Bank performance in Middle East

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A dissertation submitted in partial fulfillment of the requirements for the degree of Master of Science in Applied Economics & Data Analysis

School of Business Administration
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Master of Science in
“Applied Economics and Data Analysis”

August 2017
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«Bank performance in Middle East »

was submitted by Olga Colesnic, Sid 1017783, in partial fulfillment of the requirements for the degree of Master of Science in «Applied Economics & Data Analysis» at the University of Patras and was approved by the Dissertation Committee Members.
I would like to dedicate my dissertation to my grandparents,

Mihail and Anastasia
Acknowledgments

I would first like to thank and express my appreciation to my thesis supervisor Assistant Professor Dr. Konstantinos Kounetas of the Department of Economics at University of Patras. The door to Prof. Kounetas office was always open whenever I ran into a trouble spot or had a question about my research or writing. He consistently allowed this paper to be my own work, but steered me in the right direction whenever he thought I needed it.

I would also like to express my gratitude to the members of my examination committee: Associate Professor Venetis Ioannis, and Assistant Professor Tzagarakis Manolis. Also, I would like to extend my gratitude to all my professors at 'MSc Applied Economics & Data Analysis' postgraduate program. Finally, I must express my very profound gratitude to my mother and to my sister for providing me with unfailing support and continuous encouragement throughout my years of study and through the process of researching and writing this thesis. This accomplishment would not have been possible without them. Thank you.
Summary

The aim of this dissertation is two-fold. Firstly, it attempts to analyse the effect of risk on bank’s efficiency levels. Secondly, it seeks to determine the influence of bank size taking into consideration the possible inefficiency originated to risk abatement cost. The accomplishment of the study’s intentions rely on DEA estimations of efficiency, resulted from an output orientated directional distance function with weak and strong disposability of nonperforming loans calculated with respect to both heterogenous and homogenous technologies. The methodology has been applied on a panel data of Middle East banks over the time period between 1998 and 2014. The results suggest that on average small banks are more efficient and their size have less negative impact on their technical efficiency and risk management. On the other hand, large banks’ risk management is found to be more flexible during financial crisis. However, banks with higher fixed assets are associated with more costly dispose of non performing loans. This observation may provide an explanation for the rejection of positive relation between bank size and technical efficiency.

Keywords: efficiency, bank efficiency, risk efficiency, DEA, Middle East, non performing loans.
Περίληψη

Στόχος της παρούσας διπλωματικής εργασίας είναι διττός. Πρώτον, επιχειρεί να αναλύσει την επίδραση του κινδύνου στα επίπεδα αποτελεσματικότητας των τραπεζών. Δεύτερον, επιδιώκει να προσδιορίσει την επίδραση του μεγέθους στην επίδοση των τραπεζών λαμβάνοντας υπόψη και τις ενδεχόμενες συνέπειες αναποτελεσματικότητας διαχείρισης του κινδύνου. Η εκτίμηση των στόχων της μελέτης βασίζεται στις εκτιμήσεις αποτελεσματικότητας που υπολογιστήκαν με την μέθοδο Βέλτιστων Προτύπων Αποδοτικότητας, υποθέτοντας ετερογένεια και ομοιογένεια τραπεζών.

Το σύνορο της διαμεσολαβητικής χρηματοοικονομικής παράγωγης περιγράφεται από μια συνάρτηση απόστασης με κατεύθυνση και συνδυάζει τις υποθέσεις αδύναμης και ισχυρής δυνατότητας διαθέσεως του ρίσκου. Η μεθοδολογία εφαρμόστηκε σε στοιχεία των τραπεζών της Μέσης Ανατολής κατά την περίοδο 1998 με 2014. Τα αποτελέσματα δείχνουν ότι κατά μέσο όρο οι μικρές τράπεζες τείνουν να είναι πιο αποτελεσματικές ενώ το μέγεθος τους έχει περιορισμένες επιπτώσεις στην αναποτελεσματικότητα και στην διαχείριση κινδύνων. Αφενός, η διαχείριση κινδύνων των μεγάλων τραπεζών διαπιστώνεται ότι είναι πιο ευέλικτη κατά τη διάρκεια της χρηματοπιστωτικής κρίσης. Ωστόσο, οι τράπεζες με υψηλότερα πάγια περιουσιακά στοιχεία σχετιζόνται με πιο διαπιστώτικη διάθεση χρηματοπιστωτικών δανείων. Αυτή η διαπίστωση μπορεί να δώσει εξήγηση για την απόρριψη της θετικής σχέσης μεταξύ τεχνικής αποτελεσματικότητας και κινδύνου τράπεζας.

Λέξεις κλειδιά: αποτελεσματικότητα, αποτελεσματικότητα διαχείρισης ρίσκου, Μέση Ανατολή, μη εξυπηρετούμενα δάνεια.
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Chapter 1

Introduction

The 2008 financial crisis, illustrated the leader position of banking in normal economic development and stability of countries. However, financial sector confront some serious challenges to manage the risk taken. The principal aim of bank management and supervisors is the risk oversight, as it is strongly motivated by significant incentives. Financial firms want to enhance their risk and return trade-offs while regulators want to avoid systemic risk, the risk that the entire system collapses, as nearly it did in 2008.

In Europe, the financial crisis is divided in three phases. During the subprime financial crisis (2007-2008) large losses in mortgage market mobilize authorities to adopt a wide-ranging interventions which seemed to work effectively. The second phase, global financial crisis (2008-2010), is generated by the collapse of large US financial institutions and expose the profound European sovereign debt crisis. Some countries plugged into a deep recession accompanied by increasing estimates of prospective banking sector lososes on bad loans. Even countries with the best competitive advantage and growth prospects experience an significant increase in spreads due to stress in their financial sector in the stage of sovereign financial crisis (2010-2012), which unrevealed the fragile nature of banking system.

Non performing loans, hereafter NPLs, is an important factor in determining normal operational activity of a bank and its profitability. There are internation-
ally accepted laws which determine the magnitude of risk that a bank is allowed to take on, and the amount of money that must be reserved in order to secure the depositors from bank’s bankruptcy. Basel I, II, III states that as higher the risk, which is estimated by a bank, the amount of money to be reserved increase. Similarly, capital’s opportunity cost is higher for banks with high risk, employing suppress in earnings which result in less efficient production. To maintain a position in the increasingly competitive and regulated financial market banks are forced to operate close to the efficient production.

In this environment a number of studies have focused on the estimation of bank efficiency accounting for non performing loans (Watanabe and Tanaka, 2007; Fiordelisi et al., 2011; Barros et al., 2012; Fukuyama and Weber, 2008a; Bessis, 2011; Hughes and Mester, 1993) and find important discrepancy in results when ignoring the undesirable output. Other researches emphasis on inefficiency differences attributed to specific bank characteristics as type (Kontolaimou and Tsekouras, 2010; Elyasiani and Mehdian, 1995), organisational form (Mester, 1997) and ownership (Chiu et al., 2016). However, studies have not been found to apply those methods on Middle East banks performance assessments and none of them try to address the issue of opportunity cost of risk.

The objective of this thesis is two-fold. Firstly, it attempts to examine the influence of risk on banks’ performance in Middle East. Explicitily, a common bank production technology is adopted with both strong and weak disposability of non performing loans. Those hypothesis enable to estimate the significance of risk inclusion and the extent of its influence on banks’ efficiency. Furthermore, the relation of bank size and efficiency is explored. Secondly, it purports to explore how size specific technologies affect Middle East banks’ efficiency levels. Specifically, a common bank technology is presumed, which nests two size specific technologies, small and large banks technologies, with free and costly disposability of non performing loans. This enables comparison of inefficiencies arising from bank size and its cost to dispose risk.
Panel data which contains annual balance sheet items on 66 Middle East banks during 1998 to 2014 is used under intermediation approach, in an output orientated directional distance function model with bad outputs. The results suggest that the inclusion of non performing loans is significant for bank efficiency estimations. Moreover, the size-efficiency link is found to be negative for the Middle East financial sector. Also, according to data large banks technology is inferior due to lower efficiency from risk management. On the other hand, small banks are more efficient but, their credit quality management is sensitive to external economic shocks.

This thesis addresses these issues and provide empirical evidence on the unexplored avenues of research. It specifically contributes to the existing literature on bank performance two ways. Firstly, the influence of risk inclusion on efficiency estimates is examined including a proxy for credit quality using DEA. While previous papers mainly focus on bank performance estimated through parametric methods, they divert their attention from credit quality and size impact on Middle East financial sector performance. Unlike the previous analysis of Middle East banks efficiency, it attempts to calculate a measure for opportunity cost of risk reduction which may give information of banks’ behaviour, specifically interesting to regulators.

This thesis unfolds as follows. Chapter 2 provides an overview of the related studies in the literature, followed by a section that outlines the method used, and choice of input and output variables for the efficiency model. Section 4 reports the empirical findings. Section 5 concludes and offers avenues for future research.
Chapter 2

Literature Review

2.1 Efficiency

In economics the efficiency of a producer is strongly related to the comparison of actual to maximum potential levels of outputs and inputs. When the optimal level is described in terms of production possibilities the efficiency is called to be technical. From early stages of literature development of efficiency a debate has been raised about the existence of inefficiency in production.

On one hand, inefficiency is attributed to inability of analyst to incorporate all the relevant factors which specify the right economic objectives and the real constrains (Stigler, 1976). On the other hand, the combination of inadequate motivation, information assymetries, incomplete contracts and agency problem can generate inefficiency in processes which illustrates the variation in abilities of entities to deal with complexities of real world (Leibenstein, 1966).

The problem of defining the potential production is addressed by the efficiency literature through adoption of relative to best practise, which can be observed, rather than to some ideal standard. In that way, the efficiency become a benchmarking problem, with main purposes to determine the best practitioners and compare the performance of rest firms to it.

One of the components of economic efficiency is technical efficiency. Technical efficiency is refer to the ability to avoid wasted in production process and can have
either an output or input orientation. The output orientated technical efficiency denote the ability to produce the maximum possible output given an input, while input orientation refer to consumption of minimum allowed by technology input to produce an output.

Some landmark studies introduced a measure of technical efficiency, which was defined as the maximum equiproportionate reduction in all inputs constrained by the given technology and outputs (Farrell, 1957). This methodology gives start to a large literature of methodologies wich estimates the performance in a more sophisticated way like the non radial models and both non radial and non orientated models (Chung et al., 1997).

