Data Envelopment Analysis with Production Trade-offs: The Case of Microfinance Institutions

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A Thesis submitted for the degree of Doctor of Philosophy

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Declarations

I hereby declare that I am responsible for the work submitted through this thesis. All the material is written by me, and has not been submitted previously in any degree programme at this, or any other, institution. This thesis is an original work and does not include any part of an earlier work, without providing proper reference to the relevant sources.

During the course of the PhD programme, the following conference presentations have been made:

- Farooq, S. "Performance evaluation of Microfinance institutions (MFIs) using Data Envelopment Analysis", Young OR 18 Conference 2013 , University of Exeter, UK, April 9-11, 2013.
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Abstract

The success of microfinancing methodology, as a development tool for poverty alleviation, has been accompanied by a number of challenges. These challenges have resulted in increasing concerns about performance of those entities that act as vehicles for delivering microfinance, i.e. the microfinance institutions (MFIs). A major problem in this regard relates to selection of appropriate technique/s for evaluating MFIs' performance. Data Envelopment Analysis (DEA) is an established nonparametric methodology that has been used to assess the performance of MFIs. This study proposes a significant extension to standard DEA models. This is achieved by the identification of various trade-offs between the inputs and outputs and their subsequent incorporation in the DEA models. With this application, the current study contributes to existing knowledge in the field of operational research; by providing practical demonstration of the procedure, through which the trade-off approach can be used to enrich standard DEA models. The improvement to standard DEA models is accomplished through incorporation of additional information, in the form of technologically realistic trade-offs. In addition, application of the trade-off approach is shown to help in overcoming the problem of insufficient discrimination; resulting from having a relatively small number of DMUS, in comparison to the total number of input and output variables. The current study also proposes a framework for DEA-based performance evaluation of MFIs. This framework acknowledges the need to evaluate both the social and financial dimensions of MFIs, in order to achieve a more holistic view of their performance. For this purpose, the social and financial performance aspects of a group of MFIs', working in an under-researched economy, are analysed individually as well as simultaneously. A comparison of the efficiency scores is also used for investigating the conflict-compatibility dilemma, which is a frequently discussed issue in the microfinance literature.

Acronyms and Abbreviations

ADB: Asian Development Bank

ASA-P: Association for Social Advancement- Pakistan

BCC: Banker Charnes Cooper

BRAC-P: Bangladesh Rehabilitation Assistance Committee- Pakistan

CCR: Charnes Cooper Rhodes

CGAP: Consultative Group to Assist the Poor

CRS: Constant Returns to Scale

CSC: Community Support Concern

DAMEN: Development Action for Mobilization & Emancipation

DBL-DEA: Double Bottom-line Data Envelopment Analysis

DEA: Data Envelopment Analysis

DMU: Decision Making Unit

DRS: Decreasing Returns to Scale

FMFB: The First Microfinance Bank Ltd.

FSS: Financial Self-Sufficiency

IRC: Increasing Returns to Scale

JWS: Jinnah Welfare Society

KBL: Khushhali Bank Ltd.

KMFB: Kashf Microfinance Bank

MFB: Microfinance Bank

MFI: Microfinance Institution

MIX: Microfinance Information Exchange

NGO: Non-Governmental Organization

NRSP: National Rural Support Programme

NRSP-B: National Rural Support Programme Bank

ODEA: Outreach Data Envelopment Analysis

OO: Output Oriented

PAR: Portfolio at Risk

PDEA: Profitability Data Envelopment Analysis

PKR: Pakistan Rupee

PMN: Pakistan Microfinance Network

PPAF: Pakistan Poverty Alleviation Fund

PPS: Production Possibility Set

PRSP: Punjab Rural Support Program

RCDS: Rural Community Development Society

RSP: Rural Support Programme

RTS: Returns to Scale

SAFWCO: Sindh Agriculture and Forestry Workers Coordinating Organization

TMFB: Tameer Microfinance Bank Ltd

TO: Production Trade-off

TRDP: Thardeep Rural Development Programme

VRS: Variable Returns to Scale

W-TO: With Trade-offs

WO-TO: Without Trade-offs

Chapter 1 Introduction

1.1. Background for the Study

The current study undertakes an application of the novel trade-off approach for conducting performance evaluation of microfinance institutions (MFIs) through Data Envelopment Analysis (DEA). Microfinance refers to the provision of various financial and non-financial services, such as; small loans, money transfers, insurance, deposits, payments and different types of training services to the poor people and their micro-enterprises (Asian Development Bank, 2000). Microfinance is recognized as a useful instrument that can help poor people move out of poverty (Otero, 1999, Hamada, 2010), by enabling them to enhance their incomes; while engaging in various economic activities (Robinson, 2001).

Microfinance has emerged as a valuable substitute for the informal sources of finance, and targets those poor people who are economically active; but fail to escape poverty due to lack of financial resources. Poor people are frequently unable to engage in income generating activities; not because they lack necessary skills or market opportunities, but due to dearth of financial resources. The scarcity of sustainable and affordable financing facilities is thus believed to be one of the common reasons responsible for persistent poverty around the globe. Such dearth of financial resources, in turn, is a result of the exclusion of the poor from the formal financial sector; which has always been reluctant in catering to the resource-constrained poor people. Two major reasons quoted for this reluctance include: greater risks presumably involved in pro-poor financing due to poor people's inability to offer suitable collateral, and relatively higher transactions costs associated with lending to the poor (Siwar and Talib, 2001, Coleman, 2006). As a result, a vast majority of the underprivileged poor community has to remain dependent on informal sources of finance (such as money lenders) that are insufficient, unreliable and/or unaffordable, in most of the cases.

In this background, the success of microfinance in providing the evidence that poor are credit worthy, and that ensuring high repayment rates is possible for pro-poor lending is one of the major contribution of microfinance (Hamada, 2010). The award of Nobel Peace Prize, for the pioneering microfinance organization Grameen Bank, and its founder Dr Mohammad Yunus, has resulted in global recognition for the potential of microfinance in facilitating the achievement of poverty alleviation goals. Today, microfinance has gained acceptance as an important development tool; with a large number of MFIs catering to the financial requirements of nearly 205 million poor clients (Maes and Reed, 2012). The microfinance institutions (MFIs) are established not only in various poverty ridden countries in the African and Asian continents, but also in many of the developed economies; including the United States and the United Kingdom. The potential of microfinance, to bring betterment to the resource deprived people around the globe through facilitating poverty alleviation, establishes its worth as a suitable area of research (Koveos and Randhawa, 2004).

The performance evaluation of MFIs is a particularly important research area that has caught the interest of academic community relatively recently. A major factor leading to the increased interest in this topic is related to the emergence of various issues associated with declining donor funding, and replication of the microfinance programmes that necessitate performance evaluation of MFIs (Ahlin et al., 2011). The importance of performance evaluation of MFIs also stems from a number of desirable outcomes usually associated with performance measurement exercises.

A generally desirable outcome of the performance measurement activity is the generation of information that can be used in identifying areas of potential improvement. Performance measurement can also facilitate the process of hypothesis testing and analysis related to the sources of variation in performance levels (Fried et al., 2008). On a small scale, performance measurement can be used by managers for supporting their decisions; while on a larger scale it can be used by policy makers for formulating future policies for performance improvement. It is also considered to be an important source of necessary feedback (Ouchi, 1979), as well as an instrument for securing control over business organizations (Thanassoulis, 2001).

It is observed that most of the recent work related to performance evaluation of MFIs is done by various international organisations and microfinance practitioners, and generally falls in the domain of non-academic literature. It is also noted that ratio analysis remains one of the most commonly used techniques for evaluating performance of MFIs (Gutiérrez-Nieto et al., 2007, Bartual Sanfeliu et al., 2013). The wide spread usage of ratio analysis can be attributed, in part, to the relatively straightforward computations involved in this technique. However, the use of ratio analysis is also characterized by a number of limitations. For example, in the case of performance evaluation of organizations using multiple inputs for producing multiple outputs, ratio analysis fails to fully capture the complicated relationships between different inputs and outputs that comprise the production process (Schaffnit et al., 1997). Moreover, the possibility of inaccurate interpretation in the case of different (and sometimes conflicting) signals produced by different ratios, and the level of subjectivity involved are two commonly criticized aspects of this technique (Feroz et al., 2003).

For the current study, an initial search for a suitable technique to evaluate MFIs' performance was conducted, with the view that the selection of particular analysis technique/s needs to be in line with the major objectives of any study. For example, measurement of financial performance is usually done through calculation of profitability ratios; whereas, planning for new marketing sites may call for adoption of sales forecasting techniques. Similarly, the selection of an appropriate technique is also guided by the particular indicator/s being utilized for measuring performance.

The more commonly used indicators for measuring firms' performance include productivity, profitability, growth and customer satisfaction (Barbosa and Louri, 2005). In addition to these indicators, efficiency is also used for measuring performance (Gelade and Gilbert, 2003). For the current study, we have decided to use efficiency as an appropriate indictor for measuring performance of MFIs. Efficiency is recognized as a reliable and robust criterion of MFIs' performance (Balkenhol, 2007). The suitability of this criterion is based on the premise that efficiency in utilization of the limited resources at the disposal of MFIs can play a central role in achievement of their performance objectives. Moreover, measurement of efficiency is also considered to be important because such measurement can provide useful information for overcoming any inefficiency in performance.

Overcoming inefficiency is crucial for ensuring firm existence because inefficiency is known to be a major contributor towards higher costs leading to lower productivity (Das and Ghosh, 2006). Achieving higher levels of efficiency is also considered important for raising sufficient equity capital that is required for conversion of unregulated MFIs to regulated institutions. And finally, the recent increase in competition and commercialization of microfinance sector, along with a decrease in the availability of subsidized funds, further necessitate greater focus on improving efficiency of the microfinance sector (Abate et al., 2014).

Taking into account the aforementioned factors, we have selected a well-known non-parametric methodology, called Data Envelopment Analysis (DEA) for conducting performance evaluation of MFIs. DEA is a mathematical linear programming technique, proposed by Charnes et al. (1978) that is regularly used for measuring relative efficiency of homogenous groups of decision making units (DMUs)[1], in a large variety of profit and non-profit sector firms. The selection of DEA for current study is not solely based on its ability to measure efficiency, which is the chosen indicator of performance in the current study. The selection of this particular technique is also based on a number of desirable characteristics that are not available with other techniques traditionally used for performance evaluation of MFIs.

First of all, the ability of DEA to incorporate multiple variables, and work without having to specify the production function, makes it especially useful for evaluating organizations in the public and non-profit sectors. Organizations in such sectors tend to use multiple inputs and produce multiple outputs that might not be evaluated in terms of more traditional profit and cost measures. The DEA technique is recognized to be an appropriate tool for evaluating both the profit and non-profit (or social) sector firms (Sherman, 1984). Therefore, considering the social cum financial nature of MFIs, DEA is considered to be especially suitable for evaluating their performance.

Because DEA takes into account all relevant aspects of performance simultaneously, therefore, it can inform whether the overall performance of a firm (or MFI in this case) is relatively good, even when some of the individual ratios about its performance may be showing adverse results (Thanassoulis et al., 1996). DEA is also particularly useful from point of view of obtaining much needed performance targets for the underperforming MFIs that are not available through traditional statistical measures.

[1] In DEA terminology, the term DMUs refers to the organizational units being analysed.

The useful by-products provided through DEA estimations can be quite helpful in selecting appropriate line of action for enhancing the performance of inefficient firms (El-Mahgary and Lahdelma, 1995) [2].

1.2. Motivation

The current study is motivated by the potential improvement to the standard DEA models that can result from the application of the trade-off approach, proposed by Podinovski (2004b). A (production) trade-off can be defined as a technologically realistic judgment, supporting simultaneous variations to different input(s) and/or output(s). The trade-off approach is a novel technique that has the ability to make the standard DEA models better informed, through ensuring more accurate and “enriched” representation of the production technology (Podinovski, 2007a). The trade-off approach offers an alternative to the traditionally used method of incorporating weight restrictions into the multiplier form of the standard DEA models. The mathematical effect of incorporating the trade-offs in the envelopment form is the same as that achieved through incorporation of the traditional weight restrictions in the multiplier models.

The ability of the trade-off approach to deal with the shortcomings associated with the alternative weight restrictions approach, has led to an increased recognition of its potential (Amado and Santos, 2009, Jahanshahloo et al., 2011, Alirezaee and Boloori, 2012, Korbkandi, 2012, Førsund, 2013, Khodabakhshi et al., 2013, Davoodi and Zhiani Rezai, 2014, Santos and Amado, 2014). However, at present no known application of this technique in the microfinance sector can be found; which provides an impetus for application of this approach in the current study.

[2] A more comprehensive discussion of the desirable characteristics of the DEA technique is provided in Chapter 2, section 2.7.

Another key motivation for the application of this approach is the relatively small data set available for the current study, which presents the problem of insufficient discrimination. Insufficient discrimination is a common occurrence in DEA studies that have an inadequate number of DMUs, as compared to the total number of input and output variables selected. The trade-off approach improves the discrimination of the efficiency scores through expansion of the PPS in a manner which is consistent with the production realities. This ability of the trade-off approach thus has particular significance for the current study.

In order to contextualize the motivation of the current study, we need to take into view the phenomenal growth and rapidly increasing popularity of microfinance in the last three decades, which has led to increased interest in the search for methods of analysing performance of this sector (Manos and Yaron, 2009). At the same time it is also noted that despite its established importance, the performance evaluation of MFIs is found to be a largely under-researched area (Gutiérrez-Nieto et al., 2007, Caudill et al., 2009). More particularly, within the academic literature, there is only a limited number of empirical works, focusing on the efficiency or productivity of these institutions (Nghiem et al., 2006, Bartual Sanfeliu et al., 2013). On the other hand, the studies conducted on impact assessment of the microfinance technique constitute an impressive body of literature (Samuel, 2009). A key motivation for conducting performance evaluation of MFIs thus stems from the need to address the gap identified in the literature.

Another key motivation for analysing the performance of MFIs is based on the challenges currently faced by a majority of MFIs; having direct repercussions for their dual performance objectives of providing finance to poor people; while also ensuring adequate levels of profitability. For example, many of the MFIs are reported to face problems related to double dipping[3] (McIntosh et al., 2005), decreased quality of loan portfolios, repayment issues, extremely high interest rates and reduced efficiencies (Assefa et al., 2013). It needs to be understood that many of the problems being faced by MFIs today are a natural outcome of the way in which this innovative development strategy has evolved over time. Microfinance initially started as a donor funded industry, focussed solely on the social objective of providing finance to poor people. After the initial start-up phase, the microfinance movement picked up momentum; resulting in enhanced efforts on a global scale for formalization of pro-poor finance under this new strategy. The last two decades of the twentieth century saw microfinance booming into a full fledge movement, with millions of dollars being invested by social investors, for achieving the goal of poverty alleviation through microfinance.

With the passage of time however, the microfinance industry has grown tremendously, necessitating huge amounts of funds that may not be forthcoming from the donor community. It is observed that a significant majority of the donor community is showing increasing reluctance to provide unconditional support for the cause of microfinancing; instead requiring evidence of satisfactory performance, as a pre-requisite for continued funding. The continual decrease in donor funding has resulted in a search for alternate sources of funds. Simultaneously, there has been an observed increase in the interest of the commercial institutions in provision of funding for microfinancing purposes. This interest of commercially oriented institutions is mainly a result of the attractive interest rates and very low default levels, characterizing microfinance products. Additionally, with the success of microfinance, the previously un-bankable poor people are no longer considered high risk; and thus offer a huge unexplored potential market for the commercial institutions.

[3] Double dipping refers to multiple borrowings by the same people.

While the entry of commercial players into microfinance arena has ensured the availability of much needed funds, it has also resulted in rising competition levels, which necessitate improved performance of MFIs. McIntosh et al. (2005) point out that many of the MFIs had been enjoying monopolistic power, before the advent of commercialization. Such monopolistic power is believed to lead to technical and allocative inefficiencies, resulting in welfare losses; as well as the absence of incentives to introduce diverse products, and make investment in more efficient technologies (Assefa et al., 2013). With increased commercialization and resulting competitive pressures, MFIs are now required to overcome such negative tendencies. In order to survive in this competitive environment in the long run, MFIs are thus required to lower their costs, increase operational efficiencies, maintain reasonable levels of interest rates, and improve their performance,.

In addition to forcing the MFIs to look for commercial sources of finance, the recent agenda of the donor community to reduce dependence of MFIs on donations and subsidies, has also resulted in mounting pressure on MFIs to increase their financial sustainability[4]. However, very few MFIs have been able to achieve the much desired financial sustainability, and thus continue to depend on subsidies for their continued existence (Tucker and Miles, 2004). In addition to the failure of majority of MFIs to achieve financial self-sufficiency, their performance on the outreach[5] front is also observed to be less than satisfactory. Even for the countries like Bangladesh, which is home to the pioneer microfinance organization (the Grameen Bank), many of the poor people are still relying on the money lenders, due to inadequate supply of finance from the microfinance sector (Mallick, 2012). Moreover, problematic microfinance policies

[4] This term is frequently used to refer to financial self-sufficiency of MFIs, however there is some controversy related to its meaning that is discussed in Chapter 2, section 2.6.

[5] The term outreach, within the microfinance context, is generally defined as the ability of the microfinance providers to serve a large number of poor people.

including tight repayment schedules are also forcing clients to turn to money lenders for arranging loan repayments, thus facilitating informal money lenders' survival even in the areas having large microfinance presence (Jain and Mansuri, 2003).

The observed inability of the majority of MFIs in achieving their social and financial performance objectives is considered to be a serious challenge (Dehem and Hudon, 2013), which offers a final impetus for the current study. Summing up, the aforementioned issues related to the performance of MFIs highlight the importance of undertaking further academic research in this area that can be helpful in providing useful insights and coming up with practical suggestions to deal with the above discussed issues.

1.3. Key Objectives

In view of the foregoing discussion, there are four main objectives of the current study.

Objective 1: To illustrate the application of the trade-off approach within the context of the performance evaluation of MFIs

A major objective of the current study is to demonstrate the application of the trade-off approach, proposed by Podinovski (2004b), for performance evaluation of MFIs. The trade-off approach works on the premise that by accurately assessing the relationships existing between different input and output variables, and using this knowledge for making simultaneous changes to these variables, it is possible to improve the standard DEA models in two major ways. Firstly, the incorporation of additional information based on technological realities, in the standard DEA models results in making these models better informed; as compared to the models that are run without application of this approach. Secondly, through incorporation of technologically realistic trade-offs, it is possible to work with small data sets; without being hampered by the problems of insufficient discrimination and the loss of technological meaning of efficiency.

For current study, there were originally a relatively small number of MFIs, for which complete data were available. Of these, some of the MFIs had to be dropped later on, due to some observed heterogeneity issues. Consequently, the final data set is rather small; particularly in comparison to the total number of input and output variables that needed to be included in the analysis, to capture the dual performance aspects of MFIs. Such small data set is bound to result in the problem of insufficient discrimination. However, through the application of the trade-off approach, it is not only possible to deal with the insufficient discrimination problem; but this also provides us with an opportunity to offer a detailed description of the procedure adopted for the identification and application of various trade-offs, applicable to the production technology in the microfinance industry.

Objective 2: To develop a framework for DEA based performance evaluation of MFIs, taking into account their double bottom-line nature

Double bottom-line is a frequently used term in the microfinance literature, which refers to MFIs' dual objectives of expanding outreach for alleviation of poverty; and achieving financial self-sufficiency, to ensure long term sustainability. This particular double bottom-line nature of MFIs distinguishes them from other types of institutions that have either a social or a commercial orientation. At the same time, these dual bottom-lines of MFIs complicate the task of evaluating the performance of these MFIs. This study thus conducts performance evaluation of MFIs, with a view to investigate how well these institutions are doing in achieving both their social and financial objectives.

However, to conduct such performance evaluation through the DEA methodology, a search of the relevant literature failed to identify a comprehensive framework that could guide the proposed evaluation. It is observed that the existing work in this field has been conducted by drawing upon the frameworks developed for other types of development and commercial financial institutions. For example, the framework proposed by Yaron (1994) for evaluating rural financial institutions, and the studies by (Gutiérrez-Nieto et al. (2007), 2009) are found to be useful in identification of different input and output variables for performance evaluation of MFIs on the social and financial fronts. Similarly, the decisions related to the specification of DEA models for performance evaluation of MFIs have been generally made by drawing on the general banking literature. To the best of our knowledge, there is no single framework that synthesizes the existing knowledge, to come up with a comprehensive set of guidelines; for measuring performance of this unique type of financial institutions, through the DEA technique.

This study thus aims to propose a conceptual framework that addresses this gap in knowledge and facilitates informed decisions related to various model specification issues in DEA.

Objective 3: To contribute towards the existing debate about the outreach versus financial sustainability of MFIs

An important debate, related to MFIs' dual objectives of achieving greater outreach and maintaining financial sustainability, is based on the contradictory views regarding whether or not it is possible for MFIs to achieve these two objectives simultaneously. It has been proposed that MFIs, having the major objective of outreach maximization, tend to rely on the continued use of donor funds and subsidies, while charging relatively low interest rates. Such MFIs are thus focussed primarily on reaching poorest of the poor, without much consideration for becoming financially sustainable. On the other hand, sustainability-oriented MFIs are more focussed on increasing their profitability. Towards this end, such MFIs generally end up charging high interest rates; even if in the process they have to focus on marginally less poor, instead of poorest of the poor (David and Mosley, 1996, Woller et al., 1999).

The persistent focus of researchers and practitioners on this debate[6] has instigated a series of studies that attempt to find the proof for the existence of either a conflict or compatibility between the dual objectives of MFIs (Christen et al., 1995, Paxton and Fruman, 1997, Rhyne, 1998, Navajas et al., 2000, Woller, 2000, Christen, 2001, Solomon et al., 2002, Navajas et al., 2003, Paxton, 2003, Olivares-Polanco, 2005, Cull et al., 2007, Bassem, 2009, Ejigu, 2009, Samuel, 2009, Hermes and Lensink, 2011, Hermes et al., 2011, Quayes, 2011, Abate et al., 2014). Interestingly, despite a large number of studies, this debate is still unsettled, as different studies on this topic have provided contradictory results.

Two possible reasons for the uncertainty surrounding this debate, are quoted to be the relative lack of empirical work and simple analyses used in most of the current work on this topic (Hermes and Lensink, 2007, Hermes et al., 2011); which provide another objective for the current study. We aim to contribute towards the efforts to address this gap in literature, by carrying out performance evaluation of MFIs in such a manner that helps shed some light on this debate. Undertaking research, for investigating the existence of either a conflict or compatibility, between the social and financial objectives of MFIs is also considered important, given the regular integration of microfinance into poverty alleviation strategies (Assefa et al., 2013). Although a comprehensive analysis of the outreach-sustainability dilemma is beyond the scope of this study; however, we investigate this issue to provide additional insights, while remaining within the limits of the current study.

[6] A more detailed discussion of this debate is provided in Chapter 2, section 2.6.2.

Objective 4: To conduct performance evaluation of a group of MFIs

The current study aims at illustrating the use of DEA methodology with incorporation of the trade-off approach, for measuring and comparing performance of MFIs. To this end, we undertake the performance evaluation of a selected group of MFIs, in order to come up with better insights related to the performance of these MFIs. We also aim to explore various factors having possible impact on the performance of the selected MFIs, as measured through their relative efficiency scores.

1.4. Research Questions

Based on the major objectives of the current study, we aim to answer the following research questions:

1. How can the novel trade-off approach be utilized for making the standard DEA models better informed and more discriminating?
2. What are the major considerations that need to be addressed for developing a DEA based framework, for analysing the double bottom-lines of MFIs?
3. What additional insights can be gained from results of the current study, regarding the compatibility versus conflict debate on social and financial objectives of MFIs?
4. In addition to these major questions, we also investigate some additional factors having possible influence on the performance of the selected MFIs, based on the efficiency scores obtained through the current analysis, such as

a. Is there any link between the efficiency scores of the MFIs and such institutional factors as; the age, productivity of loan officers, and size of MFIs?

b. Is there an association between the efficiency and the number and geographical spread of MFIs' branches?

c. Is there any difference between the performances of different sub groups of MFIs, included in the current data set (i.e. NGO-MFIs versus Non-NGO MFIs)?

1.5. Research Contribution

Based on the major objectives and questions of this research, the main contributions of the current study can be summarized as follows:

The first contribution of this study is an application of the trade-off approach to the performance evaluation of the MFIs, through the DEA technique. The trade-off approach offers an alternative to the traditional method of incorporating the weight restrictions in the multiplier model, without the accompanying disadvantages; generally associated with the weight restrictions approach. Through this novel application in the field of microfinance, we provide a practical illustration of how the standard DEA models can be enriched through the application of the trade-off approach. We are able to incorporate additional information to the standard DEA models, through identification of technologically realistic trade-offs, applicable to the production technology possessed by the group of selected MFIs. In the presence of such additional information, the resulting DEA models are shown to provide better insights related to the performance of MFIs, due to more accurately capturing the existing relationships between different variables that influence performance.

Through application of the trade-off approach, we also deal with the curse of dimensionality[7] that can result in insufficient discrimination of efficiency scores. Insufficient discrimination is a commonly observed phenomenon for DEA based studies involving small data sets. As illustrated by Podinovski (2004b), and also by the current study, the production possibility set (PPS) for the DEA models without any trade-off/s is only a subset of the PPS that is generated through a DEA model, restricted through incorporation of realistic trade-off/s. As a result of incorporating trade-offs, the original

[7] See section 3.10.1 in Chapter 3, for a detailed explanation.

technology expands so as to include new area, defined by the additional information incorporated into the standard models, thus leading to improved discrimination.

Although the theory underlying the trade-off approach has gained considerable recognition, the practical implementation of this approach remains an under-explored area at present. Through the current study, we have provided detailed illustration of the procedure followed for identification of different trade-offs that can offer guidance for others interested in finding similar trade-offs for other technologies. We have been able to identify and incorporate a number of technologically realistic trade-offs to the three DEA models proposed in the study. In addition, we have also proposed several possible trade-offs, which are not applicable to the current study, but might be applicable to other microfinance technologies. With reference to the numbers used for the trade-offs identified in the current study, we would like to point out that it is not necessary for the same exact numbers to be used by others, who are interested in conducting similar studies. While other researchers can use these numbers as a reference, they may need to modify or replace the proposed trade-offs (and the associated numbers) with ones that would seem more appropriate for the technologies being studied.

The second contribution of this study is linked to a gap identified in the literature, related to the lack of a specific framework for performance evaluation of MFIs, through the DEA technique. Towards this end, we conduct a comprehensive search of the literature and bring together a considerable body of relevant knowledge, in the form of a DEA based performance evaluation framework for MFIs. This framework goes beyond the simple act of putting together different pieces of information, and provides detailed discussion of some major considerations to be taken into account, during the DEA model specification process for MFIs' assessment. The framework also provides guidelines for selecting appropriate returns to scale (RTS) assumption and suitable objective functions while finalizing the DEA models. The proposed framework is thus a helpful tool for the diverse category of microfinance stakeholders in making informed decisions; while faced with the task of choosing among different alternatives to DEA model building process for evaluating MFIs' performance.

The proposed framework also lists and discusses a comprehensive set of variables to facilitate the procedure of selecting from alternative sets of variables, for inclusion in different models capable of capturing the double bottom-lines of MFIs, both individually and holistically. It is observed that most of the current studies in this area have tended to use different variables, representing the dual objectives of MFIs, in the same model. We follow the approach whereby separate models are used for individually capturing the different performance dimensions (Paradi et al., 2011). Based on the results of the study, we demonstrate that this approach can help in gaining some additional insights. Finally, through the proposed framework, we shift the focus of performance evaluation of MFIs from simple productivity to efficiency; which is considered to be a key component in ensuring achievement of sustainability and outreach objectives of MFIs.

The third contribution of the study is related to the insights gained about the debate focusing on the conflict or compatibility existing between the financial and social objectives of MFIs. Through analysing two separate models for capturing these two performance dimensions of the MFIs, we are able to make a tentative proposition that highlights the importance of taking into account the efficiency perspective, when analysing the conflict versus compatibility dilemma. It is also worth mentioning that although this is not the first study that undertakes performance evaluation of MFIs through the DEA technique, there are a number of aspects of the current study that distinguish it from other studies in the field, adding further worth to its contribution.

Firstly, this study uses data from a small group of MFIs working in a single country, Pakistan, which is a developing economy situated in South Asia. This is in contrast to the majority of studies on this topic, which have used large data sets from several different countries. Such large data sets, though resulting in good discrimination, are faced with the possibility of non-compliance with the basic assumption of homogeneity that needs to be observed in any DEA based study. It is therefore observed that studies using cross country data, tend to face heterogeneity issues, based on differences in such areas as; the accounting practices adopted, diverse tax and regulatory applications, and differences in the relative growth of various national economies. By focusing on a single country, we eliminate the possibility of such differences overshadowing the actual differences in the efficiency levels of the selected MFIs.

The second distinctive aspect of the current study is related to the fact that the selected country, Pakistan, is currently faced with a number of challenges including; high inflation rates, low growth, security and energy crises, and high poverty levels. At present, this country is in need of effective strategies, for improving the levels of quality of life for its huge poor population, which is not an easy task; given the fact that approximately 23 % of its total population of 180 million is living on less than $ 1.25 per day. Despite the obvious need, there is a notable lack of academic studies focusing on data from this particular country, even though this country is recognized as having a rapidly evolving microfinance sector. Therefore, by using data from the MFIs belonging to this particular country, we are able to provide some useful information related to the performance of its microfinance industry.

Through our focus on an under-researched developing economy, we are also able to contribute to the existing literature, by providing additional insights about some of the factors influencing the performance of MFIs working in the developing economies.

However, it does not imply that the insights obtained from the current study are limited to developing economies only. To the contrary, it has been observed that the information gathered from studies based on poor developing countries, can also be useful for addressing poverty related problems being faced by the more developed economies (Milana and Ashta, 2012).

1.6. Dissertation Structure

This dissertation is organized into eight key chapters. Chapter 1 provides an introduction of the microfinance methodology and establishes the importance of undertaking performance evaluation of MFIs; while providing an overview of the challenges faced by MFIs, in achieving their social and financial performance objectives. This chapter also highlights the key motivations, major objectives, research questions and contributions of the current study.

Chapter 2 reviews the existing literature on the microfinance movement, starting with the origin and major impacts of this unique development tool, and moving on to the importance of the performance evaluation of MFIs. A focal point of this chapter is the debate related to the social and the financial dimensions of the MFIs' performance. Finally a discussion of the rationale for selection of the DEA methodology as an appropriate tool for evaluating MFIs' performance and the need for developing a comprehensive framework for this purpose is provided.

Chapter 3 reviews the DEA methodology. The basic concepts and general formulations, along with the relevant graphical illustrations are provided. This chapter also offers a review of the weight restrictions approach, based on its particular relevance for the major objective of the current study, relating to application of the trade-off approach. Major theoretical and methodological underpinnings of the trade-off approach, as well as the rationale for application of this approach are explained.

Chapter 4 provides a detailed discussion of the framework proposed for undertaking performance evaluation of MFIs, through the DEA methodology. The importance of considering the efficiency perspective for performance assessment of MFIs, as well as the relevance of the debate related to the conflict versus compatibility between the social and financial performance objectives of MFIs, is discussed. Particular emphasis is placed on providing detailed explanation of the major considerations that need to be taken into account, when finalizing the DEA models for performance evaluation of MFIs.

Chapter 5 explains the procedure adopted for the sample selection and data collection for the current study. The significance of using data from a single country, as well as the relevance of the particular sample for the objectives of the research, is elaborated. After this, three DEA models are proposed for evaluating the financial, social and double bottom-lines of the selected MFIs; while taking into account the major considerations for DEA model specification, as highlighted in the previous chapter. The rationale for choosing underlying orientation, appropriate returns to scale (RTS) assumption, and discussion of the input and output variables selected for the three DEA models is also provided.

Chapter 6 starts with a review of the key motivations for the application of the trade-off approach for performance evaluation of MFIs through DEA approach. Detailed illustration of the procedure adopted for identification of technologically realistic trade-offs, the trade-offs identified for current data set and relevant mathematical formulations are provided. Finally, some additional trade-offs are discussed, which although not applicable in the current study, can be useful for future studies involving different data sets.

Chapter 7 provides computational results obtained from application of the trade-offs identified for the three DEA models proposed in Chapter 5. The initial analysis, focusing on the results obtained from the restricted and the unrestricted DEA models, is followed by an examination of the changes in efficiency scores, resulting from sequential application of different trade-offs. Subsequently, benchmarks for the inefficient MFIs are identified for all three DEA models, and findings of the current study, with reference to the debate related to the conflict versus compatibility of dual objective of MFIs, are summed up. The chapter ends with an investigation of some additional aspects related to MFIs' performance, in view of the existing evidence available from the performance evaluation literature.

Chapter 8 starts with a summary of research, which is followed by a review of the main findings and conclusions, based on the empirical results obtained from the DEA models after application of the trade-off approach. Finally, some directions for future research are provided.

Chapter 2 A Review of the Microfinance Literature

2.1. Introduction

This chapter provides a review of the microfinance literature, starting with an introduction of microfinance and the back drop in which the current microfinance revolution took flight. An overview of one of the most extensively researched aspect of this technique, i.e. the impacts of microfinance, is presented next. The need for evaluating MFIs' performance and the relevance of the sustainability-outreach dimensions for such evaluation are discussed in detail, along with an explanation of the much discussed conflict versus compatibility dilemma. After this, the factors underscoring the suitability of DEA as an effective tool for performance assessment of MFIs, and some limitations observed for the existing DEA based studies in this area are discussed. Finally, the need for developing a comprehensive framework, for guiding the performance evaluation of MFIs through the DEA technique is elaborated.

2.2. Microfinance: Meaning and Importance

Microfinance refers to the provision of various financial services including small loans (or micro credits), deposits, money transfers, insurance and payment services to poor households and microenterprises (Asian Development Bank, 2000, Bolli and Vo Thi, 2012). In addition, some non-financial services may also be provided through microfinancing activity such as; marketing and skills training, health care, and financial and literacy training (Ledgerwood, 1999). Although the terms microcredit and microfinance are used sometimes interchangeably in literature, it is useful to make a distinction between these two terms. While microcredit refers to issuance of small loans to poor people, microfinance is a broader term that encompasses a number of related services, in addition to provision of micro credits[8].

It is observed that microfinance helps unleash the productivity of poor people, through enabling them to engage in various economic activities that help enhance both their income and self-confidence (Robinson, 2001). It is recognized as a powerful instrument that can help poor people move out of poverty through provision of financial capital (micro credits and other financial services), human capital (vocational and educational training) and social capital[9] (Otero, 1999).

2.3. The Microfinance Movement

2.3.1. Backdrop – Financial Exclusion of Poor People

Microfinance is an innovative development tool that has been introduced to help deal with the problem of financial exclusion faced by poor people around the world. Provision of credit to poor has been a challenging task since the beginning of financial sector evolution. Low income people, who are unable to provide suitable collateral, are generally denied access to financial services through conventional financial sector (Piot-Lepetit and Nzongang, 2014). Information asymmetries, high transaction costs, lack of adequate collateral, and risks associated with the pro poor lending practices are cited as major reasons for the financial exclusion of poor from the formal financial sector (Stiglitz and Weiss, 1981, Coleman, 2006, Armendáriz de Aghion and Morduch, 2010). Other obstacles faced by the poor in accessing finance include high interest rates, and

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[8] For more conceptual differences between microfinance and micro credits, see ELAHI, K. Q.-I. & RAHMAN, M. L. 2006. Micro-credit and micro-finance: Functional and conceptual differences. *Development in Practice,* 16**,** 476-483.

[9] Social capital is defined as a set of social relations and norms that can help people in coordinating their actions and achieving desired goals. NARAYAN, D. 1999. Bonds and bridges: Social capital and poverty. Washington, D.C.: Poverty Group, World Bank.

relatively long and complicated admissions and application procedures (Jones et al., 2007, Hamada, 2010).

This is not to say that there has been a complete dearth of efforts, before introduction of the microfinance technique, to help poor people in getting much needed finance. To the contrary, provision of subsidized credit aimed at poverty alleviation has a long history. There were a number of development strategies that had been implemented from 1950's to 1980's to facilitate provision of the pro poor finance. While the main focus of all such traditional strategies was to help the resource-constrained poor people, the actual implementation vehicles took different forms such as; government owned and operated institutions, agricultural and cooperative banks, commercial institutions encouraged by governments to participate in special financing schemes, and various other types of development financial institutions.

Unfortunately, most of these earlier schemes failed to achieve their desired objectives and many ended in complete disasters. Major problems that have been identified in relation to the failure of such schemes include: low repayment rates, accelerated costs of subsidies and politicization issues. These problems also led to the practice of benefiting more influential people, instead of the real poor, for whom these schemes were originally designed (Adams et al., 1984). Another factor contributing towards the failure of such financial interventions was related to slow policies of local governments for introducing reforms, resulting in obstruction of growth (Milana and Ashta, 2012). It was in this background, that the concept of microfinance was first put into practice, as a novel way of providing finance to poor people.

2.3.2. Origin of the Microfinance Movement

The origin of the so called modern microfinance movement is generally traced to the well-known Grameen Foundation, and its founder Dr Muhammad Yunus from Bangladesh[10]. The idea of helping poor through this innovative approach was conceived in 1970s, when Dr Muhammad Yunus started providing small, collateral free loans to poor women, facing financial exclusion. Encouraged by high repayment rates of these loans, Dr Yunus founded an organization, specializing in pro-poor financing that is today known as the Grameen Bank.

The lending model of Grameen Bank[11] was originally based on group lending methodology, and this model is considered to be the pioneer in provision of collateral free loans to the poor (Tassel, 2000). With repayment rates of Grameen Bank being more than 95%, poor were finally seen as a bankable and credit worthy population segment that was previously ignored by the formal financial sector, based on the perceived high credit risks and transaction costs associated with lending to the poor (Siwar and Talib, 2001). The astounding success of Grameen Bank led to the replication of this model worldwide[12], with nearly 7000 MFIs established in Asia, Africa, and Latin America (Chemin, 2008). In addition to the Grameen Model, many other microfinance models have been developed; introducing different innovations, in line with the diverse contextual requirements in various countries. Some well-known examples of such models include: the village banking model, rotating savings and credit associations, banking models, and credit union models, to name a few.

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[10] Bangladesh is a highly populated South Asian country, with nearly half of its population living on less than $1 a day.

[11] For a detailed account of the original Grameen Model, refer to HULME, D. 2008. The story of Grameen Bank: From subsidized microcredit to market-based microfinance. *BWPI Working Paper*. Brooks World Poverty Institute.

[12] Some examples include: The First's People's Fund in Canada, Kashaf Organization in Pakistan, Micro Credit Rainbow in Italy, and Micro Business International in USA.

After recognition of the microfinance methodology as an effective development strategy, there came an era of unprecedented growth, with financial support and subsidies provided through various channels including; international development agencies, governmental organizations, philanthropists, large commercial institutions and non-government organizations (Koveos and Randhawa, 2004). A major milestone in the history of microfinance movement can be traced to the establishment of the Consultative Group to Assist the Poor (CGAP[13]) in 1995. CGAP aims to facilitate access of poor people to various financial and non-financial services, primarily through capitalizing on success of microfinance in this endeavour. Some other landmark events include: the launch of a global movement for reaching 100 million poorest families by the year 2005 (The Microcredit Summit Campaign, 1997), inclusion of microfinance in development strategies selected in G8's action plan in 2004 summit, and declaring year 2005 as "the year of microfinance" by the United Nations.

The effectiveness of microfinance as a development tool was further substantiated with establishment of the Global Commercial Microfinance Consortium in 2005. The award of Nobel Peace Prize to Dr. Mohammad Yunus and his organization, for introducing an innovative approach for poverty alleviation through Grameen Bank model, could be seen as yet another momentous event. In 2006, Microcredit Summit meeting took place at Halifax, for celebrating the successful achievement of reaching target poor population of 100 million. Summing up the discussion, it can be observed that the microfinance concept has been hugely successful, with an average asset growth rate of nearly 39% per annum during the period 2004-2008 (Chen et al., 2012); while catering to the financial requirements of approximately 205 million poor people around the globe, by the year 2010 (Maes and Reed, 2012).

[13] CGAP is a consortium of private and public agencies that has been established with support from the World Bank.

2.4. Literature on the Impacts of Microfinance

The last two decades have seen a proliferation of academic studies in the microfinance field. Academic interest in this field initially focussed, almost exclusively, on assessing various impacts of microfinancing activities. Impact is generally defined as the extent up to which the welfare levels are increased for the poor people using microfinance products and services (Conning, 1999). According to the 'critical triangle of microfinance', proposed by Zeller and Meyer (2002), impact is one of the three basic objectives of microfinance; the other two objectives being financial sustainability and helping poor people through expanding outreach[14].

Several positive impacts of microfinancing on the lives of poor clients have been reported by a number of impact assessment studies. The first most important impact of microfinance is reported to be poverty alleviation (Mosley and Hulme, 1998, Mosley, 2001). In addition, assessment studies have been able to report several other related benefits, such as: employment creation, growth and diversification of existing businesses, and also establishment of new businesses (Ledgerwood, 1999). Development of microenterprises has been considered a particularly beneficial outcome of microfinancing for the developing economies, given the role played by microenterprises, in creation of new jobs and in fostering the economic growth (Piot-Lepetit and Nzongang, 2014).

Although microfinance is not exclusively designed for poor women[15], yet women have been predominantly considered as the key target clientele; for a large majority of microfinance programs. A major motivation for this practice arises from the high repayment rates, associated with the female clients (Boehe and Barin Cruz, 2013).

[14] Refer to section 2.6 of this chapter for a detailed discussion of outreach and sustainability aspects of MFIs' performance.

[15] For a discussion of costs and benefits of microfinance services from a gender based perspective, refer to KHANDKER, S. R. 1998. Micro-credit programme evaluation: A critical review. *IDS Bulletin*, 29**,** 11-20.

Evidence of decreased portfolio risk and lesser write-offs also support the belief that females are relatively better clients; from the perspective of reducing credit risk (D'Espallier et al., 2011). Loans disbursed to females are reported to result in a number of desirable outcomes, such as: women empowerment (Vetrivel and Chandrakumaramangalan, 2010, D'Espallier et al., 2011, Akpalu et al., 2012, Ngo and Wahhaj, 2012), increased levels of income, acquisition of more household and productive assets (Garikipati, 2008, Garikipati, 2012, Haile et al., 2012), and facilitating the growth of small and medium enterprises, owned by women (Osa Ouma and Rambo, 2013).

Impact assessment studies conducted over the years have also analysed the positive impact of microfinance on such factors as: the improvement in per capita expenditures, labour supply, and school enrolment levels (Pitt and Khandker, 1998, Chemin, 2008), assets acquisition (Kaboski and Townsend, 2005), more earnings and better contribution to the household expenses (Solomon et al., 2002), occupational mobility, lesser reliance on the moneylenders, and consumption smoothing (Kaboski and Townsend, 2005). In a recent study, the impact of microfinance membership has been found to be both positive and significant on life satisfaction of the microfinance users (Becchetti and Conzo, 2013). Microfinance organizations are hence reported to be instrumental in providing much more than pecuniary benefits to their clients.

In addition to the positive impacts of microfinance, there are also studies offering certain criticisms, generally relating to inability of MFIs to meet their desired objectives. For example, some of the reported criticisms include: incidences of domestic violence and intimidation of female clients (Goetz and Gupta, 1996), increased indebtedness of poor clients (Dichter, 1997, Johnson and Rogaly, 1997), non-suitability of microfinance for the poorest and most illiterate (Khandker, 1998, Gutierrez-Nieto, 2006), and the problems related to loan repayments leading to clients' suicides (Hulme, 2007).

Concluding the findings of the microfinance literature, related to various positive and negative impacts of microfinance; we note that despite the prevailing wave of scepticism, the total volume of studies reflecting positively on this development technique is growing more steadily; as compared to the studies reporting less than optimal outcomes. Taking into consideration the foregoing discussion, it may also be more reasonable to identify with the claim made by Milana and Ashta (2012) that despite various criticisms, problems and examples of malpractices; microfinance is still seen as a viable development strategy, that is here to stay. What needs to be done is to undertake further research, in all such areas that have been criticized, so as to find innovative solutions and make positive recommendations. This in turn can be helpful in overcoming the limitations and problems, highlighted with respect to this promising development tool.

