.5	7.5
0.36	15.99	28.77	0.009	10.0	10.0
0.36	14.93	47.42	0.014	15.0	5.0
0.05	17.93	305.43	0.091	19.0	5.0
0.19	14.99	77.17	0.023	25.0	0.0
0.11	12.99	37.63	0.011	5.0	5.0
0.15	21.93	49.74	0.015	10.0	6.0

VRSTE	Age	Size	Market share	Employer rate	Employee rate
0.06	16.90	33.50	0.010	12.0	5.0
0.09	30.92	28.60	0.008	5.0	5.0
0.08	12.93	42.54	0.013	10.0	5.0
0.30	50.99	140.31	0.042	6.0	5.0
0.18	19.93	79.45	0.024	10.0	5.0
1.00	8.94	10.59	0.003	7.5	7.5
1.00	23.95	36.33	0.011	5.0	5.0
0.27	25.99	51.66	0.015	10.0	5.0
0.11	13.99	88.95	0.026	10.0	5.0
0.15	15.99	17.98	0.005	7.5	5.0
0.26	16.94	111.21	0.033	5.0	5.0
0.30	41.89	96.06	0.029	5.0	5.0
0.55	9.90	22.91	0.007	7.0	5.0

Appendix III: Scale Efficiency Scores for the Pension Funds and Variables (SCALE)

SCALE	Age	Size	Market share	Employer rate	Employee rate
0.98	19.99	31.57	0.009	5.0	5.0
0.83	13.90	241.89	0.072	7.5	5.0
0.99	20.99	211.79	0.063	5.0	5.0
0.91	4.93	15.32	0.005	5.0	5.0
1.00	15.91	41.99	0.012	5.0	5.0
0.97	18.99	128.21	0.038	10.0	5.0
0.94	11.99	13.90	0.004	5.0	5.0
0.93	11.97	36.68	0.011	5.0	5.0
1.00	11.96	57.63	0.017	5.0	5.0
0.74	26.99	7.08	0.002	15.0	5.0
0.99	15.94	323.75	0.096	10.0	5.0
0.99	11.90	72.69	0.022	10.0	7.5
0.60	20.99	1040.09	0.309	7.5	7.5
1.00	44.99	246.22	0.073	20.0	5.0
0.99	27.98	159.72	0.047	20.5	5.0
0.95	19.93	132.06	0.039	5.0	5.0
0.90	10.99	69.05	0.021	5.0	5.0
0.35	5.96	753.93	0.224	0.0	0.0
0.98	4.88	25.64	0.008	15.0	15.0
0.96	2.99	97.51	0.029	5.0	5.0
0.98	38.99	275.56	0.082	9.0	5.0
0.49	30.99	29.01	0.009	0.0	0.0
0.99	7.93	44.23	0.013	10.0	5.0
0.94	22.99	36.47	0.011	10.0	7.5

SCALE	Age	Size	Market share	Employer rate	Employee rate
1.00	19.93	371.15	0.110	12.0	5.0
0.91	18.99	37.12	0.011	5.0	5.0
0.21	15.99	25.73	0.008	7.5	5.0
0.84	31.96	144.82	0.043	23.5	5.0
0.44	8.90	4.39	0.001	5.0	5.0
0.29	18.88	36.06	0.011	10.0	0.0
0.98	22.89	88.06	0.026	7.5	5.0
0.65	11.98	8.59	0.003	5.0	5.0
0.95	13.99	106.97	0.032	8.3	8.3
0.06	41.91	4694.97	1.394	10.0	3.0
0.99	35.93	407.75	0.121	7.5	7.5
0.91	19.93	77.91	0.023	7.5	7.5
0.99	9.96	56.07	0.017	9.0	5.0
0.94	18.99	67.70	0.020	12.5	10.0
0.59	9.91	82.33	0.024	10.0	5.0
0.77	14.97	9.28	0.003	5.0	5.0
0.89	37.89	56.75	0.017	10.0	5.0
0.98	22.99	646.24	0.192	0.0	5.0
1.00	9.97	52.47	0.016	5.0	5.0
1.00	10.93	57.52	0.017	7.8	7.5
0.88	12.99	9.56	0.003	10.0	7.5
0.95	3.92	41.84	0.012	7.5	7.5
0.95	10.99	61.07	0.018	5.0	7.5
0.76	19.89	433.03	0.129	15.0	0.0
0.99	22.99	94.46	0.028	15.0	5.0
0.85	14.88	16.74	0.005	7.5	7.5
1.00	24.91	127.67	0.038	21.6	5.0