Inefficiency can be attribute to differences in production technology, difference in the scale of operation, differences in operating efficiency, and differences in the operating enviroment in which the production occurs. Identifying the source of inefficiency is important for the adoption of private managerial practices and the design of public policies intended to improve the productivity performance.

Two are the main reasons to measure the efficiency of producers. First, it offers a base to identify the sources of inefficiency if it is managed to separate the effects of operating enviroment (Zeitsch et al., 1994). Second, the macro performance depends on micro performance, so the efficiency studies can contribute to the growth of nations topic (Fried et al., 2008).

### 2.2 Bank efficiency

A large and growing body of literature has investigated the performance of banking sector which is divided based on the approach of measuring and explaining the performance into nonstructural and structural (Hughes and Mester, 2008). Structural approach relies usually on the economics of cost minimization, profit maximisation or managerial utility maximisation. Much of the researches adopt cost minimization (Ariff and Luc, 2008; Bader et al., 2008; Ariss et al., 2007)and profit maximisation (Koutsomanoli-Filippaki et al., 2012; Mester, 1997; Paradi and Zhu,
2.2 Bank efficiency

2013; Bader et al., 2008; Berger and Humphrey, 1997; Ariff and Luc, 2008) approaches to estimate the economic efficiency of financial institutions. More specifically, whether the bank is correctly responding to relative prices in choosing its inputs and outputs, which subsumes technical efficiency.

Also, such models permit the measurement of scale and scope economies but have an inability to embody the bank’s capital structure and the management of risk. Newer literature, suppose that bank’s managers trade off risk and expected return (Berger and Humphrey, 1992; Fethi and Pasiouras, 2010; Al-Jarrah and Molyneux, 2010). Such assumption transmit the maximization problem to managerial utility. The advantage of successful estimation of both standard profit and value profit functions comes with a downturn. The estimated performance of bank is based on accounting measures which is a great source of bias.

The nonstructural or production, approach usually focuses on bank performance and explores the relationship of efficiency to various bank and environmental characteristics. It compares the performance among banks and considers the relationship of performance to investment strategies and other governmental characteristics. Studies which adopt the method aim to found evidence of agency problems in correlation with performance and bank specific variables as credit quality and size (Färe and Lovell, 1978; Fethi and Pasiouras, 2010; Färe and Lovell, 1978; Rangan et al., 1988). Although this approach is motivated by informal and formal theories, no general theory of performance provides a unifying framework for these studies. The data collection for production approach, since it do not require price data, is a major advantage for performance estimates.

A theoretical issue which rises a significant desagrement in the efficiency of banks is the definition of outputs and respectively inputs of bank production. This misunderstanding seems to fade out since three approaches to recognize the outputs in financial sector was defined (Berger and Humphrey, 1992). The intermediation approach focuses on the bank’s production of intermediation services and the total cost of production. It define the outputs to be banks’ assets of
2.2 Bank efficiency

various categories (like loans), while inputs are typically specified as labor, physical capital, deposits. Asset approach states that banks are intermediaries in the financial activities, so the assets and loans are defined as outputs while deposits and liabilities are inputs. User approach define the accounting items as input or output based on their participation to bank revenue. On the other hand, in value added approach all the balance sheet items are recognize as outputs, but not exclusively.

Although the intermediation approach is the most used in the literature (Fethi and Pasiouras, 2010; Ataullah and Le, 2006; Kontolaimou and Tsekouras, 2010; Chang and Chiu, 2006; Bader et al., 2008) since the necessary data is easily collected, a debate about the recognition of deposits persists. This Some studies recognize deposits to be output (Watanabe and Tanaka, 2007), other as a intermediary product and there also exist researches that a part of deposits are inputs and other outputs(Paradi and Zhu, 2013) . The most researchers have adopted the idea that deposits are inputs in the banking production technology with 95 out of 196 researches assuming deposits as inputs (Fethi and Pasiouras, 2010).

Both parametric and non-parametric approaches have been employed in order to determine the banking industry efficiency in the literature. Starting with 1998, bank industry performance has received a great attention by the scientists in the field. Since 1985 through 2011 275 applications of DEA was employed for estimating the banking industry efficiency (Paradi and Zhu, 2013) and almost every banking sector in the world has been examined with DEA method (Fethi and Pasiouras, 2010).

Data Envelopment Analysis (DEA) is a mathematical programming technique with the ability to develop production frontiers and to measure the distance relative to those frontiers. Comparing to econometrical method, which made assumption about the distribution of inefficiency and the functional form of the production, DEA do not require commitment to none of the functional assumptions and work better for small samples. Also, the linear programming model
is unaffected by statistical problems, like econometric approach, as a result the orientation do not play a significant role (Coelli et al., 2005). On the other hand, there are some requirements for unbiased estimation one of them being the correctly chosen number of inputs and outputs relative to the number of decision making units (DMU). Also care must be taken for heterogeneity, measurement and outliers in the data to be used (Coelli et al., 2005). Finally a drawback of the DEA approach is that it attributes all deviations of a firm’s performance from best-practice to inefficiency, as it makes no accommodation for statistical noise (Koutsomanoli-Filippaki et al., 2012).

2.3 Crucial aspects of bank efficiency

The literature point out that banks have a central role in the economy. Their purpose is to manage the savings of the public and to support the development of business and trade. It is a fact that the efficiency of financial intermediation affects the economic growth (Levine, 2005) and that there is a tight relationship between bank insolvencies and systemic crisis (Caprio and Klingebiel, 2003). Consequently, inefficient production of banks can results in adverse consequences for the economy as whole.

As expected, a large number of researches has been conducted in order to determine the banking performance with a tremendous percentage of which assuming homogeneity of banks originated in different countries (Al-Jarrah and Molyneux, 2010; Ariss et al., 2007; Ataullah et al., 2004; Bader et al., 2008; Barros et al., 2007; Casu and Molyneux, 2003). This unrealist hypothesis can drive to comparison of banks with different legal, macroeconomic, social and market environment in which the operate have a significant impact on efficiency estimates (Berger, 2007).

Awareness of the bias that may occur in this type of cross-border bank efficiency comparison has led subsequent studies to incorporate country specific environmental conditions (Park and Weber, 2006; Pastor, 1999; Ataullah and Le, 2006; Berg, 1992; Canhoto and Dermine, 2003; Fukuyama and Weber, 2008b; Lozano-Vivas
et al., 2001). The authors emphasise the contribution of assumed common frontier to misleading performance estimates of bank’s management due to uncontrolled cross-country differences. Also they find that common frontier efficiency is higher (lower) for firms that operate under good (bad) home country conditions.

However, technology heterogeneity may be related also to firm specific factors like ownership (Kontolaimou and Tsekouras, 2010; Kounetas, 2015) and size. The heterogeneity which arises from different sources can be taken into consideration favor to metaproduction function and its accommodation to both parametric and non parametric approaches (O’Donnell et al., 2008). This development has given rise to more sophisticated and less biased efficiency comparisons. For example, Kontolaimou and Tsekouras explore the productive performance of cooperative to commercial European banks and find that more inefficiency of cooperatives is attributed to their operational activity (Kontolaimou and Tsekouras, 2010; Abid et al., 2017).

To our knowledge, although the differences in internal processes, management of soft information and activity markets, none of the researches have explored the inefficiency attributed to different size of banks. With no establish theory about the relationship of size and efficiency of banks, large literature have tested the hypothesis of poitive correlation of size and efficiency, ceteris paribus (Elyasiani and Mehdian, 1995). In this enviroment the results are contradictory.

The evidence of the relationship between bank size and technical efficiency is mixed. Employing a two stage analysis, the first being the determination of efficiency using DEA and the second a regression approach on a data of 215 US banks in 1986 it was found that large banks operate under optimal scale having a higher efficiency (Rangan et al., 1988). The same result was found about Turkish banks over 1988-1999 (Yildirim, 2002). Larger bank’s market power and their ability to diversify credit risk in an uncertain macroeconomic enviroment is the interpretation of hypothesis failure to reject due to some authors (Berger, 2007; Ataullah et al., 2004).
Contradictory results also are found, and the inefficiency of large banks is expressed as the influence of complexity and politically determined bureaucratic organizational structure that impeded large bank ability to keep up with smaller private domestic and foreign banks, which are quicker to adopt new financial technology and to introduce new financial products (Ataullah et al., 2004; Leong et al., 2002; Kwan, 2002) compared to smaller banks could be due to their higher flexibility, which allowed them to adapt to changes in the banking industry brought about by the financial liberalization programme.

Overall, there is a debate in the literature about the assumption of returns to scale. Some argue that CRS hypothesis is appropriate only if all banks are producing at an optimal scale. Other studies (Noulas, 1997; Avkiran, 1999; Soteriou and Zenios, 1999) support CRS or mentioned that attention must be paid with VRS assumption. As a result of the above mentioned, efficiencies are reported under the both assumption in many researches (Canhoto and Dermine, 2003; Casu and Molyneux, 2003).

Another topic which need attention is the efficiency orientation. If the interest is how much more output can be produced with a given level of inputs, then the output orientation is adopted. However, if the question of research tend to find the minimum input to be used in order to produce a given amount of outputs, then the output orientation efficiency can answer the question. Finally, there are models which assume simultaneous contraction of inputs and expansion of outputs (e.g. additive model) (Koutsomanoli-Filippaki et al., 2012).

There is a minor effect of the assuming orientation on efficiency scores of DEA (Coelli and Perelman, 1996). Both orientations are used in the literature of banking efficiency, but the majority of them adopt input orientation as a result of better control of bank management over the inputs rather than outputs (Fethi and Pasiouras, 2010). The literature also contain a significant number of output orientated studies (Ataullah et al., 2004; Ataullah and Le, 2006).
2.4 Risk and efficiency

The reason why banks exist is the amelioration of risk between lenders and borrowers. Although the risk existence is an opportunity for bank, simultaneously it influence negatively both the future earnings and stock returns of a bank (Ahmed et al., 1999). The adjustment of efficiency to bad output was initially and still intensely applied in environmental, more specifically pollution topic related scientific articles (Kumar and Khanna, 2009; Koumetas, 2015). Recently many researchers have adopted this idea for modeling the technology of banks, and treat risk preferences as an undesirable output (Abid et al., 2017; Barros et al., 2012; Mester, 1997; Drake and Hall, 2003; Ataullah and Le, 2006; Fiordelisi et al., 2011) in the effort of interest rate creation.