2.5. Performance Evaluation of MFIs: A Milieu for the Current Study

With reference to the challenges faced by microfinance, a review of literature reveals a number of issues, related to the social (outreach) and financial (sustainability) objectives of MFIs' performance, that point out the need for rigorous research in certain areas. Some of the more frequently cited problems include: failure of the socially oriented MFIs to be free of subsidies, tendency of the profit oriented MFIs to ignore poorest of the poor (Samuel, 2009), and the inability of the microfinance industry to reach a significant majority of poor people, more quickly and efficiently (Ejigu, 2009). In addition, a review of the microfinance literature also reveals the existence of mounting pressure on MFIs to achieve financial sustainability. This recent shift towards having more commercialized and financially sustainable MFIs has resulted in several performance related problems, such as: increase in double dipping or multiple loans by the same borrowers (McIntosh et al., 2005), excessive interest rates, decrease in quality of loan portfolios, reduced monitoring to control costs, repayment problems, and inefficiencies associated with the performance of many MFIs (Assefa et al., 2013).

However, despite the recognized importance of MFIs’ performance assessment, this area is still reported to be mainly under-researched, with only a few empirical works focusing on efficiency and productivity of MFIs (Nghiem et al., 2006, Gutiérrez-Nieto et al., 2007, Caudill et al., 2009, Bartual Sanfeliu et al., 2013). The observation about inadequate research on performance related issues for MFIs is more relevant for the academic literature in this area. Microfinance practitioners and international agencies directly involved with microfinance, on the other hand, seem to have realized the importance of MFIs’ performance evaluation quite early on. As a result, one can find a number of studies conducted by various international agencies[16] and practitioners aiming to assess performance of MFIs. In comparison, the academic community has remained focussed on impact assessment studies for a longer period and mostly ignored this important area of research. This late arrival of the academic community, into the realm of analysing the performance of MFIs, leaves a number of performance related issues in need of more rigorous academic research.

In view of the forgoing discussion, a need for further academic research is identified that targets the issues related to institutional efficiency in achieving social and financial objectives of MFIs. The current study therefore aims to undertake the performance evaluation of MFIs, while taking into account their dual objectives of financial sustainability and outreach. Evaluating this double bottom-line necessitates a detailed

[16] A few examples include studies routinely conducted by World Bank, The United States Agency for International Development (USAID), Consultative Group to Assist the Poor (CGAP), Asian Development Bank (ADB), and ACCION International.

exploration of the sustainability-outreach dilemma, which is an area of intense debate in the microfinance literature.

2.6. Sustainability and Outreach Aspects of MFIs' Performance

The sustainability and outreach aspects have been recognized as two major yardsticks, by which the performance of microfinance programmes can be evaluated (Chaves and Gonzalez-Vega, 1996, Arsyad, 2005). Diverse views, about the ability of MFIs to achieve these two seemingly contradictory objectives, have led to an important debate that has dominated the microfinance literature for the past many years.

Before initiating a detailed discussion of the sustainability-outreach debate, it would be pertinent to point out that this debate is a natural offshoot of the way in which microfinance methodology has evolved over the last three decades. It can be noted that during the early stages of its growth, the microfinance movement depended almost exclusively on the donor funds and possessed a social orientation; based on its mission of reaching maximum number of poor people. Now, this industry is in its fourth decade of operations, and is currently facing rising concerns about the financial self-sufficiency of the subsidized MFIs. The significant reduction in the funding, made available through the donor community, has also acted as a catalyst for these concerns. Due to the relevance of sustainability-outreach debate for the proposed evaluation of the MFIs in the current study, a detailed discussion of major aspects of this debate is provided hereafter.

Starting with the definition of the two basic terms, the term sustainability is generally used to refer to the ability of an MFI; to recover its costs, earn adequate amounts of profit and survive without having to rely for long, on subsidized credits and/or donor funding (Siwar and Talib, 2001). The term outreach, within the microfinance context, is typically explained in terms of the ability of microfinance organizations to reach poor clients with various products and services. There are two major outreach aspects; reaching a large number of clients, and reaching poorest of the poor clients[17]. Using microfinance jargon; the former is generally referred to as the outreach breadth, while the latter is known as outreach depth (Conning, 1999).

In addition to these two more common aspects of outreach, Schreiner (2002) proposes an outreach framework that encompasses four additional outreach aspects, namely: outreach worth (willingness of the clients to pay), outreach cost (the sum of price and transaction costs)[18], outreach length (the time frame designated for supply of microfinance) and outreach scope (the number of different types of financial contracts offered to the clients of MFIs).

2.6.1. Major Approaches Underlying the Sustainability-Outreach Debate

There are two main approaches that are central to the unsettled debate about the sustainability and outreach of MFIs, namely; poverty lending approach and financial systems approach. Microfinance literature identifies two schools of thought behind these approaches that are commonly known as the welfarist and the institutionist schools of thought. The rift between these two schools of thought is known as the microfinance schism (Morduch, 2000).

2.6.1.1. The Poverty Lending Approach

The welfarist school of thought puts forward the poverty lending approach that advocates targeting of the poorest of the poor, rather than reaching a large number of relatively less poor people. In other words, outreach depth is considered more important

[17] Other terms used in the literature to refer to poorest of the poor include the core poor, the extremely poor, and very poor.

[18] Price costs include interest and fee payments that constitute revenue for microfinance organizations. Transaction costs, on the other hand, include non-cash opportunity costs and indirect cash expenses incurred by clients and such expenses do not contribute towards revenue generation by microfinance organizations.

than the breadth of outreach, under this approach. While the welfarist group does not negate the importance of financial gains, nevertheless it opposes sacrificing outreach depth for achieving financial gains (Brau and Woller, 2004).

Under poverty lending approach, sustainability refers to permanence, which is not dependent on financial self-sufficiency. A resulting implication is that MFIs can be sustainable, even with continued reliance on subsidised funding (Woller et al., 1999). It needs to be pointed out that this assertion by the welfarists is based on an altogether different meaning of sustainability, than the more generally used definition; provided at the beginning of this section. The welfarists normally make use of a definition of sustainability, proposed by Brinkerhoff (1996). According to this definition, sustainability refers to a program's ability to produce such outputs that offer sufficient satisfaction and value to various stakeholders and beneficiaries; so that adequate amounts of resources are made available for continuation of the program by satisfied stakeholders. This definition thus removes the pressure on microfinance organizations to become financially self-sufficient.

A major issue faced by the welfarist group is the increasing pressure to reduce dependence of MFIs on subsidies and grants. The subsidy dependence of MFIs is reported to be responsible for fostering lax management and reducing efficiency (Hamada, 2010). Lack of rigorous practices for managing portfolio risks by subsidy dependent MFIs, is also known to be responsible for delinquency issues and to jeopardize the operations of such MFIs in the long term (Annim, 2012). Welfarists, however, argue that elimination of subsidies and too much focus on cost recovery and financial self-sufficiency would result in exclusion of the core poor from the portfolios of MFIs, due to higher costs and difficulty of reaching such clientele (David and Mosley, 1996, Weiss and Montgomery, 2005, Assefa et al., 2013). The exclusion of core poor from the portfolios of MFIs, to ensure greater profitability, is generally known as the 'mission drift' phenomenon; which is a widely studied trend within the microfinance literature. See for example; David and Mosley (1996), Copestake (2007a), Copestake (2007b), Hishigsuren (2007), (Chahine and Tannir (2010), Mersland and Strøm (2010)), Kar (2012), and Serrano-Cinca and Gutiérrez-Nieto (2014).

A final observation about poverty lending approach is that, the proponents of this approach actively seek to analyse the impact created through microfinance, on welfare levels of poor. As a result, a large number of impact assessment studies have been undertaken by welfarist, that aim to investigate how well MFIs have been able to improve lives of poor clients in terms of social, political and economic indicators of poverty (Ejigu, 2009). In general, such studies tend to measure success of an MFI primarily on the basis of social metrics, rather than profitability or financial gains.

2.6.1.2. The Financial Systems Approach

Under the financial systems approach, put forward by the institutionist school of thought, achieving sustainability should be a major objective of MFIs[19]. According to this approach, sustainability is a crucial pre-requisite; not only for ensuring institutional permanence, but also for greater focus and efficiency of lending institutions (Ledgerwood, 1999). Financial self-sufficiency is reported to be the major route to ensure long term sustainability of MFIs, under the financial systems approach (Otero, 2006).

Achieving high levels of profitability is an essential element of the financial systems approach that generally results in charging high interest rates[20]. While the welfarist group exhibits strong concerns for possible exclusion of core poor, due to their inability

[19] Note that from the point of view of institutionists, sustainability refers to financial sustainability.

[20] High interest rates charged by sustainability oriented MFIs have resulted in a parallel stream of literature, highlighting various interest related issues. A detailed review of these studies is not provided here, because such discussion is not considered pivotal for current study.

to pay very high interest rates; the institutionist argue that such high interest rates are essential, due to greater default risk and higher operating costs incurred by MFIs (Roberts, 2013). The institutionists also believe that due to a considerable decrease in the amount of funds available from the donor community, MFIs are under immense pressure to explore additional sources of funds. High interest rates can lead to more profitable MFIs, which can be in a better position to attract more commercial investment; thus facilitating accumulation of necessary funds, to carry on business operations (Roberts, 2013).

Finally, the institutionists surmise that sustainability-oriented MFIs may be scoring low, in terms of attaining outreach depth in the short term; but they could ultimately be in a superior position to achieve the goals of poverty alleviation (Hermes and Lensink, 2007). This reasoning is partly based on the premise that with enhanced financial sustainability, MFIs will eventually be able to cross-subsidize[21] their loans effectively, and thus achieve better outreach in the longer term. On the other hand, the institutions characterized by poorly managed cost structures and operational inefficiencies, as is generally believed to be the case for most subsidy dependent MFIs, may be unable to pursue outreach maximization in the long run. The institutionist therefore claim that MFIs that achieve self-sufficiency and scale economies have greater potential for achieving goals of poverty alleviation (Paxton, 2003). Another underlying assumption is that such MFIs can contribute more towards improvement of economic conditions at a macro level, thus helping more poor in the long term than outreach oriented MFIs (Rosengard, 2004, Zeller and Johannsen, 2008).

It is also observed that assessment of MFIs' performance, from the viewpoint of financial systems approach, tends to be focussed more on financial sustainability and

[21] Cross subsidization refers to the practice of subsidizing prices for one group of customers by charging higher prices to another.

efficiency in achieving outreach breadth, than exploring how profoundly the provision of microfinancing services has impacted the welfare levels of MFIs’ clients.

Some of the major differences, observed for the poverty lending and the financial systems approach, are summarized in Table 2.1.

Table 2. 1 A Comparison of Financial Systems and Poverty Lending Approaches

	Financial Systems Approach	**Poverty Lending Approach**
School of Thought	Institutionist	Welfarist
Primary objective	Achievement of sustainability via financial self-sufficiency and outreach breadth	Achievement of poverty alleviation goal through outreach depth
Basic assumption	Better to assist a larger number of relatively less poor for a longer time	Better to assist a smaller number of core poor for a shorter time
Types of organizations	Commercial e.g. Banks	Social e.g. NGOs
Primary sources of funds	Commercial and self-generated funds through cost recoveries and profit generation	Grants and subsidized funds available from the donor community
Target clients	Relatively less poor	Poorest of the poor
Major assessment criteria	Focus on institution Breadth of outreach Levels of financial self-sufficiency	Focus on clients Depth of outreach Welfare levels of clients
Challenges	Exclusion of core poor High interest rates Increased default rates	Inefficiency High operating costs Delinquency issues

Source: Made by researcher based on a review of literature

The on-going debate about the sustainability and outreach objectives of MFIs gives rise to several important questions, some of which have a particular relevance for the current study. A few major questions are:

- Should microfinance sector continue to depend on donors and subsidized funds for provision of pro-poor finance?
- Should there be enhanced efforts to become independent of donations and subsidies, by more vigorously committing to achieve financial self-sufficiency?
- What could be the possible implications, of adopting either of the aforementioned approaches, for MFIs and their clients?
- Is there really a tension between the social and financial performance objectives of MFIs? If yes then,
- Is there a way to resolve the tension between these conflicting objectives?
- How can microfinance institutions simultaneously achieve their major objectives of greater outreach and financial sustainability?

It needs to be emphasized that the key premise for highlighting these questions is more of an exploratory nature, so as to acknowledge various issues related to this prominent debate in the microfinance literature. It would be an over-optimistic claim that by conducting performance evaluation of MFIs through the current study, we would be in a position to provide satisfactory answers to all of the above mentioned questions. Although, based on the scope of the current study, it is not our intention to look for precise answers to all these question, however, we do hope to be able to address some of the concerns related to the MFIs' performance and the dilemma reported frequently for the social and financial objectives of MFIs.

2.6.2. Conflict versus Compatibility of Outreach and Sustainability Objectives

The sustainability-outreach paradox has led to a prominent debate in the microfinance literature that focuses on the possible conflict[22] versus compatibility, between the outreach and sustainability objectives of MFIs. Considering the relevance of the outreach and sustainability objectives for performance evaluation of MFIs, we now turn to a discussion of some key aspects, related to the conflict versus compatibility debate.

The proposition of a conflict between the dual objectives of MFIs implies that institutions performing well on criterion of financial sustainability cannot perform well on the outreach front. Similarly, institutions achieving better outreach are believed to be under-performers in terms of financial sustainability; thus necessitating continued dependence on subsidized funds for their existence. Compatibility, on the other hand, refers to the notion that objectives of achieving financial sustainability and outreach can be simultaneously achieved by MFIs. A possible explanation of the compatibility between the two seemingly contradictory objectives of MFIs has been provided by Manos and Yaron (2009). According to them, the MFIs serving the very poor clients have greater motivation to design innovative operating methodologies that can help reduce their costs; therefore, such MFIs are able to become profitable, despite the increase in levels of outreach depth attained by these MFIs. The compatibility proposition is also known as the win-win proposition in the microfinance literature, based on the premise that by targeting both sustainability and outreach, there can be a

[22] In the microfinance literature, the term 'trade-off' is more frequently used instead of 'conflict'. However, in the current study we also undertake an application of the 'trade-off' approach, which has an entirely different meaning than the term 'trade-off' used in the context of the dual objectives of MFIs. To avoid any confusion, therefore, we have used the term 'trade-off' in this study, only when referring to the 'trade-off' approach.

“win-win” situation for both the institutionist and the welfarist groups (Hulme, 2000, Luzzi and Weber, 2006).

The debate about existence of a conflict or compatibility between MFIs’ sustainability and outreach is still unsettled, as different studies on this topic have offered conflicting results. There are many studies that have come up with the evidence to support existence of a conflict between MFIs’ objectives of attaining financial sustainability and outreach (Navajas et al., 2000, Solomon et al., 2002, Navajas et al., 2003, Olivares-Polanco, 2005, Cull et al., 2007, Bassem, 2009, Ejigu, 2009, Samuel, 2009, Hermes and Lensink, 2011, Hermes et al., 2011). On the other hand, there are also studies confirming the existing of compatibility between the outreach and sustainability objectives of MFIs (Christen et al., 1995, Paxton and Fruman, 1997, Rhyne, 1998, Woller, 2000, Christen, 2001, Paxton, 2003, Quayes, 2011, Abate et al., 2014).

Major findings of the aforementioned studies, related to the conflict-compatibility debate, are visually encapsulated in the following diagram.

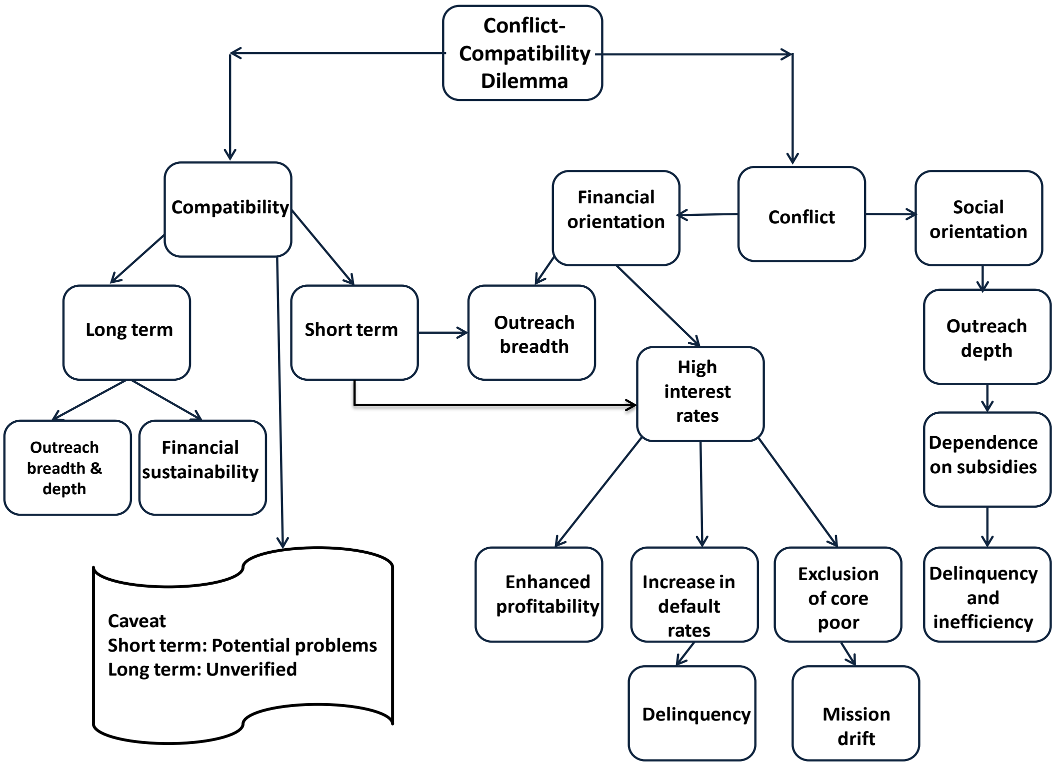

Figure 2. 1 Compatibility versus Conflict Dilemma for Dual Objectives of MFIs

Source: Made by researcher based on literature review

Based upon major findings of the existing microfinance literature (as depicted in Figure 2.1), it would be reasonable to suggest that so far, the conflict versus compatibility debate, related to outreach and sustainability objectives of MFIs, remains unsettled. If the proposition of a conflict is considered to be correct, then it means either the institution or its clients (or maybe both) are going to suffer. On the other hand, if we accept the compatibility proposition; the short term vision is marred with the same problems as the conflict dilemma, i.e. outreach breadth implies lack of outreach depth, and profitability means high interest rates that may lead to delinquency issues. The long term perspective does hold some appeal, and is also supported by some evidence, see e.g. Manos et al. (2013). However, this view is mostly based on theoretical justification and has not been extensively verified at present, thus leaving the door open for continued debate on this topic.

In view of the forgoing discussion, we surmise that current research is still unable to provide any definite solutions to different issues that arise from the on-going debate about the compatibility versus conflict between sustainability and outreach dimensions of MFIs' performance. Two possible reasons, for uncertainty surrounding this debate, are quoted to be the relative lack of empirical work and simple analyses, in most of the current work on this topic (Hermes and Lensink, 2007, Hermes et al., 2011), which provide another motivation for current study. We intend to contribute to existing literature by undertaking empirical evaluation of MFIs' performance, for coming up with possible additional insights.

2.7. Technique Selected for the Current Study

It is a well-known fact in microfinance literature that ratio analysis remains the most commonly used technique for performance evaluation of MFIs (Gutiérrez-Nieto et al., 2007, Bartual Sanfeliu et al., 2013). However, for current study, we propose the use of DEA methodology which has the potential to capture the double bottom-line nature of MFIs more effectively.

2.7.1. Reasons for Selection of DEA

It can be reasonably argued that DEA possesses a certain edge over other commonly used techniques, such as ratio and regression analysis, for performance evaluation of MFIs. In addition to the fact, that a key objective of the current study, related to application of the trade-off approach, necessitate the use of DEA; there are several other desirable characteristics of this technique, that make it particularly suitable for the proposed performance evaluation. A detailed discussion of some of these characteristics is provided hereafter.

First of all, an important advantage of the DEA technique is its ability to integrate all potential interrelationships among various factors of production, because it can incorporate multiple inputs and outputs simultaneously in the efficiency analysis (Balkenhol, 2007). Ratio analysis, on the other hand, is unable to capture the multi-dimensional aspects of the production process (Schaffnit et al., 1997). Therefore, a firm showing less than exemplary performance based on individual ratios, may be considered a good performer in a DEA context; where its overall performance is being considered through simultaneous incorporation of all the input and output variables (Thanassoulis et al., 1996). This ability of DEA makes it more suitable than traditional performance ratios, as various MFIs despite using diverse input-output mixes may still be efficient, provided they are using their resources efficiently (Hassan and Sanchez, 2009).

DEA can also help in setting targets because it can simultaneously take into account all the resources being utilized and the outputs being produced, while performing efficiency analysis. Ratio analysis, on the other hand, is unable to identify performance targets, to facilitate efficiency improvement of inefficient units. This is because ratio analysis can only relate one input to a single output at one time. However, ratio analysis is found to be useful in enhancing target setting process, if used in conjunction with DEA (Thanassoulis et al., 1996).

It is observed that DEA and other commonly used statistical techniques including regression and correlation differ in that latter tend to draw inferences from optimizing (i.e. averaging) over all the observations in the data set; whereas former obtains inferences from optimal solutions, obtained for each observation (Charnes et al., 1985). Therefore, DEA makes it possible to compare each DMU’s performance with an ideal, rather than average performance. In DEA, the relative efficiency of each firm is calculated by comparing it to the best performance levels, actually observed for the firms included in the analysis. Such comparison with the best possible performance, based on real time data, is thus considered much more desirable than comparisons with some predetermined performance targets (El-Mahgary and Lahdelma, 1995), or with some statistical averages, which in reality may not be practically applicable to the firms being assessed (Ahn et al., 1988, Avkiran, 2001).

The possibility of using physical rather than monetary measures of inputs and outputs in DEA based analysis, without recourse to costs and prices of these variables, also makes DEA very useful. This is an important quality because inflationary pressures, cost accounting methods and differences in prices across different regions can potentially bias the results, if only monetary measures of these variables are used (Sherman, 1984). Another desirable characteristic of DEA is that it does not require determination of relative importance of different inputs and outputs, as linear programming can be used for determining the weights of all such variables. DEA is also well-known for its ability to offer additional insights that may not be available through other analytical techniques. For example DEA can provide information about reference groups and benchmarks, estimates of amounts and sources of inefficiency (Charnes and Cooper, 1985, Charnes et al., 1985), as well as the measures of possible output augmentation and/or resources conservation (Boussofiane et al., 1991).

The ability of DEA to provide additional information makes it suitable to be used in conjunction with other commonly used statistical techniques. For example, using data obtained from oil and gas industry, Feroz et al. (2003) use statistical testing and demonstrate that Data Envelopment Analysis (DEA) can be used as an auxiliary tool for traditional ratio analysis; for providing supplementary information. There are a number of other studies that have combined DEA with statistical techniques, such as: DEA and regression combination used in the studies conducted by Arnold et al. (1996) and Cooper and Tone (1997), the DEA and canonical correlation analysis method introduced by Friedman and Sinuany-Stern (1997), and the simulation based study by Bardhan et al. (1998) that made use of two stage methodology introduced by Arnold et al. (1996). Thanassoulis et al. (1996) also used DEA and ratio analysis together to compare the two techniques in how well these agreed on relative performance of different DMUs, and on estimated targets for performance improvement. Based upon result of this study, it was concluded that when there is agreement on performance by these two approaches, it is possible to use them in conjunction, to gather useful information, and to facilitate communication of results to non-DEA specialist community. Similar findings were also reported by Gümüş and Çelikkol (2011), who compared these two techniques while using data on a group of non-financial firms.

Finally, one of the most important characteristics of the DEA is that, DEA can bypass the problem of explicit specification for relationships or the functional forms, relating different input and output variables (Charnes et al., 1985). This is an important characteristic given the fact that generally, for most studies, and particularly in the case of studies involving socially oriented organizations like MFIs, there is either very little or no knowledge available, for the appropriate functional forms to be employed. Therefore, DEA is considered particularly useful for studies of non-profit and public sector organizations that are involved in producing a number of outputs, not measurable through traditional cost and profit criteria. However the particular usefulness of DEA for non-profit sector does not imply that DEA is not suitable for profit oriented organizations. To the contrary, DEA is found to be equally suitable for analysing for-profit and not-for profit institutions (Sherman, 1984). This characteristic of the DEA methodology is particularly useful for evaluating MFIs, which possess both a profit (financial sustainability) and a non-profit (outreach) orientation.

2.7.2. A Review of Some DEA Based Studies for MFIs' Assessment

A review of the microfinance literature has revealed the fact that despite the large number of potential advantages, the use of DEA for performance evaluation of MFIs has been restricted to a relatively limited number of studies. An overview of the a few main studies that have used DEA for analysing the performance of MFIs is provided hereafter.

One of the initial DEA based studies for performance evaluation of MFIs was undertaken by Qayyum and Ahmad (2006). This study compares performance of MFIs from three countries; Pakistan, India and Bangladesh, based on data from the MIX Market website[23]. This study is quite thorough in terms of various discussions related to model specification and discussion of results. However, inclusion of a single output (loans disbursed) implies that this study has completely ignored the financial performance of selected MFIs, focusing instead on social performance alone.

Another noteworthy study in this area has been conducted by Gutiérrez-Nieto et al. (2007) that also uses data from the Mix Market website for 30 MFIs from Latin American region. Gutiérrez-Nieto et al. (2007) obtain DEA scores for all possible combinations of input and output variables. The scores obtained are then used to conduct principal component analysis. Choice of the variables for this study relies on the framework developed by Yaron (1994) for rural financial institutions. The study focusses on specification search methodology and a discussion of statistical analysis.

[23] MIX Market website is maintained by Microfinance Information Exchange that is a non-profit organization. This website provides data on financial and social performance indicators, for a large number of MFIs across the world.

A study conducted by Bassem (2008) uses MIX Market data for analyzing the performance of 35 Mediterranean MFIs. A major drawback of this study relates to the inadequate and often confusing language used while providing explanation of model specification and results' discussion. Consequently, it becomes rather difficult to understand the exact meaning of whatever information is intended to be communicated. In addition, a need for more rigorous literature review is also felt.

Gutiérrez-Nieto et al. (2009) have conducted another DEA based study on 89 MFIs, for which data has been obtained from the MIX Market website. This study looks at both the financial and the social performance of MFIs, through a single model. In this study, a new index of poverty reach is proposed for capturing the social dimension of MFIs' performance, in addition to the more commonly used indictor of female clients.

While the aforementioned studies have been able to provide useful information related to the performance of MFIs, certain problems related to these studies can be identified. The first problem with the current DEA based studies in microfinance is that almost all of these studies have used data available from the MIX Market. Although, MIX Market website is reported to be one of the biggest sources of data; use of this data may involve certain issues, having repercussions for the resulting performance evaluations. For example, the institutions whose data is reported on this website are restricted to be specialized institutions; with at least 90 % of their activity focusing on microfinancing. This implies exclusion of any multi-purpose institutions, for which microfinance does not represent 90% of their activity; even if these institutions are making significant contribution towards development of microfinance sector of any country. A good example of this can be found in the form of the Rural Support Programme of Pakistan, which is not represented on MIX Market website, despite the fact that this MFI is an influential player in the microfinance sector of Pakistan. Therefore, the institutions that are not represented on MIX Market website are excluded from all those analyses that rely on this website for data. As a result, MIX Market website may be unable to capture the full spectrum of the actual microfinance activity.

Another problem observed for the MIX Market data is the fact that institutions represented on this website are those that voluntarily decide to submit their data. Such voluntary reporting has the potential to introduce self-selection bias, in addition to casting doubt on the reliability of the data obtained from MIX Market[24] (Assefa et al., 2013). It is also observed that institutions whose data is reported on this website tend to be among the best performers. This carries certain implications for the performance evaluation of MFIs, as data gathered from MIX Market website may be unable to capture the whole range of MFIs' performance, instead focusing on the best performers only (Lapenu and Zeller, 2001).

Yet another problem observed for existing DEA based studies in the area of MFIs' performance evaluation is that most of these studies have used cross country data. While the prospect of getting data from several countries seems attractive in terms of making international comparison; there exist a number of significant differences, related to the working of MFIs in various parts of the world that should be given special consideration when conducting cross country studies (Milana and Ashta, 2012). Cross country data is reported to face problem of heterogeneity due to differences in accounting practices, tax and regulatory advantages, economic environment, labour market conditions, and relative growth of various national economies (Baumann, 2005). It is also reported that due to different environments, it may be easier (or harder) for MFIs located in different countries to achieve their performance targets (Ahlin et al., 2011). Moreover, the level of financial inclusion varies considerably across different

[24] For overcoming this problem, use of the diamond system introduced by MIX is a feasible option.

countries and regions, leading to differences in loan sizes, repayment structures and product portfolios of MFIs working in different areas. The possibility of such difference overshadowing the actual performance differences in institutions situated in different countries requires caution in interpreting results of cross country studies (Benston, 1994).

A final limitation observed for most of the studies reviewed, is the general lack of necessary details about various DEA model specification issues. Due to such lack of discussion about major considerations and justification for selection of appropriate returns to scale assumptions, underlying orientation and other model specification issues; these studies leave considerable gaps in developing understanding about how to evaluate performance of MFIs through DEA technique.

To the best of our knowledge, so far no one has attempted to explore the full potential of DEA technique within a microfinance context. The current study thus aims to fill this gap in literature, by developing a comprehensive DEA based framework for analysing MFIs' performance; both from outreach and sustainability perspectives[25]. Moreover, the study also demonstrates application of a novel approach, known as the trade-off approach[26]; as a means of improving standard DEA models by making them better informed, as well as increasing their discriminatory power.

[25] The proposed framework is discussed in Chapter 4.

[26] A review of the DEA methodology, along with a detailed explanation of the trade-off approach, is provided in Chapter 3.

Chapter 3 A Review of the DEA Methodology

3.1. Introduction

This chapter provides a review of the DEA technique that has been selected for evaluating the performance of microfinance institutions (MFIs) in the current study. The first section explains a few basic concepts, considered essential for developing understanding of this technique. Next, we provide an extended discussion of the DEA methodology; starting from its evolution, and moving on to various theoretical and methodological aspects of this performance evaluation tool. After this, a review of the weight restrictions approach is provided that has particular relevance for the current study. The last section is devoted to a detailed discussion of the trade-off approach that is used as an innovative application within the proposed DEA framework in the current study.

3.2. DEA – Some Basic Concepts

DEA is a non-parametric technique used for evaluating relative efficiency of homogenous organizational entities that produce multiple outputs from multiple inputs. Before starting a discussion of the DEA technique, an overview of some relevant concepts is provided.

3.2.1. Decision Making Units

In a DEA parlance, the organizational units being evaluated are called the “Decision Making Units”. This term was first coined by Charnes et al. (1978) and has subsequently been shortened to DMUs. DEA was initially used for performance measurement of firms in the public and not-for-profit sectors. Therefore, the term DMU was originally used to emphasize the focus on decision making entities, rather than on profit generating enterprises. DEA was considered to be especially suitable for such institutions, because the estimates of prices for different variables were either unreliable or sometimes completely missing in the case of public sector and non-profit organisations (Fried et al., 1993).

It was in mid-1980s that DEA was used for the first time in commercial institutions such as banks, by Sherman and Gold (1985). Since then, DEA has become equally popular in evaluation of the commercial profit-oriented organisations. At present, the term DMU is used to refer to any firm (either not-for-profit or profit-oriented) that possesses certain decision making power (or control), over the processes used for conversion of inputs into outputs (Thanassoulis et al., 2008).

3.2.2. Pareto Efficiency

In DEA literature, the term Pareto efficiency (also known as Pareto–Koopmans efficiency) is used to represent full or 100 % efficiency. A DMU is considered to achieve Pareto efficiency, if and only if, it is not possible to improve any of its inputs or outputs, without worsening some other inputs or outputs. In other words, this means that none of the Pareto efficient points on the efficient frontier is dominated by another feasible point, having the ability to use lower inputs without producing lower outputs; or alternately, having the capacity to produce more outputs without utilizing more inputs.

3.2.3. Productivity and the Production Functions

Productivity of a DMU can be defined as the ratio of outputs produced to the inputs utilized. For situations involving multiple outputs and inputs, aggregation of these outputs and inputs is required, to arrive at a ratio measure of productivity (Coelli et al., 2005, Fried et al., 2008) . Productivity can also be considered as an indicator of the degree to which utilization of available resources is undertaken by any DMU, for achieving desired goals (Roll and Moran, 1984). The process, whereby inputs are converted into outputs, is called a production technology. In econometric theory, a description of such technology is communicated through production functions that may be achieved within the constraints imposed by a production technology. A production function specifies an efficient frontier or a boundary, and the distance of a particular DMU from such a frontier provides a measure of that DMU's relative efficiency.

3.3. Evolution of the DEA Methodology

The notion of using a production function for productivity measurement was first introduced in the seminal work of Cobb and Douglas (1928). This concept was later on utilized by Farrell (1957) in his pioneering work on efficiency measurement, based on observational data. Farrell was concerned about the shortcomings of prevalent methodologies at the time, such as the indices approach to measurement of labour and capital productivity. His major criticism of these approaches related to their restrictive nature, due to which these approaches failed to produce any overall efficiency measure from combining multiple input measures. As a solution to deal with such inadequacies, Farrell proposed the use of activity analysis approach involving detailed matrix inversion routines. While proposing this new methodology, Farrell also shifted the focus of evaluation from productivity to efficiency. Unfortunately, all the discussion and numerical examples presented by Farrell were limited to single output scenarios, although he was successful in formulating the multiple inputs case.

The idea of using linear programming for measuring technical efficiency through a generalization of Pareto efficiency concept originally proposed by Farrell (1957), formed the basis for subsequent development of DEA. Farrell's work was brought to prominence nearly twenty years later by Charnes et al. (1978), who built upon his idea to come up with the revolutionary methodology called DEA. Since then DEA has enjoyed increasing popularity, for efficiency measurement involving multiple input-output scenarios.

There are two basic DEA models. The original DEA model proposed by Charnes et al. (1978), assumed constant returns to scale (CRS) and is known as the CCR[27] model. The CCR model was applicable only to those technologies that exhibited CRS globally. However, many real life situations do not follow full proportionality and thus CRS assumption may not be valid in those situations. In a major development by Banker et al. (1984), an extension of the original CCR model was proposed, whereby the CRS assumption was relaxed. The new model, commonly known as the BCC[28] model, introduced variable returns to scale (VRS) assumption, to account for differences in scale sizes of the organizational units under evaluation. With BCC, it is possible to identify which DMUs are operating at increasing, decreasing or constant returns to scale; and compare DMUs with other DMUs operating at similar scale sizes. The efficiency measurement through BCC model thus helps to distinguish between technical and scale efficiency[29], and provides a measure of pure technical efficiency, as the effects of scale size of any DMU is eliminated.

3.4. How DEA Works: An Overview

DEA is a non-parametric technique, which does not need to hypothesize about functional forms of production function. Instead it uses linear programming (LP) to identify an empirical based production frontier, formed by the most efficient firms. For determination of the different line segments forming up the efficient frontier, DEA uses actual data points; observed for the real DMUs included in the analysis. This is why DEA is also known as a data oriented methodology. Moreover, DEA is known to focus

[27] The term CCR refers to Charnes, Cooper and Rhodes.
[28] The term BCC refers to Banker, Charnes and Cooper.
[29] For a discussion of different types of efficiency, refer to section 3.9 of this chapter.

on the best possible performance, rather than the average performance; as no effort is made to fit a regression line through the centre of the observations. Instead, a piecewise linear surface is identified that rests on the top of observed data points (Seiford and Thrall, 1990). The frontier so identified is then used for calculating the relative efficiency scores of the remaining DMUs, through measuring their respective distances from the frontier. The relative efficiency scores obtained by a DEA analysis are considered to be independent of the units, which are used for measuring different inputs and outputs. This property, which is also known as units invariance (Charnes et al., 1986), permits greater freedom in the selection of input and output variables.

There are two basic steps in the DEA based efficiency assessments that warrant further explanation. The first step is the construction of a production possibility set (PPS); while the second step involves approximation of maximum possible reduction of inputs, or augmentation of outputs, within the PPS. A discussion of these steps is provided in the following sections.

3.5. Construction of Production Possibility Sets

PPS is a set consisting of all the input and output correspondences that are considered possible in principle. In DEA, a PPS is based on the input and output correspondences, actually observed for the DMUs being assessed. Banker et al. (1984), defined PPS as the smallest set consistent with the observed data and the proposed properties for the production possibility set. As discussed earlier, due to its non-parametric nature, DEA is not required to make any assumptions for specifying functional forms, relating various inputs and outputs. Instead, it starts directly with the construction of PPS.

The construction of PPS is generally possible under two main returns to scale (RTS) assumptions, i.e. the CRS and the VRS[30]. Depending on the underlying RTS

[30] The concept of returns to scale will be elaborated in more detail in the upcoming section.

assumptions, the construction of, and the proposed properties related to, a PPS differ slightly. Under the VRS assumption, a PPS can consist of three basic types of DMUs, i.e. real DMUs, composite DMUs, and outperformed or dominated DMUs. Real DMUs are the units that are actually observed. The composite DMUs represent the weighted average or convex combinations of the real DMUs. The outperformed DMUs are those units that consume more inputs and/or produce lesser outputs, as compared to the composite or the real DMUs. It is possible for a DMU to fall simultaneously into more than one of these basic categories.

Under the CRS assumption, a PPS also includes scaled DMUs. Scaled DMUs are obtained through scaling (up or down) the real, composite and outperformed DMUs. The following section explains the basic assumptions, and the process of PPS construction, under the two RTS assumptions, with graphical illustrations.

3.5.1. Basic Assumptions for PPS Construction under the VRS Assumption

For generalizing the basic assumptions related to the construction of a PPS, consider a set of n DMUs, (j=1,2,…,n). Each DMUj ($j \in J$) produces s number of outputs (r = 1,2,…,s), by using m number of inputs (i = 1,2,…,m) . If we use x and y to represent individual inputs and outputs respectively; then x_{ij} represents the level of i th input for DMUj, and y_{rj} represents the level of r th output for DMUj. The PPS, represented by T, can be defined as

$$T= \{(x, y) \mid x \in \Re_{+}^{m} \text{ can produce } y \in \Re_{+}^{s} \}$$

The basic assumptions made for defining a PPS under a VRS technology are as follows

Assumption 1: Convexity

The production possibility set T is convex.

Assumption 2: Feasibility of observed data

$(x, y) \in T$ for any $j \in J$.

Assumption 3: Free disposability of inputs and outputs

If $(x, y) \in T$ and

a) $x \leq x'$ then $(x', y) \in T$, where $x \leq x'$ means that at least one of the elements of x' is bigger than corresponding element of x.

b) $y \geq y' \geq 0$ then $(x, y') \in T$ where $y \geq y'$ means that at least one of the elements of y' is smaller than the corresponding element of y.

The assumption of free disposability is also known as the *inefficiency postulate* (Banker et al., 1984) or the *inefficient production* phenomenon (Thanassoulis, 2001).

Assumption 4: Minimum extrapolation

T is the intersection set of all $\dot{T}$ that satisfy above mentioned assumptions and also subject to the condition that each of the observed input and output vectors $(x , y) \in \dot{T}$ (Banker et al., 1984).

3.5.2. Basic Assumptions for PPS Construction under the CRS Assumption

The basic CCR-DEA model, as proposed by Charnes et al. (1978), adopted the CRS assumption; which implies neither economies nor diseconomies of scale. In other words, the CRS assumption proposes that the operational scale of any DMU does not affect its productivity, so that large and small sized DMUs are equally efficient in conversion of inputs into outputs.

Under the CRS assumption, if the input levels for any feasible input-output correspondence are scaled up or down; then under Pareto-efficiency, there would be another feasible correspondence for which, the output levels are scaled up or down in the same proportion, as the input levels. The proportionality assumption of CRS allows for inclusion of scaled inputs and outputs of observed DMUs, having same proportion, to be members of the technology under consideration. In addition to the assumptions discussed for the VRS technology; an extra assumption of proportionality, for the construction of PPS under a CRS technology, can be stated as below

Assumption 5: Proportionality If $(x, y) \in T$, then $(\kappa x, \kappa y) \in T$ for any $\kappa \geq 0$

This assumption is also known as *ray unboundedness* (Banker et al., 1984).

A Graphical Illustration of PPS

The construction of PPS under the CRS and VRS assumptions can now be explained, based on a single input and single output scenario. The input and output coordinates for a set of four DMUs namely; A, B, C and D have been plotted below (Figure 3.1)

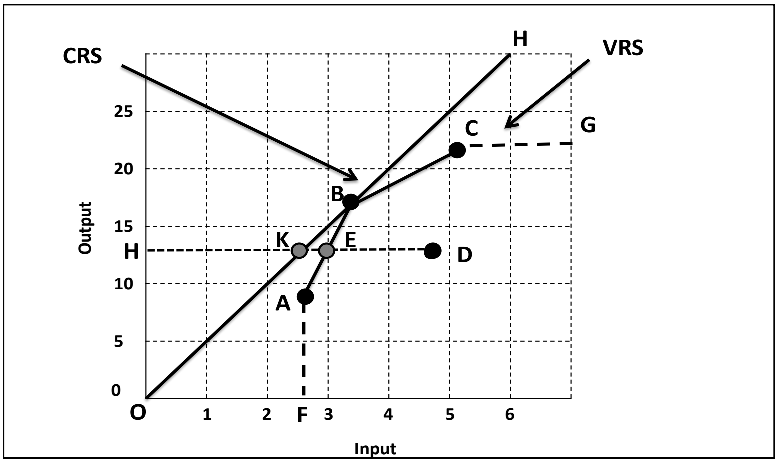

Figure 3. 1 Illustration of Production Possibility Set

The efficient frontier under the CRS assumption is represented by the ray OBH; whereas, the efficient frontier under the VRS assumption is represented by the piecewise linear boundary ABC. It can be seen that the shape of efficient frontier under the CRS assumption, is quite different from the shape of efficient frontier under the VRS assumption. Moreover, under the CRS technology, only DMU B is efficient. This is due to addition of the convexity constraint[31] in a VRS model; which results in a convex hull that envelops the data more closely, than the conical hull formed by a CRS model. As a result, the distance of an inefficient DMU from the CRS efficient frontier is greater than its distance from a VRS efficient frontier. For example in Figure 3.1, for the inefficient DMU D, the distance to VRS frontier, represented by DE; is smaller than its distance to the CRS frontier, represented by DK. This leads to the efficiency scores obtained by a VRS model, being greater than or at least equal to, the efficiency scores obtained by a CRS model. Therefore, the CRS (CCR) models generally discriminate better than the VRS (BCC) models (Fried et al., 2008).

The interpolation assumption, coupled with inefficiency assumption that allows for production of lesser output with more input, results in a PPS based on the assumption of VRS, consisting of all the DMUs, feasible in principle, on the FABCG boundary; as well as the DMUs below and to right side of this boundary. Whereas, under the CRS assumption, the PPS consists of all the DMUs, feasible in principle, on the OBH ray; as well as the DMUs below and to right side of this ray.

