Charles University in Prague

Faculty of Social Sciences

Institute of Economic Studies

MASTER THESIS

Efficiency and Stability of Islamic Banking: Empirical Evidence from the Middle East Region

Author: **Bc. Kateřina Čábelová**

Supervisor: **prof. Ing. Michal Mejstřík CSc.**

Academic Year: **2015/2016**

Declaration of Authorship

1. Hereby I declare that I have compiled this master thesis independently, using only the listed literature and sources.
2. I declare that the thesis has not been used for obtaining another title.
3. I agree on making this thesis accessible for study and research purposes.

Prague, May 13, 2016

_____

Signature

Acknowledgments

I would like to express my sincere gratitude to prof. Ing. Michal Mejstřík CSc. for supervising this thesis, useful advices and valuable suggestions. Further, I thank Mgr. Josef Obořil for the consulting of methodology and Mgr. Jitka Jopová for valuable comments. Finally, I would like to thank my friends, family, and especially to my husband, for their great support for the whole time of writing this thesis.

Abstract

The recent financial crisis has drawn the attention towards Islamic finance. Islamic banks have demonstrated not only a great resilience to financial instability but they also still maintain the rapid growth. The main characteristic of Islamic financial system is a prohibition of interest that is perceived as highly unethical in Muslim world. Interest is replaced by *Profit and Loss Sharing* principle in which a bank plays role of a business partner rather than a creditor. Fundamental differences in banking strategy between Islamic and convetional banks are apparent, however, their implications for overall bank performance are still the subject of discussions. This thesis empirically investigates efficiency and stability of banking sector in the Middle East region where both banking systems coexist alongside and where the largest concentration of Islamic assets is currently held. The efficiency was measured independently by two frontier techniques, namely Data Envelopment Analysis and Stochastic Frontier Analysis. Thereafter a regression analysis was performed to examine determinants of bank efficiency and to investigate the impact of the crisis on both types of banks. The results indicate that Islamic banks are more resilient to financial instability but their operation is more cost demanding compared to traditional banks.

JEL Classification	C13, C14, C61, G21, G28,
Keywords	Islamic Banking, Conventional Banking, Data Envelopment Analysis, Stochastic Frontier Analysis, Efficiency, Stability

Author's e-mail	katka.cabelova@gmail.com
Supervisor's e-mail	mejstrik@fsv.cuni.cz

Bibliography	ČÁBELOVÁ, Kateřina. Efficiency and Stability of Islamic Banking: Empirical Evidence from the Middle East Region. Prague, 2016. p124. Master's thesis, Charles University in Prague, Faculty of Social Sciences, Institute of Economic Studies, 2016

Abstrakt

Islámské bankovnictví zaznamenalo v důsledku světové finanční krize zvýšený zájem odborné veřejnosti. Islámské banky dlouhodobě vykazují prudký ekonomický růst a zároveň také úspěšně demonstrovaly vysokou odolnost vůči finanční nestabilitě. Charakteristickým rysem islámského bankovnictví je přísný zákaz úroku, který je v muslimském světě vnímán jako vysoce neetický. Úrok je nahrazen principem spravedlivého sdílení zisků a ztrát, banka tedy zastává spíše roli obchodního partnera než věřitele. Rozdíl ve strategii islámských a tradičních bank je zřejmý, ovšem porovnání výkonnosti těchto bankovních systémů je stále předmětem odborných diskuzí. Tato diplomová práce objasňuje rozdílnost efektivity a výkonnosti obou bankovních systémů. Pro porovnání byla zvolena oblast Středního východu, kde je soustředěno nejvíce islámských aktiv a kde oba bankovní systémy fungují na společném trhu. Pro porovnání bankovní efektivity byly v této práci využity dvě nezávislé metody, Stochastická analýza efektivní hranice a Analýza obalu dat. Na základě dosažených hodnot byly pomocí regresní analýzy zkoumány determinanty efektivity a vliv hospodářské krize na výkonnost obou bankovních systémů. Výsledky práce dokazují vyšší odolnost islámského bankovního systému vůči finanční nestabilitě, ale také vykazují vyšší náklady spojené s jeho činností, a tedy nižší efektivitu v porovnání s tradičními bankami.

Klasifikace JEL	C13, C14, C61, G21, G28,
Klíčová slova	Islámské bankovnictví, Konvenční bankovnictví, Analýza obalu dat, Stochastická analýza efektivní hranice, Efektivita, Stabilita

E-mail autora	katka.cabelova@gmail.com
E-mail vedoucího práce	mejstrik@fsv.cuni.cz

Contents

List of Tables

List of Figures

Acronyms

AE Allocative efficiency

AIC Akaike Information Criterion

BCC Bader Charnes and Cooper model

BIC Bayesian Information Criterion

CAGR Compound Annual Growth Rate

CE Cost efficiency

CCR Charnes Cooper and Rhodes model

CFP Contingency Funding Plan

CB Commercial or Conventional bank

CRS Constant Return to Scale

DEA Data Envelopment Analysis

DFA Distribution-Free Approach

DIB Dubai Islamic Bank

DMU Decision Making Unit

DRS Decreasing Return to Scale

FDH Free Disposal Hull

FE Fixed Effects

FRA Financial Ratio Analysis

GCC Gulf Cooperation Council

GLS Generalized Least Squares

IB Islamic Bank

IBIs Islamic Banking Institutions

IDB Islamic Development Bank

IFI Islamic Financial Institution

IFSB The Islamic Financial Services Board

IMF International Monetary Fund

IRR Investment Risk Reserves

IRS Increasing Return to Scale

KFH Kuwait Finance House

MENA Middle East and North Africa

MAH Murabaha Account Holder

NIM Net Interest Margin

NIRS Non-increasing Return to Scale

OIC Organization of Islamic Conference (later Organization of Islamic Cooperation)

OLS Ordinary Least Squares

PER Profit Equalization Reserves

PLS Profit and Loss Sharing

PSIA Profit Sharing Investment Account (or alternatively Profit and Loss Sharing Investment and Saving Account)

RE Random Effects

ROAA Return on Average Asset

ROAE Return on Average Equity

SE Scale Efficiency

SFA Stochastic Frontier Analysis

TE Technical Efficiency

TFA Thick Frontier Approach

TFP Total Factor Productivity

TIE Technical Inefficiency

VRS Variable Return to Scale

Master Thesis Proposal

Institute of Economic Studies
Faculty of Social Sciences
Charles University in Prague

Author:	Bc. Kateřina Čábelová	Supervisor:	prof. Ing. Michal Mejstřík CSc.
E-mail:	katka.cabelova@gmail.com	E-mail:	mejstrik@fsv.cuni.cz
Phone:	736 244 458	Phone:	222 112 326
Specialization:	Finance, Financial Markets and Banking	Defense Planned:	June 2016

Proposed Topic:

Efficiency and stability of Islamic banking

Motivation:

In last decade, Islamic banking experienced dynamic growth with expansion of financial services. Nowadays, there are more than 500 Islamic institutions operating in more than 80 countries over the world and the volume of total assets of Islamic banking sector is still growing. According to the recent studies, growth rate of Islamic banks is around 15% per year which is almost three times faster than commercial banks (Parker, 2007). This finding is quite surprising since interest on a loan is strictly prohibited by Islamic law–*sharia*. How is it then possible that Islamic banks generate such a huge profit?
To be able to answer this question, one needs to understand some Islamic principles at first. An interest on a loan is against the Islamic moral code since it generates money without appropriate effort. Instead of traditional lender who charges a commission, Islamic bank usually plays a role of investor, and the partnership (*Musharaka*) of two parties is based on principle of profit and loss sharing (PLS) at pre-agreed conditions.

Many researchers argue that Islamic financial institutions are more efficient and less risk-taking than the traditional Western banks (see e.g. Ariff et al. 2008; Safiullah 2010 or Yudistira 2004). However, the literature is not entirely consistent with regard to this. For example, Johnes et al. (2009) examined banking performance using the two methods, Data Envelopment Analysis and the Financial Ratio Analysis. They found that Islamic banks in their sample were more profit-efficient but less cost-efficient than their Western counterparties. Nevertheless, the average efficiency proved to be significantly higher in the case of Western banks.
Although many economic studies deal with the issue of Islamic banking, there is a shortage of econometric research that would empirically prove or disprove the efficiency and stability of Islamic banking. The main objective of this Master thesis is to fill in this gap.

As it was already mentioned, Sharia compliant finance is currently one of the fastest growing banking sectors, and one can expect that a market power of the Islamic banks will increase even more. Although a majority of Islamic securities – from which the best known financial instrument is *sukuk* certificate – is issued in the Middle-East countries, Islamic finance slowly penetrates into the European markets and increase competition between existing and well-established banks. Some European commercial banks (e.g. Deutsche Bank) already offer Islamic financial services in order to increase their pool of clients. Therefore, this thesis will examine the potential impacts of spread of Islamic banking model within traditional European banking environment.

Hypotheses:

1. Hypothesis #1: Due to better diversification of investment, Islamic banks are more efficient than their Western counterparties.
2. Hypothesis #2: Islamic banks are more stable in recession and suffer from lower liquidity risk than commercial banks.
3. Hypothesis #3: There is significant difference in efficiency of banks in countries where both types of banks coexist.

Methodology:

In financial literature we can find two general methods how to measure economic efficiency: a parametric (econometric) and a non-parametric (linear programming) approach. The most widely used non-parametric method is known as Data Envelopment Analysis (DEA) introduced by Charnes et al. (1978). DEA as a measure of banking performance was used, for example, by Ariff at al. (2008) and El Moussawi and Obeid (2010). The main advantage of this method is its simplicity of computation since no specification of functional form is needed. On the other hand, this method does not take into account the noise and the results are highly dependent on choice of input and output variables (Berg, 2010).

Given the shortcomings of non-parametric method mentioned above, I prefer parametric approach which allows the noise in the measuring of inefficiency and hence provides more precise results. The best known and in research frequently used parametric method is Stochastic Frontier Analysis (SFA) introduced by Aigner et al. (1977). SFA was employed in many studies, see e.g. Burki and Ahmad (2010), Hassan et al. (2009) or Hamilton et al. (2010), since it is useful tool for measuring cost, profit and technology efficiency.

Alternative way of measuring efficiency is classical panel regression analysis where Return On Equity (ROE), Return On Assets (ROA) and sometimes also Net Initial Margin (NIM) are stated as dependent variables.

In this Master thesis, panel data consisting of both Islamic and the conventional banks will be employed. These data are available on Bankscope database. Only banks providing data for whole examined period will be included into a data set in order to have balanced data. I would like to cover sufficiently long period to demonstrate how both types of banks were affected during the financial crisis.

To be able to compare efficiency between Islamic banks and their Western counterparties, dummy variable equal to one in case of Islamic bank and zero otherwise (commercial bank) will be employed. Positive sign would indicate that Islamic banks perform better compared to conventional banks, negative sign respectively. The other dummy variable will distinguish the years of crisis to take into account sudden negative changes in revenues. The rest of independent variables are mostly income statement and balance sheet data, all expressed in US dollars.

In addition, national economic differences of each country that could bias the results have to be taken into consideration. Therefore, following Yudistira (2004), Consumer Price Index will be included into the regression. Finally, all outliers from the data set will be removed.

After running regression with the whole data set, the data will be divided into two sub-samples (Islamic and commercial) and then will be tested separately in order to verify the validity of the results. Significant difference in efficiency between Islamic and traditional Western banks are expected to come through.

Expected Contribution:

This Master thesis will assess cost and profit efficiency of two differently operating banking systems: Islamic and Western (commercial). Moreover, it will observe performance of both types of banks in recession to reveal their stability.

The majority of existing studies examined the efficiency of the Islamic banking using Data Envelopment Analysis (DEA). Whereas this method has several limitations, the hypotheses in this work will be tested using two parametric methods, namely Stochastic Frontier Analysis (SFA) and panel regression analysis, which will be consequently compared. Although these methods are more complicated, it is expected that they would provide more reliable results than a non-parametric approach and thereby they would contribute with new findings in the field of economics.

Many previous studies ignore macroeconomic differences between countries. Therefore CPI will be included into the regression to improve quality of the model and to get unbiased results. Stability of each type of bank will be examined using a special dummy variable indicating years of crisis and other unexpected events.