If risk preferences are omitted, banks which are more risk averse than others and hold a higher level of financial capital will be mismeasured, even though those banks behave in an optimal way given their risk preferences (Koutsomanoli-Filippaki et al., 2012). Apart from that effect of risk on efficiency, the capital retain in order to secure the risk undertaken have a negative influence on costs (Berger and Humphrey, 1997). Instead capital to be allocated in new loans and consecutively increase balance sheet earnings assets, it must become a security for possible default of borrowers. Successively, financial institutions face an opportunity cost for risk reducing activities which is pressured by decrease in market share and profitability.

For both DEA and SFA (stochastic frontier approach) approaches, the most used variables in order to represent the risk is non performing loans (NPL), or loan loss provisions to explore the efficiency and risk relation. However, exists studies which use equity to represent the risk preferences (Koutsomanoli-Filippaki et al., 2012). Parametric studies treat the risk as a control variable (Drake and Hall, 2003; Resti, 1997) and then include it into a regression to identify the effect of risk on efficiency (Fiordelisi et al., 2011). On the other hand, DEA models include
directly the risk as a bad output into the technology frontier (Berg, 1992; Barros et al., 2012; Park and Weber, 2006; Fukuyama and Weber, 2008b). Although the first attempt to include bad loans directly in DEA as input, since the aim of the bank is to minimise it quantity (Charnes et al., 1990), was unsuccessful due to nonexisting difference with model without bad loans at all (Berg, 1992). Soon the implementation of model with bad output into DEA was achieved through the adoption of directional distance function (Chung et al., 1997). The implementation of the directional distance function advantage consists of its ability to reward, for example a bank that reduce risk and simultaneously increases earnings and market share.

Problem loans are characterized as an endogenous variable for bank performance estimation (Berger and Humphrey, 1997), the number of papers which adopt this hypothesis are increasing. Following the remarks of bad luck and bad management hypotheses (Berger and Humphrey, 1997), decomposition of the credit risk into endogenous and exogenous to financial institutions was proposed and then applied to European countries (Pastor, 1999; Pastor, 2002).

Beside European banking industry (Casu and Girardone, 2006; Barros et al., 2007; Casu and Molyneux, 2003), the Asian countries receives a great attention from scientists in the field (Ariff and Luc, 2008; Barros et al., 2012; Fukuyama and Weber, 2008b). One of the recent researches estimates efficiencies of banks using DEA, taking into account the negative impact on non performing loans and heterogeneity (Chiu et al., 2016). Efficiency was estimated taking into consideration bad loans with respect to frontier of domestic and foreign banks simultaneous with performing a decomposition of metafrontier technology inefficiency.

Studies which may have a major contribution to the models or credit risk evaluation is related to the estimation of shadow prices for non performing loans based of efficiency estimations, unfortunately their number is limited. The most remarkable ones are the study of shadow pricing for Japanese banking (Fukuyama and Weber, 2008b) and the comparison of regional to shinkin banks based on
risk cost (Fukuyama and Weber, 2008a). Both studies conclude that there is a significant opportunity cost of risk reduction for banks. The latent specify that smaller, Shrinkin, banks have a lower shadow price for risk reduction.

### 2.5 Middle East and banking efficiency

While for the developed countries the performance of banking industry is quite large and contain the credit quality, risk adjusted efficiency, risk management efficiency and decomposition of the the risk (Pastor, 1999), the same can not be stated about emerging markets. Evidence on banking efficiency in Middle East literature is still in its infancy. However, this is gradually changing as a number of recent studies have sought to apply various frontier techniques to estimate the efficiency of Middle East banks. Most of them are focused on comparing performance of islamic to the conditional banks.

Dominant are the parametric studies which evaluate profit and cost efficiency using yearly bank level accounting data on islamic and conditional banks. The findings of such studies are confronting, with some of them demonstrating that Middle East islamic banks are more cost and profit efficient (Al-Jarrahand Molyneux, 2010; Mohamad et al., 2008; Hassan and Bashir, 2003), while other found no significant difference compared to conventional banks (Beck et al., 2013). DEA approaches are less applied in performance estimations of banks in Middle East compared to parametric. Contrary results to parametric ones report the non parametric approach by finding less efficient the islamic banks compared to conventional (Johnes et al., 2009; Johnes et al., 2014; Bader et al., 2008; Assaf et al., 2011).

The relation of efficiency and bank size in Middle East literature is mainly examined through parametric approaches. Including a proxy for risk, a positive correlation between size and efficiency was found during 2001-2006 for MENA countries’ financial industry, suggesting that the larger the bank, the more efficient the bank will be mainly because of economies of scale argument. Also it was found
out that low market share and non performing loans increase the efficiency (Sufian and Akbar Noor Mohamad Noor, 2009).

Although, bank efficiency is estimated in relation with deregulations (Naceur et al., 2011), ownership and size (Haque and Brown, 2017), macro and microeconomic factors (Olson and Zoubi, 2011), crisis (Rashwan, 2010) the risk seems to not be considered in studies of bank performance. Only a parametric approach to efficiency and asset quality is effectuated on a big datasample of 141 countries of which 22 are OIC during 1995-2007. (Beck et al., 2013) Beck et al (2013) show based on yearly bank level accounting data that islamic banks is more efficient but the efficiency measure that he used is the ratio of total operating cost to total costs. For asset quality he used (i) loss reserves, (ii) loan loss provisions, and (iii) non-performing loans, all scaled by gross loans. Findings shows the negative relationship between loan provisions and efficiency.

Little attention is paid to inefficiency due to heterogeneity, only one research was found to control for differences due to country specific sources (Naceur et al., 2011), but his approach is parametrical. A non parametrical approach of meta-technology inefficiency was also conducted for Middle East but non performing loans are ignored in calculations while the metafrontier inefficiency is counting for country specific heterogeneity (Abid et al., 2017) ignoring the size specific characteristic of banks.

Overall, a lack of evidence about the hypothesis of large banks higher efficiency controlling for non performed loans in the Middle East literature is observed. Although Data envelopment analysis was used in order to determine the efficiency of financial institution, none of the found studies do not count for the so called credit or asset quality in Middle East banking performance literature. Neither the identification of risk opportunity cost along with the size attributed cost are importantly explored both in international and Middle East bibliography.

Also, studies choose Middle East and North Africa region, assuming that they have access to the same production technology, that is not quite realistic. The
assumption of homogenous banks seems to be loosen in the international literature but not in Middle East, since metafrontier ratio and technology gap of size specific factor remain a topic untouched in the estimations of banking efficiency. Finally, the researches reviewed was not found to use such long period data as that used in the present research which may unfold some important information.
Chapter 3

Methodology

3.1 Conceptual framework

Financial institution existence is justified by amelioration of risk, mainly arising from informational asymmetry (Malkiel and Fama, 1970), capability for both borrowers and lenders. However, this economic role of banks does not make them insensitive to unexpected internal or external shocks. Risk management theory provide a definition of risk and main sources of it provenance. Risks are broadly defined as uncertainties potentially resulting in adverse variations of profitability or in losses.

Risk management theory split the sources of uncertainty faced by organizations into two distinct categories. Figure 3.1 summarized the main type of risk referring to systematic and unsystematic risk. The difference of those two is based on capability of a firm to have control of them. Contrary to microeconomic events, macroeconomic environment can not be influenced by strategic or operational activities of a bank. On the other hand, management’s decisions aims to minimize firm specific risk which arise from operational, financial and business risk (Bessis, 2011).

Credit risk is the most important risk in banking and is defined by counterparts defaulting on payment obligations. Operational risk result from malfunctions or inefficiency of internal processes. Lastly, liquidity or funding risk refers to the pos-
3.1 Conceptual framework

Fig. 3.1: Sources of risk.

Managers are seen as producers who transform inputs such as labor, physical capital, and deposits into a portfolio of loans and earnings by the theory of bank interest margins determinants (Ho and Saunders, 1981). It is also recognised that bank managers choose a portfolio of loans and earning and the jointly produced output which appears as problem loans.

Some risk averse bank managers might choose to selectively control potential borrowers and actively monitor the borrowers’ subsequent behavior in order to minimise risk. On the other hand, there exits also bank managers which choose portfolios that offer higher returns while simultaneously acknowledging the potential for higher amounts of non performing loans. Those decisions are mainly influenced by internal and external risk and therefore by the maximizing wealth aim.

Combining those two theories, and having in mind that inaccurate incorporation of the relevant inputs and outputs in production process determination has inappropriately defined constrains and economic objectives as consequences (Stigler, 1976). Additionally, incorporating the idea that capital and risk are likely to be determined by the level of bank efficiency (Hughes and Mester, 1998)
there are identified several ways in which risk and performance are correlated (Berger and Humphrey, 1997; Fiordelisi et al., 2011). Firstly, it is assumed that banks operating with low levels of efficiency have higher costs due to inadequate credit monitoring and inefficiency control of operating expenses, the so called "bad management" hypothesis. Additionally, the "cost skimming" hypothesis is adopted which denote the inclination of banks to not change their level of non performing loans in short term while trading off risk in future due to moral hazard considerations. In other words, a bank may be tempted to increase revenue in short run by simply taking on higher risks (Berger and Humphrey, 1997).

'Bad luck' hypothesis states that macroeconomic shocks can precipitate increases in problem loans for the bank unrelated to managers’ skills or their risk taking strategy (Berger and Humphrey, 1997). External increases in risk result in additional cost and managerial effort. Thus under this assumption, it is expected expansion in bank risk to precede falls in cost and revenue efficiency. Furthermore, another manner of risk and efficiency correlation in expressed by "moral hazard" hypothesis, according to which managers have incentives to take on more risk particularly when the level of bank efficiency is low.

It is supposed that exogenous source of risk is identical for all banks and as a result shocks in regulation and macroeconomic environment is the same for all DMUs. Finally, the only source of heterogeneity between banks is their size which emerges because of increasing return to scale, diversification benefits that allows lower capital requirement, high market share and the impersonal interaction with costumers which arise from precessing inability of soft information for large assets banks (Hughes and Mester, 1993; Hughes et al., 1995; Hughes et al., 1996; Koutsomanoli-Filippaki et al., 2012).
3.2 Bank technology and cost of risk abatement

3.2.1 Bank technology

The production economic theory has a system orientated approach to firms processes. Firm is seen as a transformation of resources to products with value added character. So, firm is a decision making unit (DMU) that choose a production plan. It is supposed that bank convert inputs into outputs in a one stage process, without intermediation stage.