3.5.3. Increasing and Decreasing Returns to Scale

It has been pointed out that the CRS assumption is applicable only when all the firms are operating at their optimal scales. However, in a number of practical situations, factors such as; imperfect competition, financial constraints, and regulatory requirement may cause firms to operate at other than optimal scales (Coelli et al., 2005). As the technological sets tend to exhibit different returns to scale (RTS) characteristics in many real life cases, RTS are generally considered to be variable. It means that RTS may not only be constant, but also decreasing or increasing; depending on the scale sizes

[31] For more information about convexity constraint, refer to section 3.8.1 of this chapter.

involved. Different RTS classifications are explained with the help of the following diagram:

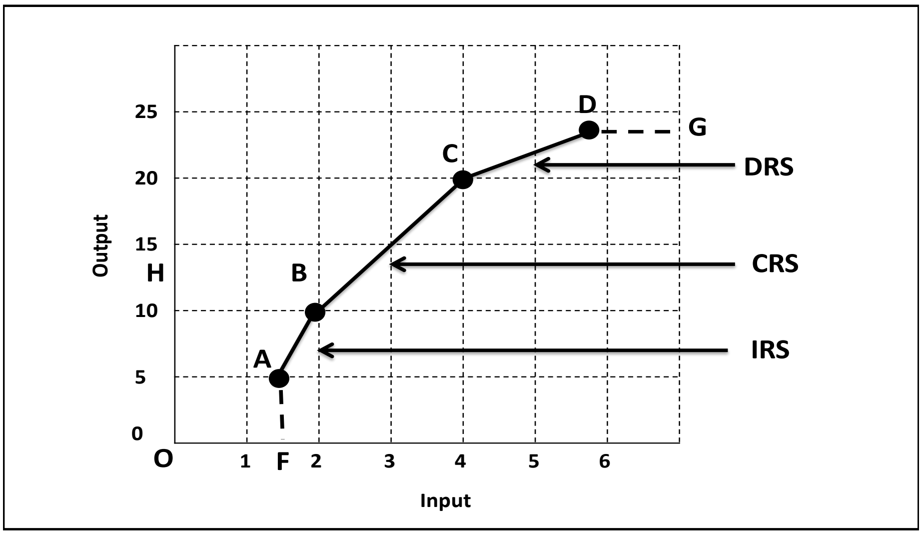

Figure 3. 2 Illustration of IRS, CRS, and DRS

Under increasing returns to scale (IRS), if the input levels are increased radially (i.e. without changing the input mix); then under Pareto-efficiency condition, it is expected to produce a radial increase in the output levels, which is more than proportionate to the increase in input levels. Under decreasing returns to scale (DRS), on the other hand; an increase in the input levels is expected to produce a less than proportionate increase in the corresponding output levels (Cooper et al., 2007). It can be seen from the Figure 3.2 that the segment AB is exhibiting IRS, whereas; the segment BC and the segment CD are exhibiting CRS and DRS, respectively[32].

3.6. Objective Function of DEA Models : The Underlying Orientation

The second stage in efficiency measurement through DEA, relates to the approximations of minimum possible input levels, for given levels of outputs; or

[32] For more details about identification of different RTS characterisations in DEA models, refer to THANASSOULIS, E. 2001. *Introduction to the Theory and Development of Data Envelopment Analysis*, Kluwer Academic Publishers.

alternately, the maximum possible output levels, for given levels of inputs. Such approximations bring forward the concept of the input and output orientations that help decide the nature of objective function for a DEA efficiency assessment[33]. In case of an objective function, aimed at input minimization (also known as the input orientation); the DEA model is instructed to ensure maximum possible reduction in the inputs levels, without decreasing the output levels. Where the objective function aims for output maximization (also known as the output orientation); the DEA model ensures maximum possible augmentation of output levels, without any increase in the inputs levels (Cooper et al., 2007).

Moreover, under the output orientation, a DMU is considered Pareto-efficient, if and only if, it is not possible to increase any one of its outputs; without decreasing at least one other output, and/or without augmenting at least one of its inputs. Under input orientation, on the other hand, a DMU is considered Pareto-efficient, if and only if, it is not possible to decrease any one of its inputs; without augmenting at least one other input, and/or without decreasing at least one of its outputs (Charnes et al., 1981). An important distinction between efficiency measures obtained under the CRS and the VRS assumptions is that in the case of CRS assumption, the efficiency scores under the input and the output orientation are equal (Coelli and Perelman, 1999, Cooper et al., 2007). On the other hand, for the VRS models, the input and output orientations result in different scores for the inefficient DMUs (Camanho and Dyson, 1999).

3.7. The Envelopment and Multiplier DEA Models

In DEA, a pair of mutually dual linear programming (LP) models is solved to calculate the relative efficiency scores of DMUs (Charnes et al., 1978, Cooper et al., 2007). Of

[33] A third less frequently cited option is to jointly maximize both; through additive and slack based models, for dealing simultaneously with the shortfalls in outputs and excesses in inputs (Cooper et al. 2007).

these, the mathematical models, involving input and output weights, are known as the multiplier models; and the models involving the DMUs' weights, are known as the envelopment models. The envelopment models are production based; while the term "envelopment" is derived from the fact that these models measure efficiency of DMUs, with reference to a production possibility based boundary (or frontier) that envelops the data. The multiplier models on the other hand are value based in the sense that these models measure efficiency with reference to the values of different inputs and outputs.

In general, the envelopment form is considered to be computationally more efficient than the multiplier form. This is due to the fact that the total number of constraints for a multiplier formulation depends on the total number of DMUs, included in the analysis. On the other hand, for the envelopment model formulation, the number of constraints depends on the number of inputs and outputs. As in any DEA assessment, the number of DMUs tends to be much greater than the number of inputs and outputs; this leads to greater computational efficiency of linear programming codes, in the case of envelopment formulation (Cooper et al., 2007).

The use of either envelopment or multiplier form of DEA models, depends on the discretion of analysts; as well as the objectives of any performance evaluation. While both the primal and dual models provide the same efficiency scores, their contribution to efficiency analysis is somewhat different. The envelopment models can be helpful for identification of Pareto efficient DMUs by using second stage optimization, and provide information about efficient targets and efficient peers. On the other hand, the multiplier models are able to identify the areas of good and bad performance; while the values (or weights) provided by multiplier models provide useful information about rates of substitution or transformation, between different factors of production. Moreover, improvement in the model discrimination, through the use of weight restrictions, is also facilitated by the multiplier DEA models (Fried et al., 2008).

3.8. General Formulations for the Basic DEA Models

The DEA models can have different formulations based on the underlying RTS assumptions. Selection of an appropriate RTS assumption requires careful evaluation of the situation to avoid inaccurate estimation of efficiency scores. For example, if CRS assumption is applied in a situation, where not all the DMUs are working at an optimal scale; then the measures of technical efficiency so provided, would be confounded by scale efficiencies (Coelli et al., 2005).

In addition to the RTS assumptions, the DEA models can be formulated either as output- oriented or input-oriented models. General formulations for the envelopment and the multiplier forms of DEA models, with different RTS assumptions and input-output orientations, are provided in the following sections.

3.8.1. General Formulations for the VRS and CRS Envelopment Models

The general formulation of the VRS envelopment model with input orientation is provided below, with the help of the notations that were introduced earlier in section 3.5.1.

VRS envelopment model with input orientation

Min θ (3.1.1)

Subject to

$\sum_{j=1}^{n} \lambda_j \, x_{ij} \leq \theta \; x_{ij_0}$ (i = 1,2,…,m) (3.1.2)

$\sum_{j=1}^{n} \lambda_{\mathrm{j}} \, y_{rj} \geq y_{rj_0}$ (r = 1,2,…,s) (3.1.3)

$\sum_{j=1}^{n} \lambda_{\mathrm{j}} = 1$ (j = 1,2,…,n) (3.1.4)

$\lambda_{\mathrm{j}} \geq 0$ (3.1.5)

θ sign free (3.1.6)

In this formulation, DMUj_0 represents one of the n DMUs that are under evaluation, while the condition $\sum_{j=1}^{n} \lambda_{\mathrm{j}} = 1$ is known as the convexity constraint. This constraint prohibits construction of any interpolation point, from scaling up or down of the observed DMUs, to act as a referent point for measuring efficiency (Thanassoulis, 2001). The input efficiency of DMUj_0 is the optimal value of θ in the above model. If we use the subscript $*$ to denote the optimal value, then the input efficiency of DMUj_0 is θ^*, and this value is less than or equal to one.

Model (3.1) is used to identify, through a set of feasible λ (lambda) values, a point within the PPS that can produce the same level of outputs as DMU$j_{0;}$ while using the lowest proportion $\theta^*$of the inputs, used by DMUj_0. This model is run separately for each DMU included in the analysis. For calculating the possible improvement in utilization of inputs for DMU$j_{0,}$ the current level of its inputs will be reduced by the minimum feasible value of θ. All the efficient DMUs have optimal θ^*values equal to one. This means that current input levels for these DMUs cannot be reduced (proportionally) any further, indicating that such DMUs are on the efficient frontier. Any DMU for which the value of θ^* is less than one, is inefficient, as it is dominated by the frontier.

VRS envelopment model with output orientation

Max ϕ (3.2.1)

Subject to

$\sum_{j=1}^{n} \lambda_j \, x_{ij} \leq x_{ij_0}$ (i = 1,2,…,m) (3.2.2)

$\sum_{j=1}^{n} \lambda_j \, y_{rj} \geq \phi \; y_{rj_0}$ (r = 1,2,…,s) (3.2.3)

$\sum_{j=1}^{n} \lambda_{\mathrm{j}} = 1$ (j = 1,2,…,n) (3.2.4)

$\lambda_j \geq 0$ (3.2.5)

ϕ sign free (3.2.6)

In model 3.2, the optimal value of ϕ represents the maximum factor by which it is possible to radially expand the output levels of DMUj_0, without changing its input levels. The output efficiency of DMUj_0 is thus the reverse of the optimal value of ϕ. The value of ϕ^* is 1 for DMUs on the efficient frontier and greater than 1 for inefficient DMUs.

General formulations for CRS envelopment models

The convexity constraint ($\sum_{j=1}^{n} \lambda_j = 1$) is the major differentiating point between the VRS and the CRS based DEA models. This constraint is not required, when the DMUs are operating under the CRS assumption. Therefore, if we remove this constraint from Model (3.1) with the input orientation, and from Model (3.2) with the output orientation, the resulting models then exhibit CRS.

3.8.2. Second Stage Optimization in DEA: A Digression on Mix Inefficiency

The efficiency measurement in DEA may face certain problem, if a DMU is located on one of those sections of the frontier that run parallel to the two axes. This would mean that despite having an efficiency score of 1, such DMU is not fully efficient in a Pareto sense. As an illustration, let's consider Figure 3.3. In this figure, DMUs B, D and E are efficient DMUs and define the frontier. The two DMUs A and C are inefficient and the measures of technical efficiency for these DMUs can be given by the ratios OA'/OA and OC'/OC, respectively. However, in the case of DMU C, it is not clear whether the point C' is a fully efficient point; as it is possible to reduce the amount of input 2 for DMU C, by the amount BC' without any detriment to the current level of its output. This is an example of *input slack* or *input excess*. Similar slacks may exist for outputs in the cases involving multiple output scenarios. The presence of slacks may reflect existence of mix inefficiency for certain DMUs, which cannot be removed without a change in the current input-output mix for such DMUs.

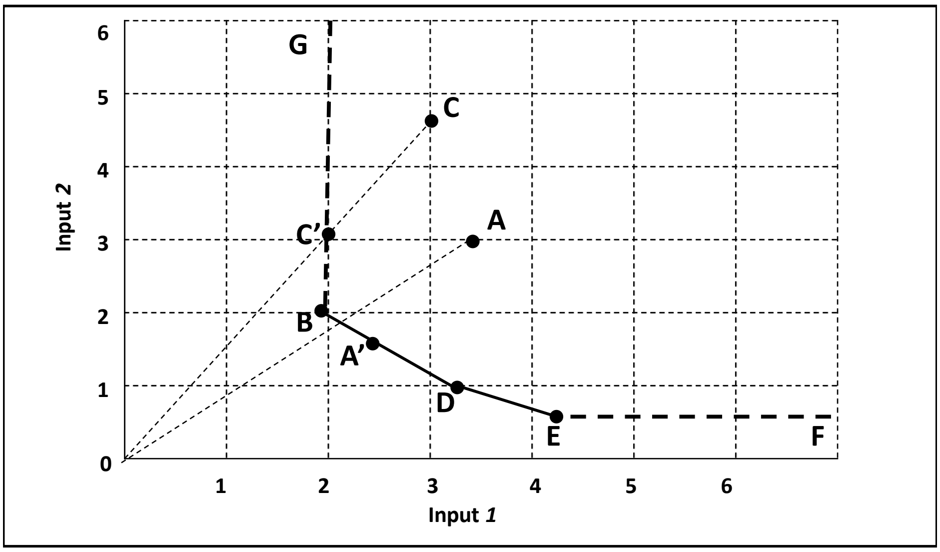

Figure 3. 3 Illustration of Input Slacks

In order to determine whether or not a DMU exhibits mix inefficiency, a second stage optimization is performed; using the slack values and the optimal scores obtained from the first stage optimization. The two stage optimisation procedure, developed by Ali and Seiford (1993), is generally used for this purpose. This procedure is applicable to DEA models, under both the CRS and the VRS assumptions.

The second stage optimization models can be formulated as below, where ${s_i}^-$ and ${s_r}^+$ represent the input and output slacks respectively.

Second stage optimization model for input orientation

Max $\sum_{i=1}^{m} {s_i}^- + \sum_{r=1}^{s} {s_r}^+$ (3.3.1)

Subject to

$\sum_{j=1}^{n} \lambda_j \, x_{ij} + {s_i}^- = \theta^* x_{ij_0}$ (i = 1,2,…,m) (3.3.2)

$\sum_{j=1}^{n} \lambda_j \, y_{rj}$ - $s_r{}^{+}$= y_{rj_0} (r = 1,2,…,s) (3.3.3)

$\sum_{j=1}^{n} \lambda_j = 1$ (j = 1,2,…,n) (3.3.4)

$\lambda_j \geq 0$ (3.3.5)

$\lambda_j, s_r{}^{+}, s_i{}^{-} \geq 0 \; \forall \; i, r, j$ (3.3.6)

Second stage optimization model for output orientation

Max $\sum_{i=1}^{m} s_i{}^{-} + \sum_{r=1}^{s} s_r{}^{+}$ (3.4.1)

Subject to

$\sum_{j=1}^{n} \lambda_j \, x_{ij} + s_i{}^{-} = x_{ij_0}$ (i = 1,2,…,m) (3.4.2)

$\sum_{j=1}^{n} \lambda_j \, y_{rj}$ - $s_r{}^{+}$= $\phi^{*} \, y_{rj_0}$ (r = 1,2,…,s) (3.4.3)

$\sum_{j=1}^{n} \lambda_j = 1$ (j = 1,2,…,n) (3.4.4)

$\lambda_j \geq 0$ (3.4.5)

$\lambda_j, s_r{}^{+}, s_i{}^{-} \geq 0 \; \forall \; i \,, r, j$ (3.4.6)

In the second stage optimization, θ^{*} and ϕ^{*} are fixed and represent the optimal values, obtained from the first stage optimization. Based on this further development related to identification of slacks, a DMU is considered 100% efficient (also known as strongly efficient or Pareto-Koopmans efficient), if and only if, the following two conditions are met

(i) θ^{*} is equal to 1, in case of input orientation (or ϕ^{*} is equal to 1, in case of output orientation), and

(ii) All slacks are zero i.e. $s_i{}^{-}$= 0 and $s_r{}^{+}$= 0

On the other hand, if the a DMU has efficiency score of 1, but the results of second stage optimization result in a non-zero value for the sum of slacks; then such a DMU is not strongly efficient, as it is exhibiting mix inefficiency. Therefore, a DMU will be considered weakly efficient, if and only if, the following two conditions are met

(i) θ^* is equal to 1 in case of input orientation (or ϕ^* is equal to 1 in case of output orientation), and

(ii) $s_i^- \neq 0$ and/or $s_r^+ \neq 0$ for some i and r in some alternate optima.

The same formulations also apply to the CRS technologies.

3.8.3. General Formulations for the VRS and CRS Multiplier Models

While the envelopment or primal models measure efficiency scores based on the efficient frontiers, the multiplier (or dual) models measure efficiency by evaluation of the ratio of weighted outputs to weighted inputs. The general formulations for the multiplier models, under the VRS and the CRS assumptions are provided below; both for the case of input and the output orientations.

VRS Input oriented multiplier models

Max $\alpha = \sum_{r=1}^{s} u_r\, y_{rj_0} - \omega$ (3.5.1)

Subject to

$\sum_{i=1}^{m} v_i\, x_{ij_0} = 1$ (3.5.2)

$\sum_{r=1}^{s} u_r\, y_{rj} - \sum_{i=1}^{m} v_i\, x_{ij} - \omega \leq 0$ for all j (3.5.3)

$u_r, v_i \geq 0$ $r = 1,2,\ldots,s,\ i = 1,2,\ldots,m$ (3.5.4)

ω sign free (3.5.5)

This model represents the dual formulation of input oriented envelopment model (Model 3.1). The notation u_r is used to represent the dual variable associated with the rth constraint, and v_i is used to represents the dual variable associated with the ith constraint in the equivalent envelopment model. The dual variables u_r and v_i are also commonly known as DEA weights (or multipliers) on the rth output and ith input respectively. The values of these variables can be used for arriving at marginal rates of transformation or substitution between inputs and outputs. The dual variable for the convexity constraint in the envelopment form of this multiplier model is represented by ω. The value of ω reflects the effect of scale size on the productivity of a DMU.

VRS output oriented multiplier models

The multiplier dual model, for the envelopment VRS model with output orientation (Model 3.2), can be written as follows

$$\text{Min } \beta = \sum_{i=1}^{m} v_i \, x_{ij_0} + \omega \qquad (3.6.1)$$

Subject to

$$\sum_{r=1}^{s} u_r \, y_{rj_0} = 1 \qquad (3.6.2)$$

$$\sum_{r=1}^{s} u_r \, y_{rj} - \sum_{i=1}^{m} v_i \, x_{ij} - \omega \leq 0 \qquad \text{for all } j \qquad (3.6.3)$$

$$u_r, v_i \geq 0 \qquad r = 1,2,\ldots,s,\ i = 1,2,\ldots,m \qquad (3.6.4)$$

$$\omega \text{ free} \qquad (3.6.5)$$

The technical efficiency of DMUj_0 is $1/\beta^*$.

General formulations for CRS multiplier models

The multiplier models (3.5) and (3.6) explained above, are specified for input and output orientations, for a VRS technology. The multiplier models for CRS technology can be simply derived from these models, by setting the value of ω equal to zero. Note that ω is the variable used to represent the dual of convexity constraint in the envelopment form, which is not required for a CRS technology.

3.9. Technical, Scale and Allocative Efficiencies

The efficiency scores obtained through CCR and BCC models can be interpreted in terms of different types of efficiencies. When efficiency is measured without taking into account the prices or values of different inputs and outputs, such efficiency is known as technical efficiency. The seminal work of Farrell (1957) explains technical efficiency as the extent to which a DMU can produce the maximum possible output from a certain level of inputs; or alternately, the extent to which a DMU uses the minimum possible level of inputs for a given level of output.

A problem related to technical efficiency is that both the input costs and output values are totally ignored by technical efficiency. As a result, the actual performance levels of DMUs under consideration may not be assessed accurately. Take for example the case of a DMU that might be having quite costly input mix, despite being technically efficient. However, if the prices of inputs are available, then it is possible to calculate input allocative efficiency. The input allocative efficiency was identified by Farrell (1957) as a component of economic efficiency and he referred to it as the price efficiency. The price efficiency can be calculated by taking the ratio of the cost and technical efficiency.

Generally, the CCR efficiency scores represent technical efficiency. The BCC efficiency scores, on the other hand are commonly referred to as pure technical efficiency; because these scores are calculated after eliminating any scale effects. The concept of scale efficiency is related to the economic concept of returns to scale. The measure of technical efficiency, as given by the CCR model, was shown to be the product of pure technical efficiency and scale efficiency by Banker (1984). The scale efficiency of a DMU can thus be found by taking ratio of the CCR and BCC efficiency scores.

Banker (1984) also introduced the concept of most productive scale size (mpss) and explained how such scale could be estimated for convex production possibility sets. The original work by Banker (1984) only considered the case of a unique optimal solution and ignored possible cases of multiple optimal solutions. Banker and Thrall (1992) further extended this approach, by considering the multiple optimal solution scenarios.

Under the new approach proposed by them, the optimal frontier was partitioned into three parts corresponding to increasing, decreasing and constant returns to scale.

3.10. Weight Restrictions Approach

A number of methodological extensions to the original DEA model have resulted from the application of the DEA technique to various real life problems. An important development in this regard is known as the "weight restrictions approach" that allows for human preferences to be taken into accounting while running a DEA model. In simple words, weight restrictions refer to incorporation of additional constraints or restrictions, on weights assigned to different inputs and/or outputs, by the DEA models. Due to the relevance of weights restrictions approach for the current study, the next section provides an overview of some basic aspects related to this approach.

3.10.1. Motivations for Incorporation of Weight restrictions

The development of the weight restrictions approach is a result of two major motivating factors. The first factor is based on the unbounded nature of the basic DEA models. The original CCR and BCC models allow complete flexibility in the assignment of weights to different input and output variables. Such flexibility sometimes leads to certain undesirable consequences, such as insufficient discrimination. Consequently, a large number of DMUs in an analysis could appear efficient; through assignment of zero, very large, or very small weights to different variables. Such assignment of weights implies either exclusion of, or unnecessary importance being assigned to, some of the variables; which is difficult to justify many times in reality (Dyson and Thanassoulis, 1988).

Insufficient discrimination is a common phenomenon, especially for situations where the total number of DMUs is relatively small, as compared to the number of inputs and outputs included in the analysis. This issue is also known the *curse of dimensionality*;

whereby, few firms have many dimensions, represented by a number of inputs and outputs (Coelli et al., 2005). In addition to a relatively smaller number of DMUs, other possible reasons responsible for the insufficient discrimination include; unusual mix of input/output variables for some subsets of DMUs, uniformity of performance of different DMUs, and comparatively different scale sizes being exhibited by some of the DMUs under the VRS assumption (Podinovski and Thanassoulis, 2007).

A number of approaches have been proposed to deal with the problem of insufficient discrimination[34]. One of the earlier developments in this regard includes the super efficiency model proposed by Andersen and Petersen (1993) for improving the discrimination for the Pareto efficient DMUs. Other common approaches for improving discrimination include cross efficiency (Doyle and Green, 1993, Green et al., 1996), and multiple criteria DEA (Li and Reeves, 1999). Despotis (2002) introduced an approach for discriminating among the globally efficient DMUs, through a second stage of DEA; while more recently, Bal et al. (2010) recommended a weighted goal programming DEA model for improving discrimination. Podinovski and Thanassoulis (2007), and Angulo-Meza and Lins (2002) also provide informative readings by discussing various methods for improving discrimination.

The second commonly cited reason for introduction of the weight restrictions approach is the need for incorporating value judgments in DEA based assessments. Allen et al. (1997) define value judgements as "logical constructs, incorporated within an efficiency assessment study, reflecting the Decision Maker's (DM) preferences in the process of assessing efficiency". Major incentives for incorporation of such value judgments include; incorporation of prior perceptions about efficiency of different DMUs, the need

[34] An informative discussion can be found in ANGULO-MEZA, L. & LINS, M. P. E. 2002. Review of methods for increasing discrimination in data envelopment analysis. *Annals of Operations Research,* 116**,** 225-242.

to relate values of inputs and outputs in certain real life problems[35], and taking into consideration the existing information about values of different input and output variables.

Taking into account the existing information about values of different variables has particular relevance for situations, where estimation of overall efficiency is the ultimate goal (Thompson et al., 1990). For such estimation, access to information about prices or worth of inputs and outputs is a pre-requisite. In the absence of relevant information on prices, value judgments can be used as a proxy for missing information about input prices or outputs' worth. This is especially helpful in situations involving assessment of not-for profit or public sector organizational units, producing outputs that cannot be evaluated easily in terms of traditional profit and return measures (Sherman, 1984). Finally, the use of value judgments is also recommended for aligning the imputed input/output values, with the economic concept of input/output substitution (Allen et al., 1997, Thanassoulis, 2001, Cooper et al., 2011).

3.10.2. Major Approaches for Restricting Weights

A number of approaches have been proposed over the years for dealing with, what Cook and Seiford (2009) called, *unacceptable* or *undesirable weighting schemes*, resulting from unbounded DEA models. There are several sub-categories of weight restrictions, such as; absolute weight restrictions, cone ratios and assurance regions. One of the earliest developments in this domain was introduced by Dyson and Thanassoulis (1988), who proposed lower and upper bounds to be imposed on individual multipliers. Other examples of this type of weight restrictions were provided by Roll et al. (1991), Cook et al. (1991), and Roll and Golany (1993). The second category of weight restrictions is known as the cone ratio approach, under which multipliers are required to

[35] An interesting example is provided in THANASSOULIS, E. 1995. Assessing police forces in England and Wales using data envelopment analysis. European Journal of Operational Research, 87, 641-657.

belong to closed cones (Charnes et al., 1989b). A third category of weight restrictions was proposed by Thompson et al. (1986), who introduced the concept of "Assurance Regions (AR)" and homogeneous linear weight restrictions. This concept was further improved by Thompson et al. (1990). Alternative generalizations of the AR approach can also be found in Allen et al. (1997), Thanassoulis and Allen (1998), Cook and Zhu (2007), and Cook and Zhu (2008).

Instead of restricting the actual weights, another proposed practice involves placing restrictions on virtual inputs and outputs. Virtual inputs and outputs are, in essence, normalized weights that reflect the extent to which the efficiency score of a DMU is affected by certain variables. Wong and Beasley (1990), introduce different ways in which such restrictions could be placed on virtual inputs and outputs. The first method is to place restriction only for the DMU under assessment, while the relative virtual values for remaining DMUs are left free. The second method is to place restrictions in respect of average DMUs. The third approach is to place restrictions on all the DMUs included in an assessment. This last method is considered to be computationally expensive, because of the larger number of constraints involved.

3.10.3. Problems with the Weight Restrictions Approach

The weight restrictions approach is one of the most common methodologies to deal with insufficient discrimination problem and to incorporate value judgments in basic DEA models (Thanassoulis, 2001). Despite the frequent application of weights restrictions, certain problems associated with this approach have been identified.

A basic limitation associated with this approach is related to the manner in which weight restrictions are incorporated in a DEA model. As discussed earlier, there are two mutually dual linear programming (LP) models, that can be solved to calculate the relative efficiency scores of DMUs, i.e. the envelopment and the multiplier models

(Cooper et al., 2007). A basic distinction between these models is the availability of different frameworks, for interpreting radial efficiency scores of the DMUs under assessment. The multiplier model provides the managerial meaning of efficiency, as the relative position of the DMU with reference to other DMUs, given the most favourable weights or prices of different inputs and outputs. The envelopment model, on the other hand, provides the technological meaning of efficiency scores, in the form of a possible radial improvement factor for different inputs and outputs (Podinovski, 2007b).

Of these two forms of linear DEA models, the envelopment form offers a clear economic meaning; but the incorporation of weights restrictions is actually done in the multiplier form, and not in the envelopment form. Consequently, in some situations, the efficient radial target identified by the DEA model may not be feasible in reality; or in other words, may not be technologically producible (Allen et al., 1997, Thanassoulis and Allen, 1998). A similar concern in this regard is raised by Podinovski and Thanassoulis (2007), who point out that the use of weight restrictions in many cases may be motivated by a desire to achieve higher discrimination; even at the cost of using unrealistic profile of optimal weights for different inputs and outputs. In such cases, it is quite possible that there would be no link between the proposed weights restrictions and the technological realities associated with specific production process being analysed; thus rendering such analysis meaningless.

3.11. The Trade-off Approach

This study suggests the use of trade-off approach (also known as the “production” trade-off approach), which has been proposed by Podinovski (2004b). The trade-off approach is recognized as a promising tool, due to its potential to incorporate technologically realistic information within the standard DEA models (Førsund, 2013). Under this approach, technologically feasible changes to different input and output variables are incorporated in the standard DEA models. There are two major benefits that can result from the application of the trade-off approach. Firstly, this approach makes the standard DEA models better informed, and secondly, it can resolve the problem of insufficient discrimination of efficiency scores; without the adverse consequences normally attributed to the alternative method of incorporation of weight restrictions.

3.11.1. How the Trade-off Approach Works

It is worth noting that under the trade-offs approach, the conditions on weights are incorporated in the envelopment form rather than the multiplier form, which results in making the interpretations of efficiency more meaningful (Podinovski, 2004b, Podinovski, 2005). This proposition is based on the aforementioned premise that the problem of loss of meaningful economic interpretation of efficiency scores, resulting from incorporation of weights restrictions, arises in the envelopment form and not in the multiplier form. Therefore, it is the envelopment form in which one should seek additional conditions on weights restrictions; rather than the multiplier form. These additional conditions on weights that are incorporated in the envelopment form are referred to as production trade-offs.

With the incorporation of trade-offs, the technology expands as new dimensions are added in the primal model; while the feasible region of the dual multiplier model becomes smaller, thus resulting in improved discrimination. As the PPS expands through relying on realistic technological trade-offs, it ensures producibility of the radial targets for inefficient DMUs (Podinovski, 2004b). As a result, the task of improving DEA scores' discrimination can be accomplished with the trade-off approach, without losing the technological meaning of efficiency scores; which is a frequent occurrence under the alternative method of incorporating weight restrictions.

It may also be noted that there are two underlying assumptions, related to feasibility of trade-offs, which may seem a bit unrealistic. First is the assumption that trade-offs have to be realistic for all the DMUS in the vast production technology. And secondly, the trade-offs should be realistic in unlimited proportions; which is an assumption highly improbable. Podinovski (2004b) has addressed both these issues by clarifying that these extreme assumptions are required to define the PPS only theoretically; so that the operational simplicity of consequent DEA models can be ensured. Therefore, the trade-offs need to be feasible only within reasonable vicinity of the observed units, as the optimal solutions provided by DEA models with trade-offs will relate to efficient targets in such vicinity. Therefore, if trade-offs are realistic for all the observed DMUs, even if they are just locally realistic, it should be sufficient.

3.11.2. Alternative Methods for Incorporation of Trade-offs

There are two methods for incorporating production trade-offs into a DEA model (Podinovski, 2004b). The first is to incorporate trade-offs in the envelopment DEA model as additional terms that will result in modification of composite units. However, there are certain practical difficulties in implementation of this method, as the existing DEA software does not permit the required modifications to be made to the DEA models for this purpose.

Instead of incorporating the trade-offs in the envelopment DEA form, the second method is to translate these production trade-offs into equivalent weights restrictions, in the multiplier DEA form. These weight restrictions in the multiplier DEA form will result in generation of additional terms in the envelopment form that represent trade-offs between different inputs and/or outputs. The main advantage of this method is that any standard DEA software can be used for solving the DEA model. The method of translating production trade-offs into weight restriction is quite straightforward and involves some simple explicit formulae enabling such translation.

Note that the mathematical effects of both the weights restrictions incorporation into the multiplier form, and introduction of the trade-offs in the envelopment form are the same i.e. the resulting DEA models offer better discrimination of efficiency scores. However, the use of trade-offs preserves all the traditional meanings of efficiency. In particular, efficiency can be interpreted as a realistic radial improvement factor and the efficient target identified for an inefficient DMU is always feasible. This is so because unlike weights restrictions approach, these trade-offs are not based on perceived managerial values or monetary considerations, but on technological realities (Podinovski, 2007b).

3.12. Trade-offs, Marginal Rate of Substitution and Boundary Properties

Before initiating a discussion of the underlying axioms, the real meaning of trade-offs, as used in the trade-off approach, need to be clearly understood for avoiding any confusion that may arise from the use of this term in other possible contexts in the literature. The term "trade-off", in its most basic form, has been used to mean a conflict, or a choice between two or more goals. For example, Brockett et al. (1997) mention the trade-offs between "efficiency of performance" and "risk coverage". Similarly, within the microfinance literature, the term "trade-off" has been frequently used to represent the divide between the social and financial objectives of MFIs. This term is also used to represent the marginal rates of substitution, see e.g. the studies by Charnes et al. (1989a) and Asmild et al. (2006). However, the aforementioned meanings of the term "trade-off" are not clearly the same as the one that is implied in the case of the trade-off approach.

Under the trade-off approach, the term “trade-off” is used to represent a technologically feasible judgement, related to simultaneous changes in certain inputs and outputs; without resulting in a change for any of the other inputs and outputs (Podinovski, 2004b). Moreover, the trade-off approach does not assume that an exact relationship is being specified by any of the proposed trade-offs. Actually, the relation between different inputs and outputs, as stated by a production trade-off, is meant to be fairly undemanding so that it can be applied to different DMUs. This is in contrast to the economic concept of marginal rate of substitution that identifies the exact proportions for changes in inputs and outputs for the DMUs on the efficient boundary only (Podinovski, 2005).

As a result of incorporation of trade-offs, new hypothetical units are added to the technology, and the technology expands. This in turn has the effect that the efficient boundary changes and becomes more demanding. Overall, new boundary points correspond to new units generated by the application of trade-offs to observed units. The slopes of the new boundary represent trade-offs as illustrated in the next section. It needs to be understood that trade-offs are *not* sought as boundary properties, but as simultaneous changes to inputs and outputs applicable to any unit in the technology (in practice, at all observed units). However, the geometry of the expanded PPS is defined by the application of trade-offs only to a small subset of observed units. For example, the trade-offs are applicable at inefficient units but this is irrelevant because this has no effect on the expanded set.

A final consideration for identification of trade-offs is that that the decision maker may be able to specify an infinite number of trade-offs, but these trade-offs could be more demanding or less demanding. The goal should be to arrive at a trade-off that is as demanding as possible, while still being sufficiently reliable and without being overly optimistic. Using a less demanding trade-off leads to a smaller expanded technology but improves the plausibility of the model.

3.13. Axioms for PPS Construction under the Trade-off Approach

For generalizing the basic assumptions related to construction of a PPS under the trade-offs approach, we again consider a set of n DMUs, (J =1,2,…,n). Each DMUj ($j \in$ J) produces s number of outputs by using m number of inputs. We use x and y to represent inputs and outputs vectors respectively. Let us further assume that we have k judgements stating production trade-offs. In the matrix form, the trade-offs can then be represented as (P_t, Q_t), where t = 1, 2,…,k. Also, the vector $P_t \in \Re^m$ modifies the inputs, and the vector $Q_t \in \Re^s$ modifies the outputs of DMUs. Based on these premise, a PPS under CRS technology (represented by T) should satisfy the following additional assumptions[36], to allow for incorporation of the trade-offs (Podinovski, 2004b).

Additional Assumption 1: Feasibility of trade-offs

If $(x, y) \in T$, then unit $(x + \pi_t P_t\ ,\ y + \pi_t Q_t) \in T$ for any trade-off t in the form (P_t, Q_t) and for any $\pi_t \geq 0$ provided that

$x + \pi_t P_t \geq 0$

$y + \pi_t Q_t \geq 0$

where π is used to represent the weights that correspond to the composite units' modification.

Additional Assumption 2: Closedness

According to this assumption, set T encompasses all its limit points and is thus a closed set. Podinovski (2004b) emphasizes that the assumption of closedness must be stated explicitly in case of a technology with production trade-offs. This is because the

[36] Basic assumptions for a technology without trade-off were explained in section 3.5 of this chapter.

closedness assumption does not automatically follow as a result of other assumptions, as is the case for any standard CRS technology, without trade-offs.

3.13.1. A Simple Illustration of Trade-offs

For ensuring smooth transition from a general description of trade-offs, to more specific case of trade-offs' development for micro finance institutions; we would like to give an example of actual input and output variables, being used for the current study. However, in order to ensure the ease of graphical illustration, the values of the selected variables and the proposed trade-off have been simplified[37]. Moreover, we focus here on a single input and single output case, as this will facilitate graphical illustration of the concept.

Let us suppose that a group of four MFIs are using a single input (loanable funds) to generate a single output (loan portfolio). The data on these variables for the four MFIs is provided in Table 3.1.

Table 3. 1 Data for Illustration of Trade-offs

MFIs	Loanable Funds (Input)	Loan Portfolio (Output)
A	4	1
B	1	1.5
C	3.5	1.7
D	5.5	2.5

Judgement 3.1 *An increase in the level of input (loanable funds) by 1 is sufficient to increase the level of output (loan portfolio)by 0.5, provided nothing else changes.*

As discussed earlier, a judgement can be incorporated both into envelopment and multiplier forms of DEA model. The effect of incorporating judgement 3.1 in the envelopment form is observed in the form of modification of composite units and expansion of PPS. Figure 3.4 represents the change in technology, reflecting the incorporation of this trade-off (judgement 3.1).

[37] A more detailed discussion of the trade-offs for microfinance sector, is provided in Chapter 6.

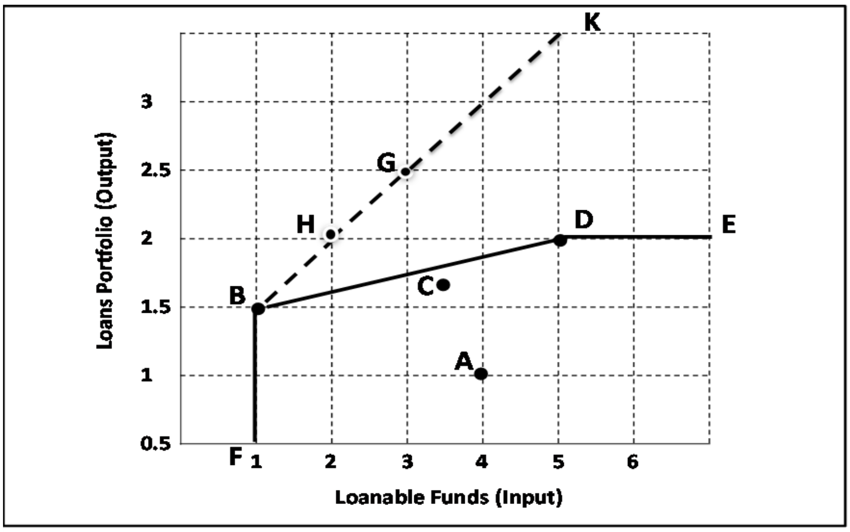

Figure 3. 4 PPS after Incorporation of the Proposed Trade-off

As can be seen from this figure, the original PPS under VRS technology is defined by the boundary FBDE. After incorporation of judgement 3.1, the PPS expands and can now be represented by the boundary FBHGK. This expansion of PPS is a result of four consecutive additions to the input of MFI B (each addition being equal to 1 unit of loanable funds) that result in four consecutive additions to its output (each addition being equal to 0.5 unit of loan portfolio).

When loanable funds for MFI B are increased by 1 unit, this will raise the loans portfolio of MFI B to 2, and point H will become feasible as a result. If we now increase the loanable funds of MFI B by another unit; this will increase its loans portfolio to 2.5, and point G will also become feasible. We can keep on repeating this procedure for further expansion of the PPS, but we need not apply this judgment indefinitely. This is in line with the explanation provided by Podinovski (2004b) that trade-offs need to be feasible only within reasonable vicinity of the observed units, because the optimal solutions provided by DEA models with trade-offs, will relate to efficient targets in such vicinity. Under the expanded PPS; the points H, G, K, and all other hypothetical units under the line segments BH, HG, and GK become feasible as a result of incorporating this first trade-off (or judgment 3.1). As can be seen, MFI B is the only efficient unit under the expanded technology.

The output oriented, envelopment DEA model for MFI B, after incorporation of this trade-off, can be written as follows

Max ϕ (3.7.1)

Subject to

$4\lambda_1 + 1\lambda_2 + 3.5\lambda_3 + 5.5\lambda_4 + 1\pi_1 \leq 1$ (3.7.2)

$1\lambda_1 + 1.5\lambda_2 + 1.7\lambda_3 + 2.5\lambda_4 + 0.5\pi_1 \geq 1.5\phi$ (3.7.3)

$\lambda_1 + \lambda_2 + \lambda_3 + \lambda_4 = 1$ (3.7.4)

$\lambda_1, \lambda_2, \lambda_3, \lambda_4, \pi_1 \geq 0$ (3.7.5)

ϕ sign free (3.7.6)

In model (3.7), π_1 represents a new hypothetical unit in the expanded PPS obtained as a result of the incorporation of the proposed trade-off.

3.14.General Formulations for DEA Models with Trade-offs

Based on the production axioms (explained in sections 3.5 and 3.13), the generalized formulations for VRS and CRS models with trade-offs, are provided hereafter.

3.14.1. General Formulations for the Envelopment Models with Trade-offs

VRS envelopment models with trade-offs under input orientation

Min θ (3.8.1)

Subject to

$\sum_{j=1}^{n} \lambda_j x_{ij} + \sum_{t=1}^{K} \pi_t P_t \le \theta x_{ij_0}$ $(i = 1,2,\ldots,m), (t = 1, 2,\ldots,k)$ (3.8.2)

$\sum_{j=1}^{n} \lambda_j y_{rj} + \sum_{t=1}^{K} \pi_t Q_t \ge y_{rj_0}$ $(r = 1,2,\ldots,s)$ (3.8.3)

$\sum_{j=1}^{n} \lambda_j = 1$ (3.8.4)

$\lambda_, \pi \ge 0$ (3.8.5)

θ sign free (3.8.6)

VRS envelopment models with trade-offs under output orientation

Max ϕ (3.9.1)

Subject to

$\sum_{j=1}^{n} \lambda_j x_{ij} + \sum_{t=1}^{K} \pi_t P_t \le x_{ij_0}$ $(i = 1,2,\ldots,m), (t = 1, 2,\ldots,k)$ (3.9.2)

$\sum_{j=1}^{n} \lambda_j y_{rj} + \sum_{t=1}^{K} \pi_t Q_t \ge \phi\, y_{rj_0}$ $(r = 1,2,\ldots,s)$ (3.9.3)

$\sum_{j=1}^{n} \lambda_j = 1$ (3.9.4)

$\lambda_, \pi \ge 0$ (3.9.5)

ϕ sign free (3.9.6)

General formulations for CRS envelopment models with trade-offs

As discussed earlier, the only difference between the CRS and the VRS envelopment forms is the inclusion of convexity constraint in the case VRS technologies, which is represented by equations (3.8.4) and (3.9.4). Therefore, the CRS envelopment models for input and output orientations with trade-off approach can be generalized by simply removing the convexity constraints from models (3.8) and (3.9).

3.14.2. General Formulations for the Multiplier Models with Trade-offs

In previous section, we explained the procedure for incorporation of trade-offs in the envelopment form of DEA models. It is also possible to implement these trade-offs in the multiplier form through weight restrictions; because the incorporation of production trade-offs in the envelopment form is equivalent to the incorporation of weight restrictions in the multiplier form. The traditional use of weight restrictions is based on value judgements or monetary considerations for incorporating perceived value of different inputs and outputs through establishing relations between their corresponding weights. The production trade-offs approach offers an alternative methodology that is related to weight restrictions. This approach is based on representation of trade-offs through weight restrictions. These restrictions correspond to the hypothetical composite units added to the technology, under envelopment form and are translated into additional constraints in the multiplier form. These additional constraints result in expansion of the PPS through identifying new feasible region.

Before providing the general formulations for the multiplier models with production trade-offs, we present an illustration of trade-offs' incorporation into the multiplier model. For this, we look at the same example that has been used for the suggested trade-off's incorporation into envelopment form (section 3.13.1). The output oriented multiplier formulation of DEA model for MFI B can be written as follows

Min $\beta = v + \omega$ (3.10.1)

Subject to

MFI A $4\,u - 1\,v - \omega \leq 0$ (3.10.2)

MFI B $1\,u - 1.5\,v - \omega \leq 0$ (3.10.3)

MFI C $3.5\,u - 1.7\,v - \omega \leq 0$ (3.10.4)

MFI D $\quad 5u - 2v - \omega \le 0$ (3.10.5)

$0.5u - 1v \le 0$ (3.10.6)

$u = 1$ (3.10.7)

$u, v \ge 0$ (3.10.8)

ω sign free (3.10.9)

In this model, constraint (3.10.6) represents conversion of the judgment 3.1 in the additional homogeneous weight restriction, and ω is the dual variable representing convexity constraint in the envelopment form. The general formulations for VRS and CRS multiplier models are provided next.