Furthermore, the Islamic financial system in the context of Islamic moral code will be introduced, since it is very crucial for understanding the topic and the logic behind. Beyond basic terms and principles rooted in sharia, various types of Islamic financial instruments that differ from traditional conventional bonds in many aspects will also be presented and analyzed to depth.

Finally, the thesis will deal with the issue of spread of Islamic institutions within Europe and their potential impacts on European commercial banking system.

Outline:

1. Introduction and motivation: Explaining why it is important to address the issue of Islamic Finance.
2. Islamic law: Economic principles need to be explained in the context of Islamic law (sharia) to be understood.
3. Islamic financial system:
    - Islamic banking sector: This part will present the principle of profit and loss sharing (PLS) in Islamic

finance instead of traditional "lender-borrower" relationship in conventional banking system.
- Islamic financial instruments: How do they differ from conventional bonds and how do they work in practice

4. Islamic vs. conventional banking: This chapter will provide extensive literature review of existing studies.
5. Empirical analysis: This part will cover hypotheses, methodology of testing and data collection.
6. Results: In this section the results of empirical research will be discussed.
7. Conclusion: Summarization of the most important findings of this thesis.

Core Bibliography:

Alkassim, F.A. (2005): *The Profitability of Islamic and Conventional Banking in the GCC Countries: A Comparative Study*

Ariff, M., Bader, M., Shamsher, M. and Hassan, T. (2008): *Cost, revenue, and profit efficiency of Islamic versus conventional banks: international evidence using data envelopment analysis*. Islamic Economic Studies, pp. 23-76

Burki, A. and Ahmad, S. (2010): *Bank governance changes in Pakistan: Is there a performance effect?* Journal of Economics and Business

Coelli, T. (2004): *Efficiency and Productivity measurements: an overview of concepts, terminology and methods*, Working paper

Čihák, M. and Hesse, H. (2010): *Islamic banks and financial stability: An empirical analysis*. Journal of Financial Services Research, pp. 95-113

El Moussawi, C. and Obeid, H. (2010): *Evaluating the productive efficiency of Islamic banking in GCC: A non-parametric approach*. International Research Journal of Finance and Economics, pp. 179-189

Hamilton, R., Qasrawi, W. and M. Al-Jarrah, M. (2010): *Cost and profit efficiency in the Jordanian banking sector 1993-2006: A parametric approach*, International Research Journal of Finance and Economics, pp. 111-123

Johnes, J., Izzeldin, M. and Pappas, V. (2009): *The efficiency of Islamic and conventional banks in the Gulf Cooperation Council (GCC) countries: An analysis using financial ratios and data envelopment analysis*, Working Papers, Lancaster University Management School, Economics Department

Sole, J. (2007): *Introducing Islamic Banks into Conventional Banking Systems*, IMF Working Paper 07/175

Srairi, S. (2010): *Cost and profit efficiency of conventional and Islamic banks in GCC countries*, Journal of Productivity Analysis, pp. 45-62

Visser, H. (2009): *Islamic Finance: Principles and Practice*. Edward Elgar, Cheltenham, ISBN 978 1 84542 525 8

Weill, L. (2010): *Do Islamic Banks Have Greater Market Power?* Working paper

Yudistira, D. (2004): *Efficiency in Islamic banking: An empirical analysis of eighteen banks*, Islamic Economic Studies, Vol. 12, No. 1

Author **Supervisor**

Glossary

Awqaf Endowement.

Bay´ Translated as a sale but this word is used mostly as a prefix when referring to different sales-based contracts in Islamic finance, such as *bay´ murabahah*, *bay´ al-salam* etc.

Bay´al-mu´ajjal Stands for sale on credit (i.e. a sale with immediate delivery of goods but deferred payment).

Bay´al-salam Contract in which the buyer pays for goods in advance and the delivery deferred by the seller.

Gharar Literally, it stands for danger, deception, risk and uncertainty. In Islamic finance this term describes all hazardous sales with excessive risk and uncertain result. *Gharar* is not consistent with *shariah*-compliant finance and therefore is prohibited

Gharar fahis A considerable degree of risk (*gharar*) that is not tolerable, and hence it makes contract invalid.

Gharar yasir A low degree of risk (*gharar*) that is tolerable as it may be unavoidable.

Halal All things and activities that are consistent with *shariah* (permitted).

Hibah Transfer of ownership (unilateral) of particular property or its related benefits to someone else without any countre-value from the recipient.

Ijarah Stands for leasing. *Ijarah* is an agreement that permits the customer (the lessee) to use an asset that is owned by Islamic financial institution (the lessor) for an agreed period against specified rental.

Islamic window Part or a special department of conventional bank that is allowed to provide Islamic financial services under the condition of strictly separated funds.

Istisna Contract of sale whereby one party promises to build, construct or manufacture a specified asset, with an obligation of producer to deliver an asset to the customer upon completion. Roughly speaking, *istisna* is a contract of sale with deferred delivery.

Kafalah bi-al-Ajr Guarantee with fee.

Khiyar-al-´ayb Option that allows a buyer to return the purchased product when he finds any defect on it that was not mentioned explicitly at the time of sale.

Mal Property, asset.

Mudarabah A special contract between two parties that is based on *Profit and Loss Sharing principle*. Capital provider (*Rabb-al-mal*) and investment manager (*mudarib*) participate in one project. Profit is then distributed between them according to the ratio upon which they agreed at time of signing the contract.

Mudarib An entrepreneur or an investment manager in *mudarabah* contract (see above).

Murabahah Cost plus financing, sale at specified profit margin. In practise it refers to a sale agreement whereby the bank (seller) purchases desired goods instead of the byuer and then it sells with at an agreed marked-up price in a form of regular instaments.

Musharakah Form of business partnership, partly similar to *mudarabah* contract. The key difference is that in *musharakah* both partners participate in both provision of capital and management. Profit and loss are shared based on the ratio of capital invested.

Muzara´ah Crop-sharing contract whereby all participants contribute land, seeds, machines, fertlizer etc., and then share the crop under agreed conditions.

Qimar Gambling, another type of prohibited agreement in which an ownership of some property is dependent upon the occurrence of an uncertain event

Qard or *qard-hassan*. Interest-free loan without any form of compensation from the borrower. Only reward for lender is expected from God.

Rabb-al-Mal Capital provider in *mudarabah* contract.

Riba	Commonly translated as interest but generally *riba* refers to any stipulated excess compensation without corresponding effort and this practise is strictly prohibited in Islamic finance.
Salam	Deferred delivery.
Sarf	General term for exchange.
Shariah	Islamic law that is rooted in Quran and Sunnah.
Sukuk	Islamic bond. *Sukuk* is Islamic certificate representing a proportionate ownership right in tangible assets.
Takaful	Special form of insurance, In Arabic *takaful* stands for solidarity.
Ususry	Another term for interest. Generally, *usury* is a practise of unethical lending in which paying of interest is required from the borrower. Sometimes, Usury refers also to interest rate that is illegaly high (considerably above market rates).
Wa´d	Unilateral promise to do (or not to do) some action in the future.
Wadiah	Contract of deposit safekeeping whereby the depositor is guaranteed the value of deposits and has an immediate access to withdraw deposits.
Zakaat	Charity.

Chapter 1
Introduction

The global financial crisis has drawn the attention towards Islamic financial system. While conventional banks were strongly hit by the recent crisis, Islamic banks have surprisingly shown the great resilience to financial instability. This event has attracted bank regulators' interest in Islamic finance as ensuring of banking stability is one of the main objectives of the financial system.

Islamic banking has started its operation after long theoretical preparations in early 1970's as an opposition to the traditional banking system that was considered unethical in Muslim point of view. Since the foundation of the first rural Islamic bank in Egypt in 1963, Islamic banking had been sharply growing worldwide, and particularly in GCC region where the biggest concentartion of Islamic assets is currently held (Okumus and Kibritci Artar, 2012).

After emergence of the first Islamic banks the world doubted ability of these banks to compete in the globalized financial environment. However, in last five decades Islamic banks showed to be not only viable but even very successful in mobilizing of large volume funds (Iqbal and Molyneux, 2005). Rapid expansion of Islamic banking in Muslim countries is not much surprising, however, this new phenomenon during its short history conquered even many non-Muslim countries (Ftiti et al. 2013). Nowadays, Islamic financial products are offered by many large international banks through its so called *Islamic windows* and their popularity is still increasing as evidenced by double-digit growth of Islamic finance assets.

Although Islamic banking is publicly viewed as controversial, one thing is indisputable – Islamic banking has brought new challenges to the banking industry and increased international competition to the large extent.

The traditional banking theory assumes that profit of conventional banks is made by purchasing of depositors' funds at low interest rate and reselling these deposits to borrowers at higher rate. Roughly speaking, the spread between these interest rates

is the bank's profit (Bader et al., 2008).

The modern Islamic banking, on the other hand, follows different banking model that is based primarily on the total absence of interest. Although Islamic banks perform the same intermediary function as conventional banks, any form of interest (*riba*) is strictly prohibited in *shariah*-compliant finance as it generates profit without corresponding effort and as such is considered unethical in Muslim world. Therefore, instead of pre-determined rate of return, *Profit and Loss Sharing* (PLS) principle in which bank plays role of a business partner rather than a creditor and in which a rate of return is never known in advance, is applied in Islamic finance to generate the profit. The PLS principle and absence of interest (*riba*) are main unique features of Islamic finance, however, due to the high risk of these contracts, different ways of financing, like cost plus financing or leasing, are rather used in practise. Application of banking principles vastly different from traditional ones implies also different determinants of performance and reactions on particular market events.

Despite the large number of existing studies that investigate efficiency and resilience of Islamic banks by employing various statistical methods and data sets, there is still no conclusive evidence in this regard. Therefore, further research in this area seems to be well-founded, especially when considering importance of this topic and its implications for banks' regulators. To further address this issue this thesis investigates efficiency and stability of banking sector in the Middle East region by conducting two frontier techniques suited for efficiency measurement, namely Data Envelopment Analysis (non-parametric) and Stochastic Frontier Analysis (econometric). Efficiency scores of 68 Islamic and 138 conventional banks over the period 2002-2014 were estimated independently by both methods and consequently compared with each other. Finally, a regression analysis is performed to examine relationship between banks' efficiency and set of bank-specific explanatory variables.

Finally, it must be stressed that this diploma thesis doesn't aim to judge religious and ethical impacts of Islamic finance. The work tries to provide an objective comparison of two completely different banking systems. Only the economic aspects are considered, irrespective of the motivation behind them. Hence, neither banking system is preferred over the other by the author of this thesis and any positive or negative evidence is based on empirical results only.

This thesis is structured as follows: Chapter 1 provides brief introduction to the topic and motivation of the research. Chapter 2 is devoted to the presentation of Islamic banking, including its history, main principles, specific characteristics and Islamic finance unique contracts. In addition, this chapter is dedicated to stability of

Islamic banking, particularly in the context of the recent financial crisis. Chapter 3 provides comprehensive literature review of existing studies dealing with efficiency comparison of two differently operating systems. Chapter 4 provides empirical analysis, including description of data, hypotheses, different methodological approaches, empirical estimates and discussion of results. Chapter 5 summarizes main findings and the contribution of this work.

Chapter 2
Islamic Banking

2.1. History of Islamic Finance

To understand the topic in detail it is crucial to introduce historical development of Islamic banking. The whole concept of Islamic banking has started as an experiment in Egyptian countryside to address the needs of Muslim population (Okumus and Kibritci Artar, 2012). It should be emphasized that Islamic banking is a fairly new phenomenon and thus term "history" is quite relative and corresponds only to 60 years of existence.

Since conventional banks were established under capitalist principles with a purpose to make profit by charging interest (*usury*) that is strictly prohibited by Islamic law, Muslims had no other choice than to create their own financial system with appropriate financial institutions in accordance with Islamic principles (Hanif, 2014).

In the second half of the 20^{th} century exemption of Muslim world from colonial powers has been almost finished and Islamic ideology began to spread rapidly among Muslim societies. Many Muslims started to look at the existing social systems by Islamic point of view and consequently they proposed some modifications and improvements. The Muslim philosophers and teologists questioned the world's leading economic and social systems and revealed their weaknesses. Capitalism was increasingly criticized into the depth and new, "ethic", banking system started to slowly emerge (Hanif, 2014).