Suppose that a bank employs a vector of inputs $x \in \mathbb{R}_+^K$ to produce a vector of good outputs $y \in \mathbb{R}_+^M$, and undesirable outputs $b \in \mathbb{R}_+^N$. It is assumed that $P(x)$ is the feasible output set for a given input vector $x$, and $L(y,b)$ is the input requirement set for a given output vector $(x,b)$. The banking technology set can be defined as:

$$T = \{ (y, b, x) : \text{ } x \text{ can produce } (y, b) \}$$

(3.1)

The technology is modeled in alternative ways. The output is strongly and freely disposable if $(y, b) \in P(x)$ and $(y', b') \leq (y, b) \Rightarrow (y', b') \in P(x)$, which implies that if an observed output vector is feasible, then any output vector smaller than that is also feasible. This assumption excludes production processes that generate undesirable outputs that are costly to dispose. For example, regulators concern about risk since it influence the economical stability of bank’s operating enviroment. On the other hand, managers are worried about the risk taken as it influence profitability, competitiveness and reputation of a bank. Those internal and external concerns imply that risk should not be treated as freely disposable.

In such cases, bad outputs are considered as being weakly disposable: $(y, b) \in P(x)$ and $0 \leq \theta \leq 1 \Rightarrow (\theta y, \theta b) \in P(x)$. This implies that risk is costly to dispose of and abatement activities would typically divert resources away from the production of desirable outputs (such as loans and earnings) and thus lead to lower good outputs with given inputs. For a bank it means that in order to
minimize the risk undertaken, managers have suppress the quantity of given loans, and consequently their profitability.

Figure 3.2 illustrate how the technology that satisfies the assumption of strong and weak disposability assumption is constructed. The output set which is bounded by $0cdef$ is the technology under strong disposability of bad outputs. The reasons for the above stated is the absence of reduction in good outputs as the undesirable outputs are deminished in segment $cd$ and the opposite for the segment $ef$, while $de$ is the section of technology where activate best practitioners. As a result, for $cd$ is assumed strong disposability of bad outputs and in the section $ef$ the same hypothesis states only for the good outputs. Follows that any try to reduce bad outputs below the point $d$ precognize the need to either reduce good outputs or to use more inputs under the non free disposable hypothesis and the output set is described by $0adef$.

The technology set provides a description of all the technologically feasible rela-
tionships between inputs and outputs and satisfies a set of axioms. Firstly, that inactivity is allowed, secondly, free lunch is not allowed (Kumar and Khanna, 2009). The remaining three is the hypothesis of convex technology which is bounded and closed, the null joint of good and bad outputs and the free disposability of inputs and outputs assumption.

The functional representation of the technology is described output orientated directional distance function, which also provides a measure for inefficiency. The directional distance function seeks to increase the good outputs whilst simultaneously reducing the bad outputs. Using mathematical symbolization the directional distance function is defined in equation 3.2.

\[
\hat{D}^F_T(x, y, b; g) = \sup \{ \beta : (y, b) + \beta g \in P(x) \}
\] (3.2)

Directional distance function formula include a vector \( g \) which denote the direction in which output can be scaled. For the purpose of model presented the most relevant scale direction is \( g = (y, -b) \) (Chung et al., 1997), denoting the decrease in bad and increase in good outputs. Returning to 3.2, given the vector \( g \), the efficient point to operate a bank under weak disposability is \( a \) at the boundary \( P(x)^w \) and contrary under strong disposability is \( k \) at boundary \( P(x)^s \).

### 3.2.2 Cost of risk abatement

The construction of technology with both strong and weak disposability assumptions of bad output and the assumption of separability of good and bad outputs in financial production process (Kumar and Khanna, 2009) permits for directional distance function to take the form:

\[
\hat{D}^t_0(y^t, b^t, x^t) = B(b^t)D_0^t(y^t, x^t)
\] (3.3)

Where \( D_0^t(y^t, x^t) \) is effect of the 'pure' technical inefficiency and \( B(b^t) \) is the effect of undesirable output on technical inefficiency. So following this logic the
3.3 Metaproduction technology and size specific cost of risk abatement

A static measure of risk efficiency is defined as:

\[ RE = \frac{(1 + D_0(y^t, b^t, x^t))}{(1 + D_0(y^t, x^t))} \]  

(3.4)

By construction, \( RE \) will take values less than or equal to one. It represents the extent to which a bank would be constrained in increasing outputs by its potential to transform its production process from free disposability to costly disposal of risk. Banks that are less constrained have a lower opportunity cost of transformation in the production process and are considered to be more risk management efficient.

This measure takes a value one only for those countries which are on the segments \( de \) and \( ef \) or those banks whose expansions fall on these segments (figure 3.2). Moreover, \( de \) and \( ef \) are common to both technologies with different assumptions on the disposability of bad outputs. For banks that lie on those segments, the cost of transforming the production process from strong disposability of bad outputs to weak disposability of these outputs would be zero. For banks located along the line segment \( 0ad \), or in the interior part of the weakly disposable output set, the \( RE \) index will assume values less than one, indicating that there is an opportunity cost of transforming the production process from strong disposability to weak disposability of bad outputs.

3.3 Metaproduction technology and size specific cost of risk abatement

Following closely Kounetas (2015), the Middle East with \( S \) types of banks (small and large) each have a specific state of technology that belongs to a specific banking system. A metafrontier can be defined to be the boundary of the unrestricted technology set. If the technology is freely interchangeable and every bank size technology have potential access to the same Middle East technology, the same DDF
(directional distance function) can be applied to the metafrontier. Moreover, it is not possible to compare different size banks when multiple technologies are available. To enable this comparison the hypothesis must be relaxed. Assuming freely interchangeable technology, meaning each \( S \) type of bank has potential access to the same Middle East technology, the metafrontier efficiencies can be calculated in the same manner as the frontier, while providing priceless benchmarking for all the banks independently from the frontier that each of them belongs.

If there are \( S \) type specific bank technologies \( T^1, T^2, \ldots, T^S \) then the metatechnology set \( T^M \) is defined as the convex hull of the jointure of all technology sets and represents the combination of input and output which is feasible in at least one of available technologies. Or:

\[
T^M(x) = \{ (y,b) : \text{can produce} (y,b) \} 
\] (3.5)

The output set \( P^M \) of metatechnology is defined in the same way as for single technology, while the corresponding efficiency of each size specific technology with respect to homogenous boundary for all heterogenous regions can be measured by the output orientated metatechnical directional distance function defined as (Eq.3.6):

\[
\overrightarrow{D}^M_M(x, y, b; g) = \sup \{ \beta : (y, b) + \beta g \in P^M(x) \} 
\] (3.6)

The metafrontier analysis allows to investigate the interrelationships between different technologies (Battese et al., 2004) and can be used to explain differences in production opportunities due to managerial choices.

### 3.3.1 Inefficiency attributed to bank size specific technology

Efficiency with respect to metatechnology permits to define the so called metatechnology ratio which is considered a measure of proximity of the \( k \)-th group individual frontier to its metafrontier. In other words, the metafrontier ratio explains
3.3 Metaproduction technology and size specific cost of risk abatement

how close a size frontier bank is to the available common Middle East metatechnology. The mentioned ratio is expressed mathematically as (O’Donnell et al., 2008):

\[
MTR(x, y, b) = \frac{MTE(x, y, b)}{TE(x, y, b)}
\] (3.7)

\(MTR\) is ratio of technical efficiency with respect to metafrontier, assuming homogenous technology, to technical efficiency with respect to frontier. The larger the value of \(MTR\) is the more advanced the technology is adopted by the firms of a specific size. In the estimation of each efficiencies score undesirable outputs are taken into account.

Simply rearranging the formula 3.7 it can be demonstrated that technology gap of the \(i\)-th bank in the \(s\)-th group frontier is the distance of group frontier to the metafrontier, weighted with the minimum inputs which are attainable employing the group specific technology. The equation which describe the above estimation is:

\[
TG(x, y, b) = 1 - MTR(x, y, b)
\] (3.8)

Technology gap values are bounded between 0 and 1. If the value of a bank ‘s technology gap is zero then the group frontier which the bank belongs to is tangent to the metafrontier. In such case no efficiency losses are due to inferiority of the group technology compared to the metatechnology. On the other hand, as closer to one is the technology gap more inefficiency has as a sources of provenience the group specific characteristics.

The values of risk efficiency score can be calculated with respect to frontier and metafrontier. Following the same logic as in the metatechnology ratio definition, risk efficiency gap or ratio (REMTR) is defined as the ratio of risk efficiency with respect to metafrontier to frontier risk efficiency (Kounetas, 2015). Equation 3.10
express this idea.

\[ REMTR = \frac{RE_{MF}}{RE_F} \]  \hspace{1cm} (3.9)

Both numerator and denominator take value less or equal to one, thus \( REMTR \) follows the same interpretation as \( MTR \). \( RE_F \) \( RE_{MF} \) represent the specific size banks and metatechnology, respectively, ability to produce more altering its production process concerning reserves for non performing loans from strong to weak disposability with respect to the technology it belongs. Furthermore, risk efficiency metatechnology ratio corresponds to the ability of its size specific to take into account the extent of reducing risk and increase earnings and loans equi proportionate considering group heterogeneity. It is important to mention that banks are more efficient when compared to the size specific frontier than when the technology is assumed to be the same both for small and big banks (Berger, 2007). This fact restrict both efficiency and risk metatechnology ratios to not higher than unit.

### 3.4 The Model

When exists a lack for relevant data, for example observations on desirable outputs exits but the generation of undesirable is unknown by product, a popular research strategy has been to model producers as unconstrained optimizers of some conventional objective and to test the hypothesis if the inefficiency in this enviroment is consistent with efficiency in the constrained enviroment (Watanabe and Tanaka, 2007).