VRS multiplier models with trade-offs under input orientation

Max $\alpha = \sum_{r=1}^{s} u_r\, y_{rj_0} - \omega$ (3.11.1)

Subject to

$\sum_{i=1}^{m} v_i\, x_{ij_0} = 1$ (3.11.2)

$\sum_{r=1}^{s} u_r\, y_{rj_0} - \sum_{i=1}^{m} v_i\, x_{ij_0} - \omega \le 0$ (3.11.3)

$\sum_{r=1}^{s} u_r\, Q_t - \sum_{i=1}^{m} v_i\, P_t \le 0 \qquad t = 1, 2,\ldots,k$ (3.11.4)

$u_r, v_i \ge 0 \qquad r = 1,2,\ldots,s,\ i = 1,2,\ldots,m$ (3.11.5)

ω sign free (3.11.6)

VRS multiplier models with trade-offs under output orientation

Min $\beta = \sum_{i=1}^{m} v_i\, x_{ij_0} + \omega$ (3.12.1)

Subject to

$\sum_{r=1}^{s} u_r\, y_{rj_0} = 1$ (3.12.2)

$\sum_{r=1}^{s} u_r\, y_{rj_0} - \sum_{i=1}^{m} v_i\, x_{ij_0} - \omega \le 0$ (3.12.3)

$\sum_{r=1}^{s} u_r\, Q_t - \sum_{i=1}^{m} v_i\, P_t \le 0 \qquad t = 1, 2,\ldots,k$ (3.12.4)

$u_r, v_i \ge 0 \qquad r = 1,2,\ldots,s,\ i = 1,2,\ldots,m$ (3.12.5)

ω free (3.12.6)

General formulations for CRS multiplier models with trade-offs

Like the envelopment form, the multiplier form of DEA model with trade-offs is only different in one aspect, i.e. inclusion of the convexity constraint in the case of VRS technology. The generalized formulations for CRS multiplier models with trade-offs, can be obtained thus by removing the convexity constraint from the VRS multiplier models.

Chapter 4: A Theoretical Framework for DEA Based Performance Evaluation of MFIs

4.1. Introduction

In this chapter we propose a general framework for performance evaluation of MFIs through the DEA technique. In the first section, the importance of evaluating MFIs' performance and suitability of the efficiency perspective for this purpose is discussed. This section also briefly reflects on the appropriateness of the DEA technique for measuring MFIs' efficiency and the need for proposing a framework. Next, we explain the relevance of the much debated conflict versus compatibility dilemma, and the rationale for focusing on efficiency as a key element in this debate. After this, we provide a detailed discussion of the major considerations related to different aspects of DEA model specification, such as; appropriate modelling approaches, returns to scale assumptions, underlying orientation and selection of variables. The chapter ends with some additional considerations that need to be taken into account while undertaking MFIs' assessment through the DEA methodology.

4.2. Performance Evaluation of MFIs: The Efficiency Perspective

Performance evaluation refers to the analysis of organizational performance in the achievement of goals and objectives. Performance evaluation is recognized as an effective tool, for facilitating the process of identifying major hurdles, standing in the way of successful achievement of organizational objectives (Gümüş and Çelikkol, 2011).

The large scale popularity and rapid growth of the microfinance industry, over the last three decades, has resulted in increased interest in finding ways to evaluate performance of MFIs (Manos and Yaron, 2009). Moreover, a number of recent developments in the microfinance sector also signify the importance of conducting such performance evaluation. Examples of some major developments include increasing competition, commercialization trend, technological changes, difficulties in procurement of subsidized funds, and challenges faced by MFIs in meeting their dual objectives of social and financial performance.

Various measures of performance have been developed that act as indicators for firms' competency in running business operations. For example, some of the commonly used indicators of firm performance include: efficiency, profitability, productivity, growth and customer satisfaction (Barbosa and Louri, 2005). Of these indicators, efficiency is one of the most frequently used indicators (Gelade and Gilbert, 2003) which can offer a measure of firms' performance in the utilization of resources for the generation of desired outputs (Yang, 2009). The current study has also used efficiency as an indicator of MFIs' performance. However, it needs to be pointed out that efficiency, within the context of current study, refers to relative efficiency which can be calculated by "comparing observed output to maximum potential output obtainable from the input, or comparing observed input to minimum potential input required to produce the output, or some combination of the two" (Fried et al., 2008).

For MFIs, scarcity of the most important resource i.e. funds to generate loans, and the pressing need to increase production for meeting the large unmet demand for micro-credits, make it particularly important to achieve higher levels of efficiency. In addition, a major problem that results in obstructing the outreach expansion is cited to be a shortage of efficient MFIs (Meyer, 2002). It is also recognized that the improvement in technology and operational efficiency of MFIs can lead to better achievement of their dual objectives (Manos and Yaron, 2009).

Having established the importance of efficiency enhancement, the next step is to explore appropriate techniques for conducing efficiency analyses. This second step is based on the simple logic that improving efficiency is only possible after current efficiency levels have been analysed, and any obstacles in the way of achieving high efficiency levels have been identified. Therefore the selection of DEA as the main evaluation technique in the current study is particularly suitable, as DEA not only provides the measures of technical efficiencies, but also offers estimates of both the sources and amounts of inefficiencies (Sherman, 1984, Charnes et al., 1985). The appropriateness of DEA technique for the current study can also be justified, based on a number of desirable characteristics that have been discussed in Chapter 2.

The review of microfinance literature has revealed that despite the potential advantages of DEA, the use of this non-parametric technique for performance evaluation of MFIs remains an under-researched area at present. To the best of our knowledge, there are just a limited number of studies that have used DEA for analysing performance of MFIs. Moreover, existing work in this area fails to provide a comprehensive framework for MFIs' performance evaluation, instead relying on the frameworks developed for other types of commercial and development financial institutions.

Considering the gap identified in the literature[38], this study proposes a conceptual framework, aimed at facilitating the performance evaluation of MFIs through the DEA technique. It is also hoped that through this framework, we will be able to provide guidelines to those, not familiar with the operation of MFIs and/or the underlying principles of the DEA methodology, so that it is possible to avoid common pitfalls and make better use of the DEA technique for the assessment of MFIs.

[38] For details, refer to Chapter 2, section 2.7.2.

4.3. Performance Evaluation Framework

The central premise, for the framework proposed in the current study, is that efficiency lies at the core of achieving the much desired objectives of MFIs; which are related to enhancing outreach (through serving a large number of the really poor people), and ensuring long term sustainability (through attaining financial self-sufficiency).

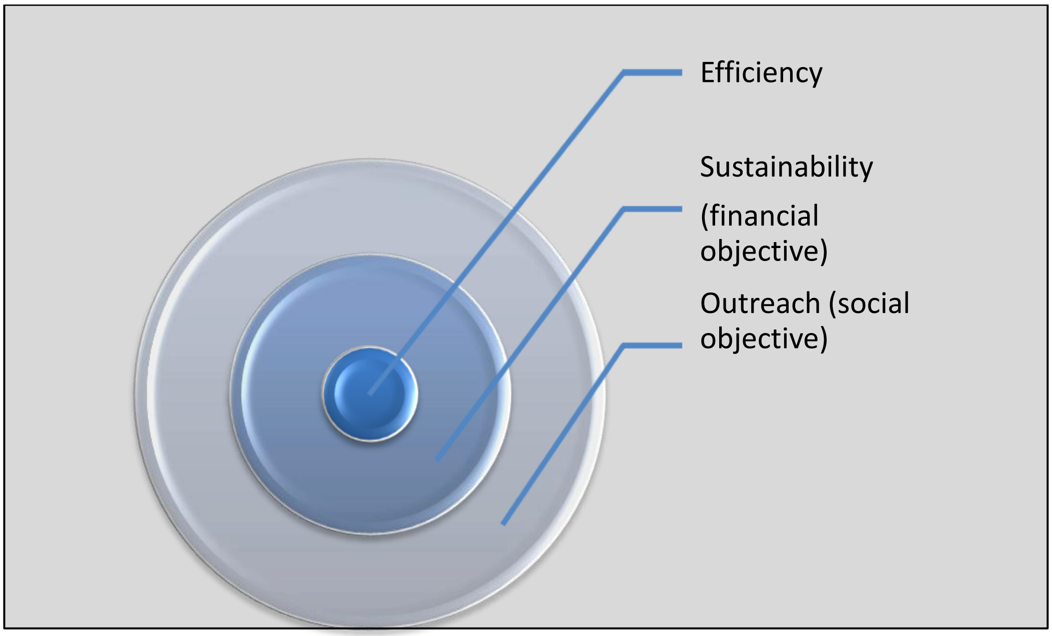

Figure 4. 1 Efficiency as a Core Component in Achieving Dual Objectives of MFIs

Building upon this proposition, we further posit that through enhanced efficiency, MFIs could be in a better position to deal with the on-going issue of the conflict versus compatibility of these dual objectives[39]. Or more precisely, efficiency in performance of MFIs needs to be looked at as a key element to be considered, when undertaking research about the conflict- compatibility dilemma, related to the social and financial objectives of MFIs[40].

[39] For details of sustainability-outreach dilemma, refer to Chapter 2, section 2.6.
[40] A more detailed discussion is provided in section 4.3.2.

4.3.1. Relevance of the Conflict versus Compatibility Debate

As a preliminary step in laying the foundation of the proposed framework, we regress briefly to the major propositions of an extensively debated issue, related to the conflict versus compatibility of sustainability and outreach objectives of MFIs. Through a review of literature in Chapter 2, it was pointed out that sustainability and outreach levels achievable by MFIs are considered by many, as two conflicting objectives that cannot be achieved simultaneously (Figure 4.2). In simple words, according to this view, the MFIs focusing mainly on serving the very poor people, have to compromise their profitability; based on higher costs associated with pro-poor lending. On the other hand, MFIs that are more concerned with earning enough profits, to ensure long term sustainability, are unable to serve the really poor; instead focusing on relatively less poor clients.

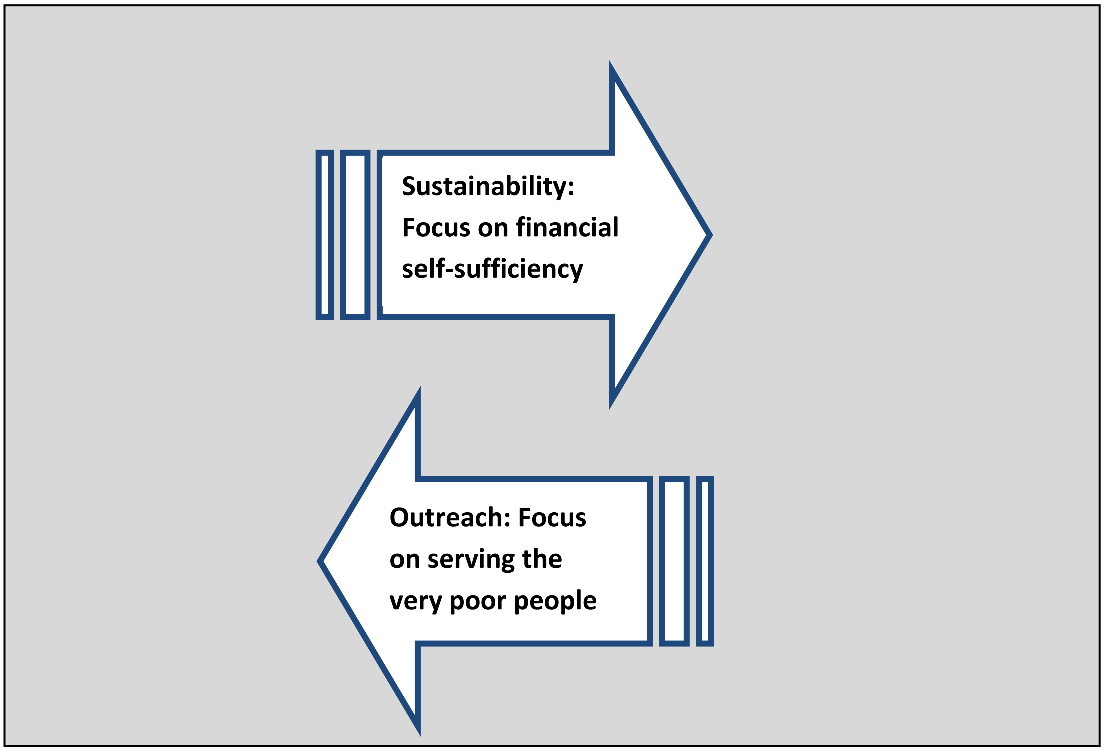

Figure 4. 2 Conflict Between Sustainability and Outreach Objectives

At the same time, there also exists evidence that supports the compatibility of these two seemingly conflicting objectives (Figure 4.3). Given the volume of contradictory evidence presented in the literature, it is not possible for us to favour either the trade-off or compatibility stance at this stage. However, we would like to contribute to the existing literature by highlighting the importance of efficiency perspective in this debate.

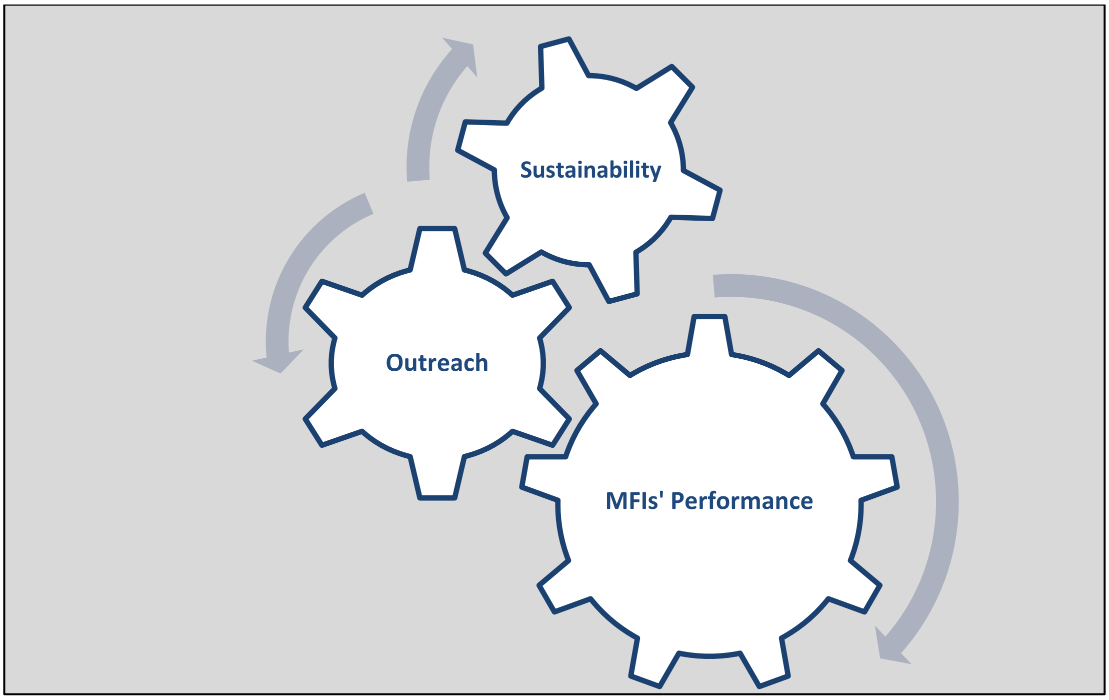

Figure 4. 3 Compatibility of Sustainability and Outreach Objectives

4.3.2. The Efficiency Perspective: Logical Underpinnings

As discussed earlier, the proposed framework for evaluating performance of MFIs is based on the simple proposition that MFIs can perform better, on both outreach and sustainability dimensions, through improving their efficiency. A discussion of the logical reasoning underlying this proposition (as depicted through Figure 4.4) is provided in this section.

The link between efficiency and institutional growth has been discussed by many. An influential theoretical model in this regard was proposed by Jovanovic (1982).

According to this model, efficient organizations are bound to grow and sustain in the long run. Inefficient organizations, on the other hand, are destined to deteriorate and fail. Within a microfinance context, it has been proposed that sustainability and outreach objectives can be achieved through either achieving higher efficiency or charging high interest rates (Woller, 2000).

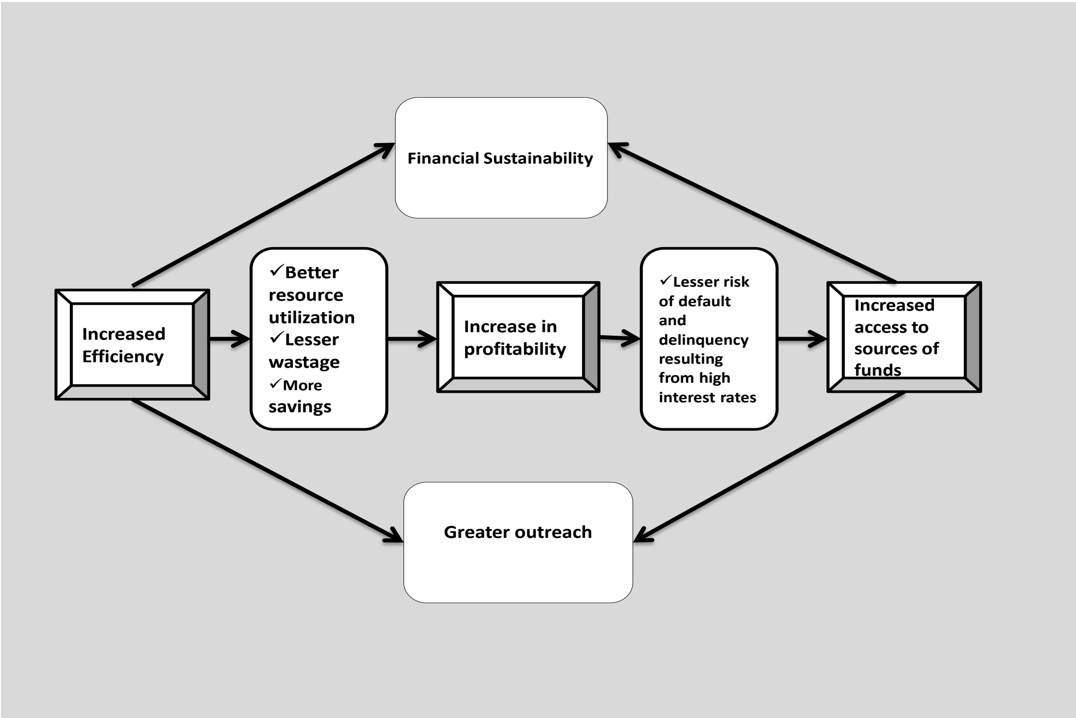

Figure 4. 4 The Link Between Efficiency and Dual Objectives of MFIs: A Rationale

Source: Made by researcher based on review of literature

It is intuitively easy to understand that greater efficiency in utilization and allocation of resources can lead to more production, lesser wastage of precious resources, and greater cost savings. Through enhanced efficiency, MFIs are thus in a better position to increase profitability; without a proportionate increase in the interest rates charged to the poor clients. Inefficiency, on the other hand, can result in increased costs that are transferred to microfinance clients in the form of higher interest rates. Such high interest rates, in turn, can result in increased default rates and delinquency issues.

In addition, the inefficient MFIs can find it more difficult to get financing from commercial sector. Efficient MFIs, on the other hand, are able to access diverse sources of funds and thus continue to serve high cost poorer clients; without the threats posed by high default risks and lack of external funding. Consequently, these efficient MFIs have greater chances of being able to achieve the objectives of financial sustainability and outreach (breadth and depth) in the long run, as compared to MFIs suffering from inefficiencies in operations.

Building upon the same argument, we also emphasize that without achieving high efficiency levels; socially oriented MFIs may remain dependent on continued support and subsidies, for achieving desired levels and depth of outreach. Or alternately, such MFIs may cease to exist, when such support is no longer available; which is a strong possibility, given the increasing reluctance on part of donor agencies to bail out any inefficient institutions. Similarly, in the absence of efficient operations, more commercially oriented MFIs will not be able to become financially sustainable, without sacrificing outreach depth for the sake of profitability.

In view of the foregoing discussion, it would be reasonable to suggest that if a conflict indeed exists between sustainability and outreach objectives of MFIs; then through more efficient performance, MFIs can reduce the magnitude or strength of the proposed conflict. Alternately, if the compatibility proposition is believed to be true; then again, efficient performance can help in achieving greater compatibility in the social and commercial objectives of MFIs. Summing up, efficiency is put forward as a crucial component that can help MFIs limit the extent of the proposed conflict; or alternately, ensure even better compatibility, in achieving the sustainability and outreach objectives.

We now turn to a detailed discussion of the proposed theoretical framework, by taking account of various theoretical and methodological considerations, related to the specification of DEA models for performance evaluation of MFIs.

4.4. Approaches for the Development of Performance Evaluation Models

One of the first considerations for conducting DEA based evaluation relates to the selection of a suitable modelling approach. After reviewing the literature on performance evaluation of financial institutions, a number of approaches, commonly used for modelling the production process, have been identified. Although, a majority of these approaches are developed, with a special focus on the banking sector firms; these approaches still offer useful information, for identification of relevant variables for the purpose of performance evaluation of MFIs. A discussion of the main approaches is provided in the following section.

4.4.1. The Profitability Approach

The profitability approach (also known as operating, revenue or income based approach) considers banks as business entities; having the ultimate objective of earning revenues, while incurring costs of running business. The main output under this approach is total revenue, comprising of net interest income and non-interest income. The input set comprises of premises and equipment expense, personnel expense, and the loan loss provision (Leightner and Lovell, 1998).

4.4.2. The Risk-Return Approach

Risk aversion on part of managers can result in greater costs for financial institutions, at least in the short run. This is mainly due to the increased expenditure by risk-averse managers, on making loans from less volatile and consequently more costly sources; as well as the greater efforts expended on loans' evaluation and monitoring activities.

From the viewpoint of standard production and cost models, such managerial attitude can render the institutions, being run by risk-averse management, as inefficient.

Based on this premise, Hughes et al (1995) proposed incorporation of risk related variables into standard efficiency models, so that it would be possible to take into account the managerial preferences towards risk. Under this approach, banks are viewed as possessing different levels of risk aversion, and thus having different profit maximization goals. The traditional utility function in banking is expanded under this approach, to include; output prices, non-performing loans (as a measure of output quality), equity or financial capital, and risk-free rate of interest.

4.4.3. The Modern Approach

This is another approach that incorporates the risk factor in performance analysis of the banking sector firms; in addition to agency costs and quality of services. Under this approach, the likelihood of bank failure and assets' quality are taken into consideration, during the process of costs' estimation. A well-known representation of this approach can be found through CAMELS[41], which is an efficiency evaluation tool based on sets of ratios; calculated for different variables, obtained from banks' financial statements (Das and Ghosh, 2006).

4.4.4. The Marketability Approach

Within a DEA context, Seiford and Zhu (1999) suggested inclusion of market valuation of banking firms' stocks; in addition to commonly used variables, related to the operational performance of firms. For this purpose, a two stage process was proposed, in which profitability was evaluated in the first stage, and then the market value of

[41] The term CAMELS is an acronym, used to represent different components of overall condition of a bank. The acronym comprises of capital adequacy, assets, management capability, earning, liquidity and sensitivity to risk.

stocks or market efficiency was calculated in the second stage; based on the results obtained in the first stage.

In addition to the more regularly used variables in the earlier DEA analysis of banks, including labour, income, expenses, number of accounts and transactions, loans, and deposits; the marketability approach recommends inclusion of such variables as the earnings per share (EPS), return to investors and the market value of stocks.

4.4.5. The Intermediation Approach

The traditional meaning of intermediation refers to the job of bringing together of borrowers and savers (Chorafas, 1998). In this perspective, the intermediation approach treats banking firms as intermediaries, between borrowers (also known as investors) and savers. The intermediation service is provided by banks through collection of surplus funds from savers, in the form of deposited and purchased funds; and subsequent utilization of these funds in the form of loans to investors, as well as different types of securities and investments.

There has been a longstanding debate about what outputs are generally produced by the banks (Berger and Humphrey, 1992), and also about what inputs are used in this process (Leightner and Lovell, 1998). The treatment of deposits, as either an input or an output variable, has particularly faced longstanding controversy, in the banking literature. This controversy arises from the dual characteristics inherent in deposits. On the one hand, deposits are related to the liquidity levels, payment services and safekeeping provided to the depositors. Based on these characteristics deposits are considered to be outputs (Worthington, 1998). On the other hand, Berger and Humphrey (1997) point out that deposits are paid for partially through interest payments. In addition, the funds obtained through deposits serve as raw material for investible funds (Elyasiani and Mehdian, 1990). Considering these two characteristics, deposits can be categorized as inputs.

Under the intermediation approach, major outputs include loans and other assets. It is observed that in contrast to the production approach[42], input set under the intermediation approach includes not only operating expenses but also borrowed funds and related interest expenses, because funds constitute the major 'raw material' that is transformed in intermediation process. Because interest expenses normally constitute major part of total costs, therefore, intermediation approach is considered suitable for assessing entire financial institutions (Berger and Humphrey, 1997). Moreover, as any competitive firm aims to minimize both its operating and financial cost, therefore, intermediation approach is considered better than production approach for assessments focusing on competitive viability of firms (Berger et al., 1987).

Different ways used to deal with the identification of variable sets for banks have led to the establishment of various sub approaches. Three main approaches, which have been developed under the umbrella of intermediation approach, include; the user cost approach, the asset approach, and the value added approach. All three of these variants to the intermediation approach use financial data, and are focused on intermediation function of bank (Das and Ghosh, 2006).

4.4.5.1. The User Cost Approach

This approach was first applied by Hancock (1985) to the analysis of banking sector firms. According to this approach, the contribution of any financial product towards bank revenue forms the basis for its categorization, as either an input or an output variable. For example, an asset will be considered an output, if financial returns from this asset are more than opportunity costs of funds; and it will be treated as an input if

[42] The production approach is discussed in section 4.4.6 of this chapter.

the inverse is true. Similarly, a liability will be considered an output if its financial cost is less than the opportunity cost; and an input if such financial cost exceeds the associated opportunity cost.

4.4.5.2. The Asset Approach

The asset approach, proposed by Sealey and Lindley (1977), is based on a reduced form model of banking activity, that focuses entirely on the intermediary role played by banks between the depositors and the end users of bank assets. This approach considers only balance sheet items, and does not take into account the profit and loss accounts of firms. As such the output set under this approach comprises of earning assets of banks (such as loans, securities, and investments); while, the input set includes deposits, labour, capital and other liabilities.

According to Camanho and Dyson (2005), the asset approach faces two limitations. Firstly, this approach is more suitable for such banks, whose main function is the purchase of funds from other banks, for conversion into loans. However, for a vast majority of banks, their role extends beyond the purchase of funds to provision of a number of services to their depositor. Such services are not accounted for, under the asset approach. Another limitation of the asset approach is based on the fact that only balance sheet data is included in the output set; with the result that any financial products such as securities or investment funds sold by a bank are ignored, despite their importance for the revenue generation.

4.4.5.3. The Value Added Approach

The value added approach, as proposed by Berger et al. (1987) , treats different balance sheet items as outputs, if these assets or liabilities are making any substantial contribution towards the bank value added. The remaining balance sheet items are treated as inputs, intermediate products or unimportant outputs; based upon the specifics of these items. Generally, the outputs under this approach include different categories of deposits and loans, as these are major contributors towards bank value added. Purchased funds of different types are considered as financial inputs, as these items need very few physical inputs (Berger et al., 1987).

4.4.6. The Production Approach

The production approach was first introduced by Benston (1965). Under this approach, financial institutions (such as banks) are considered to be service providers for their customers. Because of its focus on service provision function, this approach is also called the "service provision approach" (Bergendahl, 1998). An alternate view to look at banks under this approach is, as producers of different types of deposits, who use labour, materials and physical capital in the process (Ferrier and Lovell, 1990).

Major inputs in this approach comprise of physical variables such as; the number of staff, floor space, information systems and the quantity of materials used. Under the production approach, the interest cost is not included as an input, because only physical variables are considered to be required for providing services to the customers. The output variables are represented by different services provided to bank customers, and include such quantitative indicators as; type and number of transactions, number of financial products, number of accounts opened and the documents processed (Das and Ghosh, 2006). Outputs can also include any specialized services provided to customers during a certain time period. In the absence of data on detailed transaction flow, the data on stock of loan and deposit accounts are usually used as a proxy for the services provided (Camanho and Dyson, 2005). A major difference between production and intermediation approaches relates to their categorization of deposits. While production approach considers deposits as an output, the intermediation approach treats deposits as an input.

The production approach is considered more suitable for evaluating the efficiency levels of financial institutions at the branch level, as branches are primarily dealing with customer documents processing; while having little or no say in decisions regarding the investment and funding decisions of the institution (Berger and Humphrey, 1997) . Lack of data availability is quoted as a major cause for less frequent usage of the production approach (Efendic and Avdic, 2011).

The choice of underlying approach has significant implications for the inputs and outputs to be included in a DEA model. The approaches explained in the preceding section offer a variety of overlapping selections of inputs and outputs. Of these approaches, the intermediation approach and the production approach are two of the most frequently discussed approaches. For the performance evaluation of MFIs, selection of an underlying appropriate approach can be made by following the same considerations, as are applicable to the evaluation of other types of institutions. For example, a study of MFIs at branch level may be conducted under the production approach; while an institutional level study can be conducted under the intermediation approach, given the role of financial intermediaries played by the MFIs.

4.5. Selection of Appropriate Orientation for DEA Models

Selection of an appropriate underlying orientation is another key aspect of the DEA modelling that requires careful consideration. Major objectives underlying any analysis can play an important role in facilitating the selection of suitable orientation/s for DEA models. For example, management objectives of downsizing or cost saving, may justify the use of input orientation; while a focus on productivity augmentation, without utilizing any additional resources, would require an output orientation (Avkiran, 2001).

Another important factor that may be considered while deciding about the appropriateness of orientation, relates to the ability of the management to control different inputs and outputs. It is suggested that the underlying orientation for any DEA model should be in line with, whether the management has better control over the input or the output quantities (Coelli et al., 2005). Selecting an output orientation, when it is not possible to increase the outputs; or alternately, selecting an input orientation, when management is unable to control inputs, is not recommended.

It has been observed that studies involving commercially oriented financial institutions tend to use input orientation more often than output orientation. A justification for this practice is based on the fact that an increase in outputs is considered to be of lesser importance than the input conservation, for the purpose of setting benchmarks for the banking sector firms (Bergendahl, 1998). A key point to remember is that unlike commercial financial organizations, MFIs may not be overly concerned with minimizing inputs alone, as their outreach objective also necessitates maximizing outputs as a priority. On the other hand, an output orientation may not be a suitable choice in certain situations; particularly, when the MFIs being analysed are not in a position to maximize their outputs, due to such factors as lesser demand for outputs offered, or the inability of existing infrastructure to maximize production of outputs. Therefore, for the microfinance industry, a choice between input and output orientation should be made after taking into account various contextual considerations.

4.6. Selection of Appropriate Returns to Scale Assumptions

The concept of returns to scale has already been discussed in detail[43]. In this section, we summarize some general guidelines for the selection of appropriate RTS assumptions. It has been pointed out that the CRS assumption is more appropriate when all firms are working at an optimal scale (Coelli et al., 2005). We can find several examples for the use of CRS assumption in DEA based performance evaluation studies (Al-Tamimi and

[43] Refer to Section 3.5 for a discussion of various RTS assumptions.

Lootah, 2007, Alirezaee and Afsharian, 2007, Coughlan et al., 2010, Gümüş and Çelikkol, 2011). However, the CRS assumption may not be realistic in many empirical applications, due to the existence of such factors as; non-performing loans, regulatory changes, leverage concerns, and imperfect competition, which could result in less than optimal scale for the operations of financial institutions (Coelli et al., 2005).

Application of the CRS assumption, in cases where all the DMUs may not be working at optimal level, can result in contamination of technical efficiency scores, due to the presence of scale efficiencies. Therefore, in cases where the selected DMUs may be performing above or below the optimum levels, then VRS is deemed a better assumption (Efendic and Avdic, 2011). Just like CRS, many examples of the VRS based studies can also be found in the performance evaluation literature (Athanassopoulos, 1997, Pastor et al., 1997, Avkiran, 1999, Gelade and Gilbert, 2003, Das et al., 2009, Deville, 2009, Portela et al., 2012)

An important outcome of choosing the VRS assumption is that a DEA assessment conducted under this assumption may not produce the same relative efficiency scores under the input and the output orientations, which is the case for the CRS assumption. Such difference in scores is attributed to the selection of different variables used for measuring scale size, leading to different comparative scale sizes for DMUs, under the two orientations (Thanassoulis, 2001). This signifies the importance of exercising extra care, while choosing an appropriate orientation for the VRS based DEA models.

Another frequently observed practice in the DEA based studies is to use both the CRS and the VRS assumptions in the same study (Miller and Noulas, 1996, Athanassopoulos, 1998, Jemric and Vujcic, 2002, Sufian, 2006, Sufian and Habibullah, 2009, Tahir et al., 2009, Yang, 2009, Biener and Eling, 2011, Efendic and Avdic, 2011). Such practice is particularly useful if one is interested in analysing scale efficiencies, or when it is not clear *a priori*, whether or not the DMUs under consideration are working at an optimal scale. Note that the traditional regression based analysis, used for identification of the appropriate RTS assumption, is applicable only for single output cases, which makes it unsuitable for those DEA models that involve multiple input and multiple output correspondences. An alternate to the statistical tests for confirming appropriate RTS assumptions is to obtain expert opinions in this regard (Cooper et al., 2007).

4.7. Selection of Input and Output Variables for the DEA models

An important aspect of DEA based performance evaluation is related to the selection of appropriate inputs and outputs to be included in the DEA model. The following section details the major considerations, related to the variable selection process.

4.7.1. Major Considerations for Selecting Variables

A large variety of input-output combinations have been used in different DEA applications (Bergendahl, 1998). The identification of relevant input and output variables is a crucial step in any DEA assessment, as choice of these variables can have considerable influence on efficiency scores. It has been observed that the importance of appropriate selection of variables is greater for the non-parametric studies, as compared to the parametric analysis; due to the lack of any statistical tests of significance for the variables selected in the non-parametric studies (Gutiérrez-Nieto et al., 2007).

A commonly used approach for variable selection relates to major objectives of the firms under analysis. For example in a study of Nordic banks, Bergendahl (1998) observed that if major objective of banks is considered to be profit maximization, it would be appropriate to treat different categories of costs as inputs and revenues as outputs. If however, the major objective is assumed to be efficient service management, then the total volume of services needs to be considered as an output; while the cost of provision of such services should be considered as an input. In a similar manner, any study focusing on risk management efficiency should treat risk as an input and returns resulting from such risk taking as an output.

Another major consideration for variable selection should be to select input and output variables in line with the nature of industry or the organizational setting being analysed. In the words of Chorafas (1998), all business operations can be reduced to three words i.e. people, products and profits. It is therefore advisable that any study of operations should try to cover these three Ps of business operations, through the selected set of input-output variables. Relevant theories and underlying approaches can also play a central role in the selection of input and output variables. However, despite the well established presence of a variety of approaches, selection of inputs and outputs is still largely dictated by such factors as the availability of data, research problems and analysts' own view of the activities undertaken by the DMUs under analysis.

Developing a thorough understanding of all the variables relevant for the major objectives of a study is another important pre-requisite for ensuring suitable selection of inputs and outputs. Generally speaking, the inputs selected should be such that they reflect all the resources required for the production of outputs. Similarly, outputs to be included in any analysis should be such that they reflect the complete range of desirable outcomes, for which the selected DMUs need to be assessed. In addition, it is also desirable to include any environmental and non-discretionary factors that might be having an impact on transformation of inputs into outputs (Boussofiane et al., 1991, Thanassoulis et al., 2008). Any input or output is considered to be non-discretionary, if its value is not subject to management discretion or control. Depending on the nature of environmental factors, these could be included in an assessment either as inputs or outputs[44].

A final consideration for the variable selection process is to ensure that all relevant inputs and outputs have been identified, so that the whole range of activities is adequately reflected in subsequent models. There is always a possibility that some important variable could have been excluded due to limitations related to lack of data or small sample size (Avkiran, 2001). Such omission could have significant repercussions if this fact is not taken into consideration, when interpreting results of a DEA assessment. Addition of any irrelevant variable or alternately, failure to include any significant variable can also have serious implications for the results obtained from a DEA analysis.

4.7.2. Variables for Performance Evaluation of MFIs

Sustainability and outreach are the two primary criteria on which MFIs are evaluated globally (Tara, 2001). The literature on performance evaluation of firms identifies a number of variables that have the potential to capture the sustainability and outreach dimension of MFIs' performance. In the following paragraphs, a discussion of the major variables is provided.

Loan portfolio

Loan portfolio, also known as the gross loan portfolio or the total volume of loans, constitutes an important output in performance evaluation studies. Within the banking literature, this variable has been used quite frequently (Miller and Noulas, 1996, Athanassopoulos and Giokas, 2000, Jemric and Vujcic, 2002, Lin et al., 2009, Sufian and Habibullah, 2009). For the microfinance sector, this output variable is generally

[44] For an example of environmental variables and their treatment refer to AMADO, C. A. F. & DYSON, R. G. 2009. Exploring the use of DEA for formative evaluation in primary diabetes care: An application to compare English practices. *Journal of the Operational Research Society*, 60, 1469-1482. ibid.

used to represent the breadth of outreach (Gutiérrez-Nieto et al., 2007, Gutiérrez-Nieto et al., 2009).

Number of loans

Number of loans is a common indicator of outreach (Meyer, 2002). It is worth noting that the total amount of loans produced (or loan portfolio) is a more commonly used indicator, under the intermediation approach; while the total number of loans are usually used, in the case of production approach. Generally, the levels of average loan balance are considered to be an adequate measure of the outreach depth (Paxton, 2003, Hermes et al., 2011). The greater the number of loans created within a given volume of loan portfolio, the smaller the average loans size and the greater is the probability of serving poorer clients[45].

However, for evaluating MFIs, both these variables may have to be considered simultaneously. This requirement is based on the fact that for MFIs, making small sized loans to a large number of poor people is a basic requirement (Cull et al., 2011). Including only loan portfolio therefore may not be a good idea, as a large volume of loans may reflect positively on MFIs' performance, but if this amount is distributed through a small number of bigger sized loans, it could mean failure to achieve outreach depth. Similarly, the inclusion of number of loans alone, as an outreach indicator may result in ignoring the differences in total loan volumes and the related costs of loan production, across different institutions.

Another important factor to take into consideration is the fact that depending upon the institutional policies, a single borrower may be having more than one outstanding loan at any time. This could result in different figures for the number of loans and the

[45] There has been some disagreement on using this common proxy for outreach depth, with proposed use of other measures such as; ratio of average outstanding loan to per-capita Gross National Product, poverty levels of clients and other index measures.

number of borrowers for such MFIs. Therefore, from the perspective of outreach evaluation, it makes more sense to look at the total number of borrowers being served by an MFI. Otherwise, in situations involving multiple borrowing by the same clients, outreach efficiency may erroneously be magnified by over-representation of such clients; when using number of loans instead of the total number of borrowers as an indicator of outreach.

Loan officers and personnel

In performance evaluation studies of the financial institutions, the total number of personnel or related costs have been used as an input quite frequently; see e.g. Berger and Mester (1997), (Camanho and Dyson (1999), Avkiran (2001)), Jemric and Vujcic (2002), Tortosa-Ausina (2002) Pastor and Tortosa-Ausina (2008), and Caudill et al. (2009). In the case of MFIs, higher levels of staff productivity are believed to contribute positively towards achievement of their dual objectives (Baumann, 2005).

For evaluation of the staff productivity of MFIs, there is a choice between looking at total personnel; or alternately, focusing on the loan officers only. The personnel variable comprises of the total number of employees including; administrative staff, loan officers, contract based employees, and other advisory staff who may not be on employees' roster, but still spend most of their time with an MFI. Whereas, the employees spending most of their work hours in direct contact with the clients, are known as the credit or the loan officers.

The productivity of loan officers is used as an indicator of the lending efficiency in of MFIs (Meyer, 2002). The importance of loan officers in performance evaluation of MFIs is based on the particular nature of the role played by these officers. For MFIs, the quality of their loan portfolio relies mainly on the judgements made by the loan officers; during the screening and monitoring of potential and existing clients. Because of having a substantial impact on the repayment performance and outreach levels, the role played by the loan officers can have certain implications for the future of any MFI. It has been suggested in the microfinance literature that failure of loan officers could result in the failure of microfinancing (Dixon et al., 2007). Moreover, due to their direct and regular contact with clients, loan officers are able to provide invaluable feedback, based on identification of clients' needs; thus facilitating new strategies for product diversification.

When selecting inputs of the DEA models for MFIs' assessment, a choice may have to be made between the personnel and the loan officers. Among other considerations, the selection of either personnel or the loan officers can be made after taking into account institutional policies, with reference to the specific role assignments. For example, if there is clear cut distinction between the activities of the front line loan officers and the administrative staff, it would be acceptable to use the number of loan officers as an input. However, if there is an overlapping of the administrative and the front line roles, so that both type of activities might be undertaken by the same people, it may make more sense to consider total personnel, instead of loan officers.

A similar logic from banking literature, for considering the total number of personnel, instead of any sub categories, was presented by Schaffnit et al. (1997), who pointed out that different categories of staff do not work in isolation. Therefore, to ensure effectiveness and harmony of work processes, it is essential to take into account the broader scenario, rather than looking at different types of personnel in isolation. Summing up, the choice of using either the total personnel or only loan officers should be made, after looking at the overall research objectives and other considerations by the analysts; as the literature seems to support both choices equally. A final consideration related to this important variable is whether to use the number or the cost of staff as an input for the DEA models. In the case of well-developed microfinance sectors, with adequate levels of trained staff availability, competitiveness of job market will result in more or less similar costs, for similar levels of staff competencies. A focus on the number rather than the cost of staff thus may be acceptable in such cases. However, where differences in quality of staff are reflected in terms of higher staffing costs, it may be more appropriate to use monetary costs associated with the staff (Avkiran, 2001).

Female borrowers

Loans to females are another way of measuring outreach performance of MFIs (Meyer, 2002). Even if an MFI is successful in creating a large number of loans, unless a significant proportion of these loans is not granted to the females, the outreach performance of such MFI may not be considered satisfactory.

There is a general agreement within the microfinance sector that female clients tend to be more responsible, have lesser likelihood of becoming defaulters and use their loans for more productive purposes than their male counterparts (Armendáriz de Aghion and Morduch, 2010). In addition, women generally face more problems in accessing finance, as compared to men (Meyer, 2002). Consequently, the use of female clients as a measure of outreach is quite common, in performance evaluation studies of MFIs (Gutiérrez-Nieto et al., 2009, Hermes et al., 2011, Roberts, 2013). Female borrowers can be included either as a number, or as the proportion of total borrowers, depending upon the methodology and the availability of data.

However, whether or not this variable should be included within a DEA model should depend upon some practical considerations. For example, if higher levels of cost and complexity are involved in reaching the females as compared to the males, then it may be justified to use females as an output variable. Similarly, if females are found to face greater constraints in accessing funds, or if targeting females is found to provide greater benefits than targeting males, then it might make sense to look exclusively at female borrowers as outreach indicators. In the absence of any such conditions, the use of total number of borrowers or loans may be a more appropriate choice.

Another consideration in this regard is to determine whether targeting of female clients is a part of the major objectives of the MFIs being evaluated. If targeting females is not considered to be a primary goal[46], then use of this variable may not be a useful addition to the variables' set. Particularly, within a DEA context, the focus should be on providing a fair evaluation, based on what the DMUs (or the MFIs in this case) under consideration decide to produce; rather than penalizing them for what these DMUs cannot or do not decide to produce (Cook et al., 2013).

Loanable funds

Loanable funds represent the total amount of funds available for undertaking microfinancing activity. This variable comprises the amounts of deposits and any other funds, including borrowings, that may be available for on-lending purposes (Ariff and Can, 2008). Deposits are an important source of funds that receive interest payment. This quality of deposits qualifies their inclusion as an input in the analysis (Miller and Noulas, 1996). However, whether deposits need to be included as an input or an output, will finally depend on the use of the underlying modelling approach[47].

Loanable funds represent an important dimension of microfinance institutions' performance evaluation. MFIs can take a variety of structural forms such as NGOs, banks, cooperatives and development financial institutions. Because of this diversity, capital structures of these institutions vary significantly, across different types of MFIs;

[46] Two possible scenarios where females may not be considered as primary target clientele include a significantly larger male population and cultural or other constraints prohibiting female population from taking part in income generating activities.

[47] For example, this variable is generally used as an input under the intermediation approach, and as an output under the production approach.

thus rendering the use of another commonly used input (capital) unsuitable in some cases. It needs to be remembered that loanable funds are not to be considered purely as a proxy for capital. Rather, their inclusion may be required, based on the simple principle that whatever resources are used in the generation of outputs, need to be included in the efficiency analyses, through the DEA technique.