Gafoor (1995) distinguishes two stages in history of Islamic finance. The first stage refers to an idea and theoretical preparation and the second stage refers to a transformation of the idea into reality when the Islamic banking system was officially recognized by law or private initiatives in many countries.

2.1.1. First Stage

The earliest incentives to the reorganization of the current banking system to the interest-free banking dates back to the late forties, namely we should mention work of Anwar Qureshi (1946), Naeem Siddiqi (1948) or Mahmud Ahmad (1952) who dedicated their work to introduction of financial system in line with *shariah*. Mawdudi (1950) and Hamidullah (1957) studied the topic into the depth (Gafoor, 1995). One of the best known theorists of Islamic finance – Ayatollah Baqir – in his book Our Economy (original name *Iqtissaduna*, published in 1961) advocated an economic system that is exclusively based on *shariah*-compliant principles. Until this time all Islamic countries were either incorporated into world capitalism or elsewhere participated in the socialist system controlled by the Soviet Union, and didn't subscribe to any particular theory (Kepel, 2006).

All these authors mentioned above recognized need for commercial banks but refused to accept the evil of interest as a part of it. So they had to find an alternative way to replace conventional banking and provide financial intermediation without interest. As a result, they proposed new banking system in which both profit and loss are equitably shared by capital provider and user of funds. This practise is generally called *Profit and Loss Sharing* principle (Gafoor, 1995).

In the next three decades Muslim economists and scholars paid still more attention to interest-free banking. It was supported also by political interest created in Pakistan and by growing number of young Muslim economists interested in this topic. As a result many works dealing with an idea of Islamic banking emerged in the late sixties and early seventies (e.g. Abdullah al-Araby, 1967; Uzair, 1955; Siddiqi, 1969; al-Najjar, 1971).

In early 70's interest-free banking experienced the institutional involvement. The idea of establishing of the first interest-free bank, Islamic Development Bank (IDB), was introduced at the Second Islamic Foreign Ministers Conference, held in 1970 in Karachi (Pakistan).

2.1.2. Second Stage

The second stage referes to the application of theory to practice with help of institutional and governmental involvement. The milestone in history of Islamic banking is the First Conference of Finance Ministers of Islamic Countries held in Jeddah, Saudi Arabia (1973) under Organization of Islamic Conference (OIC[1]) where primarily the

[1] Later renamed to Organization of Islamic Cooperation

abolishing of interest was discussed. Moreover, Declaration of Intent was issued and the final decision to establish Islamic Development Bank (IDB) was made at this meeting (Hanif, 2014). However, the bank was officially inaugurated two years later, on October 20, 1975 and currently consists of 56 shareholding states.

In the same year also the first private interest-free bank, the Dubai Islamic Bank (DIB), was established by a team of businessmen from several Muslim countries (Gafoor, 1995). Currently, DIB is the largest Islamic bank in the United Arab Emirates.

In 1977 other fully-fledged Islamic bank, the Kuwait Finance House (KFH), was founded by Kuwaiti government. Since its establishment, KFH has systematically managed to expand its business, set new achievements and extend the range of services. As a result, KFH currently operates in 7 countries worldwide (Kuwait, Bahrain, United Arab Emirates, Saudi Arabia, Turkey, Malaysia and Australia) via 355 branches[2].

Both Dubai Islamic Bank and Kuwait Finance House are considered as pioneers of newly developing banking system. The secret of their success is in appropriate combining of the best traditional Islamic values with efficient technology accompanied by innovation. Currently, these two banks are undoubtedly world leaders in the field of Islamic banking and their standards are followed by many other Islamic banks. Two more private Islamic banks were set up in 1977 in Sudan and Egypt under the same name of Faisal Islamic Bank (Gafoor, 1995).

Kepel (2006) mentions two spheres of Islamic financial system that completely differs from each other even though both are based on the same logic. The first sphere promoted a mechanism of the partial redistribution of oil revenues among OIC member states through Islamic Development Bank. After applying of this mechanism into practice, the dependence between the poorer Asian and African member states and the rich oil-exporting countries increased and the Islamic cohesion has strengthened. The second sphere corresponds to the exclusive domain of private investors and depositors. After several experiments in Egypt, all of this resulted in establishment of Islamic commercial banks that started to arise extensively in 1975.

Only in ten years since the opening of the first private Islamic bank in Dubai (1975), more than 55 interest-free banks have come into existence. Almost all of them are located in Muslim countries, however, some are placed in Europe as well, namely in United Kingdom, Denmark, Switzerland or Luxembourg (Gafoor, 1995). The Islamic Finance House, established in 1978 in Luxembourg, was the first historical attempt to launch the Islamic bank in the Western world (Ariff, 1998; El-Galfy

[2]Source: Kuwait Finance House official web page

and Khiyar, 2012). It was followed by the first insurance company complying with Islamic principles (*takaful*) that has emerged in 1983 in Luxembourg as well (Derbel et al., 2011). During the eighties and nineties many traditional Western banks have set up so called *Islamic windows* (special departments of conventional banks that are allowed to offer Islamic financial services), e.g. Barclays, Citibank, HSBC, Merril Lynch, Goldman Sachs, Kleinnwort Benson and many others, to attract deposits of Muslim investors and to satisfy demand of Muslim population living in these countries (Hassan and Lewis, 2007, Marcinkowski, 2009).

Later on, banking system in some more conservative Islamic countries, such as Iran, Sudan and Pakistan, has been fully Islamized (Gafoor, 2005, Sundarajan and Errico, 2002). In most countries interest-free banks were established by private initiatives and coexisted henceforth with conventional banks. However, banks in Iran and Pakistan were under government supervision that successively covered all banks in the country and commercial banks were completely abolished. In both countries mentioned above interest-free banking was introduced in 1981. From January 1, 1981 all domestic conventional banks in Pakistan were permitted to accept deposits on the *profit and loss sharing principle* (Gafoor, 2005). From January 1, 1985 the process of the full transformation of the "old" banking system to the "new" sharia compliant system was underway (Sundarajan and Errico, 2002). From July 1, 1985 no Pakistani bank was allowed to accept any kind of interest bearing deposits and all existing deposits had to follow PLS rules (Gafoor, 2005).

In Iran the situation was very similar to Pakistan. In February 1981, certain administrative restrictions were applied to eliminate interest gain from banking activities. Specifically, interest from all transactions was replaced by a service charge up to 4% and by 4-8% "profit rate" determined according to the certain type of economic activity. Also interest on deposits was transformed to a so called "guaranteed minimum profit". Two years later, in August 1983, the Usury-free Banking Law was adopted by the Iranian government and in January 1984 fourteen-month lasting transition period has begun. The conversion of the whole banking system to the non-interest one was proceed till March 1985 (Gafoor, 2005).

By 1995 there were 144 Islamic institutions operating worldwide, including 33 state-run banks, 40 private banks and 71 investment companies (Kepel, 2006). According to Newaz et al. (2015) currently there are more than 600 Islamic financial institutions operating in more than 100 countries over the world. These figures indicate rapid expansion and great potential of Islamic finance.

2.2. Basic Principles of Islamic Banking

Islamic banking is a financial system in which a fulfillement of the teaching of Holy Quran is superior to getting maximum return on financial assets. The uniqueness of Islamic finance is based on two main pillars that are closely related. The first is a complete absence of interest (*riba*) on all Islamic transactions and the second is *Profit and Loss Sharing* (PLS) principle. Interest charges on loans and deposits are strongly prohibited in *sharia*-compliant finance as it generate profit without corresponding effort. Roughly speaking, *riba* in all its forms is inconsistent with Muslim ethic code. Due to the full absence of interest and "fairness" of provided services, Islamic finance is often called also as "*Ethic finance*" (Usman and Khan, 2012).

However, El-Gamal (2007) emphasizes that a prohibition of interest is not Islamic uniqueness. In fact, prohibition of interest (*neshekh* in Hebrew) originates in Judaism, specifically in Halakhah, the Jewes law that plays similar role as *shariah* in Islam. Surprisingly, the Rabbinic prohibition of interest was even stricter than in Islam as also increased price of credit sale (cost plus financing) was perceived as interest-based transaction and as such was prohibited.

Indeed, also Islamic banks need some source of income to grow. As any form of fixed or predetermined rate of return is strictly prohibited in Islamic finance, interest income was replaced by folowing:

1. *Mark-up* (cost plus financing) intended primarily for purchase of goods and services. These contracts represent the largest portion of banking financing.

2. *Rate of return* on Profit and Loss Sharing contracts that is, unlike CBs, determined *ex-post* according to profit or loss achieved in a particular project or investment activities and is never guaranteed.

3. *Fees and commissions* from financial services and intermediation.

Hanif (2014) in his work summarizes five main principles of Islamic finance:

1. **Prohibition of intrest-based transactions** (*riba* and *usury*) – This principle discourages time value of money in its traditional view. In Islamic finance money are regarded as a mere medium of exchange and not as an independent factor of production (money cannot create money without any value added). It menas that human capital must be combined with money to generate a return.

2. **Profit and loss sharing principle** – Under this principle, bank's return is fully dependent on the success of the investment activity and can be even negative. Hence, in Islamic banking the traditional concept of risk-free return disappear.

3. **Avoidance of uncertainty** (*gharar*) **in business** – From Muslim point of view, the risk is necessary to justify a charging fee but is strictly prohibited once it cannot be controllable. Contracts, that involve variable remuneration based on the occurrence of some event, result in rating imbalance of the transaction and hence must be avoided (Kablan and Yousfi, 2011).

4. **Avoidance of speculations** (*myser*) **and any game of chance** (*qimar*) – Closely related to previous one. Wealth should't be gained on the basis of chance or even at costs of others' right.

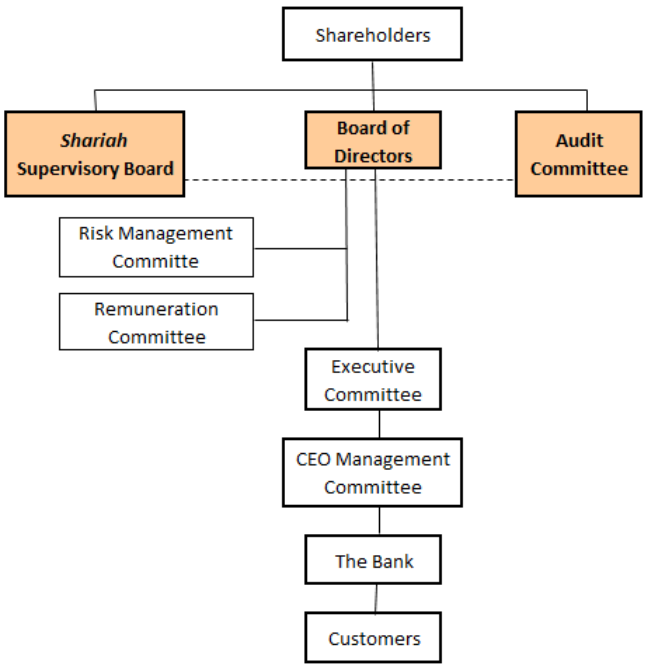
5. **Financing of Halal businesses only** – In Islamic finance Halal refers to all activities that are consistent with shariah (permitted). This principle implies that some specific investment activities, like alcoholic beverage trade, pornography, prok meat trade, sometimes dance clubs but also conventional banking, are strictly prohibited. On the contrary, socially productive activities are highly preferred to finance.

However, it should be mentioned that although Islamic banks have emerged in response to market needs of Muslim population, they are not religious institutions as many people think, and hence their services are avalibale to everybody irrespective of religion or nationality. It implies that the client may not be Muslim necessarily, and similarly Muslims are not obliged to use services of Islamic banks (except Iran and Sudan that operate only Islamic financial system). Choice of Islamic bank is a client's right, not an obligation and this statement holds for Muslim as well as Non-Muslim population. Islamic banking just provides alternative to traditional banks and through wider range of financial products increases industry's competition (Iqbal and Molyneux, 2005). Farooq and Zaheer (2015) emphasize that a motivation to choose a particular banking system is driven by various factors, starting with practical reason when a customer simply chooses the bank that has a branch closest to his house or a bank that perfectly fits his needs, over economic motivation when a customer decides according to prico of products or rate of return, to religious motivation.

Another crucial characteristic of Islamic banking is related with Islamic corporate governance system that involves special *Sharia* Supervisory Board. This Board is responsible for religious supervision and compliance of proposed transactions with

Islamic moral code. Organizational structure of Islamic banks is displayed in Figure 2.1 (Ariff and Iqbal, 2011).