SCALE	Age	Size	Market share	Employer rate	Employee rate
0.93	41.93	14809.81	4.399	27.5	2.0
1.00	32.97	208.60	0.062	5.0	5.0
1.00	4.99	215.10	0.064	7.5	5.0
0.96	11.98	123.56	0.037	5.0	5.0
0.97	2.93	15.35	0.005	5.0	5.0
0.85	15.89	4.02	0.001	7.0	5.0
0.97	21.93	316.42	0.094	6.0	3.0
0.26	5.89	7.52	0.002	0.0	0.0
0.81	11.92	9.00	0.003	7.0	5.0
1.00	18.96	30.08	0.009	10.0	10.0
0.96	18.98	22.41	0.007	5.0	5.0
0.99	27.99	432.16	0.128	7.0	5.0
0.30	23.93	16.42	0.005	10.0	10.0
0.93	23.99	24.80	0.007	7.5	5.0
0.96	44.99	743.18	0.221	8.8	5.0
1.00	6.95	80.95	0.024	7.5	5.0
0.95	17.91	34.14	0.010	5.0	5.0
1.00	27.99	477.49	0.142	5.0	5.0
0.83	7.90	6.25	0.002	5.0	5.0
0.99	12.93	174.21	0.052	7.5	7.5
0.89	19.94	73.34	0.022	9.0	5.0
0.99	1.95	24.21	0.007	0.0	0.0
0.79	29.96	142.25	0.042	7.5	7.5
0.97	22.99	66.65	0.020	8.0	7.0
0.83	7.90	6.62	0.002	5.0	5.0
0.93	16.99	19.29	0.006	7.5	5.0
0.99	14.88	319.44	0.095	8.0	5.0

SCALE	Age	Size	Market share	Employer rate	Employee rate
0.97	30.99	89.39	0.027	5.0	5.0
0.43	8.90	14.32	0.004	5.0	5.0
0.96	21.99	449.88	0.134	10.0	7.5
0.99	12.94	356.56	0.106	5.0	5.0
0.84	15.93	226.58	0.067	5.0	5.0
0.45	32.92	10.97	0.003	12.5	7.5
0.65	31.92	264.24	0.078	18.5	0.0
0.96	13.97	22.27	0.007	5.0	5.0
0.55	14.99	2.98	0.001	5.0	5.0
0.97	29.89	29.14	0.009	5.0	0.0
0.98	14.99	212.91	0.063	5.0	5.0
0.92	9.99	9.27	0.003	5.0	5.0
0.59	12.91	5.14	0.002	15.0	5.0
1.00	43.99	2815.44	0.836	15.0	5.0
0.78	15.99	14.71	0.004	5.0	5.0
0.87	17.95	10.22	0.003	5.0	5.0
0.34	5.94	2.94	0.001	5.0	5.0
0.47	18.94	7.99	0.002	10.0	5.0
1.00	15.91	34.67	0.010	5.0	5.0
0.46	13.97	772.67	0.229	5.0	5.0
0.90	16.91	270.65	0.080	7.5	7.5
0.97	15.99	28.77	0.009	10.0	10.0
0.91	14.93	47.42	0.014	15.0	5.0
0.94	17.93	305.43	0.091	19.0	5.0
0.95	14.99	77.17	0.023	25.0	0.0
0.56	12.99	37.63	0.011	5.0	5.0
0.82	21.93	49.74	0.015	10.0	6.0

SCALE	Age	Size	Market share	Employer rate	Employee rate
0.97	16.90	33.50	0.010	12.0	5.0
0.56	30.92	28.60	0.008	5.0	5.0
0.56	12.93	42.54	0.013	10.0	5.0
0.69	50.99	140.31	0.042	6.0	5.0
0.66	19.93	79.45	0.024	10.0	5.0
0.59	8.94	10.59	0.003	7.5	7.5
1.00	23.95	36.33	0.011	5.0	5.0
0.99	25.99	51.66	0.015	10.0	5.0
0.94	13.99	88.95	0.026	10.0	5.0
0.74	15.99	17.98	0.005	7.5	5.0
0.95	16.94	111.21	0.033	5.0	5.0
0.99	41.89	96.06	0.029	5.0	5.0
0.93	9.90	22.91	0.007	7.0	5.0