Operating expenses

Ability of an institution to manage its expenses at reasonable levels (in comparison to the revenues generated) can play an important role in ensuring its financial sustainability. It has been suggested in the literature that while considering expenses, both interest and non-interest expense items need to be taken into account (Chorafas, 1998). Interest expenses can be included either as a separate variable or may sometimes be added to the operating expenses (Berger et al., 1997). Non-interest expenses are also known as operating expenses and include administrative and personnel costs. These are used quite commonly as an input in efficiency studies (Sinuany-Stern et al., 1994, Gutiérrez-Nieto et al., 2007).

Number of deposits and saving accounts

Deposits generally refer to demand deposits, certificates of deposit and other types of fixed term deposits; accepted from clients and general public and held within the institution. Access to borrowing by the clients is not necessarily conditional upon the maintenance of such deposits. Saving accounts refers to voluntary or compulsory savings, deposited by the clients with their lending institution, which may or may not be held within the institution. Maintaining saving and other types of deposits on behalf of the clients is a practice that is not followed by all MFIs unanimously. Non-Bank MFIs especially, may not be allowed to accept deposits. Therefore, the use of this variable remains dependent upon the type of MFIs being evaluated.

Poverty level of clients

Another measure for analysing outreach levels achieved by MFIs, relates to the poverty level of the clients. While using ratio analysis, average loan balance per client is used as an outreach indicator. Loan size has been a major indicator for the outreach comparison, but is sometimes considered an indirect and rough measure (Morduch, 2000). Gutiérrez-Nieto et al. (2009) have proposed the use of a poverty reach index that is calculated by dividing average loan balance (per borrower) by Gross National Income (per capita). However, caution needs to be exercised when using such measures; based on the discord in the literature related to the use of ratios and index measures in the DEA models (Cook et al., 2014). Use of index measures in DEA is particularly not advised, based on the possible confusion in interpreting efficiency scores, obtained from a model having both index and volume measures (Dyson et al., 2001).

Number and geographical location of branches

In addition to the more common measures of outreach, such as the gender of clients, or the volume and number of loans; it is also possible to use the number or geographical spread of branches as a proxy, for representing the outreach dimension of performance (Sherman and Rupert, 2006). For example, MFIs having more branches in rural areas and slums are expected to serve more poor and resource deprived people, as compared to those MFIs, whose branches are mainly catering to the urban population. For incorporating this kind of information, the use of dummy variables is a common approach.

However, while the direct inclusion of such dummy variables is possible in statistical analyses, there is no such provision in DEA. Instead, the studies using DEA tend to adopt a two-step methodology to deal with this issue. Under this methodology, efficiency scores are obtained through DEA technique in a first stage of analysis and then some statistical test such as regression can be used for inclusion of the relevant dummy variables (Cooper and Tone, 1997, Avkiran, 1999). As proposed by Charnes and Cooper (1985), the use of other statistical techniques in conjunction with DEA can be quite useful for gaining additional insights.

Total income

Financial viability of any institution depends to a large extent on the sources of its income. Total income or its sub-components, i.e. interest and non-interest income can be used as an indicator of financial self-sufficiency. Non-interest income normally makes a smaller proportion of total income for MFIs as compared to banking sector firms in general, and may refer to the amounts received on one-off basis; such as from sale of some asset or received from the customers against services provided. Interest income, on the other hand, generally includes the revenues generated from the loan portfolio, financial services, or other financial assets. We can find examples of both the total income (Paradi et al., 2011), as well as, one or more of its sub-components (Athanassopoulos, 1997, Das et al., 2009), being used as output variables in efficiency studies.

Capital

Including capital as an input is a common practice in performance evaluation studies. There are a number of ways in which this variable can be incorporated in an analysis. For example, capital may be incorporated by taking the amount of operational expenses and deducting personnel expenses from this amount (Staub et al., 2010). There is also an option of including physical capital (value of fixed investments and premises) and equity capital (difference between assets and liabilities) as two different variables in an analysis (Akther et al., 2013). Taking the amount of total assets to represent capital is also acceptable (Bassem, 2008, Gümüş and Çelikkol, 2011). Yet another option is to include debt capital (total liabilities) and equity capital separately (Biener and Eling, 2011).

Measures of risk

Any model for performance evaluation of financial institutions needs to take into account the risk perspective. For the microfinance sector, the non-repayment of loans did not present a problem initially; with very high repayment rates observed for a vast majority of MFIs. However, more recently, there have been reports of increased default rates observed for microfinance sectors in different countries. This situation has led to greater concerns for viability of MFIs; thus necessitating inclusion of appropriate measures of risk, in performance evaluation studies of MFIs.

Diverse measures of risk have been used in different studies; such as; actual loan losses (Annim, 2012), loan loss provisions (Drake et al., 2006) and portfolio at risk (PAR) or non- performing loans (Bagherzadeh Valami, 2009, Paradi et al., 2011, Bartual Sanfeliu et al., 2013). Loan losses refer to the amount of debts that have been declared bad. Loan loss provisions, also known as loan loss experience, represent the amount of provisions set aside to cover bad debts. Portfolio at risk refers to the amount of non-performing loans, for which the due date of payment has already passed.

4.8. Some Additional Considerations

This section provides information about a few additional considerations that need to be taken into account during the DEA model development procedure.

4.8.1. Correlated Variables

The presence of correlated variables is sometimes used as a basis for reducing the total number of variables, by omitting some of the highly correlated variables. The most common objective for such an exercise is to improve the discrimination of the scores obtained through DEA. However, this practice of excluding variables solely on the basis of high correlation has been cautioned against (Jenkins and Anderson, 2003). Dyson et al. (2001) have also advised using correlation, only as a test for positive relationship between inputs and outputs; rather than as means of excluding correlated variables from the analysis. For example, in the case of MFIs, loan portfolio and number of loans are bound to have high correlation. Exclusion of either of these two variables can have considerable impact on efficiency scores; unless one is simply a multiple of the other. However, despite high correlation, inclusion of both these variables may be desirable for capturing the depth and breadth of outreach.

4.8.2. Lending Models

While evaluating and comparing performance of different MFIs, it is advisable to take into account the underlying lending models adopted by these MFIs. For this purpose, inclusion of dummy variables, reflecting such differences, can be an appropriate approach. As discussed earlier, the studies using DEA tend to adopt a two-step methodology for inclusion of dummy variables so that efficiency scores are obtained in the first stage of analysis. These scores are then used through some statistical techniques, such as regression, to further investigate the data set in the second stage of analysis (Cooper and Tone, 1997, Avkiran, 1999). In addition to the lending models, the two stage method can also be used for incorporating any additional considerations, such as environmental characteristic, that cannot be directly included in the first stage of analysis.

4.8.3. Subsidy Dependence of MFIs

The social mission of MFIs, which focuses on reaching poor people with financial services, has been largely supported by subsidized funds and grants, provided by various donor communities. However, with persistent reduction in subsidized funds and shifting of focus towards utilization of more commercial sources of funds over the last few years, there are large scale disparities in funding structures of various categories of MFIs. Consequently, any performance evaluation study of MFIs need to take into account, the extent of selected MFIs' dependence on subsidized funds and grants, for running their operations. The failure to do so can result in artificial inflation of financial performance of those MFIs that receive considerable amounts of subsidized funds; as opposed to those MFIs that do not receive such subsidies.

The Subsidy Dependence Index (SDI) proposed by Yaron (1999) is used frequently for measuring the impact of subsidies on financial performance of MFIs. However, the use of index measures in DEA based studies has been cautioned against, especially when such measures are mixed with volume measures (Dyson et al., 2001). An alternate approach to incorporate the subsidy dependence of MFIs is to use subsidy adjusted figures for various variables[48], selected for inclusion in the DEA models.

4.8.4. Modelling of Undesirable or Non-Isotonic Variables

The standard DEA models work on the assumption that outputs must be maximized; whereas, inputs need to be minimized. This assumption is known as isotonicity and has been used as a tool to facilitate classification of different variables as inputs or outputs. The condition of isotonic variables implies that a variable is to be classified as input, if lesser amount of that variable is considered desirable. Outputs, on the other hand, include variables, whose maximization or increase is more desirable.

However, there are certain exceptions to this general rule for situations where some non-isotonic variables may be present. For example, bad or doubtful loans are an undesirable output that should not be maximized; as greater production of this variable

[48] Interested reader is advised to refer to the website managed by PMN for details of how to calculate amounts of different variables after adjusting for subsidies.

indicates worsening of performance. To deal with such non-isotonic variables, a number of possible approaches can be adopted that have been suggested in the literature[49].

4.8.5. Heterogeneity Issues and Environmental Variables

Homogeneity is a basic assumption in DEA based studies; whereby, the firms under analysis are considered to be quite similar in terms of technology, environment, available resources, and operations. However, in real life, there are many situations where certain levels of heterogeneity may prevail among the firms being analysed. For the case of MFIs, we can identify two broad categories of heterogeneity issues existing in the environments within which different MFIs work. The first category relates to the use of cross-country data. As discussed in Chapter 2, there are a number of performance evaluation studies that have been conducted by using cross country data on MFIs. Although such data is intended to provide a comparison between performance levels of MFIs from an international perspective, there is a potential threat in the form of heterogeneity; resulting from different economic and regulatory environments prevailing in different countries.

While such heterogeneity is possible to exist more frequently for cross country data, it does not imply that the data from a single country will always be completely homogenous. To the contrary, within the same country, different MFIs may also exhibit a second category of heterogeneity; existing at the institutional level. This second category of heterogeneity can be based on differences in the organizational structures, regulatory authorities, lending models, age, and size of MFIs' operations. It is therefore advisable to take into account any exogenous factors in efficiency studies that use data

[49] See for example DYSON, R. G., ALLEN, R., CAMANHO, A. S., PODINOVSKI, V. V., SARRICO, C. S. & SHALE, E. A. 2001. Pitfalls and protocols in DEA. *European Journal of Operational Research,* 132**,** 245-259.

from a number of diverse sectors from within individual countries, or from similar sectors of different countries (Benston, 1965, Drake et al., 2006).

To deal with the heterogeneity issues present at the individual MFIs level, a possible solution is to make sub groups of more homogenous MFIs and then compare each MFI with others belonging to the same group (Dyson et al., 2001). The two-stage DEA, discussed earlier, is also an option. Moreover, there are a number of other approaches that have been recommended for dealing with various heterogeneity issues; a good review of which has been provided by Cook and Seiford (2009).

Chapter 5 Data Set and Research Design

5.1. Introduction

This chapter details various aspects of the research methodology used in the current study. First of all, the sample selection and the data collection procedure, and reasons for collecting data from a single country are elaborated. A snap shot of the selected microfinance sector, and the suitability of the sample with reference to the objectives of the current study; are discussed in the next section. This section is followed by information about the chosen unit of analysis and the rationale for selection of the underlying modelling approach. After this a discussion of appropriate RTS assumption and proposed orientation for current data set is provided. In the next section we offer an explanation of the model development procedure and the three DEA models proposed for MFIs' assessment. The final section offers a discussion of the selected input and output variables.

5.2. Sample Selection and Data Collection

The target population for this study includes a group of MFIs, located in a South Asian country, Pakistan. As discussed in the previous chapter, a vast majority of the studies in the field of microfinance have used MIX Market website, as the basic source of data. However, the current study has not used data from this particular site. In addition to the concerns raised about potential problems with the MIX Market data, a key reason for not utilizing this website is based on the fact that the kind of information required for our study was not completely available from this site. Whereas, the existence of personal contacts in a number of relevant financial organizations in Pakistan, has ensured access to consistent and reliable data required for the study.

The current study is cross sectional in nature; therefore, the final data has been collected for the year 2011, from those MFIs that are members of Pakistan Microfinance Network

(PMN)[50]. The task of data collection would have been impossible without the help received from PMN, as audited financial statements for many of the MFIs were not available publicly through their websites. This has also enabled us to overcome the challenge highlighted in the microfinance literature, regarding unavailability of audited financial statements that can lead to various inconsistencies in data reported by various types of MFIs (Caudill et al., 2009).

Focus on data from a single country is also considered desirable due to complexities involved in model development considerations, for dealing with exogenous factors and heterogeneity issues, frequently observed in cross country data[51]. Lack of academic studies focusing on the burgeoning microfinance sector in Pakistan, provides another reason for undertaking the current study using this data. During the last three years, we have approached a number of key operators in the Pakistani microfinance sector, and succeeded in forming a number of good working relationships. This has enabled us to collect a lot of data and background information on major MFIs working in this country, and also allowed us to develop a number of technologically realistic trade-offs[52].

5.2.1. An Overview of the Microfinance Sector of Pakistan

Establishment of the pioneer organizations Orangi Pilot Project and Agha Khan Rural Support Programme in 1980s, marked the advent of microfinance in Pakistan; and set the stage for what is now a flourishing sector on financial landscape of the country. After success of these programmes, the national rural support programme was introduced on a national level. In addition to the rural support programmes, various

[50] PMN was established in 1985 to support the microfinance sector of Pakistan, in achieving inclusive financial services for resource constrained population of the country.
[51] See section 4.8.5 in Chapter 4, for a discussion of the problems related to exogenous factors and cross country data.
[52] Chapter 6 provides a detailed discussion of the procedure adopted for identification of trade-off relationships.

specialized microfinance institutions and non-government organizations have also entered the microfinance arena to provide finance to poorer segments of the population. While the first two decades of microfinance in Pakistan saw relatively slow growth of the sector, things speeded up considerably from the year 2000 onwards. Establishment of Pakistan Poverty Alleviation Fund (PPAF) played a major role in this growth process. PPAF was established as an apex organization for providing wholesale refinancing facility to MFIs. Promulgation of the Microfinance Bank Ordinance 2000 and the Microfinance Institutions Ordinance 2001, introducing various prudential regulations for governing banking and non-banking sector MFIs, also marked significant milestones in history of Pakistani microfinance industry. The first microfinance bank in Pakistan was established in 2000, named Khushhali Bank (KB); with financing from Asian Development Bank (ADB). Presently, there are various types of microfinance providers in Pakistan, such as; microfinance banks, rural support programmes (RSPs), NGOs, and non-bank microfinance institutions. In addition to these main categories of microfinance providers, there is also a limited level of microfinance activity undertaken by government owned and commercial banking institutions.

5.2.2. Relevance of the Selected Sample for Research Objectives

The framework and the DEA models proposed in this study are intended to have a general applicability to diverse data sets, from different economic and financial environments. Having said that, it may be noted that the data for the current study has been collected from a country, whose microfinance industry is going through an interesting growth phase. Despite, or may be due to, the rapid growth of the microfinance sector in Pakistan; a number of challenges, related to the financial and social performance of MFIs, have been identified. This situation has particular relevance for the research objectives of our study that are related to the financial and social performance of MFIs.

Among the challenges faced by the MFIs selected for the current study; weak financial and operational sustainability, rising costs per borrower, and low productivity ratios have been recognized as some of the major constraints having adverse effect on performance of the microfinance industry in Pakistan. Moreover, there is continued reliance on subsidized credit, external support from national and international agencies, tax exemptions and donor funding that cast serious doubt on financial health of this important sector. At the same time, it is also observed that Pakistani microfinance sector has not been able to achieve economies of scale due to a number of factors, of which the issue of high operating costs remains a significant concern (Business Recorder, 2013).

The potential client base in need of microfinance services in Pakistan, is estimated to be between 25 and 30 million borrowers; whereas, current microfinance providers in this country are able to reach only 2.4 million people. It is believed that due to the large scale investment in establishment of physical infrastructure, personnel recruitment and branch network, most of microfinance providers are facing credit constraints. Such constraints result in increased pressure on MFIs to focus more on achieving financial sustainability rather than concentrating on their major objective of enhancing outreach (Business Recorder, 2013). Consequently, there seem to be only modest attainment of targets on the outreach dimension.

Microfinance industry of Pakistan thus faces the challenge of enhancing outreach, while remaining sustainable (Rauf and Mahmood, 2009). Considering this scenario, an analysis of the financial and social performance of MFIs from the data set obtained from this particular microfinance industry is hoped to be especially suitable for testing the existence of a conflict versus compatibility of the outreach and sustainability dimensions of the MFIs' performance.

The abovementioned challenges faced by Pakistani MFIs also highlight the need for undertaking research about various performance related issues, and propose ways for dealing with these challenges. However, in line with the trend observed for the overall microfinance literature, a search for the studies relating to Pakistan's microfinance sector reveals a focus on the impact assessment studies; with performance evaluation being ignored predominantly.

Within impact assessment literature, we can find a number of studies conducted by different MFIs, including; Kashf Organization, Orangi Pilot Project, National Rural Support Programme and Pakistan Poverty Alleviation Fund, to name a few. In addition, there are also a small number of performance related surveys and studies by the State Bank of Pakistan, Pakistan Microfinance Network, Pakistan Institute of Development Economics and Applied Economic Research Centre of Pakistan. Not surprisingly, most of these studies do not form a part of the formal academic literature on microfinance. We therefore conclude that the academic literature comprising of studies from Pakistan's microfinance sector is rather limited; thus providing further motivation to conduct this study, based on the data obtained from Pakistan's microfinance sector. By focusing on an under-researched country, we intend to contribute to the existing literature; in the form of additional insights and better knowledge about the operations of the MFIs working in developing economies.

5.3. Unit of Analysis

A unit of analysis is defined as the unit from which information has been obtained, for the purpose of undertaking analysis (De Vaus, 2002). Information or data can be collected either at the firm/institutional level, or within the firm, i.e. the branch level.

This study collects data at the firm level, and the firm (or the MFI) comprises the unit of analysis.

The use of consolidated firm as a unit of analysis is a common practice in the studies of financial institutions (Gilligan et al., 1984, Elyasiani and Mehdian, 1990). The selection of an entire institution rather than individual branches, as the unit of analysis, is considered preferable, because it is the consolidated firm that has the policy formulation and decision making power. Independent branches do not have this power, and are bound to implement the policies related to major lending, borrowing and operating practices; dictated to them by the head offices. As DEA tends to focus on decision making units (DMUs), therefore, firm as a whole is more appropriate for this purpose; though in many cases branch level data have also been used. Another reason for not using branches as units of analysis in current study is the fact that data on selected variables is available from the consolidated financial statements of MFIs as a whole, and not at the branch level.

5.4. Selection of an Approach for Modelling the Production Process

Two of the most commonly used approaches, for modelling the production process of financial firms, are the production and the intermediation approaches (Tortosa-Ausina, 2002, Tsionas et al., 2003). Simultaneous application of these two approaches has been recommended, for ensuring more comprehensive analysis (Camanho and Dyson, 2005). However, this task is not commonly accomplished due to the issues related to availability of data on certain variables that need to be included under the production approach (Berger and Humphrey, 1997, Tortosa-Ausina, 2002).

Of these two main approaches, we have decided to employ intermediation approach, which is considered to be a better choice for the current study, as compared to the production approach; based on the following reasoning. First of all, the intermediation approach is more suitable for studies involving financial firms as a whole. Production approach, on other hand, is considered more fitting for branch level studies (Berger and Humphrey, 1997). As current study is not looking at branch level data, therefore, the intermediation approach is more appropriate for this study. Another reason for selection of the intermediation approach relates to the ability of this approach to take into consideration overall costs; thus making it ideal for analysing overall economic viability of firms (Ferrier and Lovell, 1990). Production approach on the other hand is generally more suitable for analyses focusing on cost minimization objectives, as it only considers the production costs.

The choice of intermediation approach is also related to certain features of the institutions, included in our data set. It is observed that all the MFIs included in our analysis, irrespective of their governing structure, are involved in intermediation activities, i.e. these MFIs are using inputs such as physical capital and labour for converting financial capital (deposits and other borrowings) into micro credits and other earning assets. In addition, the ability of intermediation approach to take into account an important variable i.e. interest expense, that is ignored by production approach, and also various data quality and/or data availability issues faced by production approach, make intermediation approach a better choice in general (Elyasiani and Mehdian, 1990).

It is also observed that there exists a wide range of commercial and non-commercial institutional types, involved in micro financing. Samuel (2009) attributes this to the somewhat informal nature of micro financing as a development tool that started predominantly as a socially oriented paradigm, but has gradually incorporated elements of commercial viability and profitability. For current study also, the group of MFIs comprises of different types of microfinance providers. While the NGO category of MFIs relies on borrowing from different sources for creation of loans; the banking sector MFIs have the additional option of using deposits for generating loans. This necessitates looking at deposits as an input that is admissible under the intermediation approach (Elyasiani and Mehdian, 1990, Berger and Humphrey, 1997, Berger et al., 1997).

Finally, an important consideration to be taken into account, at the time of selecting a modelling approach, is related to the fact that suitability of any approach can vary depending on various contextual factors (Sufian, 2009). The practice of using more than one approach within a single study is also a recommended practice, for examining the robustness of resulting efficiency scores by using different alternatives (Sufian, 2009, Sufian and Habibullah, 2009). Therefore, considering the scope of the current study that necessitates an assessment of both the financial and social aspects of MFIs' performance, we propose the use of the profitability approach (for one of the models), in addition to the intermediation approach. The use of the profitability approach is also recommended, due to its ability of taking into account any unmeasured changes related to service quality, by incorporating higher returns earned against the improvement in quality of service (Berger and Mester, 2003).

5.5. Selection of Appropriate Returns to Scale Assumption

The selection of appropriate RTS assumption represents an important decision in the DEA model specification process. A number of approaches have been suggested for confirming the appropriateness of either the CRS or the VRS assumption in DEA based studies. For example, the use of hypothesis testing for determining the returns to scale effects has been proposed by Banker (1996). VRS assumption is suggested to be appropriate in studies involving large samples, where a significant correlation can be determined between size and efficiency of DMUs.

Another simpler alternative is to run the DEA models with both the CRS and the VRS assumption and compare the resulting efficiency scores. Large variations among scores obtained by the same DMUs, under the two assumptions, could reflect suitability of VRS assumption and vice versa (Avkiran, 2001). An alternative approach suggested by Cooper et al. (2007) is to make use of the expert opinion that can help estimate the appropriate RTS in DEA based studies.

For the current study, final selection of an appropriate RTS assumption has been made by following two of these approaches. We first ran the DEA models under both the constant and variable RTS assumptions using Excel Solver and the EMS. It was noted that a number of DMUs obtained different efficiency scores under the two assumptions, which led us to believe that VRS assumption might be more suitable for our data set. However, in order to further confirm this initial assessment, we investigated this issue with the help from a number of microfinance practitioners, in accordance with the approach suggested by Cooper et al. (2007). When questioned about RTS for the MFIs included in our analysis, these people suggested that an increase (or decrease) in the selected inputs is expected to produce a disproportionate increase (or decrease) in the outputs, across different MFIs; thus suggesting that the selected MFIs are operating at variable returns to scale. This feedback from industry specialists helped verify appropriateness of the VRS assumption for the current study.

We would like to point out that using both the CRS and the VRS assumption in the same study is in accordance with the general practice adopted by most of the DEA based studies of financial institutions[53]. A basic reason underlying this practice is related to the determination of the appropriate RTS assumptions. However, for the current study another motivation for this practice has been to demonstrate that the

[53] Refer to Chapter 4, section 4.6 for a list of studies using both the CRS and the VRS assumptions.

application of the trade-offs approach is equally suitable under both the CRS and the VRS assumptions.

5.6. Selection of Underlying Orientation

For this study, we have decided to use output orientation. This selection is made after a careful consideration of the unique nature of MFIs. It can be argued that for the traditional financial institutions such as commercial banks, a focus on minimizing inputs for increasing their profitability is largely considered acceptable[54]; even if such profitability may be achieved to the detriment of some of the outputs. But the unique double bottom line nature of MFIs requires that in addition to ensuring profitability, these institutions should strive to increase their outputs, by reaching maximum number of poor clients, using the given level of inputs available to them.

This selection is also in line with the logic put forward by Sedzro et al. (2010) that MFIs are rather constrained, both in terms of size and available resources, in contrast to the traditional banking sector firms. Especially, with a decrease in donor funding, the amounts of loanable funds that constitute an important input, are becoming increasingly constrained. Therefore, keeping in view the importance of their social mission of helping maximum number of poor people, these institutions should aim to maximize their output given their limited resources. An emphasis on cutting back any further on the already constrained resources (or inputs), which would be a natural outcome for input orientation, does not augment well for the social mission of these institutions.

Another factor supporting our choice of the output orientation relates to the gap observed, between the demand and supply of the microfinance services provided by the

[54] For details of the studies in banking sector that use input orientation, refer to CAMANHO, A. S. & DYSON, R. G. 1999. Efficiency, size, benchmarks and targets for bank branches: An application of data envelopment analysis. *The Journal of the Operational Research Society*, 50**,** 903-915.

selected MFIs[55]. This gap suggests the opportunity for these MFIs to increase their outputs. The inputs for provision of these services, on the other hand, are quite constrained and not under the control of MFIs. It is suggested in literature that selection of an orientation should be made in line with which input or output quantities are more under the control of the managers (Coelli et al., 2005). The aforementioned situation suggests greater control of MFIs on outputs' generation, as compared to inputs' allocation, and thus suitability of an output orientation for current study can be justified.

5.7. Model Development Procedure

The approach adopted in this research follows a multi-stage process, based on three models. In the first stage, an existing model commonly used for assessing profitability of financial institutions is utilised, for measuring financial sustainability of MFIs. In the second stage, an outreach model is proposed, for measuring the depth and the breadth of outreach achieved by MFIs. Based upon information drawn from the results of these two models; we propose a final model that focuses on both the financial and social aspects of MFIs' performance.

Through the multi-stage approach adopted in this study, we are able to focus on the two major objectives of financial sustainability and social outreach; first individually, and then more holistically. This approach of taking into account major objectives of MFIs is adopted for ensuring the effectiveness orientation of DEA, which is not possible without taking into consideration the mission and major objectives of the organizations being assessed (Sarrico and Dyson, 2000).

[55] According to an estimation by MicroWatch (Issue 28- 2013), of a total potential microfinance market in Pakistan comprising of 27,407,048 people, only 2,635,312 people are being served currently, thus implying a very low penetration rate.

5.8. Discussion of the Proposed Models

Our selection of the DEA models used in the current study is based on a detailed review of the microfinance and efficiency literature. In addition to the selection of appropriate modelling approach and the underlying orientation, this review facilitated compilation of a comprehensive list of different input and output variables; used for performance evaluation of various types of financial and non-financial institutions. From this comprehensive list, we have short listed some of the more relevant variables; keeping in view the major research objectives, data availability and other methodological considerations. A discussion of the three DEA models used in the current study is provided hereafter.

5.8.1. The Profitability DEA (PDEA) Model

The profitability model is used to evaluate the financial performance of MFIs, by taking into account their profit orientation. This model was originally proposed by Leightner and Lovell (1998), under the revenue or income based approach; and includes various revenue and cost components from profit and loss accounts of the firms, as major outputs and inputs respectively. The exclusion of revenues, from the cost and other approaches generally used in the performance evaluation studies, can result in overlooking of profit maximization aspect of performance. Use of profitability approach, on the other hand, can facilitate capturing of the profit maximization objective, through inclusion of both the revenue and the cost items (Berger and Mester, 2003).

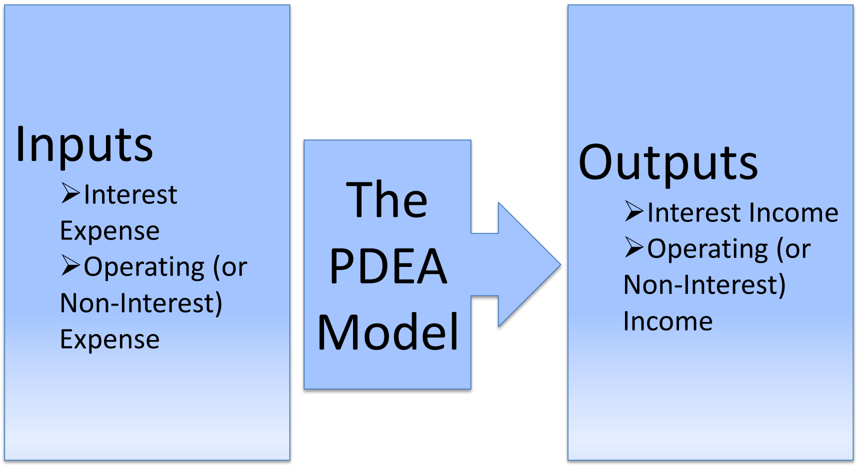

Figure 5.1 Inputs and Outputs for the Profitability DEA Model

As can be seen from the Figure 5.1, the input variables in this model include total interest expense and the operating expense (also known as the total non-interest expense). The output variables include the total interest income and the total operating (or non-interest) income. Another option for this model is to include loan loss provisions as a third input; as suggested by Drake et al. (2006). The ground on which inclusion of this variable is not considered feasible for the current model is that loan loss provisions are generally considered as a measure of risk. For our sample, the risk factor is minimal, with all the selected MFIs having a PAR (portfolio at risk) value of around 5 %. This value of PAR is considered an acceptable limit from risk perspective, as reported by the industry experts from the Pakistan microfinance sector. Therefore, neither loan loss provisions nor any of the other commonly risk related variables have been directly included in the PDEA model[56].

[56] However, the amount of loanable funds (which constitute an important input for the remaining two models of the current study) is calculated by deducting the amount of loan loss provisions, as a means of ensuring loan quality.

5.8.2. The Outreach DEA (ODEA) Model

The outreach (ODEA) model is designed to evaluate the outreach dimension of MFIs' performance. An important consideration for the development of this model is related to the selection of a comprehensive set of inputs and outputs that would be able to appropriately capture the outreach performance of MFIs. Based on the suitability of the intermediation approach for the current study, deposits should form a part of the input set. For studies focusing entirely on the MFIs working as banks, deposits can be included as a separate variable. However, for the current study, using deposits as a separate variable is not feasible because non-bank MFIs (also referred to as the NGO-MFIs) may be able to gain advantage over bank MFIs, by showing zero values for this input. Instead, we have used an input variable "loanable funds" that comprises both the deposits and the borrowings used for generation of loans.

Under the intermediation approach, we have also selected operating expenses as an input variable. A third variable included in the input set of this model is the number of loan officers. The number or costs associated with the personnel (or labour) employed, is a classical input that has been frequently used for evaluating efficiency of different types of organizations through DEA (Sherman and Gold, 1985, Berger and Humphrey, 1991, Berg et al., 1993, Athanassopoulos, 1997, Portela and Thanassoulis, 2007, Akpalu et al., 2012). In studies involving microfinance sector, both the number of loan officers and the total number of personnel have been used alternately (Gutiérrez-Nieto et al., 2007, Bassem, 2008, Gutiérrez-Nieto et al., 2009, Bassem, 2014, Widiarto and Emrouznejad, 2015).

The use of loan officers, instead of total number of personnel, is considered appropriate for evaluating efficiency of MFIs, given the greater importance of the role played by loan officers, as compared to the back end administrative personnel, in ensuring creation of a larger number of loans[57]. It may be noted that including the number of loan officers (or the number of personnel) is a more common practice under the production approach. However, combining variables from more than one approaches is not uncommon in DEA studies, see e.g., the study by Gutiérrez-Nieto et al. (2007), which uses these two approaches simultaneously for variable selection.

The output variables in this model include both the loan portfolio and the total number of loans, based on two reasons. Firstly, through inclusion of loan portfolio variable, in addition to the number of loan officers and the number of loans, it can be reasonably ensured that any MFI that may choose to employ a smaller number of loan officers to produce a smaller number of loans would not be able to score unnecessarily high efficiency scores. This is because, all else being equal, other MFIs with similar volume of loan portfolios would be in a position to achieve higher scores, through greater utilization of loan officers for producing loans, as compared to such an MFI.

Secondly, for MFIs, the greater the number of loans created within a given volume of loan portfolio, the smaller would be the average loans size; and thus greater is the probability of serving poorer clients. Therefore, inclusion of number of loans created by an MFI is meant to assess their outreach dimension. On the other hand, it is observed that the MFIs having more years of operations tend to have more clients, who qualify for bigger sized loans; thus leading to bigger amounts of loans (or loan portfolio) as compared to the relatively younger institutions. Therefore, our decision to include total loan portfolio in addition to the number of loans is also meant to avoid penalizing more mature MFIs unnecessarily.

[57] For more on the importance of loan officers, refer to section 4.7.2 in Chapter 4.

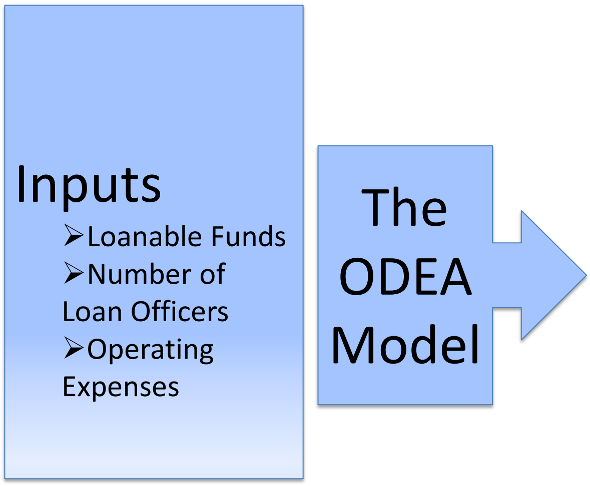

Figure 5. 2 Inputs and Outputs for the Outreach DEA Model

Another possible option for this model could have been to replace the total number of loans with the number of male borrowers and the number of female borrowers. Yet another possibility would be to consider the total number of female borrowers as a measure of outreach. However, for current data set, both these options were considered infeasible. This was due to the fact that some of the MFIs included in our analysis were lending exclusively to females, as part of their mission statement; and therefore had no male clients. Consequently, inclusion of the female borrowers as an output variable could have resulted in unrealistic inflation of the efficiency scores of such MFIs, in comparison to the MFIs that do not specifically target the female clientele. Moreover, for current data set, the cost and the benefits arising out of providing microfinancing services to females is not considered to be significantly different from that of lending to the males. Based on this fact, differentiating MFIs' performance, based on the gender of their clients was not considered to be a suitable option in this particular case.

5.8.3. The Double Bottom-line DEA (DBL-DEA) Model

This is the final model proposed in the current study that incorporates the profitability and outreach performance dimensions of MFIs, simultaneously. The variables selected for this model are represented in a pictorial form in the Figure 5.3.

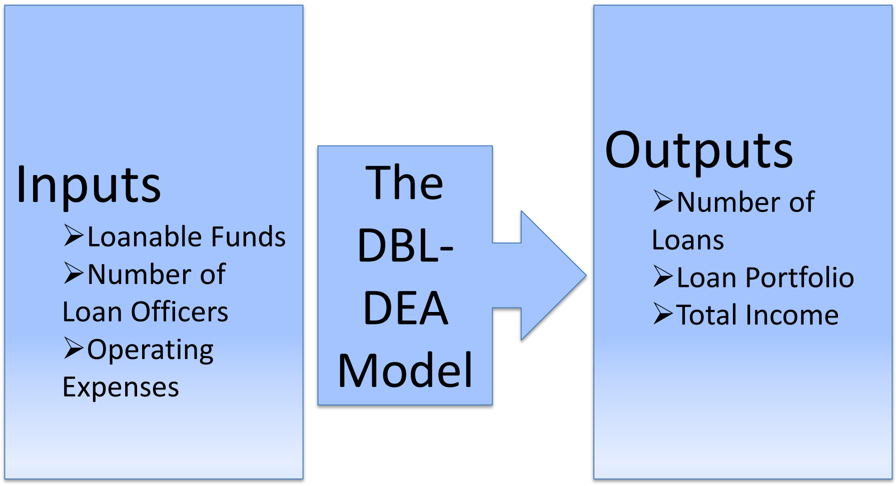

Figure 5. 3 Inputs and Outputs for the Double Bottom-Line DEA Model

For the DBL-DEA model, the foremost consideration relates to the selection of a set of variables that can incorporate both the financial and social aspects of MFIs' performance. The inclusion of loan portfolio and the total number of loan, is thus used as a means of incorporating the outreach dimension of performance. As discussed earlier, inclusion of number of loans is intended to explain differences in loan sizes offered by different MFIs; while the simultaneous inclusion of loans' volume is meant to avoid penalizing more mature MFIs with clients qualifying for bigger loans.

For capturing the financial dimension of MFIs' performance, the inclusion of total income as an output, and operating expenses as an input is proposed. As suggested by Berger and Mester (2003), such incorporation of revenue and cost components can enhance the ability of a model to capture the goal of profit maximization. The amount of loanable funds and the number of loan officers comprise the rest of the input set[58].

It is worth mentioning here that during the selection of appropriate input and output variables for the current study, it was realized that the presence of different categories of MFIs, such as NGOs and non- NGO (or bank) MFIs, could lead to a possible complication. There was a concern that certain categories of these institutions (such as the bank MFIs) that were having shareholder funding, could have an advantage over other categories of MFIs, due to greater access to such free or low cost funds for on-lending purposes. However, upon investigation it was found that before 2012, all the MFIs in Pakistan were allowed to use the free funds obtained through grants and donations for on-lending purposes. As the NGO MFIs tend to attract a greater proportion of such free funds, due to their appeal to the donor community, this implied that just like bank MFIs, these NGO MFIs were also having adequate reserves of free or low cost funds. Therefore, the bank-MFIs could not have any major advantage over the NGO MFIs in terms of availability of low cost funds.

5.8.4. Units of Measurement for the Selected Variables

The variables selected for the three proposed DEA models are measured using both monetary units and non-monetary units. These variables, along with their classification as inputs or outputs, and the respective units of measurement are listed in Table 5.1.

[58] The rationale for the selection of these two variables has been provided earlier, while describing the ODEA model.

Table 5. 1 Classification and Units of Measurement for the Selected Variables

	Variables	Classification	Units of Measurement
1	Interest Expenses	Input	Pakistan Rupees (PKR)
2	Operating or Non-Interest Expenses	Input	Pakistan Rupees (PKR)
5	Loanable Funds	Input	Pakistan Rupees (PKR)
6	Number of Loan Officers	Input	Number
3	Interest Income	Output	Pakistan Rupees (PKR)
4	Operating or Non-Interest Income	Output	Pakistan Rupees (PKR)
7	Number of Loans	Output	Number
8	Loan Portfolio	Output	Pakistan Rupees (PKR)
9	Total Income	Output	Pakistan Rupees (PKR)

5.9. A Description of the Selected Variables

In this section, we provide a description of those variables that are included in the three DEA models, used for analysing the selected MFIs, in the current study.

Loanable funds

Loanable funds include deposits and borrowings from different sources and constitute an important input for production process of MFIs. The amount of deposits represents demand deposits accepted from both the clients and the general public, and may also include any deposit certificates or fixed term deposits. Borrowings represent all the funds borrowed for the purpose of advancing loans to MFIs' clients.

Operating expenses

Operating expenses consist of administrative and personnel expenses, and include such items as; cost of labour, rents, software, utilities, and communication.

Interest expenses

As suggested by the literature (Chorafas, 1998), we have considered both the interest and the non-interest (or operating) expenses in the current study. While the operating expenses include administrative and personnel costs, the interest expense is represented by the total amount of interest paid by an MFI on deposits and borrowings.

Loan portfolio

This output variable represents outstanding principal amount for total micro credits, less the amount of provisions. Deduction of provisions is used as a tool to account for quality of loans. This amount includes restructured and delinquent loans, but does not include; loans made to employees, any interest receivable, or written off loans.

Number of loans

Total number of loans includes all those loans that have not been fully repaid or written off, and are included in the loan portfolio of an MFI.

Interest income

This variable represents the income earned from loan portfolio.

Operating Income

The operating (or non-interest) income comprises the amounts earned by an MFI from various activities other than lending.

Total income

This variable comprises of the income generated from MFIs' loan portfolios (including interest, commission and fees associated with loan portfolio), income from other financial assets and income received against charges for various services provided. We have used total income as an indicator of financial self-sufficiency of MFIs, because maintaining sufficient levels of revenues can help ensure sustainability in long run.

Number of loan officers

The total number of employees, spending most of their work hours in direct contact with clients, is known as the credit or loan staff. This variable includes: staff opening and maintaining client accounts, recovery officers for delinquent loans, and any other such staff whose main job description involves direct client contact.

Chapter 6 The Trade-off Approach: An Application to Microfinance Industry

6.1. Introduction

This chapter is related to a major objective of the current study, which entails providing a detailed demonstration of the procedure for application of the trade-off approach, within a microfinance set up. In the first section, we briefly review the motivation for application of the trade-off approach. This section is followed by a discussion of some key considerations related to, and an explanation of the procedure adopted for, the identification of technologically feasible trade-off relationships. The next section provides a detailed discussion of the trade-offs proposed for the current data set, and the relevant mathematical formulations. Finally, we discuss some additional trade-off relationships that might be useful for future studies, based on different data sets.

6.2. Motivation for Application of the Trade-Off Approach

The application of the trade-off approach in the current study is motivated by the potential improvement to the standard DEA models; resulting from the incorporation of additional information, in the form of technologically realistic trade-offs. Through incorporation of such additional information, the production technology is enhanced. The enhanced technology resulting from the proposed application thus leads to better informed models that are capable of providing additional insights, as compared to the un-restricted models. Moreover, as the expansion of PPS is achieved through relying on realistic technological trade-offs, therefore the producibility of the radial targets for inefficient DMUs can be ensured in such a case.

Another positive outcome of the proposed application is the improvement in DEA models' discrimination. This quality of the trade-off approach is particularly relevant for the current study; given the relatively small data set available, and rather large number of variables that need to be included in the analysis, for capturing the dual bottom-lines of MFIs. As discussed earlier, small data sets have the potential to cause the problem of insufficient discrimination in DEA based studies. In the presence of insufficient discrimination, it becomes relatively difficult to differentiate performance of DMUs, as most of them are able to achieve large efficiency scores.

Podinovski and Thanassoulis (2007), offer a number of suggestions for improving discrimination of DEA models. Another interesting read in this regard is provided by Angulo-Meza and Lins (2002), who conducted a review of various methods used for improving discrimination. Of various available approaches, weight restrictions approach remains one of the most widely used technique, for improving DEA models' discrimination. However, despite its wide spread usage, there are certain limitations that have been associated with the traditional method of applying weight restrictions approach[59]. The trade-off approach, proposed by Podinovski (2004b), suggests incorporation of weight restrictions in the envelopment form of DEA models[60], which is in contrast to the traditional method of applying weight restrictions in the multiplier form. This novel method of applying weight restrictions therefore results in making the interpretation of efficiency more meaningful (Podinovski, 2004a, Podinovski, 2005).

[59] For a review of weight restrictions and associated limitations, see Chapter 3, section 3.10
[60] Refer to Chapter 3, section 3.11-3.14for a detailed explanation of the trade-off approach.

6.3. Identification of Trade-Offs: Some Important Considerations

Before moving on to the task of explaining the procedure, used in trade-offs' identification for the current study; we would like to emphasize that trade-offs are assumptions that have to be acceptable, to all the DMUs under consideration. Moreover, the trade-off relationships do not simply follow from the data, though data can help in identification of potential trade-off relationships. It is important to support any proposed trade-off relationship with the help of expert judgement. On the other hand, experts' judgement should also be consistent with the data and relevant theoretical underpinnings. Ensuring this two-way authenticity is a complicated procedure that needs careful thinking, planning and execution.

Another potential complexity in this regard, is related to phrasing the proposed trade-off relationships in such a manner that they can be communicated to, and understood by, all the stakeholders accurately. This exercise may involve repeated rephrasing of the questions formulated for the purpose of confirming the proposed trade-off relationships. We would also like to point out that the trade-off relationships identified in current study represent experts' judgements related to technological realities. As such, these are estimates only. It is neither possible nor intended to specify the exact relationships. A useful implication of the fact that the trade-offs are estimates and don't need to be specified as exact relationships is that we can work with very broad and flexible estimates, which may still be useful for improving discrimination.

A final consideration related to the trade-offs is the choice of the method to be used for their incorporation into standard DEA models. There are two basic methods for incorporating trade-offs into a DEA model[61]. Based on the ease of computation, we opt for the method whereby the proposed trade-offs are converted into equivalent weight

[61] Refer to Chapter 3, section 3.11.2 for a discussion of the two methods.

restrictions that, in turn, can be incorporated in any standard DEA software. Note that irrespective of the fact that these trade-offs are converted into weight restrictions for the ease of computation, the technological meaning of the resulting efficiency scores always remains preserved. This is because the trade-offs are based on technological realities, which is not always the case for weight restrictions that are generally based on value judgements.