The direction distance function estimates, which gives the efficiencies, is calculated mainly by parametric or non parametric methods. The econometric approach separate the error term into inefficiency and noise, while the results rely highly on the functional form assumption which can be misspecified. Mathematical programming methodology do not suffer from this type of disadvantages and performs better in the absence of direct data on cost of risk reduction and productivity of
3.4 The Model

The multiple input and output technology is estimated with output orientated directional distance function and can be formulated as a linear programming problem which constrains can be modified in order to meet the different assumptions requirements. Equations 3.10 through 3.15 presents the model under CRS assumption and include undesirable bank's output which is to be computed by DEA.

\[
\min \overrightarrow{D}_0(x^k, y^k, b^k; g^k) = \max \beta
\]

subject to

\[
\sum_{k=1}^{K} z_k y_{km} \geq (1 + \beta)y_{km}, \quad m = 1, \ldots, M
\] (3.11)

\[
\sum_{k=1}^{K} z_k b_{ki}^t = (1 - \beta)b_{ki}^t, \quad i = 1, \ldots, I
\] (3.12)

\[
\sum_{k=1}^{K} z_k x_{kn} \leq (1 - \beta)x_{kn}, \quad n = 1, \ldots, N
\] (3.13)

\[
\sum_{k=1}^{K} z_k = 1
\] (3.14)

\[
z_k \geq 0, \quad k = 1, \ldots, K
\] (3.15)

Equation 3.10 shows the objective function which is to be maximized. As mentioned \(x\) is the inputs which for the research purposes are fixed assets, personnel expenses, deposits and sort term fundings and other operating expenses. \(y\) denotes the good output such as earning assets and total loans and \(b\) states for the bad output which in the present case is the reserves for non performing loans. The observations are denoted by \(k\), or the number of banks in the present case with \(k = 1, \ldots K\).

The efficiency score, or the distance from a point on the frontier of an observation \((y, b)\) is illustrated by \(\beta\). The direction of efficiency measurement is stated as \(g = (g_y, g_b)\) if undesirable output is included, contrary it is defined as \(g = (g_y)\). Given the direction vector and the production technology, the directional distance
function will yield the maximum possible proportionate expansion of good outputs while simultaneously will contract the bad output.

Strong disposability of desirable outputs assumption is represented by the equation 3.11 while the weak disposability assumption of the undesirable output is shown by the equation 3.12 denoted by the equal sign. In the case of strong disposability of NPLs this constrain is omitted and the variable is not at all included in calculations.

The weight of the kth bank is denoted by $z_k$. The constrain 3.13 represents the free disposability of inputs. The return to scale assumption is present in the LP through equation 4.11. By omitting this constrain variable return to scale is assumed. On the other hand, if equality constrain is imposed to observation weigh, constant return to scale is hypothesized.

By construction, a bank can be efficient related to variable return to scale technology and simultaneously under constant returns to be inefficient. So it is expected CRS model to present overestimated results compared to VRS. By definition the values of directional distance function under optimal scale are like an upper burden for VRS estimates (Watanabe and Tanaka, 2007).

Both efficiencies, with respect to metafrontier and frontier, are calculated by the same linear programming problem. The crucial and only difference consist of the data used when estimating efficiencies under homogeneity and size heterogeneity of banks. More specifically, the total of 66 banks are used for metatechnology measure and for frontier size dependent subsamples are used.

Table 6.2 summarize the linear problems to be solved that will enable the calculation of efficiencies, risk efficiencies and technology gaps under different return to scale and heterogeneity assumptions, as well as including or excluding NPLs.
3.5 Data presentation

Data which contains balance sheet items on Middle East banks over the period 1998 to 2014 is used to estimate the directional distance functions with respect to frontier and metafrontier. All the variables are expressed in millions of US dollar. The sample contain information on 66 banks which are located in 9 different countries\(^1\). The percentage of country participation in the sample along with proportion of banks which are not present in the whole research period are presented in table 6.1.

Based on the intermediation approach (Berger and Humphrey, 1992) inputs and outputs of the financial production process are defined. So it is assumed that banks use their fixed assets, effort from personnel, deposits and sort term funds to produce loans and earnings. Following this idea, fixed assets, personnel expenses, deposits and short term funds, other operating expenses and deposits are recognised as inputs. Futhermore, outs are represented to be net loans, total earning assets and reserves for impaired loans (NPLs).

The total banks on which the dataset provide information about are 93 from which 66 are present in every year during the period in question, while 27 is not. Having in mind the aim to compare efficiency across time, the data is balanced. The table 6.3 shows the banks which are not present in every year and are excluded from estimation.

Further, a bank is classified as large if its total assets are greater than the yearly median of total assets , and small otherwise (Ariff and Luc, 2008; Berger et al., 2005). Such manner of size determination permits movement of bank between size groups in every year as can be seen from table 3.1. No movement between groups of size is observed for 2001, 2010, and 2013 while in 2004 the higher rhythm of movement is observed, then 9% of small banks become large. Although the range of movement is limited and shrunken it gives a more realistic and time variable

\(^1\)Six of those countries are part of the Gulf Cooperation Council which imply political and economic enviroment homogeneity.
3.5 Data presentation

Table 3.1. Percentage of banks which change size through years.

<table>
<thead>
<tr>
<th>Year</th>
<th>99</th>
<th>00</th>
<th>01</th>
<th>02</th>
<th>03</th>
<th>04</th>
<th>05</th>
<th>06</th>
<th>07</th>
<th>08</th>
<th>09</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of banks</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Change</td>
<td>6%</td>
<td>6%</td>
<td>0%</td>
<td>3%</td>
<td>3%</td>
<td>9%</td>
<td>3%</td>
<td>6%</td>
<td>6%</td>
<td>3%</td>
<td>3%</td>
<td>0%</td>
<td>3%</td>
<td>3%</td>
<td>0%</td>
<td>3%</td>
</tr>
</tbody>
</table>

*Note:* Number of banks states for the DMUs which change from one size group to other due to increament or decrease compare to the year median of fixed assets. Change express the group percentage of switched banks.

approach to the determination of size.

The descriptive statistics of both inputs and outputs are presented in 3.2 and asure that as expected, on average, large banks tend to have higher expenses, profits and risk compared to small.

Fixed assets, which in this particular case is an input, represents the total value of the tangible assets which can not be easily liquified. Personal expenses also is recognised as a input because it expose the amount of money spent on salaries. Additionally, the balance sheet item, Other operating expenses, contain cost paid by banks to ensure the normal operational process. Finally, deposits stand for the money that was deposited in bank at the end of fiscal year.

On the other hand, outputs produced by a bank as assumed, are the earnings assets, net loans and impaired loans. Earning assets include stocks, bonds, income from rental property, certificates of deposit (CDs) and other interest or dividend earning accounts or instruments. Net Loans represents total loans to customers, reduced by possible default losses and unearned interest income. And last but not least, impaired loans are money that bank do not expect to be returned.

Figure 6.1 illustrate the growth rate of non performing loans for small and large banks during the period in question. Overall the risk taken by large banks is more stabile compared to small banks. Although in the periods before and after crisis the risk preferences of small and large banks do not chances differently, the same is not observed for years 2007 through 2010. During the global financial crisis the risk accumulation of banks is excessive. The quality of small bank assets worsen
### Table 3.2. Summary statistics by size of inputs and outputs during 1998-2014

<table>
<thead>
<tr>
<th></th>
<th>Average</th>
<th>Min</th>
<th>Max</th>
<th>Large</th>
<th>Small</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Input</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fixed Assets</td>
<td>144766.7</td>
<td>705</td>
<td>1071569</td>
<td>255721.9</td>
<td>33811.5</td>
</tr>
<tr>
<td>Fixed Assets</td>
<td>(197220)</td>
<td>(229069)</td>
<td>(26871)</td>
<td>(29745)</td>
<td></td>
</tr>
<tr>
<td>Personal Expenses</td>
<td>134256.3</td>
<td>846</td>
<td>1569865</td>
<td>236197</td>
<td>32315.67</td>
</tr>
<tr>
<td>Personal Expenses</td>
<td>(217500)</td>
<td>(270170)</td>
<td>(29745)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating Expenses</td>
<td>98634.91</td>
<td>1128</td>
<td>1070198</td>
<td>174044.4</td>
<td>23225.45</td>
</tr>
<tr>
<td>Operating Expenses</td>
<td>(156779)</td>
<td>(193178)</td>
<td>(22100)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deposits</td>
<td>1180×10^4</td>
<td>72355</td>
<td>10900×10^4</td>
<td>2020×10^4</td>
<td>3299077</td>
</tr>
<tr>
<td>Deposits</td>
<td>(1580×10^4)</td>
<td>(1850×10^4)</td>
<td>(3834010)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Output</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Earning Assets</td>
<td>1229×10^5</td>
<td>118336</td>
<td>1220×10^5</td>
<td>2210×10^4</td>
<td>3650806</td>
</tr>
<tr>
<td>Earning Assets</td>
<td>(1750^4)</td>
<td>(2050×10^4)</td>
<td>(4419165 )</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net Loans</td>
<td>8156390</td>
<td>59661</td>
<td>9290×10^5</td>
<td>1420×10^4</td>
<td>2126903</td>
</tr>
<tr>
<td>Net Loans</td>
<td>(1240^4)</td>
<td>(1520×10^4)</td>
<td>(2731436)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impaired Loans</td>
<td>322594.9</td>
<td>722</td>
<td>3265427</td>
<td>528509.7</td>
<td>116680.2</td>
</tr>
<tr>
<td>Impaired Loans</td>
<td>(465709)</td>
<td>(563498 )</td>
<td>(177973)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: The column 'Average', 'Min' and 'Max' present statistical measures of overall sample. The last two columns report the mean inputs and outputs for Large and small banks, respectively.

by almost 60% while large banks' risk increase by 20%.

Although, in a balance sheet item a negative value means that the bank owed those money, in the DEA process this will not be clear since DEA has a 'positivity' requirement. The methodology presented is suitable for inputs and outputs with positive value. After conducting the descriptive statistics it was find that other operational expenses was negative in 1999 for First Gulf Bank, a commercial bank in United Arab Emirates. In order to solve the complication due to negative value, the respective observation was replace by the value of precedent year operating expenses.
Chapter 4

Results and discussion

Constructing an annual frontier specific to each year is more flexible and thus more appropriate than estimating a single multiyear frontier for the banks in the sample. In other words, there were seventeen separate frontiers constructed for the study. The principal advantage of having panel data is the ability to observe each bank more than once over a period of time. The issue is also critical in a continuously changing business environment because the technology of a bank that is most efficient in one period may not be the most efficient in another. Furthermore, by doing so, at least to an extent, the problems related to the lack of random error in DEA are alleviated, by allowing an efficient bank in one period to be inefficient in another, assuming that the errors owing to luck or data problems are not consistent over time (Isik and Hassan, 2002).