Figure 2.1.: The foundations of Islamic banks



Source: Ariff and Iqbal, 2011 (own graphics)

Conventional vs. Islamic banking

In practise, Islamic and conventional banks are similar in many aspects, both put emphasis on efficient allocation of resources and reduction of information assymetry that are crucial assumptions of profit maximisation. Further, both try to reduce transaction costs and ensure sufficient diversification of portfolio to mitigate potential risks as much as possible. As financial intermediaries, both also provide similar financial services like an asset transformation, payment system, risk management and many others. Hence, one could say that both banking systems have same, or at least very similar, objectives but the way how to achieve them significantly differs (Mejía et al., 2014).

Bader et al. (2010) mentions some advantages that conventional banks enjoy over Islamic banks and that should explain higher efficiency of conventional banks. Firstly, conventional banks are allowed to accept interest which is major and fairly certain source of their revenues. Secondly, they don't share loss with the client when he fails his business. Thirdly, most of conventional transactions (especially loans)

are backed by collateral, so probability of loss is pretty low[3]. Fourthly, conventional banks are widely spread, have enormous capital and can operate also on Islamic banking market. An increasing number of international conventional banks (Deutsche Bank, HSBC, Citibank, Bank of America etc.) start to offer Islamic financial products and services to get more potential clients, and thus increase the competition on the market. Finally, in its long history conventional banking became well experienced, benefiting from much more developed technologies and proved to learn from theoretical and empirical research to avoid future failure.

Intuitively, these considerable advantages should imply and explain higher efficiency of conventional banks. Nevertheless, some researchers (Danesh, 2007; Usman and Khan, 2012) have empirically shown higher efficiency of Islamic banks compared to conventional ones. It suggests that despite their little experience, Islamic banks are not that weak market competitors as many economists expected at the beginning of its operation.

Risk Exposure

While conventional banks allow for tranfer of risk and are mostly debt-based, Islamic banks apply risk sharing principle and are largerly asset based. Table below summarizes the main differences of risk exposure between Islamic and coventional banks.

Table 2.1.: Risk exposure of Islamic and conventional banks

Conventional bank	Islamic bank
Risk **transfer** principle	Risk **sharing** principle
Sources of funds: Depositors transfer risk to the conventional bank. The rate of return is guaranteed and pre-determined.	**Sources of funds:** Investors (*Mudharabah* account holder) share risk and return with Islamic bank. The rate of return on PSIAs is never guaranteed and depends on the bank´s performance. No return (and no risk) on savings accounts.
Use of funds: Borrowers are required to pay interest irrespective of the rate of return on their projects. The risk of CB is transferred through securitization or credit default swaps.	**Use of funds:** Islamic bank shares risk in *Musharakah* and *Mudharabah* contracts (minority in IB´s portfolio) and provides mark-up financing (interest-free).
Debt-based financing	**Asset-based** financing

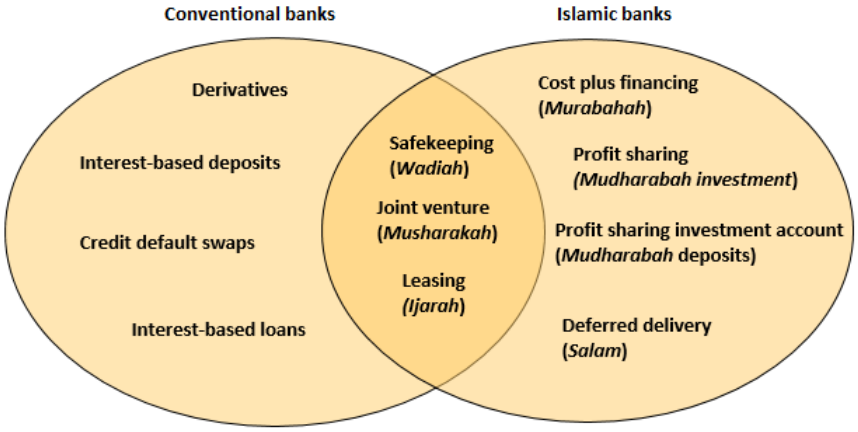
Source: Hasan and Dridi (2010)

In some literature sources the similarities of these two banking systems are stressed. Mejía et al. (2014) point out that in the fact real differences between IBs and CBs are not so big since most of conventional banking products can be easily redesigned

[3]However, this argument is widely used by both – Islamic and conventional banks' advocates.

to *shariah*-compliant products and since contracts based on PLS principle are rather exceptional in Islamic banking system (basically less than 10%). In fact, *Murabahah* (cost plus financing) contracts that can be viewed as alternative to loan financing considerably prevail in IBs' portfolio. Moreover, Islamic deposit accounts don't differ much from those of CB as the rate of return on investment deposits is very similar to the rate of return on conventional saving accounts. The only diffeence is that the rate of return on Profit Sharing Investment accounts (discussed in detail in next chapter) is never known in advance, is not guaranteed and can take even negative values when the deposits are wrongly invested by IB, while CBs' rate of return is pre-determined (*ex-ante*) and guaranteed. Risk averse Muslim depositors who don't want to participate in PLS contracts can use saving accounts similiar to those of CBs but without receiving any return (interest).

Figure 2.2.: Conventional and Islamic banks' financial contracts



Source: Hasan and Dridi, 2010 (own graphics)

2.3. Asset Concentration of Islamic Banks

The global Islamic financial sector still continues to maintain an improving trend as evidenced by the fact that Islamic assets (including conventional banks) have grown at compound annual growth rate (CAGR) of 17,6% between years 2009 and 2013. Over the period of 2013-2018 Islamic banking assets are expected to grow at CAGR of 19,7% (E&Y, 2013-14).

According to IFSB's (2015) estimates, in 2014 Islamic banks reached assets in total volume of USD 1.868 billion what is USD 80 billion more than at the end of 2013.

The research of IFSB (2015) indicates that the largest concentration of Islamic finance assets is hold in the Middle East including GCC (about 72%), followed by other parts of Asia (22%). The motivation of conducting analysis on the Middle East was driven primarily by the high representativeness of this region.

Despite the increasing number of new emerging markets, participation of other world regions, particularly, Europe, America and Sub-Saharan Africa remains low.

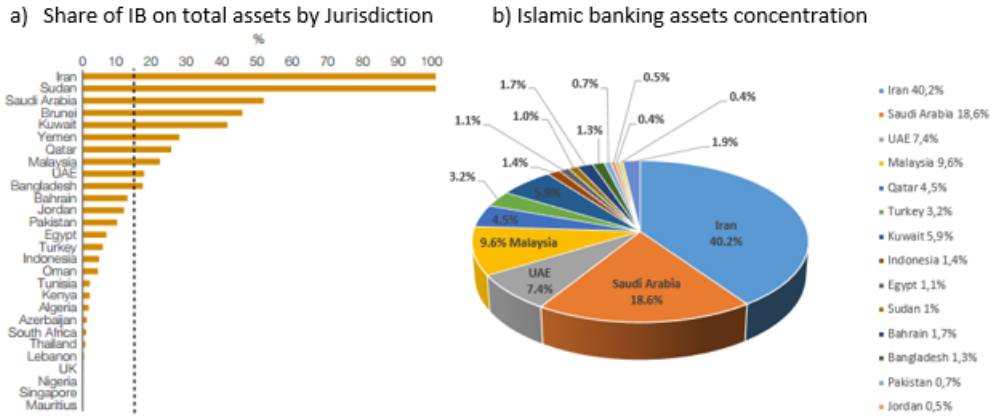
Table 2.2.: Concentration of Islamic banking assets by region (in USD billion, 2014)

Region	**Banking Assets**	**Sukuk Outstanding**	**Islamic funds**	**Takaful**	**Total**	**Share**
GCC	564.2	95.5	33.5	9.0	702.2	37.6%
MENA (excl. GCC)	633.7	0.1	0.3	7.7	641.8	34.4%
Asia	203.8	188.4	23.2	3.9	419.3	22.4%
Sub-Saharan Africa	20.1	1.3	1.8	0.6	23.8	1.3%
Others	54.4	9.4	17.0	0.3	81.1	4.3%
Total	**1 476.2**	**294.7**	**75.8**	**21.5**	**1 868.2**	**100%**

Source: IFSB (2015): Islamic Financial Services Industry Stability Report 2015

In last few decades the Islamic finance industry has significantly improved its position in traditional markets, particularly in GCC region. Apart from Iran and Sudan that are the only two countries in the world that operate fully under *shariah*-compliance, Islamic banking recently achieved systemic importance in other seven countries, namely Saudi Arabia, United Arab Emirates, Kuwait, Qatar, Malaysia, Yemen and Brunei. These countries operate Islamic banks in coexistence with conventional banks within a dual financial system, and achieved approx. 15-20% share on the total banking market what is impressive when considering short history of Islamic banks' existence, and hold at least 5% of total Islamic finance assets (IFSB, 2015).

Figure 2.3.: Islamic banking assets concentration



Source: IFSB (2015): Islamic Financial Services Industry Stability Report 2015

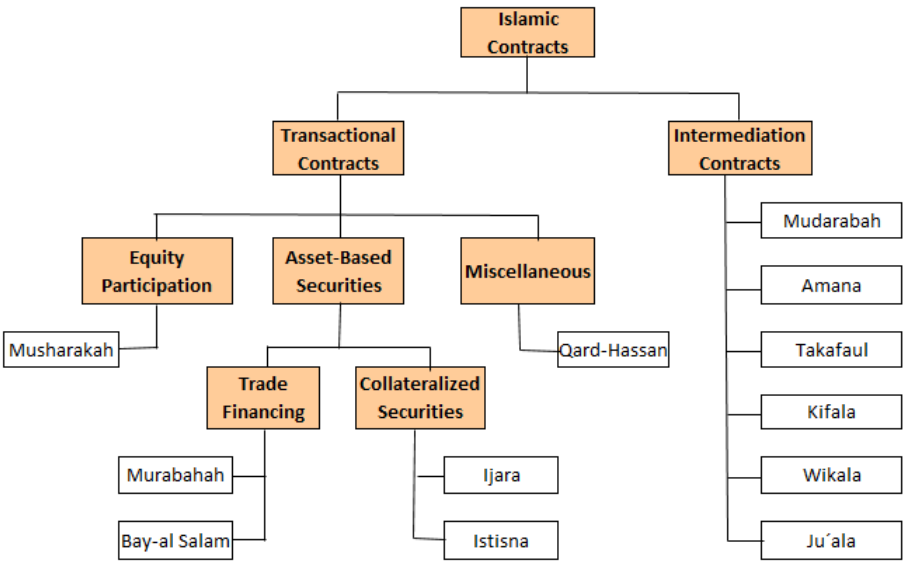
However, Islamic financial service are widely provided also in many Non-Muslim countries, they already expanded worlwide. Within EU, the first country that engaged Islamic finance market was the UK with 22 banks providing Islamic transactions, therof 5 of them are fully *shariah*-compliant. The second very important market for Islamic banking is France where the largest Muslim population in Europe live. In addition, France recently adopted soem tax and legislative measures to facilitate implementation of Islamic products. Germany, Luxembourg and Switzerland also belong among countries involved in expansion of Islamic banking in Europe (Weill, 2013).

2.4. Types of Islamic Contracts

There are two main types of contracts recognized in Islamic financial system. Following El-Hawary, Grais and Iqbal (2007) and Mejía et al. (2014), these contracts can be widely divided as follows:

- **Transactional contracts** that are supposed to administer real transactions that generally have form of partnership (*shirkah*), sale (*bay*), analogy to conventional leasing (*ijarah*) or exchange (*sarf*). This category includes commodity trade and other asset-becked contracts, e.g. *murabahah* or *salam*, contracts that arrange equity participation, such as *musharakah,* and other forms of collateralized securities. This types of contracts also covers instruments that are supposed to promote social welfare such as interest-free loans (*qard-hassan*), charity in a form of grant contracts (*zakaat*) and Islamic endowments (*awqaf*).