6.4. Procedure for Trade-offs' Development for the Current Study

The trade-off approach works by introduction of technologically possible changes, introduced simultaneously to different inputs and outputs. In this section, we provide a detailed explanation of the procedure adopted for identification of various trade-offs, applicable to the current data set. The main objective here is to clarify the complexity involved in this procedure.

The application of the trade-off approach required, first of all, the identification of the possible trade-offs, for the production technology used in the microfinance sector. Such identification was not possible, without first developing a thorough understanding of the MFIs included in the current study, in particular; and also of the microfinance operations, in general. For understanding the operations of MFIs, a thorough review of the microfinance literature, with a particular focus on performance evaluation of MFIs, was conducted as a first step. Moreover, preliminary general information about the selected MFIs was collected through easily accessible sources, such as the websites maintained by various MFIs. For better understanding the scope of activities undertaken by Pakistani MFIs, a review of relevant prudential regulations was also conducted.

After the initial phase of collecting the peripheral information, the more complicated task of identifying the technologically realistic trade-offs was initiated. In this phase, the knowledge gained about various indicators of performance, specifically developed for the evaluation of microfinance sector, played an important part. Along with this knowledge, a preliminary analysis of the data helped us in proposing several tentative trade-off relationships. Moreover, for ensuring the practical worth and authenticity of the proposed trade-offs, getting feedback from the experts, who had direct exposure of the microfinance industry in Pakistan was essential. For this purpose a number of useful contacts were established, and the feedback from relevant personnel was sought on a regular basis, throughout the period of this research. The input from various analysts at the PMN, who were directly responsible for MFIs' data collection and analysis, proved to be invaluable at this stage.

Based on the feedback from this initial phase, some of the originally proposed trade-off relationships had to be discarded. Those trade-offs, which were considered more realistic from a technological perspective, were then communicated to the microfinance experts through elite interviewing approach[62]. Interviewees included both top and middle level management of the relevant MFIs, as well as the senior management of the PMN. The initial set of interviews took place through Skype and phone calls, in which the basic research plan for the current study and the concept of trade-offs were discussed thoroughly, to ensure better understanding of the research objectives and methodology. This stage sometimes required us to phrase the questions in different ways, to make the interviewees understand what we meant from the proposed trade-off relationships.

For some of the trade-offs, we were able to propose tentative values; whereas, for others, the respondents were asked to provide their own estimates of the numbers, related to these trade-offs, after considering the technologies possessed and constraints faced by various MFIs. For example, we asked the management of different MFIs that if

[62] Elite interviewing refers to a well-known qualitative research methodology. For further information, reader is referred to HARVEY, W. S. 2011. Strategies for conducting elite interviews. *Qualitative Research,* 11**,** 431-441.

they were having an extra one million (PKR) of loanable funds at their disposal, how much increase in the loan portfolio and number of loans they will expect; from using that additional money in any given year. Later on, these people were called again to discuss any ambiguities related to the proposed trade-offs. Finally, the responses were collected and organized; which took three main forms, i.e. acceptance, rejection or modifications suggested for the numbers or limits proposed for various trade-offs.

We were then able to compare the information collected from different respondents, which helped us confirm the values for the proposed trade-off relationships. Through this procedure, a number of trade-off relationships were finalized. Of these, we then isolated those trade-offs, for which agreement of the selected MFIs was unanimously ensured.

Through this exercise, two different sets of trade-offs were identified for the outreach (ODEA) and profitability (PDEA) models. Based on these trade-offs, the final trade-offs capturing both outreach and sustainability performance dimensions were finalized for the double bottom-line (DBL-DEA) model, with some minor adjustments. An explanation of the proposed trade-offs is provided in the next section.

6.5. Proposed Trade-offs for the Profitability DEA (PDEA) Model

The PDEA model is used for analysing the financial performance of MFIs, by looking at two inputs (interest expense and operating expense) and two outputs (interest income and operating income). The rationale for use of this particular model, as a tool for assessing financial sustainability dimension of the MFIs' performance, has already been discussed in Chapter 5. Here, we would like to elaborate how the application of appropriate trade-offs can help in incorporation of additional relevant information to the standard DEA models. For the PDEA model, we were able to finalize trade-off relationships between three variables i.e. interest expense, interest income, and operating income. These trade-offs are explained next.

Trade-off 1: Interest expense and interest income

Judgement: ***For each additional million of interest expense, an increase of 1.5 million in interest income is technologically possible, without requiring any additional resources*[63]*.***

Explanation: An alternative explanation of this trade-off is that in order to increase the interest income by 1.5 million, no more than an increase of 1 million in the interest expense is required. This first trade-off relationship has been represented through a simple judgement that proposes simultaneous changes to the values of one input (interest expense) and one output (interest income); while the remaining two variables of the PDEA model remain unchanged. From the perspective of enhancing profitability, increased expense is an extra cost that should be incurred only if it is possible to earn something over and above the cost incurred. Moreover, increased interest expenses generally represent additional funds available, for provision of micro credits and related services to the clients. These additional funds are thus expected to generate more loans, leading to earning of additional income for the MFIs.

Now, we will explain how we arrived at the values for the proposed trade-off between the interest expense and interest income variables. For getting an initial estimate for the value of the proposed trade-off; we investigated the relevant interest rates, applicable to the borrowing and lending of the MFIs in our sample. It was observed that the microfinance industry in Pakistan was having access to cheap funds from PPAF and other resources. On the other hand, these MFIs were charging comparatively higher

[63] For information on relevant units of measurements used for different input and output variables, refer to Chapter 5, section 5.8.4.

interest rates on amounts lent[64], as is the common practice in most microfinance industries. As a further test for estimating an appropriate value for the proposed trade-off, we reviewed our data set and calculated the ratio of interest income to interest expenses. It was observed that the average value for this ratio was 3.63.

These observations led us to believe that the selected MFIs can increase their interest income by more than three times the value of the interest expenses incurred. Therefore, we initially proposed a ratio of 1: 3, between interest expense and interest income. These proposed values were then communicated to different respondents for their feedback. Many of the MFIs considered the increase of 3 million in interest income, resulting from a 1 million increase in interest expense, feasible. However, there were some MFIs, which considered the proposed increase to be somewhat high. Therefore, considering the fact that the any trade-off relationship is required to be acceptable for all MFIs, we then proposed an increase of either 2 or 1.5 or 1 million in interest income. We were finally able to get a consensus that with an additional 1 million of interest expense, it would be possible to increase the interest income by 1.5 million.

Translating Trade-off 1 into equivalent weight restriction

As discussed earlier, existing DEA software do not support incorporation of required modifications, resulting from the proposed trade-off relationships, in the envelopment form of the DEA model. However, if we translate the proposed trade-offs into equivalent weight restrictions, we can use any standard DEA software for calculation of efficiency scores. Therefore, the next step in the application of the trade-off approach required us to translate the proposed trade-off into corresponding weight restriction, which could then be incorporated into the multiplier DEA model, as an additional constraint. The general form of the output oriented multiplier DEA model is presented

[64] The subsidized interest rates available to the selected MFIs, ranged from 5 to 8 %. While the interest charged on loans by MFIs (constituting interest income for these institutions) was around 33% on average.

in Chapter 3, Model 3.12. As we are using homogeneous weight restrictions; therefore, for the PDEA model, we consider the following generally used form of the homogenous weight restrictions:

$$a_1u_1 + a_2u_2 - b_1v_1 - b_2v_2 \leq 0 \qquad (6.5.1)$$

In the above equation, a_1 and a_2 are the coefficients for the weights u_1 and u_2 attached to the two outputs (interest income and operating income). While b_1 and b_2 are the coefficients for the weights v_1 and v_2 that are attached to the two inputs (interest expense and operating expense). Each of the four coefficients a_1, a_2, b_1, and b_2 can be either zero, positive or negative. Moreover, if at least one of the coefficients a_1, a_2, and one of the coefficients b_1, b_2 are equal to some non- zero values, then the corresponding weight restriction would be called a linked weight restriction; because it would be linking input and output weights. Using these notations, the proposed trade-off can be expressed as follows:

$$(a_1, a_2) = (1.5, 0); \qquad (b_1, b_2) = (1, 0) \qquad (6.5.2)$$

For incorporating this trade-off into the dual multiplier model, we need to translate the above formulation into an equivalent weight restriction, which can be written in the form:

$$1.5\ u_1 - 1\ v_1 \leq 0 \qquad (6.5.3)$$

According to this constraint, an increase of one million in interest expenses is adequate for increasing the interest income by 1.5 million, provided that nothing else changes.

Trade-off 2: Interest expense, interest income and operating income

Judgement: ***For each extra million of interest expense, an increase of 1.5 million in interest income and an increase of 0.2 million in operating income is technologically possible, without requiring any additional resources.***

A basic assumption for Trade-off 1 is that an increase in the interest expense will only affect the interest income, while no other variable would be affected. In other words, the proposed trade-off will not result in a change in either the operating expense or the operating income, which are the two remaining variables for the PDEA model. We need to explain here that this assumption may or may not hold true in different situations. For example, if we are looking at it purely from the outreach perspective, then ideally, all the available funds should be used only for creating loan portfolio. This would mean that there would not be any substantial increase in the operating income with increase in the amount of the increased interest expense. Conversely, from a profitability perspective, augmentation of MFIs' earnings from various sources, in addition to those related to the issuance of micro-credits, is not an uncommon practice. Therefore, to adequately capture the profitability dimension of MFIs' performance, it was considered necessary to incorporate additional information about this aspect of MFIs' operations. The next trade-off thus required us to estimate an increase in operating income that could result from an increase in the interest expense. We were able to get consensus from all the MFIs that an increase of 0.2 million in their operating income was feasible from an increase of 1 million in interest expense.

An added complexity in this trade-off was that while the Trade-off 1 could be applied, without considering a change in any of the other variables; Trade-off 2 would be complete only if a change in the interest expense was related to subsequent changes in, both the interest income and operating income. In other words, increasing just the operating income, when interest expense increased, was not considered feasible. The underlying logic is that MFIs tend to use the available funds mainly for microfinancing purposes in view of their basic mission of providing micro financing services. At the same time, there is also some operating income that is normally generated from loanable funds, in routine. Considering this fact about the production technology of MFIs, we thus came up with the above quoted judgment for Trade-off 2. Next, we explain how this judgment can be expressed as a homogeneous weight restriction.

Translating Trade-off 2 into Weight Restrictions

Using the notations specified for Trade-off 1 in equation (6.5.1), the Trade-off 2 can be expresses as follows:

$(a_1, a_2) = (1.5, 0.2); \qquad (b_1, b_2) = (1, 0)$ (6.5.4)

The weight restriction that follows from the above expression can be stated as:

$1.5\, u_1 + 0.2\, u_2 - 1\, v_1 \leq 0$ (6.5.5)

We can observe from the above equation that when we are using this trade-off, we no longer need to apply Trade-off 1 individually, as it is already a part of the more complex Trade-off 2.

Trade-off 3: Interest expense and interest income

Judgement: ***For each 1 million less of interest expense, a decrease of 10 million in interest income is technologically possible, provided nothing else changes.***

Explanation: This trade-off is based on the logic that a decrease in interest expense generally implies lesser amount of loanable funds available; which would in turn mean smaller loan portfolio, as well as lesser income[65]. For arriving at some reasonable estimates for the values of this trade-off, we needed to consider the fact that the larger a proposed decrease in one of the outputs, resulting from a unit decrease in one of the inputs; more intuitively appealing it would seem to various MFIs. This, in turn, increased chances of its acceptability by more MFIs. Therefore, we proposed that a decrease in interest expense by 1 was sufficient to decrease the interest income by 10. We originally proposed a decrease of 12 million in interest income from a decrease of I

[65] Note that availability of the loanable funds at lesser interest rate, or the use of retained earnings as loanable funds, can also lead to having lesser interest expense. However, in such cases, there would be no subsequent decrease in the amount of loanable funds or interest income.

million in interest expense. This value was obtained by calculating the ratio of the interest income to interest expense and choosing the highest value. However, after consultation with the selected MFI, this value was decreased to 10 million.

Translating Trade-off 3 into Weight Restrictions

Once again, using the notations specified for Trade-off 1 in equation (6.5.1), the above value judgment can be expressed as the following trade-off:

$(a_1, a_2) = (-10, 0); \qquad (b_1, b_2) = (-1, 0)$ (6.5.6)

The above formulation can then be translated into a weight restriction of the following form:

$-10\ u_1 - (-1)\ v_1 \leq 0, \qquad \text{or} - 10\ u_1 + 1\ v_1 \leq 0$ (6.5.7)

Note that if Trade-off 1 and Trade-off 3 are applied simultaneously, these will result in forming a range for the ratio of the two weights. To explain it in mathematical notation form, we consider the two weight restrictions representing the proposed trade-off relationship once again. We know that the weight restriction relating to Trade-off 1 was expressed as follows:

$1.5\ u_1 - 1\ v_1 \leq 0$

From this weight restriction, it follows that:

$1.5\ u_1 \leq 1\ v_1$

The weight restriction representing Trade-off 3 was written as:

$-\ 10\ u_1 + 1\ v_1 \leq 0$

From this second weight restriction, it follows that:

$1\ v_1 \leq 10\ u_1$

Combining these two expressions, we get:

$1.5\ u_1 \leq 1\ v_1 \leq 10\ u_1$, or

$1.5 \leq \quad v_1 / u_1 \quad \leq 10$

6.6. Proposed Trade-offs for the Outreach DEA (ODEA) Model

The ODEA model aims to analyse the outreach performance of the MFIs, by looking at the loans (volume and number) produced, through utilization of available resources. We have identified 4 trade-off relationships for the ODEA model. The first and the third trade-off for this model (i.e. Trade-off 4 and Trade-off 6) are relatively simple; as each of these involves a single relationship, between two variables only. The second and the fourth trade-off (i.e. Trade-off 5 and Trade-off 7-8) are more complex in nature. The second trade-off for this model involves two inter-dependent relationships. The fourth trade-off, though identifying a single relationship between two variables, involves two sided estimation of the proposed trade-off relationship. We now explain these trade-offs in detail.

Trade-off 4: Loanable funds and loan portfolio

Judgement: ***For each 1 million increase in the loanable funds, it is technologically possible to increase the loan portfolio by 0.8 million, without requiring any additional resources.***

Explanation: This trade-off captures the direct relationship between the loanable funds and the loan portfolio being created from the use of these funds. During our initial correspondence with some of the bigger MFIs, we were informed that an increase of 1 million in loanable funds could easily translate into an increase of about 1.5 million in loan portfolio, without requiring any additional resources. Based on this information; we initially considered an increase of 1.5 million in loan portfolio, from an increase of 1 million in loanable funds. However, any proposed trade-off relationship must be acceptable for all the MFIs included in the analysis. Therefore, we contacted the relevant experts to come with an acceptable value of the loan portfolio. Finally, we got agreement from all the MFIs that an increase of 0.8 million in loan portfolio would be feasible, when the loanable funds increased by 1 million.

Here, we would like to point out that some of the MFIs initially objected to the proposed increase of 0.8 million in loan portfolio, resulting from a 1 million increase in the loanable funds; considering it to be insufficiently low. For convincing those MFIs who considered this value inadequately low, we had to explain further that an increase of 1.5 in interest income is only proposed to be a *feasible* value. Therefore, they should not consider it in terms of being really *adequate*, but only as a safe lower bound.

Translating Trade-off 4 into Weight Restrictions

The above formulated trade-off relationship needs to be expressed as an additional constraint in the multiplier model. For ODEA model, the general form of the homogenous weight restrictions can be stated as follows:

$$a_1u_1 + a_2u_2 - b_1v_1 - b_2v_2 - b_3v_3 \leq 0 \qquad (6.6.1)$$

In the above equation, a_1 and a_2 are the coefficients for the weights u_1 and u_2 attached to the two outputs (loan portfolio and number of loans). While b_1, b_2, and b_3 are the coefficients for the weights v_1, v_2, and v_3, attached to the three inputs (loanable funds, operating expenses, and the number of loan officers). Each of these five coefficients a_1, a_2, b_1, b_2, and b_3 can be either zero, positive or negative. Using these notations, the proposed trade-off now may be expressed as follows:

$$(a_1, a_2) = (0.8,0); \qquad (b_1, b_2, b_3) = (1, 0, 0) \qquad (6.6.2)$$

According to the inequality (6.6.1), the expression (6.6.2) translates into the following homogeneous weight restriction:

$$0.8\, u_1 - 1\, v_1 \leq 0 \qquad (6.6.3)$$

Trade-off 5: Loanable funds, loan portfolio and number of loans

An important assumption related to Trade-off 4 was that apart from the loanable funds and the number of loans, no other variable changed as a result of the proposed trade-off. If, however, there are other variables that might be affected by a proposed trade-off, then it becomes imperative to take into account any such possible changes.

For example, let us re-consider the judgement for the proposed trade-off between the amounts of loanable funds and loan portfolio (Trade-off 4). An implicit assumption for this trade-off was that the number of loans would not increase when the amount of loans, i.e. the loan portfolio, increased. Remember that, this assumption is relatively subjective in nature. For example, this could be true, provided that any additional funds were being used to increase the loan limits for existing customers only. An increase in loan portfolio in such a case then, would not lead to an increase in the number of loans. On the other hand, there might be some situations where an increase in the loan portfolio could lead to an increase in the number of loans also. This may be particularly the case for the more outreach-oriented MFIs, which are generally having greater motivation to reach a larger number of poor clients. Consequently, the additional loan portfolio would be split by such MFIs into a greater number of smaller sized loans.

As the ODEA model is primarily intended to investigate the outreach performance; therefore, we then considered this second scenario, according to which the original assumption for Trade-off 4, “provided that nothing else changes” did not hold. Consequently, the above proposed increase of 0.8 million in loan portfolio, which was considered feasible as a result of an increase of 1 million in loanable funds, could also lead to an increase in the number of loans. We, therefore, proposed another relatively more demanding judgement, including changes in three input and output variables simultaneously.

Judgement: ***For each 1 million increase in loanable funds, it is technologically possible to increase the loan portfolio by 0.8 million and the number of loans by 50, without requiring any additional resources.***

Explanation: As can be seen, this trade-off incorporated additional information, related to the number of loans expected to be created, from a certain amount of loan portfolio; which, in turn, was created from an additional one million of loanable funds. From an outreach perspective, greater the number of loans being created from a given amount of funds, better would be the performance on the outreach dimension. Incorporating this trade-off was thus meant to add to the ability of our model to assess efficiency, from the perspective of the selected MFIs' outreach performance.

In our discussion of the Trade-off 4, we explained how we arrived at the estimated value of 0.8 million increase for loan portfolio, which was considered feasible from an increase of one million in loanable funds. This trade-off relationship was then replaced by a more complex relationship in the form of trade-off 5; whereby, an increase in loanable funds, implied an increase in both the loan portfolio and the number of loans. The procedure for arriving at an initial estimation for the values of this new aspect of the proposed trade-off relationship is explained next.

First of all, we observed that there was a lot of variation, in terms of average loan sizes, which ranged from as low as 8000 to as high as 38000 (resulting in an average of 16000). However, we had another concern that two of the selected MFIs, namely; KMFB and TMFB, were having extremely large average loan sizes (35000 and 38000, respectively), thereby skewing the average. We felt that this warranted further investigation. One of the possible reasons, for such high values of the average loan size, could be the age factor. It is normal for older MFIs, who generally have more mature clients qualifying for bigger loans, to have larger values for their average loan sizes.

However, these two MFIs were found to be 4 and 6 years old respectively; while there were other much older MFIs, with smaller average loan size than these two institutions. This suggested that age might not be a relevant factor for the observed anomaly. We then excluded these two MFIs, and re-calculated the mean for average loan size, which came up to be 12000. We therefore proposed an increase of 67 loans (=0.8 million / 12000), which could result from an increase of 0.8 million in loan portfolio. However, this was not acceptable for some of the MFIs, who considered this value somewhat high. After further discussion, an increase of 50 loans was accepted as a feasible increase by all the MFIs.

It should be noted that an increase of 50 loans was considered feasible for the current data set, through consensus of the selected MFIs. However, this value may be considered inappropriate under other situations. For example, consider the case where a microfinance industry is having a large number of MFIs, with a predominant social orientation. Under such circumstances, there might be a greater focus on the outreach performance of MFIs, which would require creation of a larger number of small sized loans. The situation may be exactly opposite for microfinance industries dominated by profit oriented MFIs. In such case, MFIs may prefer a smaller increase in number of loans, from an increase in the loan portfolio, in order to avoid unnecessary costs and ensure higher profitability, through offering bigger loans.

Similarly, while estimating values for this trade-off, it may also make sense to consider the maturity of the microfinance sectors being studied. The microfinance sectors, characterized by relatively younger institutions for which clients have not yet qualified for bigger loan amounts; may consider, a large number of relatively small sized loans being produced from a certain increase in loan portfolio, more feasible. On the other hand, older MFIs with more mature clients and bigger loan sizes; may have a preference for a small (or even no) increase, in the number of loans from an increase of 0.8 million in their loan portfolio. Such MFIs may instead prefer to increase existing loan limits for their mature customers, who are qualified for bigger loans. Trade-off 4 could then be a more appropriate choice in such a situation. Yet another consideration related to this trade-off, is the relevant regulations applicable to the MFIs being analysed. Minimum or maximum limits on loan sizes may vary considerably, for the MFIs working in different countries; or even sometimes, for the MFIs from the same country, but having different organizational structures. Therefore, when considering this trade-off for different data sets, we would recommend taking into account all the relevant factors, in order to propose technologically realistic trade-offs.

Translating Trade-off 5 into Weight Restrictions

Once again, using the afore-mentioned notations, the above judgement can be expressed as the following trade-off:

$$(a_1, a_2) = (0.8, 50); \qquad (b_1, b_2, b_3) = (1, 0, 0) \qquad (6.6.4)$$

The equation (6.6.4) is equivalent to the following weight restriction:

$$0.8\,u_1 + 50\,u_2 - 1\,v_1 \leq 0 \qquad (6.6.5)$$

Note that the equation (6.6.5) represents the combination of the two proposed trade-off relationships that can combine into a single, more complex trade-off. Therefore, if we apply Trade-off 5, then there is no need for Trade-off 4 which is just a simpler, less complex sub-part of Trade-off 5.

Trade-off 6: Loanable funds and loan portfolio

Judgement: ***For each 1 million less of loanable funds, a decrease of 2 million in loan portfolio is possible, provided nothing else changes.***

Explanation: This judgement proposes a decrease of 1 million in loan portfolio, as a result of decrease in the loanable funds by 1 million. As we discussed in Trade off 4, it is possible for some of the MFIs to increase their portfolio in a greater proportion, with a unit increase in the loanable funds. Therefore, for estimating the value of a possible decrease in one of the outputs, when one of the inputs decreased, we needed to look at the maximum possible decrease, given the production technology. A higher value for a possible decrease in an output, resulting from a certain decrease in an output also helps in ensuring better acceptability of such a trade-off, by a larger number of MFIs. Another less desirable outcome of using a bigger value for the decrease in an output could be lesser improvement in the model discrimination, as compared to the case where we proposed a relatively smaller decrease. But we need to emphasize that the basic criterion for any proposed trade-off should not be to improve the model discrimination *per se*. Acceptability of a trade-off, based on its being a technological reality, needs to be the key underlying standard. Only then we can have better informed and technologically realistic models, resulting from the application of the proposed trade-offs. For arriving at a reasonable value of this trade-off, we thus asked different MFIs for their estimates of the possible decrease in loan portfolio, which could result from having a smaller amount of loanable funds. From the responses so gathered, we then selected the highest value for this trade-off relationship.

Note that, another possible implication of the above stated judgment, relates to the possibility of a change in the number of loans, with a decrease in the amount of loan portfolio. However, like we discussed earlier, a decrease in the number of loans may not be a compulsory outcome; particularly, when a smaller volume of loans (or loan portfolio) implies the same number of relatively smaller sized loans. Therefore, in this proposed trade-off, we considered the scenario where a change in the number of loans would not be a necessary outcome of having a smaller loan portfolio.

Translating Trade-off 6 into Weight Restrictions

Using the notation expressed through equation (6.6.1), for representing the form of homogenous weight restrictions for the ODEA model, the above judgment generates the following trade-off:

$(a_1, a_2) = (-2, 0)$; $(b_1, b_2, b_3) = (-1, 0, 0)$ (6.6.6)

Which is equal to the following weight restriction:

$-2\ u_1 - (-1)\ v_1 \leq 0$, or $-2\ u_1 + 1\ v_1 \leq 0$ (6.6.7)

Note that, if we were to incorporate Trade-off 4 (instead of the more complex Trade-off 5) and Trade-off 6 simultaneously; then it would result in a range, for the ratio of weights of the two variables involved. This is actually just like the situation as was explained earlier, for simultaneous incorporation of Trade-off 1 and Trade-off 3.

Trade-off 7: Loan officers and number of loans

Judgement: ***For each extra loan officer, it is technologically possible to increase the number of loans by 150, without requiring any additional resources.***

Explanation: This trade-off is related to the productivity of loan officers. Due to the nature of their job, loan officers are generally considered to be an important input that has direct implications for the outreach performance of MFIs. Higher productivity of loan officers can also result in additional saving in terms of transaction costs and *vice versa*. According to MIX (2010); the average benchmark for Asian MFIs, for the number of borrowers handled by each loan officer, ranges from 306 to 486 (depending on the scale of MFIs). To propose a trade-off, we decided to use a relatively more conservative lower bound, at the ratio of 1 loan officer to 150 loans. This ratio was considered feasible by all the MFIs in the sample.

Another consideration for developing this trade-off was related to the possibility of a change in the loans' volume (i.e. the loan portfolio), from a change in the number of loans. It is argued that with increase of a loan officer, it is still possible for MFIs to create more loans (of smaller size) from a given loan portfolio. Therefore, it was not considered necessary to increase the loan portfolio as a result of an increase in the number of loans.

Translating Trade-off 7 into Weight Restrictions

Using the notation provided in equation (6.6.1), the above judgment related to the number of loan officers and the number of loans, generates the following trade-off:

$(a_1, a_2) = (0, 150)$; $(b_1, b_2, b_3) = (0, 0, 1)$ (6.6.8)

The above formulation results in the following constraint:

$150\, u_2 - 1\, v_3 \leq 0$ (6.6.9)

Trade-off 8: Loan officers and the number of loans

Judgement: ***For each decrease of 1 loan officer, a decrease in the number of loans by 500 is technologically possible, provided nothing else changes.***

Explanation: This judgement is again related to the proposed trade-off relationship between the number of loan officers and the number of loans. However, in contrast to the previous trade-off, this judgement considers the situation when there is one less loan officer. In order to get an idea for the acceptable values of this trade-off, we started by looking at the maximum number of loans, produced per loan officer by the selected MFIs. Like we discussed earlier, considering the biggest numbers in such cases made more intuitive sense; based on the simple logic that, greater the proposed decrease in an output resulting from a certain decrease in an input, better would be the chance of acceptability of such a trade-off by all the MFIs.

From our data set, it was evident that even the most efficient MFI could produce a maximum of around 500 loans, per loan officer. Based on the current data set, 500 loans was thus the maximum possible decrease in the number of loans, in case of having one less loan officer. This trade-off fortunately did not require a lot of deliberation by the MFIs concerned, and we were able to get a quick consensus for this value.

Once again, we need to point out that a decrease of 500 loans was considered possible in this case, without requiring a simultaneous decrease in the amount of loan portfolio. The logic is that with a decrease in number of loan officers by 1, it may still be possible to create a smaller number of bigger sized loans; while using the same amount of the loan portfolio. Therefore, we did not incorporate a subsequent decrease in loan portfolio for this trade-off.

Translating Trade-off 8 into Weight Restrictions

The proposed trade-off between the number of loan officers and the number of loans can be expressed as follows:

$$(a_1, a_2) = (0, -500); \qquad (b_1, b_2, b_3) = (0, 0, -1) \qquad (6.6.10)$$

The constraint resulting from the above formulation can be expressed as:

$$-500\, u_2 - (-1\, v_3) \leq 0 \qquad (6.6.11)$$

Which is equivalent to:

$$-500\, u_2 + 1\, v_3 \leq 0 \qquad (6.6.12)$$

6.7. Proposed Trade-offs for the Double Bottom-line DEA (DBL-DEA) Model

For this final model, it is possible to use some of the trade-off relationships, identified earlier for the ODEA model; and proposed through Trade-off 5, Trade-off 6, Trade-off 7, and Trade-off 8. However, the trade-off relationships identified for the PDEA model, could not be applied in this model; due to the different sets of variables, used in the DBL-DEA and PDEA models. Instead of using individual measures of income, in the form of interest income and operating income (as was the case for the PDEA model), we used the variable 'total income' for incorporating the profitability performance perspective in the DBL-DEA model. Therefore, instead of Trade-off 1, Trade-off 2, or Trade-off 3, which focussed on interest income and operating incomes separately; the following trade-off was identified for DBL-DEA model, by relating the amount of loanable funds to the total income variable.

Trade-off 9: Loanable funds and total income

Judgement a: ***For each additional million of loanable funds, it is technologically possible to increase the total income by 0.25 million, without requiring any additional resources.***

Explanation: This trade-off is proposed after analysing the current interest rates and fee structure of Pakistan's microfinance sector. As mentioned earlier, on account of substantial differences observed between rate of interest paid (on borrowed funds) and charged (on loans generated) by MFIs in our analysis, it was considered feasible for these institutions to realize significant amounts of income. Under the circumstances, an increase of 0.25 million represented a conservative lower bound, which was considered feasible by all the MFIs in our dataset.

However, this relationship could not be incorporated in the DBL-DEA model, in the form of an isolated relationship between these two variables alone. To put it in simple words; an increase in the loanable funds could lead to an increase in the total income, only if these funds were being utilized for income earning activities, of which loans generation is a major feasible activity for MFIs. Thus a related outcome of the increase in total income would be an increase in the volume of loans generated. As discussed earlier for Trade-off 5, an increase in loan portfolio may also be accompanied by an increase in the number of loans. These additional considerations required us to consider the more holistic picture, rather than the isolated effects of an increase in loanable funds. We thus combined the individual judgements offered in Trade-off 4, Trade-off 5, and Trade-off 9 (a), into a single, more complex judgement. After consultation with MFIs' management, the following comprehensive judgement was finalized to incorporate the proposed trade-off in the DBL-DEA model.

Judgement b: ***An additional 1 million of loanable funds is sufficient to increase the loan portfolio by 0.8 million, number of loans by 50 and total income by 0.25 million, provided no additional resources are required.***

Translating Trade-off 9 (b) into Weight Restrictions

For DBL-DEA model, the general form of the homogenous weight restrictions can be stated as follows:

$$a_1u_1 + a_2u_2 + a_3u_3 - b_1v_1 - b_2v_2 - b_3v_3 \leq 0 \qquad (6.7.1)$$

In the above equation, a_1, a_2, and a_3 are the coefficients for the weights u_1, u_2, and u_3; attached to the three outputs of the DBL-DEA model (loan portfolio, number of loans, and total income). Similarly, b_1, b_2 and b_3 are the coefficients for the weights v_1, v_2, and v_3; attached to the three inputs of the DBL-DEA model (loanable funds, operating expenses, and the number of loan officers). As stated earlier, each of these six coefficients a_1, a_2, a_3, b_1, b_2, and b_3 can be either zero, positive or negative. Using these notations, the proposed complex trade-off can now be expressed as under:

$$(a_1, a_2, a_3) = (0.8, 50, 0.25); \quad (b_1, b_2, b_3) = (1, 0, 0) \qquad (6.7.2)$$

The above formulation translates into the following linked weight restriction:

$$0.8\,u_1 + 50\,u_2 + 0.25\,u_3 - 1\,v_1 \leq 0 \qquad (6.7.3)$$

Note that in the presence of this trade-off, we are not required to incorporate Trade-Trade-off 4, Trade-off 5 or Trade-off 9 (a); as these are already included in this more complex trade-off. However, TO 6, TO 7 and Trade-off 8 can be used for the DBL-DEA model, with the same values, as were identified for the ODEA model.

6.8. Additional Trade-offs

We have proposed a number of technologically realistic trade-offs in the previous section. These trade-off relationships are related to the different variables that are included in the three models, proposed for the current study. In addition to the trade-offs identified for the current study, consideration of additional variables by other researchers, can lead to formulation of several other possible trade-offs.

Another point to note is that almost all of the proposed trade-offs in the current study have involved relationships between one of the inputs and one or more of the outputs. It must be remembered that trade-off relationships can also exist between two or more different inputs and also between two or more different outputs. For the sake of explanation, let us assume that a study includes two output variables, namely; the number of female borrowers, and the number of male borrowers. In that case, a possible trade-off relationship may exist; according to which, a decrease in one of the two variables, may be related to a corresponding (though not necessarily proportionate) increase, in the other variable.

In this last section of the current chapter, we propose a few tentative trade-offs that could be proposed between variables considered relevant for performance evaluation of MFIs[66]. We would like to demonstrate a possible way of arriving at estimates for the values of these additional trade-offs. However, we must emphasize that whatever values have been suggested here, are based on our own dataset. Therefore, these values need to be verified and adjusted accordingly, when/if used in studies, focusing on different data sets.

[66] Reasons for inclusion (or non-inclusion) of different variables, in the three proposed DEA models for the current study, have been discussed in Chapter 5.

Trade-off 10: Loan portfolio and operating expenses

Judgement: ***For each 0.8 million increase in the loan portfolio, an increase of 0.2 million in operating expenses is technologically possible, without requiring any additional resources.***

Explanation: For arriving at an estimate for this trade-off, we calculated the ratio of operating expenses to loan portfolio, for our data set. The average for this ratio came up to be 27 %. This meant an increase of approximately 0.2 million in operating expenses, that would be required for generating an additional 0.8 million of loan portfolio. However, when we contacted the specialists from the Pakistan's microfinance industry, for validating the values of this trade-off, they informed us that an increase of 0.8 million in the loan portfolio could normally be achieved, without any increase in the operating expenses. Therefore, we would advise undertaking a thorough investigation of the specific environment and other characteristics of the MFIs being analysed, in order to come up with technologically realistic trade-offs.

In addition to the Trade-off 9, there is possibility of coming up with additional trade-offs that may link changes in operating expenses to some other variables. For example; a trade-off between operating expenses and operating income, a trade-off between operating expenses and number of credit officers (or number of personnel) or a trade-off between operating expenses and loan portfolio, to name a few.

Trade-off 11: Loanable funds and number of female borrowers

Judgement: ***For each 1 million increase in the loanable funds, it is technologically possible to increase the number of female borrowers by 25, provided no additional resources are required.***

Explanation: According to this trade-off, an increase in loanable funds by 1 million could be accompanied by an increase of 25 loans for the female clients. An increase of

25 female borrowers is proposed, considering a previous trade-off (Trade-off 5); whereby an increase of 50 loans was considered feasible with an additional 1 million of loanable funds. This means we are proposing that only 50% of these additional 50 loans may be granted to female clients. According to latest available benchmarks for Asian MFIs, the percentage of women borrowers is normally between 77 to 85 % of the total number of borrowers (MIX, 2010). Therefore, this trade-off is representing only a safe lower bound by adopting a very conservative figure. By doing so, there would be greater chances of the proposed trade-off being acceptable, even for those MFIs that are not targeting female clients primarily.

Trade-off 12: Loanable funds and number of female borrowers

Judgement: ***For each 1 million decrease in the loanable funds, a decrease of 45 in the number of female borrowers is technologically possible, provided nothing else changes.***

Explanation: For having a broad estimate of the value for decrease in the number of female borrowers, we have once again used the percentage specified for the Asian MFIs (MIX, 2010). Based on this criterion, the highest possible number for the decrease in female borrowers came up to be approximately 43 (85 % of 50 loans); therefore, the decrease in the number of female borrowers is proposed to be 45.

Trade-off 13: Number of personnel and number of loans

Judgement: ***For each extra personnel, it is technologically possible to increase the number of loans by 125, provided no additional resources are required.***

Explanation: Like Trade-off 7 and Trade-off 8, this trade-off is also related to MFIs' staff productivity and outreach performance. Staff productivity can be measured by using either the number of total personnel or the number of loan officers. Although, we have decided to use the number of loan officers as an input in our study; the use of number of personnel for this purpose, also offers a feasible alternative. According to MIX (2010), the average benchmark for Asian MFIs; for the number of borrowers handled by each personnel, ranges from 154 to 198 (depending on the scale of operations). To propose a trade-off at the ratio of 1 personnel to 125 loans is thus a conservative lower estimate.

Moreover, the literature on financial institutions' efficiency suggests two alternatives to incorporate the staff variable into any analysis. The choice is to use either the number of staff or the costs related to this input. Therefore, instead of using the number of personnel, it is also possible to use the costs related to the total personnel.

Trade-off 14: Interest expense and total income

Judgement: ***For each 1 million increase in the interest expense, it is technologically possible to increase the total income by 2 million, without requiring any additional resources.***

Explanation: This trade-off is based on the relationship identified between interest expense and income[67]. While none of the models used in the current study use these two variables simultaneously; it is a possibility for any other research, which decides to use these two variables in a single model. We would like to demonstrate here, how to arrive at an initial estimate for the trade-off relationship between these two variables. As discussed earlier, due to large difference in the interest paid and received, the total income generated by the MFIs cam be fairly high. On average, for the MFIs included in our dataset, the total income is four times the amount of the interest expenses. In line with the logic explained earlier for several other trade-offs, we propose a rather conservative estimate, by stating a ratio of 1:2 between these two variables.

[67] A detailed explanation of the proposed relationship is provided through TO 1 in the PDEA model.

Trade-off 15: Interest expense and total income

Judgement: ***For each 1 million decrease in interest expense, it is technologically possible to decrease the total income by 4 million, provided nothing else changes.***

Explanation: As expounded earlier, by proposing a bigger decrease in total income resulting from a decrease of one million in interest expenses, we can better ensure acceptability of the proposed trade-off.

In the current study, we have proposed a number of trade-offs; between interest expense and interest income (Trade-off 1 and Trade-off 3), between interest expense, interest income and operating income (Trade-off 2), and between interest expense and total income (Trade-off 14 and Trade-off 15). In addition, formulation of realistic trade-offs may also be possible between interest expense and other variables. Some examples include: trade-off between interest expense and loanable funds, trade-off between interest expense and number of loans, and trade-off between interest expense and number of female borrowers, to name a few.

Chapter 7 Computational Results and Analysis

7.1. Introduction

This chapter provides an analysis of the efficiency scores, obtained from running the three DEA models[68] that aim to assess the financial and social performance of the selected MFIs. For each model, the efficiency scores obtained; with and without the application of the trade-off approach are discussed, first of all. Then, a discussion of the changes in efficiency scores; resulting from the sequential application of various trade-offs, is provided. This is followed by identification of the benchmarks for inefficient DMUs. After this, we sum up the findings of the current study, with reference to the trade-off versus compatibility dilemma, related to the outreach and sustainability performance of MFIs. Finally, the results of the investigation, about some additional aspects related to the MFIs' performance, are provided; along with a comparison with the existing evidence available from the performance evaluation literature.

7.2. Performance Evaluation of MFIs: The Trade-off Approach in DEA

We hereby illustrate an application of the novel trade-off approach, within the microfinance context, which is motivated by the dual objectives of making the standard DEA models more informed and better discriminating. However, prior to starting any discussion, we would like to mention that despite the suitability of the VRS assumption for the current data set[69], the proposed DEA models are run under both the CRS and the VRS assumptions[70]. The simultaneous use of the CRS and the VRS assumptions within the same studies is a regular practice in performance evaluation of financial

[68] For a description of the proposed models, refer to Chapter 5, section 5.8.
[69] The data on the selected variables for the three DEA models are provided in the Appendix.
[70] A detailed discussion is available in Chapter 5, section 5.5.

institutions[71]. A key objective for such practice is reported to be the identification of any inherent scale inefficiencies.

However, for the current study, the basic motivation is to demonstrate that the application of the trade-off approach works equally well, under both the CRS and the VRS assumptions. Therefore, the changes in efficiency scores resulting from incorporation of the proposed trade-offs are reported for both the CRS and the VRS assumptions. However, for the rest of the analyses, focusing on various performance dimensions of the selected MFIs; only the results obtained under the VRS assumption are discussed, due to better suitability of this assumption for the current data set.

7.3. The Profitability DEA (PDEA) Model

The PDEA model is intended to provide insights about financial sustainability of selected MFIs. The PDEA model is run under the two different RTS assumptions, using output orientation (OO)[72]. The resulting efficiency scores, before and after the incorporation of the proposed trade-offs[73], are provided in Table 7.1.

7.3.1. A Comparison of Scores with and without Incorporation of Trade-offs

In Table 7.1 the first two columns contain the number and abbreviated names of the MFIs included in the analysis. The efficiency scores for the PDEA model, under the CRS assumption, without application of the proposed trade-offs (WO-TO)[74], are provided in the third column. The scores under the CRS assumption, after incorporation of the proposed trade-offs (W-TO)[75], are listed in the fourth column. Similarly, efficiency scores under the VRS assumption, without the proposed trade-offs (WO-TO),

[71] Refer to Chapter 4, section 4.6 for details of studies, using both the CRS and the VRS assumptions.
[72] Rationale for suitability of output orientation for the current study, is provided in Chapter 5, section 5.6.
[73] Detailed discussion of the trade-offs, identified for the three DEA models, is provided in Chapter 6.
[74] TO refers to ‘trade-off’ and WO-TO refers to ‘without trade-off’.
[75] W-TO refers to ‘with trade-off’.

are listed in the fifth column. Finally, the efficiency scores under the VRS assumption, and with the proposed trade-offs (W-TO), are listed in the sixth column.

Table 7. 1The PDEA (OO) Model Scores

	MFIs	CRS WO-TO	CRS W-TO	VRS WO-TO	VRS W-TO
1	FMFB	94.59%	91.71%	100.00%	100.00%
2	KBL	100.00%	100.00%	100.00%	100.00%
3	KMFB	70.97%	63.06%	71.95%	68.05%
4	NRSP-B	57.38%	56.92%	76.84%	73.08%
5	TMFB	54.29%	52.19%	100.00%	100.00%
6	ASA-P	100.00%	100.00%	100.00%	100.00%
7	ASASAH	26.14%	26.14%	26.57%	26.57%
8	BRAC-P	47.94%	47.94%	53.50%	52.79%
9	CSC	75.68%	75.68%	100.00%	98.71%
10	DAMEN	63.34%	62.63%	66.52%	65.45%
11	JWS	89.09%	89.09%	100.00%	100.00%
12	RCDS	73.64%	73.64%	100.00%	50.15%
13	SAFWCO	94.64%	94.64%	100.00%	100.00%
14	NRSP	72.44%	67.57%	100.00%	93.04%
15	PRSP	100.00%	100.00%	100.00%	100.00%
16	TRDP	90.99%	90.99%	100.00%	100.00%
Fully Efficient MFIs		3	3	11	8
Average Score		75.70%	74.51%	87.21%	82.99%

We can see from column 3 of Table 7.1, that for the CRS-based unrestricted[76] PDEA model (WO-TO), there are three fully efficient MFIs, namely; KBL, ASA-P and PRSP. In the restricted[77] PDEA model (W-TO) also, these three MFIs remain 100% efficient. However, the efficiency scores drop in the restricted model (W-TO) for a number of

[76] This refers to the standard PDEA model, without incorporation of any of the proposed trade-offs.
[77] This refers to the PDEA model, run with incorporation of the proposed trade-offs.

other MFIs including: FMFB, KMFB, NRSP-B, TMFB, DAMEN, and NRSP. Overall, the average efficiency score drops from 75.70% to 74.51% for the CRS based model, as a result of the application of the trade-off approach.

Under the VRS assumption, there are eleven fully efficient DMUs in the non-restricted model (WO-TO); whereas, five MFIs are scoring less than 100%. These inefficient MFIs include: KMFB, NRSP-B, ASASAH, BRAC-P, and DAMEN. After the incorporation of the proposed trade-off (W-TO), three other institution, namely; CSC, RCDS, and NRSP, also become less than 100% efficient, thus reducing the total number of fully efficient MFIs to eight. Other MFIs achieving smaller efficiency scores in the restricted VRS model include: KMFB, NRSP-B, BRAC-P, and DAMEN. Overall, the average efficiency score drops from 87.21% to 82.99% for the VRS-based model, as a result of the incorporation of the proposed trade-offs.