4.1 Performance and non performing loans

It is expected that mispecification of production function of banks would be followed by biased efficiency estimates. In this section, the traditional (considering only desirable) and the risk adjusted (considering both desirable and undesirable) performance estimates are compared. Using output orientated directional distance function the scaling vector in case of NPLs inclusion is \( g = (g_y, g_b) = (1, 1, -1) \) while for the simple model is \( (1, 1, 0) \). Both CRS and VRS scale are considered.
### Table 4.1. Comparison between models with and without undesirable output.

<table>
<thead>
<tr>
<th>Year</th>
<th>With Undesirable</th>
<th>Without undesirable</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>With Undesirable</td>
<td>Without undesirable</td>
</tr>
<tr>
<td></td>
<td>CRS Mean eff. Efficient</td>
<td>CRS Mean eff. Efficient</td>
</tr>
<tr>
<td></td>
<td>VRS Mean eff. Efficient</td>
<td>VRS Mean eff. Efficient</td>
</tr>
<tr>
<td>1998</td>
<td>.239 14</td>
<td>.330 4</td>
</tr>
<tr>
<td>1999</td>
<td>.240 12</td>
<td>.628 7</td>
</tr>
<tr>
<td>2001</td>
<td>.174 13</td>
<td>.357 4</td>
</tr>
<tr>
<td>2002</td>
<td>.109 12</td>
<td>.229 6</td>
</tr>
<tr>
<td>2003</td>
<td>.184 16</td>
<td>.347 5</td>
</tr>
<tr>
<td>2004</td>
<td>.212 11</td>
<td>.550 2</td>
</tr>
<tr>
<td>2005</td>
<td>.352 7</td>
<td>.450 2</td>
</tr>
<tr>
<td>2006</td>
<td>.278 11</td>
<td>.338 4</td>
</tr>
<tr>
<td>2008</td>
<td>.195 13</td>
<td>.271 6</td>
</tr>
<tr>
<td>2009</td>
<td>.238 9</td>
<td>.413 4</td>
</tr>
<tr>
<td>2010</td>
<td>.233 10</td>
<td>.393 3</td>
</tr>
<tr>
<td>2011</td>
<td>.228 9</td>
<td>.389 2</td>
</tr>
<tr>
<td>2012</td>
<td>.194 12</td>
<td>.285 5</td>
</tr>
<tr>
<td>2013</td>
<td>.183 14</td>
<td>.257 6</td>
</tr>
<tr>
<td>2014</td>
<td>.163 16</td>
<td>.234 6</td>
</tr>
</tbody>
</table>

**Note:** The table presents the average inefficiency or distance with respect to common frontier under CRS and VRS.

Table 4.1 compares the estimated efficiency levels of banks in every year assuming strong and weak disposability of bad output. The performance scores was calculated with respect to a common Middle East frontier. On average, and for every year the simple model reports higher inefficiencies and lower number of fully efficient banks. As expected, exclusion of NPLs from the objective function results in underestimated efficiency levels and place banks further from the common frontier.

Under VRS and CRS assumptions, the two estimates’ distributions of performance are illustrated to be different (figure 6.2). Hence, there is a possibility that the underlining real technology of financial production does not permit for analogous expansion of good outputs as the bad output, because the distances from CRS and VRS differ significantly (Watanabe and Tanaka, 2007). Ignoring the other assumptions, the specifications of constant return to scale estimate larger inefficiency compared to variable returns to scale. This conclusion remain valid when reserves for non performing loans are included or otherwise. It is a confirma-
4.2 Efficiency-size relation and the impact of assets’ quality

It is assumed that the role of a manager is to maximize the wealth of a bank, through increment of market share (loans) or profitability (earning assets) in the simple model. On the other hand, the more realistic specification describe the role of a manager to be more complicated. He has to take production decisions that increase loans and earnings but with the constrain of keeping the risk bank exposure to the lowest possible.

In that environment, it will be interesting to find out which bank are more efficient in risk constrained management choses. It is possible through comparing
4.2 Efficiency-size relation and the impact of assets’ quality

Table 4.2. Efficiency and risk efficiency by banks’ size and year.

<table>
<thead>
<tr>
<th>Bank’s Size</th>
<th>Efficiency</th>
<th>Risk Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CRS</td>
<td>VRS</td>
</tr>
<tr>
<td></td>
<td>Small</td>
<td>Large</td>
</tr>
<tr>
<td>Year</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1998</td>
<td>.231</td>
<td>.247</td>
</tr>
<tr>
<td>1999</td>
<td>.216</td>
<td>.264</td>
</tr>
<tr>
<td>2000</td>
<td>.173</td>
<td>.170</td>
</tr>
<tr>
<td>2001</td>
<td>.170</td>
<td>.179</td>
</tr>
<tr>
<td>2002</td>
<td>.093</td>
<td>.126</td>
</tr>
<tr>
<td>2003</td>
<td>.152</td>
<td>.217</td>
</tr>
<tr>
<td>2004</td>
<td>.197</td>
<td>.227</td>
</tr>
<tr>
<td>2005</td>
<td>.306</td>
<td>.399</td>
</tr>
<tr>
<td>2006</td>
<td>.246</td>
<td>.310</td>
</tr>
<tr>
<td>2007</td>
<td>.269</td>
<td>.258</td>
</tr>
<tr>
<td>2008</td>
<td>.197</td>
<td>.194</td>
</tr>
<tr>
<td>2009</td>
<td>.235</td>
<td>.241</td>
</tr>
<tr>
<td>2010</td>
<td>.242</td>
<td>.223</td>
</tr>
<tr>
<td>2011</td>
<td>.204</td>
<td>.252</td>
</tr>
<tr>
<td>2012</td>
<td>.188</td>
<td>.201</td>
</tr>
<tr>
<td>2013</td>
<td>.161</td>
<td>.205</td>
</tr>
<tr>
<td>2014</td>
<td>.166</td>
<td>.160</td>
</tr>
<tr>
<td>Mean</td>
<td>.199</td>
<td>.228</td>
</tr>
<tr>
<td>St. dev.</td>
<td>.177</td>
<td>.157</td>
</tr>
<tr>
<td>Min</td>
<td>.000</td>
<td>.000</td>
</tr>
<tr>
<td>Max</td>
<td>.791</td>
<td>.848</td>
</tr>
</tbody>
</table>

Note: Risk efficiency and efficiency are estimated with respect to a common frontier. The size is defined post estimation.

simple and risk adjusted efficiencies of small and large banks with respect to the common frontier\(^1\). Table 4.2 illustrate the mean distance (inefficiency) of small and big banks with respect to common technology frontier under CRS and VRS, with recognizing the impact of risk on efficiency estimations while the risk efficiency estimate the impact of NPLs inclusion denoted by risk efficiency. In this section it is assumed that in Middle East exists only one technology of financial production and all banks have access to.

Efficiency-size link

On average small banks are closer to the underlying available Middle East technology and this is revealed with the lower value of distance in all four specifications (table 4.2). For example, in risk adjusted model, under optimal scale assumption, from 1998 to 2014, the average small bank in order to be efficient needs to increase

\(^1\)Alternatively, heterogenous frontiers could be assumed but then the comparison ex post between small and big banks would not be possible (Watanabe and Tanaka, 2007)
4.2 Efficiency-size relation and the impact of assets’ quality

its loans and earnings by 20% and decrease its NPLs (credit risk) by 20%. However, large banks must expand their market share and profitability by 22% to be fully efficient. So, higher fixed assets seems to be related with more inefficiency, revealing a negative link between bank size and efficiency.

Literature presents contradictory evidence about the correlation sign of bank size and efficiency. Middle East banking industry show sign of a negative relation between the amount of fixed assets and performance during the research period as it was found out. This research output is in line with other studies (Koutsomanoli-Filippaki et al., 2012; Kwan, 2002; Ataullah et al., 2004; Leong et al., 2002), and seems to agree that complexity and politically determined bureaucratic organizational structure impeede large banks to introduce new technology and products, while small banks are more flexible to adapt changes and remain efficient. On the other hand, disagreement is raising when comparing the results with studies which mention that large bank’s market power make them more efficient (Rangan et al., 1988; Yildirim, 2002; Berger, 2007).

Efficiency and assets quality

To estimate the influence of NPLs on efficiency, the financial production technology is constructed assuming both strong and weak disposability of non performing loans or asset quality. Those assumptions enable to estimate the so called risk efficiency, which explain the extent to which the performance of a bank is influenced by the risk management decisions and by other internal or external factors. Also this measure describe the extent to which a bank is constrained in risk reduction by the opportunity cost arising from depletion of profitability and loans.

Table 4.1 shows the estimated values for risk efficiency for every year and different scale assumption. On average, in none of the years banks were fully risk efficient implying the existence of risk minimization opportunity cost. Optimal scale specification of the output orientated directional distance function report a loan and earning sacrifice of 10% for a proportional reduction of risk, for both
4.2 Efficiency-size relation and the impact of assets’ quality

Figure 4.1: Risk efficiency distribution of small and large banks with respect to common technology.

small and large banks, while VRS model imply that a 1% reduction in banking activity is enough to reduce the cost. Turning the attention to yearly averages, there is observed that in some years small banks have higher constrains to reduce the risk and in others large banks’ inefficiency is not reduced by the produced mix of outputs. If the risk efficiency measure is interpreted as an opportunity cost of risk diminishment then it can be stated that large banks have higher constrains to increase their asset quality. For example, in 2004 an average bank in order to adopt a more secure strategy was necessary to renounce almost 25% of their market share and profits which is quite useful for supervisors.

Figure 4.1 offer an illustration of risk efficiency distribution for small and large banks. In every year the distribution of large banks is at lower RE values which imply a negative effect of risk management on bank inefficiency. However, small banks’s asset quality administration tend to increase their efficiency more in 2006-2008 and 2012-2014. Based on figure 6.1 during the financial crisis both small and large banks experienced a dramatrical increase in non performing loans, which
means their risk aversion increase also, but the inefficiency did not decrease (figure 4.1). According to bad luck hypothesis, the increase in risk do not originate to managerial inefficiency but to external shocks (Berger and Humphrey, 1997). On the other hand, the characteristic positive risk impact on efficiency of banks before crisis and the following vanishing influence suggest the inability to reject the cost skimming hypothesis for all banks (Fiordelisi et al., 2011; Koutsomanoli-Filippaki et al., 2012; Avkiran, 1999).