Appendix IV: Technical Efficiency Scores for Provident Funds and Variables (CRSTE)

CRTSTE	Age	Size	Market share	Employer rate	Employee rate
0.28	13.90	10.97	0.000033	7.5	5.0
0.55	13.98	8.38	0.000025	10.0	15.0
0.54	5.89	13.82	0.000041	10.0	5.0
0.39	8.93	68.94	0.000205	5.0	5.0
0.12	8.91	775.83	0.002304	14.0	-
0.32	4.91	5,158.53	0.015321	-	5.0
0.32	4.92	28.78	0.000085	10.0	5.0
0.55	12.89	30.56	0.000091	7.5	7.5
0.38	5.90	27.73	0.000082	-	31.0
1.00	27.99	287.93	0.000855	8.3	8.3
0.40	43.90	29.77	0.000088	10.0	10.0
0.10	18.99	1,471.31	0.004370	10.0	10.0
0.57	22.99	11.43	0.000034	5.0	5.0
0.63	51.99	100.87	0.000300	7.5	5.0
0.98	4.96	1.94	0.000006	5.0	5.0
0.41	37.90	32.09	0.000095	7.5	7.5
1.00	5.91	26.09	0.000077	5.0	5.0
1.00	2.99	6.11	0.000018	10.0	5.0
0.08	30.98	248.72	0.000739	5.0	5.0
0.19	32.93	258.19	0.000767	7.5	5.0
0.61	8.97	14.91	0.000044	25.0	5.0
0.25	23.97	492.05	0.001461	5.0	5.0
0.23	32.89	124.47	0.000370	10.0	10.0
0.19	20.93	21.03	0.000062	5.0	5.0
0.24	46.92	104.28	0.000310	5.0	5.0
0.30	23.93	141.33	0.000420	7.5	7.5
1.00	13.99	154.14	0.000458	5.0	5.0
0.37	6.99	71.69	0.000213	5.0	5.0
0.89	4.99	21.02	0.000062	5.0	-
0.72	1.90	40.07	0.000119	10.0	5.0
0.37	6.90	26.13	0.000078	10.0	10.0
0.31	14.99	2.39	0.000007	5.0	5.0
0.09	67.99	47.76	0.000142	5.0	3.0
0.12	6.96	1,389.37	0.004126	5.0	3.0
0.07	16.99	62.44	0.000185	10.8	7.0
0.06	15.92	20.72	0.000062	10.0	5.0
0.33	12.93	55.46	0.000165	5.0	5.0
0.82	24.93	200.37	0.000595	10.0	7.5
1.00	3.89	4.70	0.000014	5.0	5.0
0.27	47.91	30.43	0.000090	5.0	5.0
0.61	15.99	10.10	0.000030	5.0	5.0

CRTSTE	Age	Size	Market share	Employer rate	Employee rate
0.27	2.99	59.97	0.000178	-	5.0
0.19	10.99	11.09	0.000033	7.5	5.0

Appendix V: Technical Efficiency Scores for Provident Funds and Variables (VRSTE)

VRS TE	Age	Size	Market share	Employer rate	Employee rate
0.34	13.90	10.97	0.000033	7.5	5.0
0.79	13.98	8.38	0.000025	10.0	15.0
1.00	5.89	13.82	0.000041	10.0	5.0
0.40	8.93	68.94	0.000205	5.0	5.0
0.24	8.91	775.83	0.002304	14.0	-
1.00	4.91	5,158.53	0.015321	-	5.0
0.53	4.92	28.78	0.000085	10.0	5.0
0.66	12.89	30.56	0.000091	7.5	7.5
0.44	5.90	27.73	0.000082	-	31.0
1.00	27.99	287.93	0.000855	8.3	8.3
0.42	43.90	29.77	0.000088	10.0	10.0
0.50	18.99	1,471.31	0.004370	10.0	10.0
1.00	22.99	11.43	0.000034	5.0	5.0
0.65	51.99	100.87	0.000300	7.5	5.0
1.00	4.96	1.94	0.000006	5.0	5.0
0.94	37.90	32.09	0.000095	7.5	7.5
1.00	5.91	26.09	0.000077	5.0	5.0
1.00	2.99	6.11	0.000018	10.0	5.0
0.08	30.98	248.72	0.000739	5.0	5.0
0.22	32.93	258.19	0.000767	7.5	5.0
1.00	8.97	14.91	0.000044	25.0	5.0
0.26	23.97	492.05	0.001461	5.0	5.0
0.32	32.89	124.47	0.000370	10.0	10.0
0.21	20.93	21.03	0.000062	5.0	5.0
0.29	46.92	104.28	0.000310	5.0	5.0