Moreover, for the VRS-based restricted model, ten MFIs are scoring more and six MFIs are scoring less than the average efficiency score of 82.99 %. If, however, we exclude the fully efficient MFIs, then the average efficiency score of the remaining MFIs drops to 65.98%. This low score indicates the potential for considerable improvement in the performance of these MFIs, from a profitability perspective.

7.3.2. A Comparison of Scores with Sequential Incorporation of Trade-offs

In the last section, we have shown the cumulative effect on model discrimination, resulting from incorporation of all the trade-offs in the PDEA model. Through Table 7.2, we illustrate how each subsequent trade-off brings incremental improvement in the discrimination of the DEA models. The third column of this table gives scores without any trade-offs; while the fourth, fifth and sixth columns show respectively, the scores obtained after incorporation of TO1, TO2, and finally TO 2 and TO3 applied together.

Table 7. 2 The PDEA (VRS, OO) Model Scores

	MFIs	WO-TO	TO1	TO 2	TO 2 + TO 3
1	FMFB	100.00%	100.00%	100.00%	100.00%
2	KBL	100.00%	100.00%	100.00%	100.00%
3	KMFB	71.95%	71.95%	71.95%	68.05%
4	NRSP-B	76.84%	75.98%	73.08%	73.08%
5	TMFB	100.00%	100.00%	100.00%	100.00%
6	ASA-P	100.00%	100.00%	100.00%	100.00%
7	ASASAH	26.57%	26.57%	26.57%	26.57%
8	BRAC-P	53.50%	53.05%	52.79%	52.79%
9	CSC	100.00%	100.00%	100.00%	98.71%
10	DAMEN	66.52%	65.60%	65.45%	65.45%
11	JWS	100.00%	100.00%	100.00%	100.00%
12	RCDS	100.00%	100.00%	100.00%	50.15%
13	SAFWCO	100.00%	100.00%	100.00%	100.00%
14	NRSP	100.00%	100.00%	93.04%	93.04%
15	PRSP	100.00%	100.00%	100.00%	100.00%
16	TRDP	100.00%	100.00%	100.00%	100.00%
Fully Efficient MFIs		11	11	10	8
Average Score		87.21%	87.07%	86.43%	82.99%

We can observe that with the incorporation of TO1, the efficiency scores for NRSP-B, BRAC-P, and DAMEN drop slightly, as compared to the scores without any trade-off. As a result, there is a small decrease in the average efficiency scores from 87.21% to 87.07%. With the incorporation of TO2 individually, in addition to the same three MFIs, the efficiency score for NRSP also drops, bringing down the average efficiency score to 86.43%. Moreover, the number of fully efficient MFIs decreases from eleven to ten. When both TO2 and TO3 are applied together[78], then in comparison to the unrestricted model, the efficiency scores in the restricted model decline for a total of seven MFIs, namely; KMFB, NRSP-B, BRAC-P, CSC, DAMEN, RCDS, and NRSP. In

[78] Note that with the incorporation of TO 2, there is no need to apply TO1, as it is already a part of the more comprehensive TO2.

addition, the average efficiency score drops to 82.99%, while the number of fully efficient MFIs becomes eight.

7.3.3. Benchmarks for the PDEA Model

Benchmarking refers to the process of identifying suitable measures, for comparing performance of peer DMUs, and using these measures to establish standards of excellence (Zhu, 2009). As a benchmarking tool, DEA can facilitate performance improvement for low scoring MFIs, through emulating the practices of efficient peers. Information about the efficient peers, identified for the inefficient DMUs in the PDEA model, is provided in Table 7.3. The figures in the third column represent the contribution of different efficient peers, for obtaining the radial projection of respective inefficient MFIs. For instance, in case of KMFB, the radial projection of KMFB is obtained by combining DMUs 2 and 6, with the weights 0.19 and 0.81, respectively.

Table 7. 3 The PDEA (VRS, OO, W-TO) Model

	MFIs	Efficient Peers
1	FMFB	Benchmark for 2 MFIs
2	KBL	Benchmark for 4 MFIs
3	KMFB	2 (0.19) 6 (0.81)
4	NRSP-B	1 (0.21) 2 (0.07) 6 (0.72)
5	TMFB	Benchmark for 1 MFI
6	ASA-P	Benchmark for 7 MFIs
7	ASASAH	6 (0.66) 11 (0.02) 15 (0.06) 16 (0.26)
8	BRAC-P	2 (0.14) 5 (0.01) 6 (0.85)
9	CSC	6 (0.11) 11 (0.42) 12 (0.47)
10	DAMEN	6 (0.29) 12 (0.24) 15 (0.47)
11	JWS	Benchmark for 3 MFIs
12	RCDS	11 (0.64) 15 (0.36)
13	SAFWCO	Benchmark for 0 MFIs
14	NRSP	1 (0.25) 2 (0.55) 6 (0.20)
15	PRSP	Benchmark for 3 MFIs
16	TRDP	Benchmark for 1 MFI

From Table 7.3, it can be observed that ASA-P stands out as the global leader or the strongest benchmark, as it appears as an efficient peer for seven inefficient MFIs. Information about the global leader can be useful as it provides a good point of reference, while taking managerial measures for improving performance (Oral and Yolalan, 1990). Other relatively efficient benchmarks include: KBL, JWS, and PRSP, appearing in the reference sets of four, three, and three MFIs, respectively.

Using an arbitrary cut off point of 65% for efficiency scores, as the minimum acceptable profitability performance of MFIs, three of the worst performers in terms of profit efficiency are ASASAH, BRAC-P and RCDS. In order to improve their efficiency, ASASAH can follow the best practices of two of its largest benchmarks, namely; TRDP and ASA-P. For RCDS, the efficient peers that it needs to emulate are JWS and PRSP; whereas, for BRAC-P, the efficient peers are ASA-P and KBL.

7.4. The Outreach DEA (ODEA) Model

The ODEA model is developed with the aim to provide insights about performance of MFIs on the social front, i.e. their ability to reach a large number of poor people.

7.4.1. A Comparison of Scores with and without Incorporation of Trade-offs

The technical efficiency scores obtained from the ODEA model, under output orientation, with and without incorporation of the proposed trade-offs, are provided in the Table 7.4.

Table 7. 4 The ODEA (OO) Model Scores

	MFIs	CRS WO-TO	CRS W-TO	VRS WO-TO	VRS W-TO
1	FMFB	74.52%	41.02%	74.81%	44.25%
2	KBL	100.00%	80.17%	100.00%	83.80%
3	KMFB	66.44%	48.18%	67.90%	48.93%
4	NRSP-B	95.71%	58.64%	98.83%	65.96%
5	TMFB	100.00%	71.33%	100.00%	88.11%
6	ASA-P	100.00%	100.00%	100.00%	100.00%
7	ASASAH	44.85%	41.03%	51.90%	47.98%
8	BRAC-P	79.39%	79.39%	80.62%	80.62%
9	CSC	66.07%	56.54%	73.77%	70.86%
10	DAMEN	100.00%	79.10%	100.00%	89.21%
11	JWS	86.99%	74.77%	100.00%	100.00%
12	RCDS	70.38%	60.20%	100.00%	100.00%
13	SAFWCO	74.76%	72.63%	100.00%	94.47%
14	NRSP	56.16%	42.43%	100.00%	58.49%
15	PRSP	100.00%	73.63%	100.00%	100.00%
16	TRDP	82.10%	64.86%	100.00%	88.35%
Fully Efficient MFIs		5	1	10	4
Average Score		81.09%	65.24%	90.49%	78.81%

An inspection of different columns of Table 7.4 helps us understand, how the incorporation of the identified trade-offs improves the discrimination for the ODEA model. For the unrestricted CRS (WO-TO) model, there are five fully efficient MFIs, namely; KBL, TMFB, ASA-P, DAMEN, and PRSP. After incorporation of the trade-offs (W-TO), ASA-P remains the only fully efficient MFI; while the efficiency scores for KBL, TMFB, DAMEN and PRSP drop from 100 % to 80.17%, 71.33%, 79.10%, and 73.63%, respectively. This means that the number of fully efficient MFIs has dropped from five to one; whereas, the average efficiency score has gone down from 81.09% to 62.54%, as a result of the proposed trade-offs' incorporation.

Considering the unrestricted VRS (WO-TO) model, it is observed that there are ten fully efficient MFIs. After incorporation of the proposed trade-offs, the number of fully efficient MFIs drops from ten to four; with KBL, TMFB, DAMEN, SAFWCO, NRSP, and TRDP becoming less than 100 % efficient. Moreover, the efficiency scores drop for another five MFIs that include: FMFB, KMFB, NRSP-B, ASASAH, and CSC. Thus, there is considerable improvement in the model discrimination, as the average efficiency score drops from 90.49% in the unrestricted model, to 78.81% in the model with the proposed trade-offs.

Additionally, for the VRS based restricted model, ten MFIs are scoring more, and six MFIs are scoring less; than the average efficiency score of 78.81%. If we exclude the fully efficient MFIs, then the average efficiency score of the remaining MFIs becomes 71.75 %, indicating the potential for substantial improvement in the output efficiency of these MFIs.

7.4.2. A Comparison of Scores with Sequential Incorporation of Trade-offs

We now turn to a discussion of how the efficiency scores for different MFIs change, with incorporation of each sequential trade-off (Table 7.5).

Table 7. 5 The ODEA (VRS, OO) Model Scores

	MFIs	WO-TO	TO 4	TO 5	TO 5 + TO 6	TO 5 + TO 6 + TO 7	TO 5 + TO 6 + TO 7+ TO 8
1	FMFB	74.81%	57.41%	44.98%	44.98%	44.98%	44.25%
2	KBL	100.00%	100.00%	92.03%	88.41%	83.80%	83.80%
3	KMFB	67.90%	61.68%	61.68%	61.68%	61.68%	48.93%
4	NRSP-B	98.83%	68.58%	66.50%	66.50%	66.50%	65.96%
5	TMFB	100.00%	88.58%	88.11%	88.11%	88.11%	88.11%
6	ASA-P	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
7	ASASAH	51.90%	51.90%	51.73%	47.98%	47.98%	47.98%
8	BRAC-P	80.62%	80.62%	80.62%	80.62%	80.62%	80.62%
9	CSC	73.77%	73.08%	72.08%	72.08%	72.08%	70.86%
10	DAMEN	100.00%	100.00%	90.46%	90.46%	90.46%	89.21%
11	JWS	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
12	RCDS	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
13	SAFWCO	100.00%	100.00%	100.00%	95.09%	94.47%	94.47%
14	NRSP	100.00%	100.00%	70.73%	66.23%	58.49%	58.49%
15	PRSP	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
16	TRDP	100.00%	100.00%	100.00%	100.00%	88.35%	88.35%
Fully Efficient MFIs		10	9	6	5	4	4
Average Score		90.49%	86.37%	82.43%	81.38%	79.85%	78.81%

A visual examination of Table 7.5 reveals that as a result of incorporation of TO 4, the number of fully efficient MFIs drops from ten to nine. Also, there is a decrease in the efficiency scores of five MFIs, including: FMFB, KMFB, NRSP-B, TMFB, and CSC. When TO 5 is applied, then except for KMFB, the efficiency scores for the remaining four of these MFIs drop further. Moreover, a decrease in efficiency scores can also be observed for another four MFIs, namely; KBL, ASASAH, DAMEN, and NRSP. This brings down the number of fully efficient MFIs to six. When we incorporate TO 5 and TO 6 together, then in addition to the aforementioned MFIs (except for FMFB), the score for SAFWCO also drops; meaning that the efficiency scores have decreased for a total of ten MFIs. Moreover, we can see that the number of fully efficient MFIs has now become five. When we simultaneously apply TO 5, TO 6, and TO 7, then in addition to a number of previously inefficient MFIs, the efficiency score for TRDP also drops, bringing the number of fully efficient MFIs down to four. And finally, with incorporation of TO5 to TO 8 together, the efficiency scores drop further for a number of MFIs (FMFB, KMFB, NRSP-B, CSC, DAMEN), although there is no change in the number of fully efficient MFIs.

A comparison of the changes in the efficiency scores, resulting from the incorporation of different trade-offs can also provide some interesting insights. For example, it can be observed that the incorporation of TO 4, 5 and 6 results in the greatest drop in efficiency scores of the first five MFIs; in addition to a decrease of efficiency scores for NRSP and DAMEN. As these trade-offs are related to the volume and number of loans created from a given amount of loanable funds; therefore, any deterioration in efficiency as a result of their incorporation reflects poor performance of these MFIs on the outreach front.

Further analysis of the scores reveals that the efficiency scores drop for a number of MFIs when TO 7 and TO 8 are applied; although the magnitude of this change is not overly large. Remember that these two trade-offs are related to the productivity of loan officers, which is used as an indicator of the lending efficiency of MFIs (Meyer, 2002). Therefore, this observation implies that while many of the MFIs are making good use of this input, there is still potential for further improvement.

7.4.3. Benchmarks for the ODEA Model

The details of efficient peers for the selected MFIs are provided in the following table.

Table 7. 6 The ODEA (VRS, OO, W-TO) Model

	MFIs	Efficient Peers
1	FMFB	6 (1.00)
2	KBL	6 (1.00)
3	KMFB	6 (0.73) 11 (0.27)
4	NRSP-B	6 (1.00)
5	TMFB	6 (1.00)
6	ASA-P	Benchmark for 12 MFIs
7	ASASAH	6 (0.17) 11 (0.83)
8	BRAC-P	6 (0.87) 11 (0.13)
9	CSC	6 (0.03) 11 (0.97)
10	DAMEN	6 (0.07) 11 (0.93)
11	JWS	Benchmark for 7 MFIs
12	RCDS	Benchmark for 0 MFIs
13	SAFWCO	6 (0.10) 11 (0.90)
14	NRSP	6 (1.00)
15	PRSP	Benchmark for 0 MFIs
16	TRDP	6 (0.02) 11 (0.98)

An inspection of Table 7.6 reveals that for the ODEA model, ASA-P is once again the most efficient peer, as it appears as in the reference set of twelve inefficient MFIs. JWS appears as an efficient peer for seven MFIs. On the other hand, two of the MFIs, namely; PRSP and RCDS are not efficient peers for any MFI, despite having scored 100% on the outreach aspect. Considering the previously selected cut-off limit of 65%, the lowest scoring MFIs in the ODEA model include FMFB, KMFB, ASASAH, and NRSP. These MFIs may improve their performance by emulating their strongest peers, i.e. ASA-P and JWS.

7.5. The DBL-DEA Model

The DBL-DEA model is designed to capture both the financial and social aspects of MFIs' performance.

7.5.1. A Comparison of Scores with and without Incorporation of Trade-offs

The efficiency scores obtained from the DBL-DEA model, with and without incorporation of the proposed production trade-offs, are provided in Table7.7.

Table 7. 7 The DBL-DEA (OO) Model Scores

	MFIs	CRS WO-TO	CRS W-TO	VRS WO-TO	VRS W-TO
1	FMFB	100.00%	52.54%	100.00%	65.03%
2	KBL	100.00%	84.54%	100.00%	94.17%
3	KMFB	100.00%	60.70%	100.00%	60.75%
4	NRSP-B	95.71%	58.64%	98.83%	65.96%
5	TMFB	100.00%	72.17%	100.00%	90.48%
6	ASA-P	100.00%	100.00%	100.00%	100.00%
7	ASASAH	59.05%	46.25%	59.19%	50.12%
8	BRAC-P	87.18%	80.72%	87.98%	80.98%
9	CSC	86.04%	65.54%	86.60%	75.95%
10	DAMEN	100.00%	82.67%	100.00%	89.73%
11	JWS	100.00%	82.45%	100.00%	100.00%
12	RCDS	76.31%	62.76%	100.00%	100.00%
13	SAFWCO	76.16%	73.66%	100.00%	94.47%
14	NRSP	95.36%	57.47%	100.00%	86.98%
15	PRSP	100.00%	76.92%	100.00%	100.00%
16	TRDP	82.10%	64.86%	100.00%	88.35%
Fully Efficient MFIs		8	1	12	4
Average Score		89.85%	70.34%	95.79%	83.94%

For the DBL-DEA model, run under the CRS assumption and without any trade-off (WO-TO), there are eight fully efficient MFIs including: FMFB, KBL, KMFB, TMFB, ASA-P, DAMEN, JWS and PRSP. After incorporation of the proposed trade-offs, only ASA-P remains fully efficient; while the scores for the other seven previously efficient

MFIs become less than 100%. In addition, the efficiency score for the eight previously inefficient MFIs drop further, resulting in an overall decrease in the average efficiency from 89.85% to 70.34%, as a result of the trade-offs' incorporation.

For the unrestricted VRS (WO-TO) model, there are twelve fully efficient MFIs; while NRSP-B, ASASAH, BRAC-P and CSC are the only four MFIs that have scored less than 100%. After incorporation of the proposed trade-offs, the number of fully efficient MFIs drops from twelve to four. The MFIs, for which the efficiency scores become less than 100% in the restricted model include: FMFB, KBL, KMFB, TMFB, DAMEN, SAFWCO, NRSP, and TRDP. Also, after incorporation of the proposed trade-offs, the efficiency scores drop further for the aforementioned four MFIs that had scored less than 100% in the unrestricted model, bringing down the average efficiency score to 83.94%.

For the restricted VRS model (WO-TO), there are ten MFIs scoring more, and six MFIs scoring less, than the average efficiency score of 83.94%. Excluding the fully efficient MFIs, the average score for the remaining MFIs becomes 78.58%; implying potential for further improvement in the double bottom-line efficiency of these MFIs.

7.5.2. A Comparison of Scores with Sequential Incorporation of Trade-offs

In this section, a discussion of changes in efficiency scores, observed with sequential incorporation of trade-offs, is provided.

Table 7. 8 The DBL-DEA (VRS, OO) Model Scores

	MFIs	WO-TO	TO 4	TO 5	TO 9	TO 9 + TO 6	TO 9 + TO 6 + TO 7	TO 9 + TO 6 + TO 7 + TO 8
1	FMFB	100.00%	100.00%	100.00%	79.97%	66.08%	66.08%	65.03%
2	KBL	100.00%	100.00%	100.00%	100.00%	94.17%	94.17%	94.17%
3	KMFB	100.00%	100.00%	100.00%	98.59%	84.35%	84.35%	60.75%
4	NRSP-B	98.83%	90.08%	90.08%	66.50%	66.50%	66.50%	65.96%
5	TMFB	100.00%	100.00%	100.00%	91.68%	90.48%	90.48%	90.48%
6	ASA-P	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
7	ASASAH	59.19%	59.19%	59.19%	59.17%	52.23%	52.23%	50.12%
8	BRAC-P	87.98%	87.98%	87.98%	87.98%	80.98%	80.98%	80.98%
9	CSC	86.60%	86.60%	86.60%	85.84%	81.10%	81.10%	75.95%
10	DAMEN	100.00%	100.00%	100.00%	91.84%	91.33%	91.33%	89.73%
11	JWS	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
12	RCDS	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
13	SAFWCO	100.00%	100.00%	100.00%	100.00%	95.09%	94.47%	94.47%
14	NRSP	100.00%	100.00%	100.00%	100.00%	86.98%	86.98%	86.98%
15	PRSP	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
16	TRDP	100.00%	100.00%	100.00%	100.00%	100.00%	88.35%	88.35%
Fully Efficient MFIs		12	12	12	8	5	4	4
Average Score		95.79%	95.24%	95.24%	91.35%	86.83%	86.06%	83.94%

An examination of Table 7.8 helps to explain how different trade-offs affect the relative efficiency scores of various MFIs, in the DBL-DEA model. It can be seen that TO 4 and TO 5, when applied individually, result in only minor improvement for a single MFI (NRSP-B), as compared to the unrestricted model. However, when we apply TO 9, which is a stronger trade-off as compared to TO 4 and TO 5, the efficiency scores for seven MFIs decline. These MFIs include: FMFB, KMFB, NRSP-B, TMFB, ASASAH, CSC, and DAMEN. Also, the number of fully efficient MFIs drops from twelve to eight; whereas, the average efficiency score drops to 91.35%.

When TO 6 and TO 9 are applied together, then in addition to six of the aforementioned MFIs[79], the efficiency scores decrease for another four MFIs, namely; KBL, BRAC-P, SAFWCO, and NRSP. At the same time, the number of fully efficient MFIs now becomes five, with average efficiency score becoming 86.83%. In the next step, the addition of TO 7 results in another MFI (TRDP) becoming less than 100% efficient, while the score for SAFWCO also decreases slightly. This indicates a small decrease in the average efficiency score, which becomes 86.06%; whereas, the number of fully efficient MFIs drops down to four. Finally, when we apply four trade-offs simultaneously (TO6, TO7, TO8, TO9), then the efficiency scores drop further for FMFB, KMFB, NRSP-B, ASASAH, CSC, and DAMEN. This brings the average efficiency score down to 83.94%, while the number of fully efficient MFIs remains the same.

An interesting observation about the results of the restricted DBL-DEA model is the negligible difference in the efficiency scores, obtained after the incorporation of TO 4 and TO 5 individually. This is in contrast to the ODEA model, where the same two trade-offs improved discrimination for a number of MFIs. A simple reason for this difference is the fact that DBL-DEA model is having a larger number of input and output variables, as compared to the ODEA model; thus enabling the MFIs to score well, despite the incorporation of TO 4 and TO 5. However, a smaller improvement in discrimination should not be taken as an indicator of the worth (or usefulness) of any trade-off. Neither should it be considered as a reflection of the effectiveness of the said

[79] The only exception is NRSP-B, whose score does not drop any further.

trade-off/s. No matter how small the improvement, it should still be considered better than having no improvement at all.

It is also worth noting that the sequence in which different trade-offs are applied to a model can also influence the explanatory power of resulting efficiency scores. For example in the ODEA model, the simultaneous application of TO 5 and TO 6 helped in identification of the MFIs scoring worse on social performance dimension. However, this is not the case for the DBL-DEA model; where we have applied the trade-offs in a slightly different manner, with a stronger trade-off i.e. TO 9, used to replace both TO 4 and TO 5. This trade-off is having multiple changes that are incorporated in a single step, thereby making the interpretation of resulting scores a bit complex. We would advise thus greater care when interpreting scores obtained from such complex trade-offs. A possible route could be to try and disaggregate the different aspects of a more comprehensive trade-off, into individual trade-offs; and apply these separately, for the sake of understanding their individual impacts. For example, in the case of PDEA model, application of TO 2 eliminates the need to apply TO 1. However, we have still applied TO 1 individually, for investigating how this trade-off has affected the scores of different MFIs.

7.5.3. Benchmarks for the DBL-DEA Model

Table 7. 9 The DBL-DEA (VRS, OO, W-TO) Model

	MFIs	Efficient Peers
1	FMFB	6 (1.00)
2	KBL	6 (1.00)
3	KMFB	6 (0.98) 11 (0.02)
4	NRSP-B	6 (1.00)
5	TMFB	6 (1.00)
6	ASA-P	Benchmark for 12 MFIs
7	ASASAH	6 (0.20) 11 (0.80)
8	BRAC-P	6 (0.97) 11 (0.03)
9	CSC	6 (0.05) 11 (0.95)
10	DAMEN	6 (0.07) 11 (0.93)
11	JWS	Benchmark for 7 MFIs
12	RCDS	Benchmark for 0 MFIs
13	SAFWCO	6 (0.10) 11 (0.90)
14	NRSP	6 (1.00)
15	PRSP	Benchmark for 0 MFIs
16	TRDP	6 (0.02) 11 (0.98)

Like the previous two models, for the DBL-DEA model also, ASA-P is a global leader, as it appears as a benchmark for twelve inefficient MFIs. JWS is the second most efficient benchmark institution, having appeared as an efficient peer for seven MFIs. RCDS and PRSP are not efficient peers for any MFI, although both of these MFIs have scored 100% in the restricted model. The worst performing MFIs that have scored less than 65% on the double bottom-line performance dimension, include two MFIs, namely: KMFB and ASASAH. The relevant benchmarking institution for KMFB is ASA-P, while JWS is the stronger benchmark for ASASAH.

7.6. An Investigation of the Conflict versus Compatibility Dilemma

One of the objectives of the current study relates to an investigation of the much debated existence of, either a conflict or compatibility; between the social and financial performance of MFIs, within the context of the current data set. To help shed some light on this issue, we compare the results of the PDEA and the ODEA models that have been used to measure individually, the sustainability and outreach dimensions of the MFIs' performance.

An overview of the computational results reveals that there are seven MFIs, including KBL, TMFB, ASA-P, JWS, SAFWCO, PRSP, and TRDP; that have scored well (from 80% to 100%), in both the outreach and profitability models. On the other hand, there are six MFIs that have performed well, but on only one of the sustainability and outreach performance aspects. These MFIs include: FMFB, BRAC-P, CSC, DAMEN, RCDS, and NRSP. Finally, there is a small number of MFIs comprising KMFB, ASASAH, and NRSP-B that are not scoring well, in either the PDEA model or the ODEA model. This indicates a poor performance by these MFIs on both the sustainability and outreach performance dimensions.

Before discussing the implications of these conflicting findings of the current study, we would like to highlight a few basic factors that can help explain, to some extent, the logic behind observed diversity in the results of different studies, relating to the conflict-compatibility dilemma. It would be reasonable to suggest, for example, that such diversity of findings can depend partly, on different contextual factors. For instance, it is quite possible that different environmental and institutional characteristic, related to the diverse data sets used in various studies, could have played a part in the observed differences in their findings. Use of different analytical techniques is another possible factor, which may lead to different results for achievement of dual performance objectives of MFIs. Differences in the definitions and measures of performance can also contribute to the observed diversity. As a case in example; the performance of MFIs is defined, measured and reported, for the most part, in terms of a variety of ratios. While not denying the importance of these ratios, it also needs to be acknowledged that ratio-based analyses provide only partial and segregated account of the overall performance of MFIs. As a result, various studies on performance evaluation of MFIs may offer diverse results; simply on the basis of utilizing different sets of ratios, used as indicators of performance.

The basic aim of the foregoing discussion has been to explore various factors contributing towards the much debated conflict-compatibility dilemma. However, the factors discussed above do not offer an explanation for the contradiction observed in the current study; whereby, within the same data set, we can observe both compatibility and conflict between the social and financial performance objectives for the selected MFIs. For example, if we consider the fact that there are six MFIs, which have done well on only one of the outreach and sustainability performance dimensions; then we may support the studies claiming existence of a conflict between these two performance dimensions (Navajas et al., 2000, Solomon et al., 2002, Navajas et al., 2003, Olivares-Polanco, 2005, Cull et al., 2007, Ejigu, 2009, Hermes and Lensink, 2011, Abate et al., 2014). On the other hand, we also need to take into account the fact that there are seven MFIs, which have been able to score well on both the social and financial performance dimensions. This trend is consistent with the studies reporting compatibility of the dual objectives of MFIs (Christen et al., 1995, Paxton and Fruman, 1997, Rhyne, 1998, Woller, 2000, Christen, 2001, Paxton, 2003, Quayes, 2011). Finally, there are three MFIs, which have done poorly, on both the social and financial performance fronts. These contradictory findings highlight the relevance of the efficiency[80] premise, presented in the framework proposed for performance evaluation of MFIs, in the current study. Through this framework, we have offered a simple but logical argument that,

[80] Efficiency is defined, in the present context, simply as the difference between the observed and the best possible values of the inputs used and the outputs produced by the MFIs.

through achieving higher levels of efficiency, MFIs can be in a better position to achieve their dual objectives simultaneously. Inefficient MFIs, on the other hand, may be forced to compromise, on either one or both, of their performance objectives. The results of this study provide the examples of both these types of MFIs, thus lending credence to the efficiency premise.

We further posit that there can be certain characteristics related to efficient performance[81], which if followed correctly by the inefficient MFIs, can help them attain better performance levels. It may be pointed out that for the DEA literature; the notions related to efficiency in performance, identification of best practices, and setting performance targets that can facilitate more efficient achievement of objectives, represent common knowledge. However, the same is not true for the literature on the performance evaluation of MFIs. For the microfinance field, the concepts of efficiency and best practice remain, so far, relatively simplistic. As pointed out by Woller (2000), apart from a broad consensus that the notion of best practices for MFIs is generally considered synonymous to some minimum levels of financial and operational self-sufficiency, very little is offered in terms of possible recommendations for improving efficiency. This notion of best practices generally results in setting up of common standards or targets, without taking into account fundamental differences in the institutional characteristics. As a result these performance standards are not always found to be relevant.

Contrary to such simplistic notions of efficiency and best practices, we illustrate through the current study, that the use of DEA technique can help determine the existing levels of MFIs' relative efficiency. Note that the measure of efficiency obtained from DEA provides a more comprehensive picture of MFIs' performance as it is calculated

[81] Such characteristics are known as the *best practices* in the DEA terminology.

by taking into account multiple inputs and outputs of MFIs. This is clearly in contrast to the more commonly used ratio technique which only provides snippets of information about various aspects of MFIs' performance. Moreover, the best practices and reference peers, identifiable through the DEA technique, can be invaluable tools for setting realistic and achievable standards of performance for underperforming MFIs.

Summing up, it would be reasonable to suggest that efficiency in performance needs to be considered as an essential element, for dealing with the conflict-compatibility dilemma. If we assume, for the sake of argument, that the achievement of dual objectives of MFIs indeed involves a conflict; then through enhancing efficiency, it may be possible to reduce the intensity of the observed conflict. On the other hand, if the compatibility proposition is assumed to be true, then again, efficiency in performance may help further strengthening of such compatibility of social and financial objectives of MFIs.

7.7. Analysis of Major Changes in Efficiency Scores for Selected MFIs

We have observed that with the application of different trade-offs, the efficiency scores for a number of MFIs have been affected. In this section, we offer a discussion about some of the MFIs, for which application of certain trade-offs has resulted in serious decline of the efficiency scores and also undertake an investigation of the possible reason underlying this deterioration in efficiency scores. In this regard, it can be seen that for FMFB, the application of TO 4 has resulted in a decrease in efficiency from 74.81% to 57.41% in the ODEA model. This trade-off is related to the technologically possible increase in loan portfolio with an increase in loanable funds. Therefore, a decrease in efficiency for FMFB implies that this MFI may not be making good use of the loanable funds for creating loans portfolio. This suggestion was further investigated and it was discovered that of all the MFIs included in the analysis, FMFB is having the lowest ratio of loan portfolio to the loanable funds, which supports our initial analysis. A similar decrease in efficiency scores obtained from the ODEA model can be observed for NRSP-B for which the efficiency score dropped from 98.83% to 68.58% after application of TO 4. For NRSP-B again, the ratio of loan portfolio to the loanable funds is rather low, which suggests that NRSP-B is not making optimal use of the funds at its disposal for creating adequate volume of loans.

Another MFI for which significant drop in efficiency scores is observed both in the ODEA and the DBL-DEA models is KMFB. The observed decline in efficiency scores was a result of the application of TO 8, which incorporates information about productivity of loan officers, in terms of number of loans created by these officers. Therefore, the decrease in efficiency of KMFB from 61.68% to 48.93% in the ODEA model and from 84.35% to 60.75% in the DBL-DEA model, after application of this trade-off led us to calculate the ratio of number of loans to the number of loan officers. Not surprisingly, this ratio is found to be lowest for KMFB with only 115 loans per loan officers, as compared to the highest ratio of 514 loans per loan officer that is observed for KBL.

Two other instances of sharply deteriorating efficiency scores were observed for FMFB and NRSP-B after application of TO 9 in the DBL-DEA model. It needs to be noticed that this trade-off is representing a complex relationship between three variables i.e. loanable funds, loan portfolio and number of loans. Therefore, one possible reason for this change in efficiency score for these two MFIs is the poor performance of these institutions in converting available funds into loan portfolio, as discussed earlier. In addition, a look at the ratio of loan portfolio to number of loans reveals that these two MFIs are also having quite large ratio of loan portfolio to number of loans. This implies that FMFB and NRSP-B are offering relatively large sized loans to their customers, thus performing poorly on the outreach dimension. Two other MFIs, namely; KMFB and TMFB are also found to have high ratios of loan portfolio to number of loans which can explain the considerable decrease in the efficiency scores for these MFIs after application of TO 6 and TO 9, in the DBL-DEA model.

7.8. Analysing Some Additional Dimensions

In this section, we compare the findings of the current study with the existing literature in the field of performance evaluation. For this purpose, we examine some commonly studied aspects related to firms' performance. For example, size and age as common attributes of firm efficiency, have been widely studied in the literature on performance assessment. Similarly, the impact of institutional type and staff productivity are also considered to be major characteristics that can influence performance. A discussion of some key associations considered relevant, given the scope of the current study, is provided hereafter.

7.8.1. Association Between Efficiency and the Age of MFIs

Discussions about the possible association between age and efficiency started quite early on, within the firm growth literature. One of the prominent studies in this regard was conducted by Jovanovic (1982), who proposed a model of firm growth, involving relationship between efficiency and age of firms. There is also considerable empirical evidence, confirming a positive relationship between these two variables (Pitt and Lee, 1981, Chen and Tang, 1987, Majumdar, 1997, Masood and Ahmad, 2010). Learning-by-doing effects are known as the major contributors towards such positive association (Malerba, 1992).

For the current study, the average efficiency scores for the group of older MFIs (11-20 years old) are larger than the average efficiency scores for the group of younger MFIs (1-10 years old), for all three models. Moreover, the t-tests run for checking the statistical significance reveal that the difference between the two groups is significant at 10% level for the PDEA model, at 5% level for the ODEA model and at 1% level for the DBL-DEA model (Table 7.10). These results thus reinforce the previous findings related to a positive association between firm age and efficiency.

Table 7. 10 Association Between Firm Age and Efficiency (VRS, W-TO)

Average Efficiency Scores	Age Group 1 (1-10 years)	Age Group 2 (11-20 years)	Difference in Scores	P-Value
PDEA	74.36%	89.70%	15.35%	0.1052
ODEA	67.98%	87.24%	19.26%	0.0264
DBL-DEA	73.33%	92.18%	18.85%	0.0062

An interesting observation, which could be made on the basis of the average efficiency scores, is that the association between the age and efficiency becomes even more prominent for the scores of the two of the DEA models (ODEA and DBL-DEA), obtained after incorporation of the proposed trade-offs, in comparison to these models run without any trade-offs (Table 7.11).

Table 7. 11 Association Between Firm Age and Efficiency (VRS, WO-TO)

Average Efficiency Scores	Age Group 1 (1-10 years)	Age Group 2 (11-20 years)	Difference in Scores	P-Value
PDEA	75.55%	96.28%	20.73%	0.0303
ODEA	82.01%	97.09%	15.08%	0.0245
DBL-DEA	92.29%	98.51%	6.23%	0.1303

For the ODEA model, the difference in efficiency scores increases from 15.08% in the unrestricted model (Table 7.11) to 19.26% in the restricted model (Table 7.10). For DBL-DEA model, an increase from 6.23% (Table 7.11) to 18.85 % (Table 7.10) is observed. A plausible explanation for this phenomenon is that with the incorporation of trade-offs, the restricted models become better informed, in comparison to the non-restricted models. As a result, the models with trade-offs are able to provide greater support for existing evidence, related to the association between age and efficiency of MFIs, as compared to the models without any trade-offs.

At the same time, we also note that the PDEA model has behaved somewhat differently. As we can see, the difference in efficiency scores of the two groups of MFIs is found to be greater in the non-restricted PDEA model. One of the possible reasons for this anomaly may be the fact that within the older group of MFIs, the score for RCDS dropped drastically (from 100% to 50.15%), with incorporation of the proposed trade-offs; thus causing considerable distortion to the average score of the whole group in the restricted PDEA model. We have, therefore, calculated the average efficiency scores for the larger group of MFIs, without including RCDS. The resulting average efficiency score for the restricted PDEA model in this case comes up to be 18.28%; whereas, for the unrestricted model, the new score is 20.26%. However, this offers only part explanation of the anomaly; suggesting presence of other possible reasons that are not explored by this study.

Another interesting observation about the relationship between age and efficiency is that the gains in technical efficiency are reported to gradually become smaller, with the passage of time (Lundvall and Battese, 2000), as a result of diminishing returns to scale for learning-by-doing processes (Young, 1991). However, due to having a relatively young set of MFIs in the current data set, we are not able to investigate this aspect further.

7.8.2. Association Between the Institutional Type and Efficiency

There is considerable research on the possible relationship between efficiency and institutional type of MFIs that warrants an exploration of the issue, within the context of the current study. For the MFIs included in the current data set, there are two major categories of institutional type, namely; non-NGO MFIs and NGO MFIs. Within non-NGO category of MFIs, we have five banks; whereas, in the NGO category of MFIs, we have eleven not-for profit and rural support programmes. The p-values and average efficiency scores for the current data set, divided into these two groups, are provided in Table 7.12.

Table 7. 12 Association Between Institutional Type and Efficiency (VRS, W-TO)

Average Efficiency Scores	Non-NGO/Bank MFIs	NGO -MFIs	Difference in Scores	P-Value
PDEA	88.23%	80.61%	7.62%	0.2852
ODEA	66.21%	84.54%	18.33%	0.045
DBL-DEA	75.28%	87.87%	12.59%	0.0736

We can observe from the average efficiency scores that for both the ODEA and the DBL-DEA models, the NGO group of MFIs has scored better, as compared to the non-NGO group of MFIs. The difference between the two groups is also found to be statistically significant at 5% level for the ODEA model and at 10% level for the DBL-DEA model. The superior performance of NGO-MFIs on the outreach dimension is consistent with the results of the studies conducted by Gutiérrez-Nieto et al. (2009), Sedzro et al. (2010), and more recently by Barry and Tacneng (2014). According to all these studies, the average social efficiency of MFIs falling under the category of NGOs is higher than MFIs belonging to the non-NGO category.

A plausible explanation, for the superior outreach performance of NGOs by having more clients, is based on the fact that it is comparatively easier for the poorer people to borrow from NGO-MFIs, as compared to the non-NGO MFIs (especially bank MFIs). This in turn is due to the lack of account opening culture observed generally in the poorer communities, on the one hand; and greater formalities (or restrictions) imposed by the bank MFIs, for account opening and loan processing, on the other hand. Consequently, all else being equal, poorer people may prefer to get loans from the NGO MFIs than the non-NGO (or more particularly, bank) MFIs.

Here, we would also like to refer to one of our earlier observation in section 7.4.2, whereby the first five MFIs' scores deteriorated the most, with the application of the trade-offs, related to the loans portfolio and number of loans. Note that all these five MFIs belong to the bank category of MFIs, and these were able to achieve higher scores in the unrestricted model by using unrealistic weights for the output variables representing outreach. With the incorporation of technologically possible trade-offs, these non-NGO or bank-MFIs were then forced to reallocate the weights in a more realistic manner, resulting in smaller scores on the outreach front.

We would also like to mention another finding of the study by Barry and Tacneng (2014), according to which the NGO category of MFIs tends to be more profitable, than other types of MFIs. At the same time, NGOs are also reported to be primarily not-for profit organizations (Bibu et al., 2013). These findings are in contradiction with the results obtained for the current study. For our data set, the non-NGO MFIs are able to perform only slightly better than NGO-MFIs, on profitability dimension; as is evident from a comparison of the average efficiency scores of the two groups in the PDEA model. Moreover, this difference in the two groups is not found to be statistically significant. It needs to be noted however, that while Barry and Tacneng (2014) used return on assets (ROA), as the major criterion for assessing profitability performance; we have used a DEA model for this purpose. In contrast to the individual ratios based on different variables, this model has incorporated multiple aspects, related to profit efficiency; which may be a possible reason for the contradiction found in the results of the two studies.

Moreover, another possible explanation of this negligible difference between profitability efficiency of NGO and non-NGO MFIs is that due to recent pressure for ensuring financial sustainability, this particular group of MFIs is now forced to ensure adequate levels of profit, like other profit oriented institutional categories of MFIs. Finally, we can add to existing literature by proposing that when the social and financial performance are considered simultaneously; then NGO-MFIs may turn out to be better performers, than their non-NGO counterparts. This proposition is supported by the average efficiency scores of the DBL-DEA model for the current study.

7.8.3. Association Between the Size and Efficiency of MFIs

Larger firms[82] are generally expected to be superior performers than smaller firms, due to such factors as: better access to resources, more technical knowledge and superior organization. However, the existing literature on this topic has come up with mixed findings, with the result that the exact nature and direction of this relationship still remains a bit ambiguous. For example, Chen and Tang (1987), and Masood and Ahmad (2010), report no significant association between firm size and efficiency. On the other hand, a study by Barry and Tacneng (2014) claims that bigger MFIs tend to perform better, on both the social and financial dimensions of performance. Another interesting example, of the contradiction observed for the proposed relationship between size and efficiency, is provided by Barbosa and Louri (2005). Their study, which is based on data from two different countries, comes up with a positive relationship between firm size and performance, for one country; while no significant relationship between these two variables could be verified, for the other country. Majumdar (1997) has pointed out

[82] Firm size is measured by such indicators as assets, employees or even income levels; though assets are one of the more frequently used proxy for firm size.

that the relationship of firms' performance with their size is largely dependent on the environmental and institutional factors. This view offers a plausible explanation for the observed differences in the results of various studies, related to the association between firm size and performance.

Within the context of the current study, the possible relationship between firm performance and size has been investigated, by using assets as a proxy for size. For this purpose, the selected MFIs are divided into two groups, to differentiate them on the basis of size. The MFIs having assets of more than one billion (PKR), are categorized as large MFIs, and those having assets of less than one billion (PKR) are categorized as small MFIs. As a result of this segregation, seven MFIs belong to the small sized group; while nine MFIs are included in the large sized group of MFIs. The average efficiency scores for the two groups of MFIs, obtained from the three DEA models and the p-values obtained from the t-test are reported in Table 7.13 below.

Table 7. 13 Association Between Efficiency and Firm Size (VRS, W-TO)

Average Efficiency Scores	Group 1 (Small MFIs)	Group 2 (Large MFIs)	Difference in Scores	P-Value
PDEA	77.27%	87.44%	10.17%	0.2071
ODEA	84.41%	74.46%	9.95%	0.171
DBL-DEA	85.52%	82.71%	2.81%	0.3692

If we look at the average efficiency scores alone for the two groups, it may be suggested that for the PDEA model, the group of larger MFIs is performing better, in comparison to the group of smaller MFIs. However, for the ODEA model, the situation is reverse; with smaller MFIs having greater average efficiency score than the larger MFIs. This observation could imply that MFIs' performance on the profitability dimension may be affected by their size, but from the outreach perspective, size may not be having a positive influence. Finally, for the DBL-DEA model, the average efficiency scores for the two groups of MFIs are not having a lot of difference.

However, when we consider the p-values, it can be seen that the observed differences between average efficiency scores of the larger and smaller MFIs are not statistically significant for any of the three models. Based on this fact, we conclude that for the current data set, the size of institution is not having a significant association with their performance.

7.8.4. Association Between the Number of Branches and Efficiency

According to the performance evaluation literature, having a greater number of branches may have a positive influence on firm efficiency. For example, a study by Elyasiani and Mehdian (1990) reports that banks with greater number of branches tend to be more efficient, as compared to the banks having lesser number of branches. However, they have not provided any explanation of this phenomenon. We would like to suggest that having larger number of branches implies comparatively bigger set ups, greater access to potential client base, and possibly more commercially/profit oriented MFIs. Such characteristics, in turn, can have positive impact on the firm performance.

For testing the applicability of this proposition for the current data set, we split the selected MFIs into two groups. The first group comprises MFIs having less than 50 branches, while the second group comprises MFIs having more than 50 branches.

Table 7. 14 Association Between Branch Network and Efficiency (VRS, W-TO)

Average Efficiency Scores	Group 1 (less than 50 branches)	Group 2 (more than 50 branches)	Difference in Scores	P-Value
PDEA	72.70%	90.99%	18.29%	0.0653
ODEA	78.78%	78.84%	0.06%	0.4976
DBL-DEA	81.57%	85.77%	4.20%	0.3085

It can be seen from Table 7.14 that although for all three DEA models, the average scores for MFIs having more than 50 branches are greater, than the scores for MFIs having less than 50 branches; however, this difference is statistically significant only for the PDEA model at 10% significance level. This observation lends some support to our earlier proposition about bigger set ups and greater profit orientation of MFIs with bigger network of branches.