Figure 2.4.: Islamic financial system profile of contracts



Source: El-Hawary et al., 2007 (own graphics)

- **Intermediation contracts** that facilitate an efficient implementation of transactional contracts and perform a function of monitoring and capital allocation. These contracts help to develop a long-term partnership between capital owner (*Rabb-al-Mal*) and an entrepeneur (*Mudarib*) who invests expertise in running business activities together with an agreed share of profit and loss (*mudharabah*). However, in fact the whole loss is borne by capital provider only.[4] Moreover, intermediation contracts provide other financial services like consulting, insurance (*takaful*), guarantees (*kifala*) and custodial services (*amana, wikala*).

2.5. Source of Funds

The liability side of Islamic banks slightly differs from that of conventional banks. It consists of three main items:

1. Current accounts (similar to CBs)
2. Equity

[4]Note that *mudharabah* contract on bank's asset side is discussed in this chapter. In case of *mudharabah* contract on the liability side reverse principle of risk sharing is applied, i.e. the loss is fully borne by the *mudharabah* contract holder and bank is protected.

3. Profit and loss sharing saving and investment accounts (PSIAs[5]) that are unique to Islamic banks.

2.5.1. Deposits

Wadiah is a traditional contract between a depositor and a bank for safekeeping as we know from traditional banking but with the difference that the depositor doesn't pay or receive any return (interest). Islamic bank is permitted by the depositor to utilize its funds for any purpose it deems appropriate and in return guarantees the value of deposits and allows easy access to deposits withdrawals (Mejía et al., 2014). Some Islamic banks provide interest-free loans (*qard-hassan*) to *wadiah* account holders. Farooq and Zaheer (2015) point out that these interest-free loans are provided by Islamic banks to attract people to save their deposits. Kamso (2013) stresses that some Islamic banks provide qard-hassan only to people in need, including students, socially weak population or small farmers and producers who wouldn't reasch oter sources of financing, to increase social welfare.

2.5.2. Profit Sharing Investment Accounts

Unlike current accounts (*amana*), Profit Sharing Investment Accounts generate positive rate of return to their holders, however, not in the form of interest. As Islamic banks cannot accumulate funds from interest charges, they use investment – *mudharabah* – contracts in the form of PSIAs as a main source of funds (Farooq and Zaheer, 2015). In other words, PSIA is a special account that allows a depositor to open investment fund with Islamic bank on the *mudharabah* principle. In this contract bank plays a role of an entrepreneur and generally has full discretionary power in investment decision making. *Mudharabah* account holder (MAH), on the other hand, is a capital provider only (*Rabb-Al-Mal*).

Both parties have to agree on the ratio of profit sharing that is based on proportion of their initial investments. Therefore, profit from an investment is finally distributed between both participants according to specific terms of *mudharabah* contract while risk exposure is highly unbalanced. The potential loss is completely borne by the *mudharabah* contract holder, irrespective of the loss being caused by bank's negli-

[5] In the literature PSIA generally denotes Profit Sharing Investment Account, hence it doesn't include saving accounts from the definition. However, in this thesis, following Farooq and Zaheer (2015), PSIA refers to both PLS saving and investment accounts as saving accounts are also arranged under mudharabah contracts. Regarding financial resilience of Islamic banks, Farooq and Zaheer (2015) point out that saving deposits, as they are demand deposits, are even more sensitive to changes in rate of return than investment deposits, especially when it turns to loss.

gence. The only exception is fraud or violation of the contract terms by the bank (Hamdi and Zarai, 2013). Thus, the bank is protected against loss, what is not equitable to depositors. The bank is still motivated to exert maximum effort in investment activities, since PSIAs are the main source of IBs' revenues that are primarily used for covering of operational expenses and to rise their funds. Nevertheless, PSIAs are rather risky accounts as neither return nor principal repayment is guaranteed (Mejía et al., 2014; Farooq and Zaheer, 2015).

The advantage of PSIA is, unlike equity that is irredeemable, that MAHs invest their funds for an agreed period and are permitted to withdraw their money at any time (with or without penalty for premature withdrawal). Hence, PSIA can be considered as a special type of a puttable equity instrument with limited duration that allows the account holder to sell it back to the bank. On the other hand, shareholders enjoy different advantages over MAHs, e.g. participation in the Board selection or an access to insider information. MAHs have no other choice than to fully rely on shareholders' monitoring of the Board. Therefore, once interests of MAHs and shareholders contradict, complex agency problems and moral hazard with management arise, especially when IB's management asserts their own interests rather than those of MAHs (Farooq and Zaheer, 2015; El-Gamal, 2003).

Farooq and Zaheer (2015) discuss two factors that should protect MAHs against risk arising from asymmetric information and absence of decision rights. The first factor is limited duration of PSIAs. As PSIAs can be redeemed by MAH anytime, bank's management is exposed to commercial pressure to generate competitive return on investments to avoid depositors' leave to another bank. Once MAH finds out that his bank pays lower return than the actual market rate, he can withdraw the money and invest his funds elsewhere. This competitive pressure force IB's management to perform as effectively as possible. The second factor is the harmony of MAHs' and shareholders' interests. Motivation of the management to satisfy MAH's expectations is obvious. The larger volume of investment accounts, the higher IB's market value and higher shareholders' rate of return at negligible financial risk for a bank. Moreover, both MAHs and shareholders are exposed to the same portfolio investment isk. It implies that mutual alignment of interet significantly mitigate moral hazard, agency costs related to information asymmetry and corporate governance issues. In author's opinion a third factor to be mentioned is the reputational risk. Once bank's management loses confidence and bank's name is devalued, it is extremely difficult to attract customers again and bring them back to the bank.

PSIAs should be perceived rather as investment products than standard accounts that we know from CBs. The crucial difference is in the rate of return. The con-

ventional banks provide to their depositors the certain *ex-ante* rate of return on investment in the form of interest rate premium, while Islamic banks' rate of return (*ex-post*) is highly uncertain, can turn to the negative values and must follow PLS principle (Archer and Riffat, 2009). In reality, unlike current account holders and shareholders, PSIA holders directly participate in medium and long-term investments but without having any decision rights and guarantee of return. However, PSIAs, as well as current accounts and shareholders' equity, are used to finance assets in Islamic banks (Jedidia and Hamza, 2014).

2.6. Use of Funds

Previous chapter summarizes weaknesses and potential risks related to Islamic banks' funds and it was shown that on the liability side Islamic banks are more vulnerable than conventional ones. However, on the asset side, Islamic banks are supposed to be more stable than CBs as all speculative activities are prohibited in Islamic financial system and as an asset-backed financing, like credit on purchase of real goods or services, is predominantly provided by Islamic banks. Moreover, conservative Islamic system imposes restrictions on excessive uncertainty (*gharar*), short sales, gambling (*qimar*) and sale of debt. All these characteristics enhance market discipline and improve financial stability (Farooq and Zaheer, 2015; Chapra, 2008). The recent research showed that the quality of Islamic banks' assets is still improving. In 2013 the average gross Non-performing Financing (NPF) ratio decreased to 4,12% from previously reached 4,86% in 2012 (IFSB, 2015).

Jedidia and Hamza (2014) divided Islamic assets into two categories. The first category ***commercial financing*** referers to the fact that PLS principle is not applied on these instruments. Commercial financing represents such instruments where the bank purchases an asset instead of the client and allows him to utilize it. This category includes mainly *murabahah* (cost plus financing)*, ijara* (leasing)*, istisna* (order to manufacture) and *salam* (deferred delivery) contracts. In this case, PLS principle is replaced rather by transfer of ownership of particular assets from the bank to the clients. The second category refers to ***investment financing***, also called PLS assets, what suggests that this asset is fully based on PLS principle. Two main instruments – *musharakah and mudarabah* – belong to this category. However, it should be noted that the PLS assets are not prevailing in Islamic banking system. Although contracts on PLS basis are considered as an ideal form of financing in Islamic financial environment, Islamic banks are more likely to provide asset-backed arrangements with a certain fixed return, like mark-up sales, operating leasing or diminishing partner-

ship, to eliminate moral hazard problems. According to Farooq and Zaheer (2015) these three instruments constitute about 80% of total financing volume provided by Islamic banks while proportion of PLS arrangements remains relatively low due to high risk they represent. Baele et al. (2010) demonstrated that in Pakistan, that belongs among the most conservative Muslim countries in the world, only about 2% of Islamic banking assets was represented by PLS contracts (Jedidia and Hamza, 2014).

2.6.1. Commercial Financing

Murabahah (Cost plus financing)

Murabahah refers to a sale of goods at specified profit margin for a bank (mark-up) and payments being settled in regular installments. The seller (a bank) is obliged to truthfully inform the client about original price of desired goods. Based on this price a bank stipulates its profit margin that is usually based upon inter-bank offered rate-IBOR (El-Galfy and Khiyar, 2012, Hanif, 2014). Of course, one can oppose that in principle *murabahah* represents the same function as an interest in traditional banking (profit from interest replaced by fixed mark-up but the yield in time is the same) and only the interpretation differs. However, this interpretation is in line with Islamic regulation and ethic code, hence is permitted.

Salam (Deferred delivery)

Contract of sale in which payments is made in advance (at time of contracting) but the delivery of goods ore service is deferred to a specified future date. However, *salam* is not applicable for all types of commodities (Arrif and Iqbal, 2013). *Salam* sale is frequently utilized in agriculture, a bank pays immediately to the farmers for a delivery of agricultural production at time of completion of harvest. The difference of spot price (at time of signing a contract) and future price is bank' s profit (Hanif, 2014).

Istisna (Order to manufacture)

Contract in which manufacturer agrees to manufacture and delivery a well-specified commodity. Terms condition (price, delivery date, payment date) are known in advance and specified in the contract. Hence, unlike salam, price may not to be paid in advance. *Istisna* allows also payments in installements based on individual preferences (El-Galfy and Khiyar, 2012). Hanif (2014) emphasizes a great potential

of *istisna* and *salam* contracts as they enhance agriculture, manufacturing and construction industries, especially in underdeveloped countries. *Istisna* has proved to be a useful contract for financing infrastructure projects, including bridges, roads, powerhouses, dams etc.

Ijarah (Leasing)

Islamic rental agreement as we know from conventional finance. Islamic bank purchases an equipment that the client desire and then leases it back to him under predetermined conditions (rental amount, schedule, etc.). Sometimes a bank leases a tangible asset from third party and subleases it to final customer (El-Galfy and Khiyar, 2012). At time of contract termination, an asset is usually passed on the customer, either for free or for a specific symbolic price. However, during a tenure of lease contract, an asset is owned by the bank and hence the bank bears all corresponding risks and reward related with ownership of particular asset (Hanif, 2014).

Wakalah (Contract of agency)

Under this contract, a bank plays a role of an investment manager. In general, *wakalah* is an contract in which one person appoints someone else to accomplish some task on his behalf for a fixed fee (El-Galfy and Khiyar, 2012).

2.6.2. Investment financing

Mudarabah (Trust financing)

Mudarabah is a form of partnership in which a financier (*Rabb-al-mal*) provides capital to the investment manager or an entrepreneur (*mudarib*) who contributes necessary knowledge and skills to the project. Capital provider in this case doesn't participate in management decisions. Profit from the project is allocated under predetermined conditions while loss is borne by capital provider (bank) only. The entrepreneur's loss is up to his effort and time for those he has no reward (El-Galfy and Khiyar, 2012).

Musharakah (Active partnership)

Similar to *mudarabah* contract but in *musharakah* both partners actively participate in management and capital provision and both share profit and loss. Profit is distributed according to pre-agreed ratio while the loss is shared according to their initial investments (Arrif and Iqbal, 2013). Islamic bank is equity participant and is entitled

to a profit sharing, the length of contract is not specified. Hence, *musharakah* is quite similar to a holding of voting stocks in limited company and is generally regarded as a purest form of Islamic finance (Kamso, 2013). *Musharakah* contract is sometimes combined with *ijara*, particularly in real estate financing (Hanif, 2014).

Diminishing Musharakah (Diminishing partnership)

Special form of *musharakah* contract in which both parties (usually financing bank and a beneficiary) enter into a partnership to own some assets (as in case of standard *musharakah*) but with additional condition that a bank will gradually sell its share on asset to the beneficiary at a pre-agreed price and schedule (Arrif and Iqbal, 2013). In other words, Islamic bank participates in the equity of the project since its beginning but its share is continuously reducing until the bank has no share on equity and hence ceases to be a business partner (Kamso, 2013).