VRS TE	Age	Size	Market share	Employer rate	Employee rate
0.47	23.93	141.33	0.000420	7.5	7.5
1.00	13.99	154.14	0.000458	5.0	5.0
0.52	6.99	71.69	0.000213	5.0	5.0
1.00	4.99	21.02	0.000062	5.0	-
0.75	1.90	40.07	0.000119	10.0	5.0
0.37	6.90	26.13	0.000078	10.0	10.0
0.59	14.99	2.39	0.000007	5.0	5.0
0.14	67.99	47.76	0.000142	5.0	3.0
1.00	6.96	1,389.37	0.004126	5.0	3.0
0.11	16.99	62.44	0.000185	10.8	7.0
0.09	15.92	20.72	0.000062	10.0	5.0
0.38	12.93	55.46	0.000165	5.0	5.0
1.00	24.93	200.37	0.000595	10.0	7.5
1.00	3.89	4.70	0.000014	5.0	5.0
0.34	47.91	30.43	0.000090	5.0	5.0
1.00	15.99	10.10	0.000030	5.0	5.0
0.33	2.99	59.97	0.000178	-	5.0
0.40	10.99	11.09	0.000033	7.5	5.0

Appendix VI: Scale Efficiency Scores for the Provident Funds and Variables (SCALE)

SCALE	Age	Size	Market share	Employer rate	Employee rate
0.81	13.90	10.97	0.000033	7.5	5.0
0.70	13.98	8.38	0.000025	10.0	15.0
0.54	5.89	13.82	0.000041	10.0	5.0
0.97	8.93	68.94	0.000205	5.0	5.0
0.51	8.91	775.83	0.002304	14.0	-
0.32	4.91	5,158.53	0.015321	-	5.0
0.60	4.92	28.78	0.000085	10.0	5.0
0.83	12.89	30.56	0.000091	7.5	7.5
0.87	5.90	27.73	0.000082	-	31.0
1.00	27.99	287.93	0.000855	8.3	8.3
0.96	43.90	29.77	0.000088	10.0	10.0
0.20	18.99	1,471.31	0.004370	10.0	10.0
0.57	22.99	11.43	0.000034	5.0	5.0
0.96	51.99	100.87	0.000300	7.5	5.0
0.98	4.96	1.94	0.000006	5.0	5.0
0.44	37.90	32.09	0.000095	7.5	7.5
1.00	5.91	26.09	0.000077	5.0	5.0
1.00	2.99	6.11	0.000018	10.0	5.0
0.93	30.98	248.72	0.000739	5.0	5.0
0.86	32.93	258.19	0.000767	7.5	5.0
0.61	8.97	14.91	0.000044	25.0	5.0
0.95	23.97	492.05	0.001461	5.0	5.0
0.72	32.89	124.47	0.000370	10.0	10.0
0.90	20.93	21.03	0.000062	5.0	5.0
0.81	46.92	104.28	0.000310	5.0	5.0

SCALE	Age	Size	Market share	Employer rate	Employee rate
0.65	23.93	141.33	0.000420	7.5	7.5
1.00	13.99	154.14	0.000458	5.0	5.0
0.71	6.99	71.69	0.000213	5.0	5.0
0.89	4.99	21.02	0.000062	5.0	-
0.95	1.90	40.07	0.000119	10.0	5.0
1.00	6.90	26.13	0.000078	10.0	10.0
0.53	14.99	2.39	0.000007	5.0	5.0
0.62	67.99	47.76	0.000142	5.0	3.0
0.12	6.96	1,389.37	0.004126	5.0	3.0
0.64	16.99	62.44	0.000185	10.8	7.0
0.68	15.92	20.72	0.000062	10.0	5.0
0.86	12.93	55.46	0.000165	5.0	5.0
0.82	24.93	200.37	0.000595	10.0	7.5
1.00	3.89	4.70	0.000014	5.0	5.0
0.79	47.91	30.43	0.000090	5.0	5.0
0.61	15.99	10.10	0.000030	5.0	5.0
0.82	2.99	59.97	0.000178	-	5.0
0.48	10.99	11.09	0.000033	7.5	5.0