In contrast to the PDEA model, the differences between the two identified groups are not statistically significant for either the ODEA or the DBL-DEA models. In particular, the negligible difference of 0.06%, in the outreach performance of the two groups of MFIs implies that having a greater number of branches is not having any influence on the outreach efficiency of the selected MFIs. This is understandable in the sense that sometimes reaching a larger number of clients may depend, more on the location of branches, than on the total number of branches. For example, having branches in more populous areas can have a positive impact on outreach, through serving more clients; as compared to having a larger network of branches in far off, sparsely populated areas.

A relevant consideration in this regard thus would be the geographical spread of branches that can have conflicting implications for the financial and social efficiency of MFIs. For example, MFIs having more branches, in easy to reach urban and semi-urban areas, may incur lesser costs, as compared to the MFIs that are having greater presence in rural communities, located in remote places. This could have positive influence for profit efficiency of the former category of MFIs. On the other hand, the convenience and proximity offered by the geographically dispersed network of branches could mean better price flexibility of the products offered, which could be having a positive impact on the profit efficiency of the latter category of MFIs. Such existence of better price flexibility may be explained on the basis of the observation that the customers located in remote areas, having smaller number of financial institutions, are willing to pay much higher prices for the products of locally situated institutions. Such higher costs may be acceptable for these people simply to avoid the hassle of going to less costly but out of easy access, non-local institutions (Elyasiani and Mehdian, 1990). Considering these issues we decided to undertake some additional investigation related to the geographical spread of the selected MFIs. The findings of this investigation are reported in the following section.

7.8.5. Association Between Efficiency and the Geographical Spread of Branches

It is observed that five of the MFIs in our data set, namely; KBL, NRSP, FMFB, ASA-P and TMFB, are having the highest geographical spread, with branches in 72, 49, 48, 33, and 29 districts respectively (Ali, 2011). As suggested earlier, having a wide geographical spread generally translates into larger set ups, greater resources and larger potential client base. These characteristics in turn imply a positive connotation for the social and financial performance of MFIs, having presence in geographically dispersed markets. We would expect then at least some reflection of a positive influence of such high geographical spread of branches on the performance of these five MFIs.

Upon investigation, we find that in line with our expectations, all of these MFIs are among the list of best performers for the PDEA model. Moreover, three of these MFIs i.e. KBL, TMFB and ASA-P are also good performers in the ODEA and DBL-DEA models, with scores ranging from 83.80% to 100%. The performance of NRSP is also good in the DBL-DEA model, with efficiency score of 86.98%. However, this MFI has scored only 58.49% in the ODEA model. For FMFB the only high efficiency score is achieved in PDEA model (100%), with fairly low scores in both the ODEA model (44.25%) and the DBL-DEA model (65.03%).

The poor performance of these two MFIs on different aspects of performance once again provides credence to the intuitive suggestion made earlier, that in addition to favourable environmental and institutional characteristics; there can be certain efficiency related best practices that can play an important role in ensuring good performance standards. The presence or absence of such best practices can therefore have an impact on how different MFIs are able to utilize their resources, to meet their dual performance objectives.

7.8.6. Association Between Efficiency and Productivity of Loan Officers

A final aspect to be discussed, with reference to the possible influences on the performance of MFIs, relates to their staff productivity. According to the microfinance literature, the role played by staff, and particularly by loan officers, is found to be a significant influence on the financial and social performance of MFIs (Baumann, 2005). In order to investigate this issue further, we calculated the productivity of loan officers[83] (Table 7.15) and compared it with the efficiency scores of the MFIs appearing relatively efficient in all three DEA (VRS, W-TO) models.

[83] The productivity of loan officers is measured as total number of loans divided by the total number of loan officers.

Table 7. 15 Productivity of the Loan Officers

	MFIs	Loans per Loan Officer		MFIs	Loans per Loan Officer
1	KBL	514	9	NRSP-B	226
2	DAMEN	388	10	CSC	197
3	ASA-P	306	11	RCDS	180
4	FMFB	289	12	BRAC-P	174
5	TMFB	260	13	NRSP	163
6	JWS	250	14	ASASAH	149
7	TRDP	231	15	PRSP	128
8	SAFWCO	230	16	KMFB	115

We find that seven MFIs have performed comparatively well with efficiency scores ranging from 80% to 100% in all three models. These MFIs include: KBL, ASA-P, TMFB, JWS, TRDP, SAFWCO, and PRSP. We can see from Table 7.15 that with the exception of PRSP, all these MFIs belong to top 50% of the high scorers on staff productivity, which is consistent with the proposed link between staff productivity and efficient performance.

7.9. The Choice Between Different Models for MFIs' Evaluation

We would like to conclude this chapter with a discussion about different situations which may call for the use of either one or more than one models for MFIs' performance evaluation. It is suggested that, the use of a single double bottom-line model (like the DBL-DEA model), can be effective for situations where an overall ranking of the selected MFIs is the major objective, irrespective of the individual performance of these MFIs on the outreach and sustainability parameters. The use of a single model may also be suitable for microfinance industries that are characterised by diverse categories of MFIs that may be more inclined towards achieving either the outreach or the sustainability objectives, instead of focussing equally on both these performance dimensions. In other words, if these two objectives are not given equal importance by various institutions comprising a microfinance sector, then from an external benchmarking point of view a single model could suffice.

On the other hand, if the objective is not the overall ranking, but rather a more in-depth look at how different MFIs are doing at their individual bottom-lines, then it makes more sense to look at different models, such as the PDEA and ODEA models; because such models are capable of capturing these performance dimensions separately. The use of a single model, in such cases may not be appropriate. Taking the example of the data set used in the current study, a look at the efficiency scores for the three models reveals that for certain MFIs such as FMFB, BRAC-P, DAMEN, RCDS, and NRSP, the DBL-DEA model alone is inadequate in reflecting upon their performance on outreach and sustainability dimensions. This is so because FMFB is scoring only 65.03% in this model, showing it to be a rather underperformer. However, a look at the PDEA and ODEA models reveals that it has scored 100% on profitability dimension, while scoring only 44.25% on the outreach dimension. Similarly, BRAC is scoring quite well in the DBL-DEA model (80.98%) but its score in PDEA model is only 52.79%. Same is the case for DAMEN and RCDS, both of which are quite poor performers on the profitability dimension, despite scoring well in the double bottom-line model. A final example is NRSP, which is a poor performer on the outreach criterion but is still able to score well in the double bottom-line model.

To sum up, the choice between a single more holistic model capturing both outreach and sustainability or profitability dimensions and two separate models focussing on these dimensions individually, will depend on the objectives of any research study. For the current study, the use of all three models has been considered necessary in order to explain the process of how different trade-offs can be modified and incorporated into different single and double bottom-line models.

Chapter 8 Conclusion

8.1. Summary of the Research

This study has demonstrated an empirical application of the trade-off approach in the field of microfinance. The trade-off approach, proposed by Podinovski (2004b), has been recognized as a promising tool; based on its ability to expand the production possibility sets in the standard DEA models, in line with the technological realities (Førsund, 2013). The application of the trade-off approach is used as an alternative to the traditional method of applying the widely used weight restrictions approach, and is shown to deal with the limitations associated with the traditionally used method of applying the weight restrictions.

There is an increasing number of studies focusing on this innovative methodology that has the potential to make the standard DEA models better informed and more discriminating, see for example, (Amado and Santos (2009), Jahanshahloo et al. (2011), Alirezaee and Boloori (2012), Korbkandi (2012), Khodabakhshi et al. (2013), Davoodi and Zhiani Rezai (2014), Santos and Amado (2014)). However, at present there is no known application of this approach in the microfinance sector, which provided the basic motivation for the proposed application.

The selection of MFIs, for the application of the trade-offs approach through the DEA technique, was guided by a number of factors. A detailed discussion of these factors was provided in Chapter 2, in which a review of the relevant literature in the field of microfinance was undertaken. Here, we would like to summarize a few major considerations. First of all, microfinance is recognized as an innovative development tool, having considerable potential for the alleviation of poverty (Hamada, 2010). Through provision of financial and non-financial services to the resource-constrained poor people, MFIs facilitate income generating activities. With greater integration of microfinance into poverty alleviation strategies, it is becoming increasingly important to conduct further research on various aspects of this promising development technique.

Although the past three decades have seen a growing body of microfinance literature, a substantial part of this literature consists of impact assessment studies. On the other hand, despite the recognized importance of performance evaluation of MFIs, this topic has remained largely under-researched, at least within the academic field. The proportion of empirical literature on the efficiency and productivity aspects of MFIs performance, in particular, remains comparatively small (Nghiem et al., 2006, Gutiérrez-Nieto et al., 2007, Caudill et al., 2009, Bartual Sanfeliu et al., 2013). The second incentive for the proposed application of the trade-off approach to the performance evaluation of the MFIs thus arose from this gap in the literature.

In addition to making a contribution towards the efforts to fill the aforementioned gap, another stimulus for the current study's focus on MFIs' performance evaluation was the identification of various performance related issues that highlight the need for undertaking research in this area. The example of a few major challenges include: multiple borrowings by the same MFI clients (McIntosh et al., 2005), loan repayment problems, high interest rates, deterioration in the quality of loan portfolios, and an overall decline in the efficiency of MFIs (Assefa et al., 2013).

In addition to these problems, the pressure on MFIs to improve their performance has been identified as another grave challenge. This pressure is observed to be a result of two major forces. On one hand, the donor community, which has been the primary supplier of funds for the microfinance sector till recent past, is now urging MFIs to prove their worth for continued funding support. On the other hand, the need to meet the ever-expanding financing requirements of this burgeoning sector has led the MFIs to look towards commercial sources of finance. The entry of commercial players to the microfinance arena has, in turn, led to increased competition that necessitates improved performance of MFIs; for surviving in such competitive environment. In view of the questions being raised about the ability of the MFIs to survive in this competitive environment, undertaking research on performance measurement as a tool for the assessment of MFIs' success, assumes even greater significance.

For conducting performance evaluation of MFIs, their unique double bottom-line nature has been a major consideration. In contrast to the traditional financial institutions that have a single bottom-line, based on their sole objective of profit maximization, the MFIs are required to adhere to double bottom-lines. The bottom-line based on financial sustainability objective of MFIs implies a focus on covering costs and earning enough profits to remain sustainable in the long run; without continued dependence on subsidised funds and grants. The bottom-line based on the social objective, on the other hand, necessitates servicing a large number of the core poor[84]. However, for reaching such poor clients MFIs generally have to incur higher costs, which make the objective of financial sustainability more difficult to be achieved.

The double bottom-line criterion of the MFIs thus necessitates the simultaneous maximization of their social output through enhancing outreach, and achievement of financial sustainability through improving their profitability; which is not an easy task. Therefore, it has been observed that a vast majority of MFIs have been finding it increasingly difficult to achieve these dual performance objectives (Caudill et al., 2009). As a matter of fact, the perceived inability of a large majority of MFIs, in meeting their social and financial performance targets is reported to be a serious challenge (Dehem and Hudon, 2013). The challenge faced by MFIs in meeting their dual performance objectives, further highlights the need for conducting research in the area of

[84] The term core poor has been used in the microfinance literature, to refer to poorest of the poor.

performance evaluation of MFIs. This situation has also provided a motivation for the selection of microfinance as a suitable area, for the current application of the trade-off approach.

This study has made use of the DEA technique for evaluating MFIs. In addition to the fact that the application of the trade-off approach necessitates the use of DEA, there are a number of other factors that underscore the suitability of this non-parametric technique for the proposed performance evaluation. In Chapter 2, we have reviewed the relevant microfinance literature and provided a detailed discussion of why the DEA technique is considered to be superior to other methodologies, traditionally used for MFIs' assessment.

After an overview of the basic concepts, graphical illustrations and general formulations related to the DEA methodology in Chapter 3, we have also discussed the weight restrictions approach that has frequently been used to incorporate value judgments and to improve the discrimination in the standard DEA models. It has been observed that despite the wide application, there are certain limitations of this technique that can cast doubt on the results obtained from the models restricted through this technique. The limitations associated with the traditionally used method of incorporating weight restrictions, has provided further support for the novel method of applying the weight restrictions in the form of technologically realistic trade-offs. The trade-off approach can help answer different questions that have been raised traditionally for any restricted DEA model such as; what are the technological meanings of weights restrictions, and how best to interpret the efficiency scores obtained from the restricted DEA models.

For conducting a DEA based evaluation of MFIs, a search of the literature has highlighted the lack of a comprehensive framework to guide such an evaluation. Although, some of the existing studies, such as those conducted by Yaron (1994) and

(Gutiérrez-Nieto et al. (2007), 2009), offer useful information; these do not fully replace the need for a more systematic framework. The relative dearth of necessary discussions related to major considerations for modelling various aspects of DEA methodology, in particular, has identified the need for a more comprehensive framework to facilitate application of the DEA technique for performance evaluation of MFIs. In Chapter 4, we have drawn upon the existing literature from the fields of performance evaluation, microfinance and data envelopment analysis and proposed a framework for DEA based evaluation of MFIs.

While proposing the aforementioned framework in Chapter 4, an important consideration has been the dichotomy reported between the social and financial objectives of MFIs. A review of the existing literature on microfinance has highlighted two conflicting views, about the performance of MFIs on the social and financial fronts. One view proposes the existence of a conflict between the dual objectives of achieving financial sustainability and reaching a large number of the extremely poor people. The second view, on the other hand, suggests compatibility of these two objectives; thus implying simultaneous achievement of the social and financial goals of MFIs. At present, the debate about MFIs' dual objectives is an on-going one, and occupies a prominent position in the current microfinance literature. The fact that current research is still unable to provide any definite answers to different questions aising from the continuing debate about the compatibility versus conflict between dual objectives of MFIs, has provided another direction to be explored through the current study.

By proposing a framework that has the ability to analyse the performance of MFIs, both on the social and the financial dimensions, this research has made an effort to adequately incorporate the double bottom-line nature of the MFIs. For this purpose, the selection of the DEA has proved particularly useful; as this technique has the ability of handling multiple inputs and outputs that need to be included in the current study for analysing MFIs' dual bottom-lines. Moreover, we have proposed the use of two different models, i.e. PDEA and ODEA models that are meant to capture the two performance dimensions separately. In addition to the PDEA and ODEA models, we have also proposed a more comprehensive model, called the DBL-DEA model to analyse the performance of MFIs on the financial and social dimension simultaneously. With reference to the performance evaluation of MFIs, it is also observed that an appreciation of the role played by efficiency, in achievement of MFIs' performance objectives, is beginning to get the much needed attention of the academic research community, though not of the same scale that it may actually deserve. As pointed out by Hermes et al. (2011), in views of the recent move towards commercialization, microfinance industry is particularly encouraged to pursue the objective of efficiency enhancement more robustly.

Therefore, in the current study, we have selected efficiency as a more suitable indicator of MFIs' performance; and this focus on the efficiency perspective is presented as a central component of the theoretical framework that has been proposed in Chapter 4. A discussion about various issues related to the performance evaluation of MFIs through the DEA technique has been provided as a part of the proposed framework. This chapter also offers a comprehensive list of variables that can be used for evaluating MFIs, as well as a discussion of various alternative variables that may be included in the DEA models, under different contextual settings.

In Chapter 5, we offer a more detailed discussion of the research methodology and various factors underlying the decisions related to the DEA models' specification, with a particular reference to the specific data set utilized for the current study. The data set has been compiled from the audited financial statements of a group of MFIs, based in

Pakistan. Despite having a rapidly evolving microfinance sector and facing some serious poverty related challenges; which highlight the need for academic research in this developing economy, the dearth of studies in this area has offered an incentive for the use of data from this particular economy.

The application of the trade-off approach has been aimed to provide more realistic and enriched analyses offered by the restricted DEA models[85]. Towards this end, the basic theoretical underpinnings and the mathematical formulations related to the trade-off approach have been introduced in Chapter 3. Later on in Chapter 6, we have provided more exhaustive discussions, relating to the practicalities involved in the application of the trade-off approach. Chapter 6 also offers a detailed illustration of the procedure adopted for the identification of a number of trade-offs feasible for the current data set, as well as some tentative trade-offs that may be useful for future studies, using different data sets and DEA models. The procedure for converting the proposed trade-offs into equivalent weight restrictions, for facilitating their incorporation into standard DEA models, is also explained in Chapter 6.

Finally, we would like to mention another particular aspect of the current study, which is once again related to the assessment of the double bottom-line nature of the MFIs. For capturing the financial and social bottom-lines of MFIs, it is necessary to include a relatively large number of input and output variables, which presented us with the problem of inadequate discrimination of efficiency scores. One way to deal with this problem would have been to use data from a sufficiently large number of MFIs. However, due to the relatively small number of MFIs, on which the complete set of data is available, the problem of insufficient discrimination is exacerbated for the current

[85] The three DEA models proposed for MFIs' evaluation, i.e. PDEA, ODEA, and DBL-DEA models that are run with incorporation of the proposed trade-offs.

study. As a result, the unrestricted models[86] are found to be inadequately discriminating making it impossible to compare the performance of different MFIs, as most of them are shown to be fully efficient. We have been able to deal with the problem of insufficient discrimination, through the proposed application of the trade-off approach. The estimates of relative efficiency resulting from the DEA models, restricted through the incorporation of various trade-offs identified for the selected MFIs, are found to be reasonably discriminating and have provided much better insights about the efficiency of the selected MFIs. These findings and resulting implications have been discussed in Chapter 7.

8.2. Discussion of the Key Findings

In light of the results obtained from running the three proposed DEA models, before and after the incorporation of the proposed trade-offs, the key findings of the current study can be summarized as follows:

8.2.1. Improvement to the Standard DEA Models

The first key outcome of the current study is the practical demonstration of the fact that application of the trade-off approach can result in improving the DEA models; while conforming to the technological realities of the production process. With this application; we have shown how the resulting technology is enhanced, and the DEA models are enriched through incorporation of additional knowledge. This has resulted in obtaining additional insights which are not offered by the original technology in the unrestricted models.

We would like to point out that the incorporation of additional information to the standard DEA models, which can enhance the technology in a realistic manner, is the major objective of the application of the trade-off approach. Simply manipulating data

[86] The PDEA, ODEA, and DBL-DEA models that are first run without incorporation of any trade-offs.

for the sake of improving discrimination is not an objective; although the manner in which this approach works, does provide the additional advantage in the shape of better discrimination. More specific references to the observed improvements and additional insights, obtained through the application of the trade-off approach in the current study are provided in the relevant sections of the upcoming discussion.

8.2.2. The Potential for Performance Improvement of the MFIs

With reference to the potential for performance improvement of the selected MFIs, it has been observed that the average efficiency scores for the inefficient MFIs are rather low for all three models. For the DBL-DEA model, the average efficiency score (excluding the scores of the fully efficient MFIs) is 78.58%, for the ODEA model this score is 71.75 %, and for the PDEA model the average efficiency score of the inefficient MFIs is 65.98%. These scores indicate the potential for substantial improvement in the performance of these MFIs, both on the financial and the social dimensions.

When considering the individual MFIs, an overview of the findings from the three DEA models has revealed some of the MFIs to be particularly poor performers. For example, KMFB, NRSP-B and ASASAH turn out to be poor performers in all three DEA models. FMFB[87] and CSC are low scorers in the both the ODEA and the DBL-DEA models. NRSP is found to be doing poorly in the ODEA model; while RCDS and BRAC-P are poor performers in the PDEA model.

For improving the performance of the relatively inefficient MFIs, a review of the best practices followed by the global leader/s is a recommended practice in DEA. It is observed that from the profitability perspective, ASA-P turns out to be the strongest benchmark; appearing in the reference set of seven inefficient MFIs (PDEA model). Similarly, when considering the social performance of the selected MFIs (ODEA

[87] The poor performance of FMFB could be attributed in part to the fact that many of its branches are located in the areas that were hugely affected by severe floods of 2010.

model), ASA-P is again the global leader; appearing as a benchmark for twelve MFIs. For the DBL-DEA model, ASA-P appears again as a benchmark for twelve inefficient MFIs. JWS has been identifies as another notable benchmark, which has appeared in the reference set of seven MFIs in both the ODEA and the DBL-DEA models; while for the PDEA model, it appears in the reference set of three MFIs.

8.2.3. Better Discriminatory Power of the Restricted DEA Models

As discussed earlier, the primary objective of trade-offs' application is to ensure more appropriate construction of technology. However, a natural outcome of the way in which the trade-off approach works is the improved discrimination of the resulting efficiency scores. For current study, the three unrestricted models, which were run without the application of the trade-off approach; exhibited very poor discrimination, with a large number of fully efficient and high scoring MFIs. Consequently, it was difficult to offer any meaningful interpretations, based on these results, related to the relative performance levels of various MFIs. However, the models run after the incorporation of various trade-offs have shown fairly improved discrimination; thus facilitating the task of analysing performance differences among the selected MFIs.

With reference to the discrimination of the three DEA models, the main findings can be summarized as follow:

- **PDEA Model**: For the CRS based model, we have observed improved discrimination with the efficiency scores for six MFIs decreasing after introduction of the proposed production trade-offs. Overall, the average efficiency score has decreased from 75.70% to 74.51% for this model. For the VRS based model, the incorporation of the proposed trade-offs has resulted in reduced efficiency scores for a total of seven MFIs; with average efficiency score dropping from 87.21% to 82.99%. Also, for the

VRS based model, the number of fully efficient MFIs has dropped from eleven (in the unrestricted model) to eight (in the restricted model).

- **ODEA Model**: For the CRS based ODEA model, the incorporation of the proposed trade-offs has resulted in a drop of fully efficient MFIs from five to one; whereas the average efficiency score dropped down from 81.09% to 62.54%. Considering the VRS model, the number of fully MFIs has dropped from ten to four, after the incorporation of the proposed trade-offs. We have also observed considerable improvement in model discrimination; with average efficiency score dropping from 90.49% in the unrestricted model to 78.81% in the restricted model.

- **DBL-DEA Model**: For this model under the CRS assumption, the number of fully efficient MFIs has dropped from eight to one; with average efficiency score declining from 89.85% to 70.34%, as a result of the trade-offs' incorporation. For the VRS based model, the application of the trade-offs resulted in a decline of fully efficient MFIs from twelve to four. Moreover, the average efficiency score has dropped from 95.79 % to 83.94%.

Summing up the discussion, we can say that the application of the trade-off approach has resulted in considerable improvement in the model discrimination; which has facilitated the identification of patterns of performance for the selected MFIs.

8.2.4. The Conflict versus Compatibility Dilemma

For addressing the research objective of analysing the dichotomy reported about the existence of a conflict or compatibility, between the financial and social performance of the MFIs, the results obtained from the ODEA and PDEA models are compared. It is observed that seven out of the sixteen selected MFIs have done relatively well, on both the social and financial fronts; with scores ranging from 80% to 100%. On the other hand, the remaining MFIs have done poorly on either one or both of the social and financial performance dimensions. The high scores achieved by the former MFIs thus lend credence to the claims made by those studies, which report compatibility between outreach and sustainability objectives of MFIs (Christen et al., 1995, Paxton and Fruman, 1997, Rhyne, 1998, Woller, 2000, Christen, 2001, Paxton, 2003, Quayes, 2011). At the same time, the good performance of six of the selected MFIs in only one of the models supports those other studies, which indicate existence of a conflict between the dual objectives of MFIs (Navajas et al., 2000, Solomon et al., 2002, Navajas et al., 2003, Olivares-Polanco, 2005, Cull et al., 2007, Ejigu, 2009, Hermes and Lensink, 2011, Abate et al., 2014).

The considerable variation observed in the performance of the MFIs, on the two dimensions of sustainability and outreach, has also lent some support for the central premise of the theoretical framework proposed in the current study. According to this premise, efficiency[88] in the performance of MFIs needs to be looked at as a core element; when investigating the controversy surrounding the conflict-compatibility dilemma, observed for the dual objectives of MFIs. In other words, all other things being equal, more efficient performance facilitates the process of achieving the objectives of financial sustainability and outreach, in a more compatible manner. Inefficiency in performance, on the other hand, could result in greater difficulty in simultaneous achievement of these dual objectives. This could force MFIs to focus instead on either one or the other of these two performance dimensions; thus providing support for the existing evidence for a conflict between social and financial performance of MFIs. Based on the same premise, the poor performance of certain MFIs in the current study, on both the financial and social performance aspects; may reflect either considerable inefficiencies or some contextual elements, not highlighted

[88] Defined in terms of how well an MFI is performing in using its available resources for producing the desired outputs.

through the current study. Summing up the discussion, it may be stated that the efficiency premise presented in the current study can be used to explain, at least to some extent, the contradictory findings of different studies, relating to the existence of either a conflict or compatibility between the dual performance objectives of MFIs.

8.2.5. Changes in Efficiency Scores for Selected MFI: An Overview

It is observed that with the incorporation of some of the identified production trade-offs, the efficiency scores for certain MFIs have dropped considerably. An analysis of these changes provides us with some interesting insights about performance of these MFIs on certain dimensions. For example, the application of TO 4, which is related to the technologically possible increase in the volume of loans with an increase in the amount of loanable funds, has resulted in a major decrease of efficiency scores for both FMFB and NRSP-B, in the ODEA model. An investigation of the ratio of loan portfolio to loanable funds reveals that these two MFIs are scoring quite low on this ratio as compared to other MFIs. This implies potential problem with these MFIs due to under-utilization of available funds for creation of loan portfolio.

Similarly, the application of TO 8 has resulted in decreased efficiency scores for KMFB, in both the ODEA and the DBL-DEA models. This trade-off incorporates information about productivity of loan officers in terms of number of loans produced by these officers. A look at the ratio of number of loans to loan officers shows that KMFB is having an extremely low ratio in comparison to other MFIs. This observation leads us to suggest that KMFB needs to take steps for improving the productivity of its loan officers.

Also, the application of TO 9 leads to a decrease in the efficiency scores of NRSP-B and FMFB, in the DBL-DEA model again. TO 9 represents a relatively complex relationship as it involves three variables, namely; loanable funds, number of loans and the loan portfolio. Part of the explanation for this decline in efficiency scores has already been explored above, which relates to poor utilization of available funds for creating loan portfolio. Extending upon this discussion, we observe that these two institutions are also having very high ratio of loan portfolio to number of loans. This implies that these MFIs are offering relatively small number of larger sized loans, thus having a poor outreach performance. Other considerable changes in efficiency scores are observed for TMFB and KMFB after the application of TO 9 and TO 6; which suggest relatively poor outreach performance due to offering larger sized loans. This observation is further supported by the high ratio of loan portfolio to number of loans, for these two MFIs.

8.2.6. The Association between Efficiency and Institutional Characteristics

One of the research questions for the current study has focussed on testing the possible association, between efficiency and a number of institutional characteristics, highlighted by the existing literature as having possible influences on firm performance. The main findings of the study, with reference to some of these reported associations that have been tested for the current data set, are summarized here.

- A statistically significant and positive association has been observed between the age of the selected MFIs and their respective efficiency scores; with the older[89] MFIs having larger average efficiency score as compared to the younger[90] MFIs. This finding is consistent with other studies showing a positive relationship between the age and efficiency of firms (Pitt and Lee, 1981, Chen and Tang, 1987, Majumdar, 1997, Masood and Ahmad, 2010).

[89] 11-20 years.
[90] 1-10 years.

Another observation about the observed association between the age and efficiency of the selected MFIS is that this association is stronger in both the ODEA and the DBL-DEA restricted model, as compared to the non-restricted models. A possible explanation of this phenomenon could be the improvement in the restricted models, resulting from the incorporation of the proposed trade-offs that have made these models better informed; and capable of reflecting more technological realities. As a result the restricted ODEA and DBL-DEA models are able to provide greater support for the existing evidence.

A contradiction in this regard has been observed for the PDEA restricted model, for which the association is not stronger in comparison to the unrestricted model. This apparent contradiction has been explained on the basis of two possible factors. The first is the drastic decrease in the efficiency score of one of the older MFIs (RCDS) as a result of trade-offs' incorporation; which has led to an overall decrease in the average efficiency score of the older group of MFIs in the restricted model. The second possible reason is the incorporation of a relatively fewer number of trade-offs in the PDEA model as compared to the other two models. This implies a smaller subsequent improvement to the restricted PDEA model, in terms of its ability to better reflect the technological realities.

- With reference to the association between the institutional type and efficiency, we have two main groups of MFIs in the current data set, namely, the NGO-MFIs and the non-NGO MFIs. It is observed that the group of NGO-MFIs has a larger average social efficiency score as compared to the group of non-NGO MFIs and this difference is found to be statistically significant at 5%. This finding is consistent with a number of other studies that report higher social efficiency for NGO category of MFIs, in comparison to the non-NGO category of MFIs (Gutiérrez-Nieto et al., 2009, Sedzro et al., 2010). The NGO-MFIs are believed to be better performers in terms of outreach, based on the observed priority of their social objectives over the financial objectives (Barry and Tacneng, 2014).

It is also observed that the average efficiency score of NGO-MFIs is not significantly different from that of the non-NGO MFIs, in the PDEA model. This finding is in contradiction to the observation that NGOs are primarily not-for profit organizations (Bibu et al., 2013). This result is also opposed to the finding of the study by Barry and Tacneng (2014), according to which NGO-MFIs score better on profitability dimension as compared to non-NGO MFIs. Two possible explanations may be offered for this difference in the finding of the current study. The first relates to the use of a different technique, i.e. a DEA model that incorporates multiple aspects for analysing profit efficiency, in comparison to the single criterion of return of assets, used by Barry and Tacneng (2014). The second explanation could be that as a result of the mounting pressure to ensure financial sustainability for surviving in the increasingly competitive microfinance landscape, the NGO-MFIs are forced to improve their profitability and thus their performance on the profitability dimension is not found to be significantly different from that of non-NGO MFIs.

Finally, an additional proposition can be made, based on the results of the DBL-DEA model, which undertakes simultaneous assessment of the financial and social performance of the MFIs. According to this proposition, when the social and financial performance dimensions are considered simultaneously, then the overall performance of the NGO-MFIs tends to be better than the non-NGO MFIs.

- Another point of inquiry in this study is related to the possible association between the size and efficiency of the firms. While larger firms can be better performers, because of possessing superior organization, knowledge and resources;

however, the role played by various contextual factors could also have considerable implications (either adverse or favourable) for the efficiency of different sized firms (Majumdar, 1997), thus leading to the contradictory findings in the literature for the proposed association.

For the current data set, the selected MFIs have been divided into two groups, based on the size of their respective assets. It is found that the average efficiency scores of the larger and smaller MFIs are not statistically significant for any of the three DEA models used for capturing the profitability, outreach, and double bottom-line performance dimension of these MFIs. Therefore, we conclude that for the current data set, the institutional size has no significant affect on their performance.

- To test the possible association between efficiency and the number of branches, the selected MFIs are divided into two groups; with one having more than 50 and the other having less than 50 branches. It is observed that the average efficiency scores for all three models are greater for the group of MFIs with bigger network of branches. However, these differences are not found to be statistically significant for either the ODEA or the DBL-DEA models. For the PDEA model, the difference between the two groups is found to be significant at 10%.
- A related association has been tested for the geographical spread of branches and the efficiency for a group of five MFIs, on which the data for geographical spread of branches was available. It is noted that three of these five MFIs, which are having a noticeably large presence in the form of geographically dispersed set of branches, have done particularly well in all three models, with scores ranging from 83.80% to 100%. The fourth MFI has also scored well in two of the models; while the fifth MFI has scored well in only one of the three proposed models. This observation suggests

possibility of a positive association between efficiency and geographical spread of branches.

- A final association that has been tested in the current study is related to the impact of staff productivity on firm performance. The literature reports that the productivity of loan officers of MFIs has significant impact on the performance of MFIs, both on the social and the financial dimension (Baumann, 2005). For the current data set, six out of the seven MFIs, which have scored more than 80 % in all three DEA models, are having very high staff productivity ratios. To be more precise, these six MFIs belong to the top 50% of the high scorers in terms of staff productivity; thus lending support for the existing evidence.

8.2.7. MFIs' evaluation: Single versus Individual Bottom-line Models

In the current study, we have suggested the use of two different models for looking at the profitability and the outreach performance dimension, individually i.e. the PDEA and the ODEA models. In addition to these two models, a third model is also suggested for capturing these two performance dimensions simultaneously i.e. the DBL-DEA model. The basic intention behind the use of all three models has been to illustrate how certain trade-off relationships may have to be modified for incorporation into different models. As a case in example, the relatively simple trade-off relationship captured by TO 4 is replaced in the ODEA model by a comparatively more complex relationship through TO 5. This TO 5 is then further modified and incorporated through a more comprehensive trade-off i.e. TO 9 in the DBL-DEA model.

In the absence of such motivation for incorporation of different trade-off relationships, the choice between either individual performance dimension models or a single holistic model may depend on the nature and objectives of any research study. It is suggested that if a study is aiming for an overall ranking of the selected MFIs and is not concerned with how these MFIs may be behaving on the individual outreach and sustainability dimensions, then a single model incorporating both bottom-lines should suffice. The use of such a model is also recommended for situation involving diverse categories of MFIs, with different emphasis placed on the profitability and outreach performance. On the other hand, if any study intends to investigate how different MFIs are behaving on their outreach and sustainability dimensions individually, then it may make more sense to use two different models, capable of capturing these performance dimensions independently.

8.3. Key Contributions

8.3.1. An Application of the Trade-off Approach in the Microfinance Sector

- The current study makes a methodological contribution to the field of Operational Research, by undertaking the first application of the trade-off approach in the microfinance sector. It is observed that despite the increased appreciation for the theoretical underpinnings of the trade-off approach, the task of undertaking practical application of this approach remains fairly unexplored at present. While, we can find examples of the application of the trade-off approach in the education, agriculture, health care and legal sectors; to the best of our knowledge, at present there is no application of this approach within the field of microfinance. Therefore, the current application is the first of its kind and constitutes a main contribution of this study.
- The application of the trade-off approach is offered as an alternative to the widely used weight restrictions approach, which has faced frequent criticism due to certain limitations resulting from its application. Through this study, we have elaborated how the application of the trade-off approach ensures that the limitations identified for

the traditional method of incorporating weight restrictions can no longer pose a problem.

- Through application of the trade-off approach, we have illustrated how the standard DEA models can be improved through imposing technologically possible patterns of changes, identified for the relationships prevailing among different variables. The imposition of such producible changes, in turn, is shown to result in better informed models that are capable of providing enhanced insights about the performance of the selected MFIs. Moreover, the model restricted through the incorporation of the trade-offs are also shown to exhibit greater consistency with existing evidence from the literature, in comparison to the unrestricted models.
- The application of the trade-off approach in the current study is also used to illustrate how such an application can help in dealing with the frequently faced problem of insufficient discrimination of the DEA models. For the current study, there was a relatively small number of MFIs on which the complete data were available; whereas, the double bottom-line nature of these institutions necessitated inclusion of several input and output variables, causing the problem of insufficient discrimination. Through the identification and subsequent incorporation of a number of trade-offs, we have been able to obtain fairly discriminating efficiency scores. We have also graphically illustrated how the technology expands as a result of the trade-offs' incorporation, which in turn leads to improved discrimination, while retaining the technological meaning of the efficiency scores so generated.

Through application of the trade-off approach thus two significant advantages have been achieved. Firstly, the DEA models are shown to become better informed, after the incorporation of the proposed trade-offs. And secondly, a solution to the problem of insufficient discrimination of the DEA models has been offered through this practical illustration.

- We have been able to develop a number of technologically realistic production trade-offs, applicable to the data set used in the current study. Moreover, we have also suggested several additional possible trade-off relationships that can be used for future studies in this area.
- We have provided detailed demonstration of the procedure adopted for the identification of the trade-offs. It may be pointed out that the task of developing the trade-offs may sound simple, but there are a number of potential barriers that need to be overcome in order to identify technologically realistic trade-off approach. Through current application, we have highlighted the need to develop a thorough understanding of the technology, and the relationships between selected input and output variables, as a necessary precursor to the development of technologically possible production trade-offs.

We have also explained the process of arriving at reasonable initial estimates for the proposed trade-off relationships, and the adjustments required for arriving at final trade-offs that are not only verified by the expert opinion, but are also acceptable to all the institutions involved. The illustration of the process for identifying realistic and acceptable trade-offs is a notable achievement, based on the observation that a lot of people find it difficult to understand how to arrive at reasonable estimates for the numbers to be associated with any identified trade-off relationships.

A relevant point that needs explanation is that the trade-off relationships do not simply follow from the data available, although data can be helpful in tentative estimation of the relationships between different variables, as was shown in the case of some of the trade-offs developed in this study. Moreover, any proposed trade-off relationship not only needs to be consistent with the data and the relevant theoretical underpinnings, it should also be verified through expert judgements, as has been illustrated through the current application.

- Another important point to be remembered regarding the trade-off relationships identified in the current study is that these trade-offs are estimates based on technological realities which, as mentioned earlier, are also supported by the expert opinion. However, these relationships still need to be looked at as estimates only, without the need to specify the exact numbers associated with the identified relationships. A useful outcome of this premise is the ability to work with relatively broad and flexible estimates; which on the one hand would ensure their greater acceptability, and on the other hand could still be useful for improving discrimination and result in bigger and better representation of the technology.

In order to ensure acceptability of the proposed trade-offs, therefore, the number used for the set of trade-offs utilized in the current study have been relatively relaxed. As such, these numbers can act as useful reference points to be used by other researchers interested in similar work; without the necessity of explicitly sticking with the exact same numbers. Any future research aiming to utilize similar trade-offs can verify and/or modify the suggested trade-off relationship, after taking into consideration the specific contextual elements, as well as the data sets and the production technologies being investigated.

8.3.2. Development of a Framework for DEA Based Evaluation of MFIs

- The development of a theoretical framework, for conducting performance evaluation of MFIs through the DEA technique, constitutes the second contribution of this study. The need to develop such a framework has been identified through a review of the literature, which reveals a gap in understanding related to the procedure to be followed for developing DEA models for MFIs' assessment. To address this gap, a thorough review of the literature has been conducted to synthesize the existing knowledge about various theories and practices from the fields of microfinancing, performance evaluation, and operations research.

The knowledge so accumulated has helped us propose a theoretical framework that takes into account both the particular nature of this unique category of financial cum social institutions, and the resulting considerations related to the DEA model specification procedure. For example, the proposed framework offers a detailed discussion of the issues related to the selection of relevant performance evaluation variables, suitable modelling approaches, appropriate orientations for the DEA models, and suitable returns to scale assumptions; while taking into account different contextual factors.

Moreover, the large variety of variables and different environmental and institutional contexts in which MFIs work, can give rise to certain ambiguities and complexities when finalizing the DEA models. The proposed framework has discussed a number of such situations and offered useful guidelines, wherever possible. The resulting framework is thus expected to have greater potential for facilitating the application of the DEA technique within the context of microfinancing.

- A notable aspect of the proposed framework is related to the individual, as well as, the simultaneous assessment of the MFIs' social and financial performance dimensions; based on the use of three different DEA models. Taking into account the dual objectives of MFIs, related to the financial sustainability and outreach, this study has proposed the use of two different models i.e. the PDEA and the ODEA models, for evaluating each of these two performance aspects individually. At the same time, a more comprehensive model for measuring the double bottom-line performance of MFIs simultaneously i.e. the DBL-DEA model, has also been developed.

A key advantage of using two separate models for assessing the financial and social performance of the selected MFIs is observed in the form of the opportunity to make a comparison between these two performance dimensions, which has helped in investigating the compatibility-conflict dilemma. Through the results of the current study, we have been able to add a new perspective to the existing literature on the conflict versus compatibility dilemma; observed for MFIs' dual objectives of enhancing outreach and achieving financial sustainability. According to this perspective, efficiency needs to be looked as one of the key factors that can help decide whether or not it could be possible for MFIs to simultaneously achieve their dual objectives.

8.3.3. Focus on an Under-Researched Area

- Through the current study, we have demonstrated a practical application of the trade-off approach, for evaluating performance of a group of MFIs, working in an under-researched developing economy. The focus of the current study on a microfinance sector that has been facing challenging environment, leading to hindered achievement of MFIs' dual objectives, has also facilitated a study of the variation in the social and financial performance patterns for the selected MFIs. By focusing on this particular data set, which at present remains largely unexplored, the current study has been able to make useful contribution to the existing literature.

- It may also be pointed out that although the current study illustrates the application of the trade-off approach for a developing economy, this application can act as a useful guide for future applications, in both the developed and developing economies. The contemplation of any additional contextual and practical considerations involved in such future applications can also have an added benefit, in the form of development of additional trade-offs that could not be identified within the context of the current study.

8.4. Future Research Directions

It is possible to identify three directions for future research related to the current study. The first is linked to the fact that the current study has been conducted by using data from a relatively small number of MFIs. The use of a relatively small data set has not resulted in any limitations for the current study; as the aim of the current study is not to arrive at specific policy recommendations. The major aim of the current study, of illustrating how the DEA models can be enriched through the application of the trade-off approach has been achieved effectively; despite the small number of MFIs. Moreover, the small number of MFIs has provided us the opportunity to demonstrate the ability of the trade-off approach to improve the DEA model discrimination. Having said that, it would be interesting to see future research that would be using relatively larger data sets that could result in more generalizable conclusions. Another possible advantage of such research could be to facilitate the policy formulation process for improved performance of MFIs.

A second possible future direction could be to use data from more than one year. With a longitudinal study, it may be possible to counter the effects of any one-off events, impacting the performance of certain MFIs. For example, the catastrophic floods in 2010, affected some of the selected MFIs more than others, especially those having branches in the flood affected areas of Pakistan e.g. FMFB. With a longitudinal study, it may be possible to determine whether the poor performance of any such affected MFIs is solely the result of an uncontrollable event, or is based on some other inherent deficiencies in the working of such MFIs.

Finally, given the scope of the study, it has not been possible for us to provide more concrete evidence for the efficiency premise that is proposed through the theoretical framework developed in the current study. So a third possible direction for the future research could be to explore this issue in greater detail, and provide support for accepting or rejecting this proposition, based on empirical findings.

Appendix

Data on Input Variables				
MFIs	Interest expenses (000) PKR	Operating Expenses (000) PKR	Loanable Funds (000) PKR	Number of Loan Officers
FMFB	502,257	710,114	5,919,718	413
KBL	285,788	1,121,733	5,634,637	687
KMFB	70,563	450,631	1,141,614	174
NRSP-B	261,360	337,548	3,079,232	451
TMFB	445,874	1,016,204	6,314,254	511
ASA-P	35,994	153,665	820,380	467
ASASAH	36,710	118,650	328,232	127
BRAC-P	95,556	299,508	744,557	564
CSC	18,883	60,833	270,298	65
DAMEN	62,633	75,584	540,342	80
JWS	20,398	51,577	217,098	56
RCDS	21,677	47,959	297,969	108
SAFWCO	20,218	66,914	280,347	134
NRSP	815,781	822,575	6,938,257	1,952
PRSP	91,916	41,635	771,497	448
TRDP	28,023	53,498	492,845	180

Data on Output Variables					
MFIs	Loan Portfolio (000) PKR	Number of Loans	Interest Income (000) PKR	Operating Income (000) PKR	Total Income (000) PKR
FMFB	2,407,144	119,204	809,805	544,075	1,353,880
KBL	4,273,802	352,962	1,284,802	399,795	1,684,597
KMFB	703,944	20,014	318,828	54,408	373,236
NRSP-B	2,088,951	101,870	541,680	122,132	663,812
TMFB	5,070,422	132,728	1,574,087	99,842	1,673,929
ASA-P	1,359,949	142,814	441,520	3,651	445,171
ASASAH	165,860	18,941	85,764	3,984	89,748
BRAC-P	979,861	98,095	318,075	34,145	352,220
CSC	192,701	12,828	75,924	15,160	91,084
DAMEN	459,314	31,036	133,563	32,808	166,371
JWS	210,171	14,020	67,195	21,105	88,300
RCDS	261,522	19,388	83,038	12,863	95,901
SAFWCO	312,435	30,856	82,425	24,204	106,629
NRSP	3,657,845	317,381	1,659,683	429,155	2,088,838
PRSP	594,825	57,200	107,589	96,335	203,924
TRDP	391,021	41,645	94,411	25,284	119,695

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