2.7. Liquidity Risk in Islamic Banking

Effective transformation of maturities, i.e. accumulation of funds from short-term deposits to finance long-term assets, is one of the most crucial functions of all banks. However, this maturity mismatch makes them vulnerable to an inherent liquidity risk (Mohammad, 2013). Therefore, liquidity risk generally belongs among most perilous risks that banks face, irrespective the type of banking system. We distinguish between two types of liquidity risk that have negative impact on the whole market, especially then their mutual interaction.

Funding liquidity risk that International Monatery Fund[6] defines as *"... the risk that a firm or an institution will not be able to meet expected cash flow requirements (future and current) by raising funds on short notice."*

Market liquidity risk is then defined by IMF as *"... the risk that a firm will not be able to sell an asset quickly without materially affecting its price."*

The funding (or liability) liquidity risk is basically related to unexpected large volume withdrawals or mass transfer of depositors' funds to the another institution due to loss of confidence, reduced creditworthiness, reputational risk or *shariah* non-compliance. The market (or asset) liquidity risk arises when a bank is not able to sufficiently control the market price because of particular market deficiencies (Mohammad, 2013; Jedidia and Hamza, 2014).

[6] IMF (2011): Global financial stability report, Durable Financial Stability: Getting There from Here, Chapter 2: How to adress systemic part of liquidity risk, p.77

Liquidity is one of the major challenges that Islamic banks currently face. Despite large volume of excess cash from the oil trade, Islamic banks have generally very limited access to high quality *shariah*-compliant short-term investment opportunities that are essential for ensuring bank's stability. Due to the lack of such products it is very difficult to manage short-term excess liquidity (IFSB, 2015). On the money market side the situation is even more complicated. Unlike conventional banks, Islamic banks can not invest excess short term cash in international treasury bills, standard overnight facilities and other assets of sufficient depth due to interest-bearing nature of these instruments (KPMG, 2006). Farooq and Zaheer (2015) emphasize that a liquidity crunch may hit Islamic banks much deeply than conventional banks. Firstly, Islamic financial markets are less developed due to their relatively short history and secondly, there is a lack of efficient *shariah*-compliant liquidity management tools and finally, there is basically no lender of the last resort facility (with some exceptions).

Consequently, Islamic banks are exposed to wider and more severe mismatch of assets and liabilities (Muhammad, 2013). Moreover, Islamic banks may face the increased withdrawal risk as PLS principle is applied on investment deposits. In addition, Jedidia and Hamza (2014) pointed out that Islamic banks are more vulnerable to liquidity risk as retail dominates corporate market in banks deposits. Given these shortcomings, Islamic banks must hold higher reserves what increases their cost inefficiency and negatively affect the overall performance.

On the other hand, Islamic depositors are basically very religion-oriented and hence they are not so sensitive to the changes of the rate of return on their deposits and financial strength of their bank. Some surveys also suggest that depositors who prefer Islamic banks mainly from religious reasons are more loyal and less likely to withdraw their deposits than those of conventional banks, even in times of financial stress (Farooq and Zaheer, 2015). Gerrard and Cunningham (1997) conducted a survey in Singapore and more than 60% of Muslim respondents answered that they wouldn't abandon their bank even if the bank didn't make sufficient profit to pay return, while more than 65% of non-Muslim respondents stated that they would surely withraw their money and found another bank.

To prevent liquidity shock, Islamic banks are required by IFSB to hold a sufficient liquidity buffer (in cash or in a form of Islamic bonds – *sukuk*) to be able to overcome the longer period of liquidity squeeze. However, holding of reserves in not the only precaution, each Islamic bank should have implemented also its own contingency funding plan (Jedidia and Hamza, 2014).

Investigation of this question is of growing importance as it has substantial policy

implications. If the stronger resilience of Islamic banks was really proven, then the larger inclusion of some Islamic safety principles to the financial system or closer cooperation of both banking systems could significantly mitigate the transmission of financial crisis to the whole economy.

2.8. Stability of Islamic Finance

The recent financial crisis clearly revealed importance of financial stability for an economy as a whole. Financial instability is generally accompanied by banks' failures that imply far-reaching negative externalities for the society. Thus, ensuring banks' stability is one of the most important tasks of financial systems, espcially when considering how contagious bank failures are.

Nevertheless, it was the global financial crisis what has drawn the attention to Islamic banks as they withstood the crisis almost unaffected. Since that time many researchers started to study principles of Islamic banking and investigate the question what makes Islamic banks more resilient to financial instability compared to their conventional counterparts.

Weill (2013) in his work provides several arguments that justify higher stability of Islamic banks. At first, Islamic banking is based on *set of ethical principles* that are associated with many restrictions, including prohibition of speculations, gambling, betting, etc. but also mitigate risks, and hence make Islamic banks less vulnerable to financial instability. The second argument is based on *the lower risk of insolvency* in Islamic banking. The PLS principle implies that a part of banks' income fluctuations is transferred to depositors through fluctuating payments. Whereas conventional banks guarantee fixed payments irrespective of their profit, Islamic payments to creditors are solely dependent on bank's profit. Third, most of Islamic financial activities are *asset backed*, therefore potential loss is minimal. Last argument is based on *moral hazard* problem. As the rate of return in Islamic banks is highly correlated with bank's performance, depositors are much more motivated to monitor banks. Whereas depositors of conventional banks are protected by deposit insurance, hence theirs incentives to monitor banks are minimal. This can lead to increased uncontrolled risk taking of banks' managers. To sum up, Islamic banks are naturaly lead to discipline as depositors invest their funds only in banks with favourable risk profile.

Therefore, given their overall precaution, Islamic banks are generally considered less susceptible to financial instability than their conventional couterparts. Their competitive advantage is application of risk sharing principle, it means that part of the banks' risk is transferred to customers and *vice versa*.

However, Mejía et al. (2014) emphasize that in practise this advantage fades away as Islamic banks face the market pressure and hence they are compelled to pay competitive return to investment account holders, irrespective of bank's actual performance. In addition, share of PLS businesses on total IB's activities is pretty low, in reality IBs' portfolio consists particularly of short-term and low-profitable transactions. Weill (2013) presents other counter-argumets. The first is based on high risky nature of Islamic finance as only variable returns can be earned from financed projects. Roughly speaking, equity-based rather than debt-based instruments prevail in Islamic finance. Secondly, in the theory Islamic banks can not rely on collateral to reduce credit risk[7] and the last but not least argument is that the recent crisis as a single evidence of a greater resilience of Islamic banks can not be generalized. Moreover, this crisis was triggered by special event that was fateful for conventional banks but it doesn't mean that the next crisis won't arise under different circumstances with reverse consequences.

Islamic banking unique risks

Islamic banks basically face the same risks as CBs, however, there are also several unique risks that arise from specific characteristics of Islamic banking products. Mejía et al. (2014) present four these risks:

1. *Equity investment risk* – Everyone who decide to invest his funds to the partnership in order to directly participate in business activities is automatically exposed to all relating business risks.

2. *Shariah compliance risk* – Inadequate *shariah* compliance or a misinterpretation of Islamic fundamental rules can lead to the loss of public confidence and consequently to the loss of depositors. Collective withdrawal could expose a bank to severe liquidity issues.

3. *Rate of return risk* – When market rates increase, depositors obviously expect higher return on their investment accounts, although the actual rate can be never determined before maturity of investment period.

4. *Displaced commercial risk* - This risk is closely related to the previous one and arises when an Islamic bank is compelled by competitive market circumstances to pay higher rate of return to investment account holders than is the actual rate resulting from particular contract terms. Therefore, Islamic banks

[7] The same argument is in the literature used by both Islamic and traditional banking advocates.

are required to hold special reserves (IRR, PER) to compensate the difference between market and actual rate of return and hence to prevent depositors to save their funds elsewhere.

To mitigate these risks and achieve profit stabilization over a longer time period, Islamic banks are required to hold a special reserves (Mejía et al., 2014):

- *Profit Equalization Reserves (PER)*: A small portion of profit from investments activities is set aside before distribution of particular profit between investment account holders (IAH) and shareholders to mitigate variability of profit payouts. Islamic bank can never guarantee satisfactory returns on investment deposits in priciple, therefore these reserves are used to increase investment account holders' return in times of low market rates to prevent them withdraw their funds elsewhere.

- *Investment Risk Reserves (IRR)*: An amount appropriated by an Islamic financial institution out of investment account holder's share after deducting bank's (*mudarib*) profit. These reserves can be redistributed to investment accounts over time and serve primarily as a cushion against future losses a payment stabilization.

Table 2.3.: Characteristics of PER and IRR

	PER	**IRR**
Source	*Mudarib* (bank's) income	Investment account holders' income
Stage of appropriation	Before allocation of *mudarib* share	After allocation of *mudarib* share
Purpose	Profit stabilization	Cushion against future losses
Ultimate beneficiary	IAH and *mudarib* (bank)	IAH

Source: Mejía et al. (2014) and Investment&Finance [online]

Impact of the financial crisis on the Middle East region

Middle East region was affected by the global financial crisis in a same way as the rest of the world. Aggregate real GDP growth in GCC countries rapidly fell from well performing 7,2% in 2008 to 0,8% in 2009. Banks faced to liquidity issues and especially in GCC there were housing bubbles that burst sooner or later. Consequently, housing prices significantly dropped, in UAE by 52%, in Qatar by 35% and in Kuwait by even more than 60% (Salah, 2010).

Table 2.4.: GDP growth (%) in the Middle East countries before and during crisis

	2006	**2007**	**2008**	**2009**	**2010**
Bahrain	6.5	8.3	6.2	**2.5**	4.3
Egypt	6.8	7.1	7.2	**4.7**	5.1
Iran	5.7	9.1	0.9	**2.3**	6.6
Iraq	10.2	1.4	8.2	**3.4**	6.4
Israel	5.8	6.1	3.1	**1.3**	5.5
Jordan	8.1	8.2	7.2	**5.5**	2.3
Kuwait	7.5	6	2.5	**-7.1**	-2.4
Lebanon	1.6	9.4	9.1	**10.3**	8
Oman	5.4	4.5	8.2	**6.1**	4.8
Qatar	26.2	18	17.7	**12**	19.6
Saudi Arabia	5.6	6	8.4	**1.8**	4.8
UAE	9.8	3.2	3.2	**-5.2**	1.6
Yemen	3.2	3.3	4	**4.1**	3.3

Source: Worldbank database

The world economy was hit at most in 2009. These impacts were highly individual, some countries were hit more (Kuwait, UAE, Saudi Arabia) as evidenced by rapid decrease of GDP growth, other countries (Lebanon, Yemen), on the other hand, experienced even positive development (Worldbank, 2015). The government responses in GCC region were similar to those of Western countries, i.e. they reduced interest rate and partly released compulsory reserve requiremnents that must be hold at respective central banks. Moreover, GCC governments officially guaranteed the repayments of deposits to prevent bank runs, and provided banks with the swap execution facilities to enable local businesses to meet their payment obligation denominated in USD (Salah, 2010).

Chapter 3
Literature Review

In last two decades Islamic banking has attracted many researchers' attention as it is a relatively new form of banking that continues to sharply grow in terms of total assets, despite the complete absence of an interest (*riba*). Therefore, economists have started to examine in detail the differences of these two banking systems and to investigate which of them is more efficient and stable in times of financial instability. This chapter provides review of existing studies.

Many studies dealing with bank efficiency have been already conducted by using various statistical methods, however, there is still no general consensus in this regard. Athough conventional banking had been considered to be the only efficient system for a long time. Currently there are many researchers who argue that Islamic banks are at least as efficient as their conventional counterparts (e.g. Sarker, 1999; Samad, 2004). Some of them (e.g. Usman and Khan, 2012) believe that Islamic banks are even more efficient than conventional ones (Ftiti et al., 2013).

This chapter provides a literature overview of existing studies that can be classified according to the method used in the research into two categories:

- *Traditional financial ratio-based analyses*
- *Studies based on frontier analysis approach.*

Following Bader et al. (2010) existing studies can be alternatively divided as follows:

- *Studies that evaluate performance of Islamic banks only*
- *Studies that compare efficiency of Islamic and conventional banks.*

Most studies that are focused on assessing the performance of Islamic banks examine the relationship between profitability and banking characteristics (Yudistira, 2004). For instance, Bashir (2001) collected bank level financial data of 14 Islamic banks in

the 8 Middle Eastern countries during the period 1993-1998 and performed regression analysis to reveal the main determinants of Islamic banks' performance. Four variables were employed in his work to measure a bank's performance: return on assets (ROA), return on equity (ROE), profitability and non-interest margin (NIM). According to his findings, the bank profitability is mostly determined by non-interest earning assets, customer and short-term funding and overhead expenses. Moreover, since deposits in Islamic banking system are treated as shares, holding the bank reserves has two negative impacts on Islamic banks. Firstly, reserves reduce an amount of funds that could be used for investment and secondly, reserves yield no return. Thus, opportunity costs of reserves are considerable. The author also claims that appropriate capital ratios and loan portfolios play an important role when explaining the performance of Islamic banks. Specifically, the bank performance improves as capital and loan ratios increase.