Additionally, it was disclosed that more efficiency is attached to large banks when comparing the ability to both increase loans and earning while simultaneously decrease the risk. Having in mind the negative size efficiency link, it can be stated that big banks have an better ability to diversify their credit risk, because of their market power (Rangan et al., 1988; Yildirim, 2002; Berger, 2007; Ataullah et al., 2004). This conclusion demonstrate that the assumptions about risk and efficiency relationship are not exclusive.

4.3 Group specific inefficiencies

In this section, it is attempted to explore what amount of inefficiency is generated by the size alternative technology. Furthermore, the risk management inefficiency which emerges form the size specific production technology is investigated.

To proceed towards, the efficiencies with respect to size specific frontier and to the common frontier are estimated. It is presumed that large and small banks have different technologies, and concomitantly have access to a common Middle East bank technology production. Afterwards the metatechnology ratio calculated. Motivated by the bias produced when NPLs are excluded, previous approximated risk adjusted efficiencies are employed for MTR evaluation. Then RE of size specific frontiers and common frontier are used to define the metatechnology risk efficiency ratio. The results of average MTR and REMTR of small and large banks are presented in table 4.3.
### Table 4.3. Metatechnology ratio and risk efficiency metatechnology ratio by banks’ size and year.

<table>
<thead>
<tr>
<th>Bank’s Size</th>
<th>Year</th>
<th>CRS</th>
<th>VRS</th>
<th>CRS</th>
<th>VRS</th>
<th>CRS</th>
<th>VRS</th>
<th>CRS</th>
<th>VRS</th>
<th>CRS</th>
<th>VRS</th>
<th>CRS</th>
<th>VRS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small</td>
<td>.999</td>
<td>.871</td>
<td>.999</td>
<td>.987</td>
<td>.998</td>
<td>.988</td>
<td>.999</td>
<td>.997</td>
<td>.999</td>
<td>.994</td>
<td>.998</td>
<td>.994</td>
<td>.999</td>
</tr>
<tr>
<td>Large</td>
<td>.999</td>
<td>.877</td>
<td>.999</td>
<td>.985</td>
<td>.999</td>
<td>.829</td>
<td>.999</td>
<td>.999</td>
<td>.999</td>
<td>.999</td>
<td>.999</td>
<td>.999</td>
<td>.999</td>
</tr>
<tr>
<td>Small</td>
<td>.997</td>
<td>.945</td>
<td>.995</td>
<td>.999</td>
<td>.996</td>
<td>.967</td>
<td>.979</td>
<td>.999</td>
<td>.999</td>
<td>.999</td>
<td>.999</td>
<td>.999</td>
<td>.999</td>
</tr>
<tr>
<td>Large</td>
<td>.996</td>
<td>.949</td>
<td>.995</td>
<td>.978</td>
<td>.996</td>
<td>.961</td>
<td>.991</td>
<td>.999</td>
<td>.999</td>
<td>.999</td>
<td>.999</td>
<td>.999</td>
<td>.999</td>
</tr>
<tr>
<td>Small</td>
<td>.977</td>
<td>.935</td>
<td>.975</td>
<td>.980</td>
<td>.977</td>
<td>.944</td>
<td>.992</td>
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<td>.999</td>
<td>.999</td>
<td>.999</td>
<td>.999</td>
<td>.999</td>
</tr>
<tr>
<td>Large</td>
<td>.977</td>
<td>.906</td>
<td>.975</td>
<td>.970</td>
<td>.976</td>
<td>.949</td>
<td>.995</td>
<td>.999</td>
<td>.999</td>
<td>.999</td>
<td>.999</td>
<td>.999</td>
<td>.999</td>
</tr>
<tr>
<td>Small</td>
<td>.984</td>
<td>.905</td>
<td>.988</td>
<td>.979</td>
<td>.985</td>
<td>.996</td>
<td>.999</td>
<td>.999</td>
<td>.999</td>
<td>.999</td>
<td>.999</td>
<td>.999</td>
<td>.999</td>
</tr>
<tr>
<td>Large</td>
<td>.984</td>
<td>.690</td>
<td>.988</td>
<td>.984</td>
<td>.985</td>
<td>.996</td>
<td>.999</td>
<td>.999</td>
<td>.999</td>
<td>.999</td>
<td>.999</td>
<td>.999</td>
<td>.999</td>
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<tr>
<td>Average</td>
<td>.975</td>
<td>.640</td>
<td>.977</td>
<td>.602</td>
<td>.603</td>
<td>.042</td>
<td>.607</td>
<td>.600</td>
<td>.600</td>
<td>.602</td>
<td>.605</td>
<td>.607</td>
<td>.607</td>
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<tr>
<td>Std. deviation</td>
<td>.035</td>
<td>.064</td>
<td>.002</td>
<td>.018</td>
<td>.023</td>
<td>.067</td>
<td>.000</td>
<td>.007</td>
<td>.000</td>
<td>.007</td>
<td>.000</td>
<td>.008</td>
<td>.008</td>
</tr>
<tr>
<td>Min</td>
<td>.815</td>
<td>.628</td>
<td>.959</td>
<td>.855</td>
<td>.822</td>
<td>.608</td>
<td>.988</td>
<td>.925</td>
<td>.988</td>
<td>.925</td>
<td>.988</td>
<td>.925</td>
<td>.988</td>
</tr>
<tr>
<td>Max</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
</tr>
</tbody>
</table>

#### Size inefficiency

MTR express how close is the size specific frontier to the common underlying technology. It has the ability to identify technology differentials among size banking system. To remind, as higher the value of MTR as less inefficient is the adopted technology (small or large). Small banks have higher MTR in all model specifications (table 4.3), indicating more advanced technology selection compared to large banks. Explicitly, if large banks would adopt the available Middle East technology, they could be efficient with a 6% lower change in the outputs (reducing risk and increasing loans and earnings) while keeping their input mix stable. In the same manner, small banks efforts for efficient output strategy would be minimized by 2.5% (CRS model).

In other words, less inefficiency is arising from the management and operational processes, which determine the technology, adopted by small banks. Information about the time trend and distribution of MTR of small and big banks are illustrated in figure 4.2 for optimal and variable scale assumption. Small bank’s
4.3 Group specific inefficiencies

Figure 4.2: Metatechnology ratio distribution for size groups.

technology is closer to the available Middle East production frontier before financial crisis. Starting with 2007, large banks follow closely the common technology, while it seems to be a difficult task for their smaller counterparts. Although CRS expose the flexibility of large banks to adapt more efficiently to riskier environment, VRS model present small banks’ technology to be more efficient in every year.

Based on metatechnology ratios described in table 4.3, the same distribution of small and large banks by year is tested using the non parametric Mann Whitney test on MTRs estimations. The results of the test are presented in table 6.5 and point out that technology configurations are statistically important factors in efficiency determination.

Several conclusions about bank size and efficiency can be drawn from the results presented in this section. Firstly, on average small bank technology of Middle East is more efficient, but is accompanied with more sensibility to external shocks. Macroeconomic events, like financial crisis which started in 2007 seems to increase the inefficiency of small bank production, meaning that the chosen output com-
4.3 Group specific inefficiencies

Combination of risk, loans and earnings are further than the possible ones if optimal return to scale characterize the technology. On the other hand, inferiority of large banks technology before crisis period became superior to small bank’s technology during crisis.

Affirmation of earlier literature engage the obtained results that find efficiency decrease as the main source of bank’s productivity and competitiveness losses (Berger, 2007; Ataullah et al., 2004; Rangan et al., 1988; Degl’Innocenti et al., 2017). Furthermore, as claimed by 'bad luck' hypothesis, the higher inefficiency of small banks does not mean that the managers are not efficient. It is logical to say that, if small banks has a more diversified risk and a higher influence in market, then it could be more efficient during the macroeconomic shocks. On the other hand, the before crisis larger inefficiency of big financial institutions may be explain by either the cost skimming or the moral hazard hypothesis.

**Risk inefficiency**

The results of risk efficiency metatechnology ratio are provided in table 4.3 which gives some valuable information on opportunity cost of risk which is due to size specific technology. On average small banks technology is superior, since only 2% reduction in sacrificed market share and profitability will be necessary if small banks’ frontier were absolutely the same as available Middle East technology. Nevertheless, large banks frontier appears to be further from the efficient cost disposal of risk. On average, large banks renounce from more desirable outputs to increase the asset quality. If those banks adopt the common technology they will earn a 4% on loans and profitability spare.

To determine the time trend and explore in more depth the behavior of risk efficiency ratio with respect to metafrontier a distribution graph is provided in figure 4.3. In every year and under variable to scale assumption small banks have the same risk opportunity cost with respect to both frontier and metafrontier. Every small bank in 2004, 2005, and 2007 does not have additional charge originated by
4.3 Group specific inefficiencies

Figure 4.3: Distribution of risk efficiency metatechnology ratio by year and bank size.

Its supressed size. This is true also for CRS assumption in 2004 while in the rest years slightly higher contraction of banks activity is required to avoid risk under homogeneity assumption, but it does not exceed the five percent. So large banks are by 4% more inefficient due to their adopted technology of risk management.

Figure 4.3 highlights the inefficient risk management, due to the inflexibility of big banks to adopt their activities to risk management development. It could be explained by the impersonal interaction between lenders and borrowers in significantly large financial institutions (Koutsomanoli-Filippaki et al., 2012). Additionally, the benefits from diversification of risk could be exploited even more, and higher levels of efficiency could be approached. On the other hand, the risky environment of crisis has obligated large banks to adopt more effective credit monitoring systems. Contrary, small banks have more beneficial reaction on their technical efficiency due to their technology process to manage risk. This could be explained by their minor market share which permits them to monitor credit better and to exploit benefits from soft information processes (Elyasi and Mehdian, 1995).
Chapter 5

Conclusions

This thesis had stressed the impact of risk preferences and size on Middle East bank performance. For this purpose, it was assumed that the financial production is characterized by both free and costly risk abatement, which enable the identification of inefficiency due to risk management. Furthermore, a metaproduction model is adopted to identify inefficiency attributed to bank size. An output orientated directional distance function was employed under intermediation approach. Using accounting data on 66 Middle East banks for 1998 to 2014 period, banks’ efficiencies were estimated with DEA method.