Tahir and Haron (2010) examine the cost and profit efficiency of Islamic banking in four world regions (Europe, the Far East and Central Asia, the Middle East and Africa) using a parametric method, Stochastic Frontier Analysis (SFA). The sample of 193 banks for period of 2003-2008 was obtained from Bankscope database. Their findings suggest that the overall efficiency of Islamic banks has improved during that period and that the Islamic banks in the four mentioned regions operate relatively better in terms of controlling costs than in generating profit.

Mousa (2015) analyzes efficiency of 8 banks listed in Bahrain Bourse during a period 2010-2013 by employing Financial ratio Analysis (FRA) and Data Envelopment Analysis (DEA). In FRA six ratios were used to evaluate three main bank's characteristics – *profitability, liquidity and financial health*. The author's findings suggest that FRA doesn't provide comprehensive evaluation of bank's efficiency due to one-dimensional nature of ratios. Under DEA, only two banks were found to be fully efficient, the remaining six banks exhibited lower technical efficiency.

Rozzani and Rahman (2013) in their work identify determinants affecting bank efficiency using Stochastic Frontier Analysis and provide comparison between Islamic and conventional banks. Financial data from banks' annual reports were obtained for a sample of 35 banks operating in Malaysia (16 Islamic and 19 conventional). Thus, the research was conducted in a country where both types of banks coexist. The results suggest that the level of profit efficiency was similar for both Islamic and conventional banks with the overall efficiency below 50% of optimum efficiency. It indicates that Malaysian banks still utilize their resources insufficiently. Moreover, significant positive relationship between bank size and efficiency of conventional bank was observed while no such significant relationship between bank's size and

efficiency was found in the case of Islamic banks. However, in a case of conventional banks, a significant negative relationship between efficiency and credit risk was observed. This implies that conventional banks' efficiency should increase with bank size and with decline of operational costs and credit risk while Islamic banks' efficiency should increase with the decrease of operational costs.

Akhtar, Ali and Sadaqat (2011) evaluate liquidity risk management of conventional and Islamic banks in Pakistan. Their results revealed positive but insignificant correlation of bank's size and net working capital to net assets with liquidity risk. Moreover, return on assets (ROA) of Islamic banks and capital adequacy ratio (CAD) of conventional banks were found to be positively and significantly correlated with liquidity risk.

Beck et al. (2010) in their study deal not only with the issue of efficiency of Islamic and conventional banking but also explain why Islamic banks preformed relatively better during the recent financial crisis. Two main samples were employed in their research, both of them cover the period 1995-2007 (pre-crisis period) and one sample for post-crisis period for examining bank's stability in recession. The larger data set consists of 2,956 banks across 141 countries. The smaller sample includes only countries where both Islamic and conventional banks are operating, thus 486 banks in total, from which 89 are Islamic banks, from 20 countries worldwide.

In this research a variety of variables and financial indicators were employed to assess banking performance, namely (1) indicators for comparison of the business orientation: (i) a ratio of fee-based to total operating income and (ii) loan to deposit ratio; (2) indicators of bank efficiency: (i) overhead cost, calculated as total operating costs divided by total costs, and (ii) cost-income ratio – the higher the ratio, the lower the cost efficiency; (3) indicators of asset quality: (i) loss reserves, (ii) loan loss provision and (iii) non-performing loans. All these indicators are decreasing in asset quality; (4) indicators of bank stability from which the most important is (i) z-score indicating the distance from insolvency. And finally, (5) indicator of maturity matching for assessing the sensitivity to bank runs.

The results indicate that while Islamic banks seem to be more cost efficient compared to conventional banks in a large cross-country sample, these findings reverse in countries where both types of banks coexist. Nevertheless, conventional banks operating in countries with a high share of Islamic banks are more cost-efficient but less stable. On the other hand, Islamic banks exhibit higher capitalization ratio and higher liquidity reserves that explain relatively successful performance during the crisis. However, the empirical estimation showed that there are no significant differences between Islamic and conventional banks. At least they are much smaller than

expected.

However, Yudistira (2004) brings reverse conclusions about the stability of Islamic banking system during recession. He measured technical, pure technical and scale efficiency across 18 Islamic banks in years 1997-2000 using a non-parametric method, Data Envelopment Analysis. For a proper modeling bank behavior, three output (total loans, other income and liquid assets) and 3 input (staff costs, fixed assets and total deposits) variables were employed in DEA model. His findings indicate that inefficiency of Islamic banks in the sample is quite low (just over 10 %) compared to many conventional banks. Furthermore, he claims that Islamic banks were strongly affected by the global financial crisis in years 1998-1999 but they recovered very quickly after difficult period. It suggests that the mutual dependence of Islamic banks is considerable and that Islamic banking should be considered when searching a global financial stability.

The findings also suggest that Islamic banks operating outside the Middle East region are more efficient than banks within the region since they are relatively new in the market and thus much more supported by regulators. Further, Yudistira (2004) found that small-to-medium Islamic banks suffer from diseconomies of scale which implies that Mergers & Acquisitions should be supported. This finding is consistent with Hassan (2005), who notes that the most of Islamic banks are smaller than their conventional counterparts and therefore they should be allowed to merge in order to obtain an optimal size and become more technically efficient.

Mokhtar, Abdulah and Al-Habshi (2006) examine efficiency of full-fledged Islamic banks, Islamic windows and conventional banks in Malaysia over the 1997-2003 period. Technical and cost efficiency was estimated using SFA. According to their findings, the efficiency of Islamic banks has significantly increased during examined period while efficiency of conventional banks remained stable. Nevertheless, the efficiency of Islamic banks was found to be lower than that of conventional banks. In addition, the results indicate that Islamic windows are less efficient than full-fledged Islamic banks while Islamic windows of domestic banks seem to be less efficient than those of foreign banks.

Samad and Hasan (1999) examined the performance of Malaysian Islamic banks during the period 1984-1997 by applying financial ratio analysis. They found that the slow growth of loans under profit and loss sharing principle is caused by bankers´ lack of knowledge. However, Islamic banks performed better than their conventional counterparties in terms of liquidity and were found to be less risky. Moreover, Sarker (1999) argues that Islamic financial products have different risk characteristic and

therefore different regulation policy should be implemented.

Also Sufian (2007) analyzes the performance of Malaysian Islamic banks in years 2001-2005. Many efficiency scores were estimated using Data Envelopment Analysis in his study. Sufian employed two different approaches to assess how efficiency scores differ with a change of inputs and outputs. Problem loans as non-discretionary inputs were implemented to the model to investigate the impact of risk factors. The results show that pure technical inefficiency was dominated by scale inefficiency in the Malaysian Islamic banking. Further, the results indicate that domestic banks exhibit lower technical efficiency relative to foreign banks, most likely due to lower scale efficiency.

Hassan (2005) examines relative efficiency of global Islamic banking system using income statement and balance sheet data of 43 Islamic banks from 21 countries in a period 1995-2001. Both parametric (Stochastic Frontier Analysis) and non-parametric (Data Envelopment Analysis) techniques were applied to measure efficiency of these banks. Five DEA efficiency measures (technical, pure technical, cost, allocative and scale efficiency) were computed and consequently correlated with the conventional measures of performance.

Hassan (2005) found that Islamic banks are more efficient in generating profit since the average profit efficiency (profit efficiency frontier) is 84%, whereas the average cost efficiency is only 74% (stochastic cost frontier). The results also show that the major source of inefficiency in Islamic banks is of allocative rather than technical nature.

Average scale efficiency was found to be around 89%, while average pure technical efficiency is near 95%. It suggests that the dominant source of total technical inefficiency is not input related (pure technical inefficiency) but output related (scale inefficiency).

However, on average, Islamic banks in the sample seem to perform less efficiently relative to their conventional counterparts in other regions of the world. Further, all five efficiency measures mentioned above are highly correlated with Return on Asset and Return on Equity which implies that these measures can be used simultaneously with conventional financial ratios when determining Islamic bank performance and comparing both banking systems.

Using SFA model, Srairi (2010) estimated banks' efficiency in GCC countries covering period 1999-2007. His empirical findings suggest that Islamic banks, on average, are less efficient in term of cost and profit than conventional banks. Moreover, he revealed that both types of banks are more efficient in generating profit than

in managing costs.

This is supported also by Abdul-Majid, Saal and Battisti who invetigated the efficiency of Islamic banks across 10 countries during the period 1996-2002. With employing output distance function approach they revealed that Islamic banks produce relatively low output with given inputs and hence they are less efficient compared to conventional banks.

Rahman and Rosman (2013) employed DEA to assess efficiency of 63 selected Islamic banks in MENA region (including GCC) and Asia in a period 2006-2009. Authors' findings suggest that in general, Islamic banks exhibit hig level of pure technical efficiency indicating management's ability to use inputs in a way of maximizing output and efficient cost control. The most efficient banks in the sample were those from GCC region.

Their results also indicate that the main source of Islamic banks' technical inefficiency arises from scale of operation.

Only few studies have investigated revenue and profit efficiency of Islamic banks, however, these studies demonstrated that profit efficiency is significantly lower than cost efficiency. It implies that major sources of inefficiency are on the revenue side (Maudos et al., 2002).

Chapter 4
Empirical Analysis

4.1. Theoretical Background

Before starting to analyze banking performance, one has to decide which efficiency concept to use, more precisely, which concept will be most suitable for available data. This decision generally depends on the question being investigated.

In economic theory, an institution is generally considered to work efficiently if resources are utilized in a way that maximizes production at the lowest possible costs. However, economic efficiency is quite relative term and economists distinguish several types of efficiency, eg. profit efficiency, cost efficiency, technical efficiency, efficiency of scale etc. Different types of efficiency are not mutually exclusive which means that more than one can describe an economy or institution's operating . In the next section, the most common efficiencies will be described, starting with two most widely used in the literature, cost and profit efficiency.

Cost efficiency

The bank's costs depend on the level of output (y), input prices (w), on the inefficiency level (u) and a set of random factors that comprise measurement errors, bad luck, etc. (v). Thus, following Maudos and Pastor (2009), the cost function has following form:

$$C = C(y,w,u,v) = C(y,w)\,exp(u+v)$$

Cost efficiency is then simply defined as a producing certain output y with the minimum necessary costs. Mathematically we can write cost efficiency as follows:

$$CE = \frac{C^{min}}{C} = \frac{C(y,w)\,exp(v)}{C(y,w)\,exp(u+v)}$$

Hassan (2005) defines cost efficiency as a measure of how far a bank's costs are from the best performing bank's costs if both of them were to produce the same output under the same environmental conditions.

Profit efficiency

Before we define profit efficiency, let's start with the formulation of profit function. Berger and Mester (1997) distinguish two ways how to measure profit efficiency: The first, using standard profit function and the second, alternative profit function. The difference is in whether we consider existence of market power when specifying output prices or not.

The standard profit function works under the assumption of perfect competition in the market of inputs and outputs, unlike the alternative efficiency concept. The bank then maximizes profit by modifying the vectors of inputs and outputs (Maudos and Pastor, 2009). Thus, standard profit function has a following form:

$$\pi = \pi(w, p, u, v) = \pi(w, p)\, exp(v - u)$$

where w is a vector of input prices, p is a vector of output prices, u stands for inefficiency and v is a set of random factors.