The evidence from this study points towards the idea of biased efficiency estimations resulting from models which omit bank’s risk preferences. In the same line with relative literature, ignorance of bad loans gives overestimated inefficiency, and lower number of decision making units being fully efficient. Furthermore, the difference of risk adjusted and simple inefficiency was found to be statistically significant. Besides the technical inefficiency of Middle East banks, it was demonstrated that non performing loans have a positive effect on bank efficiency.

The findings suggest that small banks are closer to the underlying common Middle East technology when non performing loans are included in the model. The persistence of such observation during the examined period conduct to the conclusion of a negative relation between size and efficiency of banks. Although
large banks’ risk preferences have elevated effect on efficiency, they are more inefficient compared to smaller counterparts.

The investigation of inefficiency attributed to bank size unrevealed the technological inferiority of large banks which is associate with bad management. On the other hand, small banks technology is closer to the common available Middle East frontier during the research period, excepting 2008 to 2010. This accentuate the idea of bad luck hypothesis and highlight the sensibility of small banks to external economic shocks.

Finally, the results on risk efficiency metatechnology ratio indicate that on average, production inferiority of large banks are ascribed to their low-quality management of non performing loans. Interestingly, during financial crisis the risk abatement cost of large banks is closer to the efficient, which can be explained by the benefits of risk diversification. Contrary, having a lower market share and less diversified risk, small banks face difficulties to adapt their cost of risk reduction to the efficient. However, sacrifice of market share and earnings are not very high, implying more personal relation with borrowers and effective process of soft information for small bank ‘s management.

Possible implications of our study for bank management and regulation are as follows. Since the average large bank ‘s technical inefficiency is attributed poor risk management, it is beneficial for large banks to develop a better process of monitoring possible costumers. Also, the results indicate that bank size measured by total assets has a negative effect on technical efficiency. This suggests that consolidation of large banks in the region must be controled in order to lower technical inefficiency in banking.

Owing to its limitations, the research could be extend in a variety of ways. The scope of this study could be further extended to investigate the country and ownership inefficiencies. Second, it is suggested that further analysis to be undertaken in the investigation of bias which the accounting strategy of banks impose. Third, future research into the efficiency of the banking sector could
also consider the to decompose the internal and external risk inefficiency. Finally, result comparison with an investigation based on a larger data and determining the size of bank based on market share and profitability, would be interesting.

Despite these limitations, the findings of this study are expected to contribute significantly to the existing knowledge of the operating performance of banking industry in the Middle East countries. Nevertheless, the study has also provided further insight into the banks’ size efficiency relation, as well as the policy makers with regard to attaining stability in systemic risk. Additionally directions for technical efficiency improvements through more personal credit monitoring facilitate sustainable competitiveness banking operations in the future.
Chapter 6

Appendix A

Table 6.1. Countries participation in the sample.

<table>
<thead>
<tr>
<th>Country</th>
<th>Banks</th>
<th>Non-balanced</th>
<th>% of total data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bahrain</td>
<td>8</td>
<td>4</td>
<td>7.97</td>
</tr>
<tr>
<td>Israel</td>
<td>10</td>
<td>1</td>
<td>11.14</td>
</tr>
<tr>
<td>Jordan</td>
<td>13</td>
<td>2</td>
<td>14.45</td>
</tr>
<tr>
<td>Kuwait</td>
<td>9</td>
<td>5</td>
<td>8.71</td>
</tr>
<tr>
<td>Lebanon</td>
<td>16</td>
<td>7</td>
<td>16.81</td>
</tr>
<tr>
<td>Oman</td>
<td>6</td>
<td>1</td>
<td>6.82</td>
</tr>
<tr>
<td>Qatar</td>
<td>6</td>
<td>2</td>
<td>6.48</td>
</tr>
<tr>
<td>Saudi Arabia</td>
<td>9</td>
<td>0</td>
<td>10.33</td>
</tr>
<tr>
<td>United Arab Emirates</td>
<td>16</td>
<td>4</td>
<td>17.29</td>
</tr>
</tbody>
</table>

Figure 6.1: Mean growth of non performing loans by year for small and large banks.
Table 6.2. DEA linear programming problems to be solved

<table>
<thead>
<tr>
<th>Relation</th>
<th>Technology</th>
<th>Non-performing loans</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Risk-efficiency</td>
<td>Homegenous</td>
<td>with</td>
<td>total</td>
</tr>
<tr>
<td>2 Size-efficiency</td>
<td>Homogenous</td>
<td>with</td>
<td>total</td>
</tr>
<tr>
<td>3 Risk costing</td>
<td>Homogenous</td>
<td>with</td>
<td>total</td>
</tr>
<tr>
<td>4 Risk cost-size</td>
<td>Homogenous</td>
<td>with</td>
<td>total</td>
</tr>
<tr>
<td></td>
<td>Heterogenous</td>
<td>without</td>
<td></td>
</tr>
</tbody>
</table>

Figure 6.2: Performance distributions of simple and risk adjusted model for by year.
Table 6.3. *Banks which are not present in every year*

<table>
<thead>
<tr>
<th>Country</th>
<th>Specialization</th>
<th>Bank name</th>
</tr>
</thead>
<tbody>
<tr>
<td>BAHRAIN</td>
<td>Commercial</td>
<td>Ahli United Bank BSC</td>
</tr>
<tr>
<td></td>
<td>Islamic</td>
<td>Albaraka Banking Group B.S.C.</td>
</tr>
<tr>
<td></td>
<td>Islamic</td>
<td>Kuwait Finance House</td>
</tr>
<tr>
<td></td>
<td>Investment</td>
<td>United Gulf Bank (BSC) EC</td>
</tr>
<tr>
<td>ISRAEL</td>
<td>Commercial</td>
<td>Bank Otsar Hahayal Ltd</td>
</tr>
<tr>
<td>JORDAN</td>
<td>Islamic</td>
<td>Islamic International Arab Bank</td>
</tr>
<tr>
<td></td>
<td>Islamic</td>
<td>Jordan Islamic Bank</td>
</tr>
<tr>
<td>KUWAIT</td>
<td>Investment</td>
<td>Global Investment House</td>
</tr>
<tr>
<td></td>
<td>Investment</td>
<td>Gulf Investment Corporation</td>
</tr>
<tr>
<td></td>
<td>Investment</td>
<td>Kuwait Finance &amp; Investment Company</td>
</tr>
<tr>
<td></td>
<td>Islamic</td>
<td>Kuwait Finance House</td>
</tr>
<tr>
<td></td>
<td>Investment</td>
<td>Kuwait Investment Company</td>
</tr>
<tr>
<td>LEBANON</td>
<td>Commercial</td>
<td>B.L.C. Bank S.A.L</td>
</tr>
<tr>
<td></td>
<td>Commercial</td>
<td>Bank Audi Private Bank</td>
</tr>
<tr>
<td></td>
<td>Commercial</td>
<td>Banque BEMO Sal</td>
</tr>
<tr>
<td></td>
<td>Commercial</td>
<td>Banque Pharaon &amp; Chiha</td>
</tr>
<tr>
<td></td>
<td>Commercial</td>
<td>Lebanese Swiss Bank</td>
</tr>
<tr>
<td></td>
<td>Commercial</td>
<td>MEAB SAL</td>
</tr>
<tr>
<td></td>
<td>Commercial</td>
<td>North Africa Commercial Bank</td>
</tr>
<tr>
<td>OMAN</td>
<td>Commercial</td>
<td>Bank Muscat SAOG</td>
</tr>
<tr>
<td>QATAR</td>
<td>Commercial</td>
<td>Doha Bank</td>
</tr>
<tr>
<td></td>
<td>Commercial</td>
<td>International Bank of Qatar</td>
</tr>
<tr>
<td>UNITED ARAB EMIRATES</td>
<td>Investment</td>
<td>Abu Dhabi Investment Company</td>
</tr>
<tr>
<td></td>
<td>Islamic</td>
<td>Abu Dhabi Islamic Bank</td>
</tr>
<tr>
<td></td>
<td>Commercial</td>
<td>Commercial Bank of Dubai</td>
</tr>
<tr>
<td></td>
<td>Commercial</td>
<td>Invest Bank P.S.C.</td>
</tr>
<tr>
<td></td>
<td>Islamic</td>
<td>Sharjah Islamic Bank</td>
</tr>
</tbody>
</table>
Table 6.4. Mann-Whitney U test for resulting efficiencies for specifications with and without undesirable output.

<table>
<thead>
<tr>
<th>Year</th>
<th>1998</th>
<th>1999</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
</tr>
</thead>
<tbody>
<tr>
<td>p-value</td>
<td>0.008</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.032</td>
<td>0.000</td>
<td>0.003</td>
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</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>z</td>
<td>2.415</td>
<td>2.584</td>
<td>4.863</td>
<td>5.277</td>
<td>5.363</td>
<td>2.957</td>
<td>4.207</td>
<td>2.637</td>
</tr>
<tr>
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<td>0.009</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.003</td>
<td>0.000</td>
<td>0.008</td>
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</tbody>
</table>

Variable return to scale

<table>
<thead>
<tr>
<th>Year</th>
<th>1998</th>
<th>1999</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
</tr>
</thead>
<tbody>
<tr>
<td>p-value</td>
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<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>z</td>
<td>2.961</td>
<td>3.531</td>
<td>4.720</td>
<td>4.854</td>
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<td>4.080</td>
<td>4.862</td>
<td>3.999</td>
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<tr>
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<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Note: Based on the p-value the null hypothesis of same TEs distribution for both models specification with and without including NPLs in every year is rejected at high significance level.

Table 6.5. Results of Mann Whitney tests concerning the differences of TG under the year specific technologies and metatechnology.

<table>
<thead>
<tr>
<th>Year</th>
<th>1998</th>
<th>1999</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
</tr>
</thead>
<tbody>
<tr>
<td>p-value</td>
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<td>0.000</td>
<td>0.000</td>
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<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>z</td>
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<td>3.948</td>
<td>4.708</td>
<td>4.558</td>
<td>5.222</td>
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<tr>
<td>p-value</td>
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<td>0.000</td>
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<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Variable return to scale

<table>
<thead>
<tr>
<th>Year</th>
<th>1998</th>
<th>1999</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
</tr>
</thead>
<tbody>
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<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
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<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Note: Based on the p-value the null hypothesis of same MTRs distribution for both big and small banks in every year is rejected at high significance level.
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