So, we can define profit efficiency (E_π) as a ratio of the profit obtained by a bank to the maximum achievable profit if it were efficient $(u = 0)$:

$$E_\pi = \frac{\pi}{\pi^{max}} = \frac{\pi(w,\, p)\, exp(v)}{\pi(w,\, p)\, exp(v)}$$

However, the disadvantage of this concept is that it assumes the absence of market power in pricing due to exogenous nature of the output prices. If we take vector of output (y) as given, rather than vector of prices (p), we can measure banking efficiency using *alternative profit function* (Maudos and Pastor, 2009):

$$\pi_A = \pi_A(y, w, u, v) = \pi_A(y, w)\, exp(v - u)$$

While the standard profit function was specified in terms of input and output prices (w and p), the alternative function is determined by input prices (w) and output quantities (y). Therefore, the alternative profit efficiency measures how far a production unit is from generating maximum profit given its volume of output instead of vector of output prices (Hassan, 2005).

Berger and Mester (1997) point out that alternative efficiency concept more corresponds to reality, particularly when any assumption on perfect market is violated.

Generally, alternative profit efficiency is nowadays considered to be a better and more reliable measure and its popularity among researchers still increases.

Profit efficiency is not examined in this thesis due to a difficult comparison of profit in Islamic and conventional banking. In the literature investigation of cost efficiency highly dominate when Islamic and traditional banks are compared. Therefore, we focused rather on another types of efficiencies. At first, *scale* and *technical efficiency*, introduced by Farell (1957) and thereafter *allocative* and *cost efficiency* were estimated. All efficiency concepts are discussed in detail in following sections.

4.2. Data and Hypotheses

The data set used in this thesis was compiled mainly from balance sheet and income statement data of 206 commercial and Islamic banks operating in 14 Middle East countries (in alphabetical order: Bahrain, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Palestine, Qatar, Saudi Arabia, Syria, United Arab Emirates and Yemen) over the period 2002-2014. Table 4.1 provides detailed information about banks in the sample. Complete list of all 206 banks is provided in Appendix A.

Table 4.1.: Descriptive statistics

	Commercial banks	Islamic banks	Total
Bahrain	13	9	22
Iran	0	12	12
Iraq	4	3	7
Israel	11	0	11
Jordan	11	3	14
Kuwait	5	11	16
Lebanon	40	2	42
Oman	6	2	8
State of Palestine	2	2	4
Qatar	6	4	10
Saudi Arabia	8	5	13
Syria	9	2	11
United Arab Emirates	18	9	27
Yemen	5	4	9
Total	**138**	**68**	**206**

Note: GCC countries in bold

Source: Bankscope and author's collection

Data were obtained from Bankscope Database[1] (Bureau Van Dijk) based on fol-

[1] World banking information source, Update – May 2015

lowing search strategy:

1. Active banks
2. Commercial and Islamic banks
3. Middle East region
4. Period 2002-2014

Note that only banks that provided data for at least one year were included to the sample. Our decision to reduce sample data only on the Middle East region was driven by several reasons. At first, we wanted to include only countries where both types of banks coexist to get the meaningful results as comparison of banks operating in different geographical, economic and cultural environment is supposed to be biased by many external factors. Second, in the Middle East, particularly in GCC, there is the largest concentration of Islamic banking activities. This region represents more than 80% of Islamic banking assets. Third, countries in this region exhibit many common characteristics, including strong dependence on oil export and similar economic and political environment. Lastly, there are also many cultural similarities, inlcuding language, traditions and family-oriented population (Ftiti et al., 2013). Hence, the Middle East is the most representative region providing a fair comparison of two differently operating banking system under given cicumstances.

One of many advantage of Bankscope database is that it converts financial data to a common international standards (indeed, where possible) and thereby allows a simple comparison of data. This feature is very beneficial, especially when "non-standard" Islamic banks are present in the sample. Moreover, yearly data can be inflation-adjusted. There is also an option to export data in original currencies of respective countries, however, for purposes fo this thesis, all accounting data were converted to a single currency. In this thesis, all variables are expressed in millions of US dollars.

Covering of this relatively long sample period was motivated by 3 reasons: Firstly, to cover period as long as possible and so extend existing literature, secondly, to investigate impact fo the global finanicial crisis on both banking systems, and finally, a covering of longer period provides us with larger data set and hence with more representative estimates (Bader et al., 2008). Although Bankscope provides also interim financials, only end-year data were used in this study.

Finally, all observations with omitted variables (problem of omitted variables arises especially in DEA) were removed from the sample, hence we have *unbalanced panel* data of 206 banks over the period 2002-2014.

Hypotheses

This chapter presents hypotheses and motivation behind them. Specifically, two main and four secondary hypotheses are being investigated in this thesis.

The first hypothesis is based on the argument of higher costs of Islamic financial activities, implying lower level of efficiency. Weill (2013) describes some characteristcs of Islamic banks that support this statement. At first, Islamic banks are required to hold higher share of liquid assets as opportunities to borrow funds in the inter-bank market are very limited. Second, cost plus financing (*murabahah*), representing the highest portion of financial instruments provided by Islamic banks, is composed of two sales transactions instead of one. Finally, contracts based on PLS principle generally require creation of separate legal entities. Implementation of these entities is necessary for financing of specific investment activities but is very costly. Regarding higher costs of financial service and additional charges in Islamic finance, El-Gamal (2007) in his work mentions the term *"cost of being Muslim"*. Therefore, the first hypothesis is stated as follows:

- H_1 : *Islamic banks are significantly less cost efficient than their conventional counterparties.*

The second hypothesis is based on the recent experience of the global financial crisis when Islamic banks withstood the crisis almost uneffected, while conventional banks were hit hardly.

- H_2 : *Islamic banks are more stable and resilient to financial instability than conventional banks.*

The best way how to evaluate banks' stability is to monitor them in a longer time period and assess how they respond to negative events in the economy compared to other banks. Finacial instability is generally negatively reflected in banks' performance but we need to know to which extent. Therefore, efficiency scores will be estimated for both types of banks and for each year in the sample period and then the impact of he crisis will be examined.

The remaining hypotheses are associated with determinants of banks' performance and are stated as follows:

- H_3 : *Banks' performance is positively correlated with bank's size due to cost advantages related with economies of scale.*

- H_4 : *Islamic banks have better capital structure due to high portion of equity-like instruments.*
- H_5 : *Banks' performance is significantly affected by the quality of portfolio.*
- H_6 : *Profitability positivelly influences cost efficiency of banks.*

4.3. Financial Ratio Analysis

Although banks' performance is primarily examined by Frontier techniques in this thesis, there is one more method used in literature for assessing firms' or banks' efficiency - **Financial Ratio Analysis**. FRA is popular especially because financial ratios are generally easy to calculate but above easy to interpret. However, many researchers have shown that FRA has also many weaknesses and limitations.

Iqbal and Molyneux (2005) point out that frontier approaches have proved to be superior to analyses that are based on traditional financial ratios as they utilize advanced statistical techniques that eliminate biases arising from differences in input and output prices, as well as in other exogenous variables affecting banks' performance. Thus, frontier approaches are highly preferred in banking literature as they are more appropriate when measuring not only the bank performance in general but also when measuring the effects of mergers and acquisition, abolition of geographic restrictions, capital regulation, deregulation of depost rates etc. (Bader et al., 2008).

Standard financial ratio-based analyses, on the other hand, are useful for benchmarking as well but their application is basically limited in scope as they give only one-dimensional view of product, technology or services, and hence don't consider any trade-offs or mutual interactions between key variables in a final outcome. Therefore, inclusion of more inputs and outputs to production function is crucial for efficiency evaluation that provides more reliable and credible results (Mousa, 2015).

According to Kumbirai and Webb (2010) finacial ratios are useful tool for identidying particular banks' strenghths and weaknesses as they inform about profitability, stability and liquidity, and enables comparison through benchmarking and industry average. However, Mousa (2015) opposes that use of financial ratios is a suitable method only when financial institution employs a single input to produce a single output and this assumption basically fails in practise. Roughly speaking, a single ratio cannot provide a complete view of performance of any decision makig unit as all ratios are one-dimensionaly oriented and hence omitt some other factors that influence the overall eficiency. Moreover, there are many financial ratios available

for particular data, however, there is no generally accepted criterion for selecting an appropriate ratio that would provide objective results. Choose of one ratio can discriminate some banks against others and vice versa.

To sum up, FRA is useful tool when asking for fast and simple comparison across units in the sample, however, it should be viewed only as a rough concept. Once a researcher wants to study an efficiency more deeply with considering all necessary assumptions, one of the frontier approaches should be applied in the analysis.

In the banking literature, these banks' charachteristic are mostly examined:

- **Profitability** - measured e.g. by ROA, ROE, EPS or net income/total assets
- **Liquidity** - Total liquid assets/Total assets, Total loans/ Total deposits
- **Efficiency** - Cost to Income ratio
- **Asset quality** -Loan loss reserves/gross loans, Loan loss reserves/Impaired loans
- **Capital structure** - Equity ratio, Tier 1 capital
- **Financial helath** - Capital adequacy ratio (CAD)

Despite all shortcomings of FRA mentioned above, we provide very simple ratio analysis for Islamic and conventional banks operating in the Middle East to get some preliminary statistics for further estimation. The results are diplayed in the Table 4.2.

Table 4.2.: Comparison of selected financial ratios in the Middle East region

		2007		2009		2012		2014	
Specialisation		IB	CB	IB	CB	IB	CB	IB	CB
Loan Loss Res / Gross Loans	%	5.7	5.5	10.7	6.2	7.8	6.1	5.3	5.4
Loan Loss Res / Impaired Loans	%	131.0	122.2	108.2	94.5	81.6	88.1	106.8	129.9
Impaired Loans / Equity	%	14.7	27.1	21.3	38.4	35.4	33.4	24.1	23.7
Tier 1 Ratio	%	32.0	14.9	31.6	16.3	30.5	15.7	25.2	16.1
Equity / Tot Assets	%	33.1	13.4	28.9	13.6	31.4	14.5	28.0	14.5
Equity / Cust & ST Funding	%	74.6	16.0	86.5	21.7	73.5	21.4	82.4	22.2
Cap Funds / Tot Assets	%	23.8	12.6	22.1	14.8	16.9	13.7	15.0	13.1
Net Interest Margin	%	5.8	3.4	2.9	3.2	2.6	3.3	2.7	3.1
Return On Avg Assets (ROAA)	%	5.2	2.3	-1.5	1.0	0.5	1.3	0.7	1.4
Return On Avg Equity (ROAE)	%	16.7	15.6	-1.3	10.3	5.2	10.0	6.7	10.5
Cost To Income Ratio	%	47.9	46.5	92.7	52.7	85.2	50.3	75.5	45.4
Net Loans / Tot Assets	%	43.4	45.2	45.5	45.6	46.4	44.9	50.0	51.4
Net Loans / Dep & ST Funding	%	80.5	57.0	79.7	58.5	71.5	58.5	98.1	68.6
Liquid Assets / Dep & ST Funding	%	76.4	41.0	73.5	40.6	64.1	36.2	48.2	31.4
n		57	106	70	119	74	129	45	85

Source: Bankscope and author's collection

The results reveal that there are considerable differences in some bank-specific characteristics across Islamic and conventional banks indicating different banking and credit policy. Specifically, the results suggest that Islamic banks really hold higher reserves and hence they are relatively better protected against potential loss from impaired loans (except 2014). Moreover, it seems that both types of banks have learned from insufficient reserves in 2012. However, the ratios also indicate that increase in loan loss reserves is significantly negatively reflected in *Cost to income ratio* (CIR). In 2009 Islamic banks increased the share of *Loan Loss Reserves* on *Gross loans* by 87% what resulted in worsening of CIR by 93%, while conventional banks increased *LLR/GL* by 12% only and their CIR decreased by 14%. This is not surprising as reserves generate no profit and hence holding a high share of reserves is highly inefficient. It was empirically proven that as Islamic banks gradually reduce their reserves, their efficiency improves.

Moreover, we can see that Islamic banks have significantly higher *equity ratio* indicating better capital structure as they provide wider range of equity-like instruments through PLS contracts, and significantly higher share of *liquid assets* as most of Islamic financial transactions are asset-backed.

4.4. Frontier Approaches

Economic theory distinguishes two general methods of measuring an economic efficiency: a parametric (econometric) and a non-parametric (mathematical programming) approach. These frontier techniques vary in the assumptions about the shape of the frontier, distributions assumed for random error and inefficiencies and finally, about the treatment of random error (Bauer at al. 1998). The Frontier efficiency techniques belong among the most commonly used methods for measuring banks' efficiency. These techniques are based on principle of estimating a frontier on which the best-performing bank stands and consequently it measures the distance of all bank from this frontier (Weill, 2013).

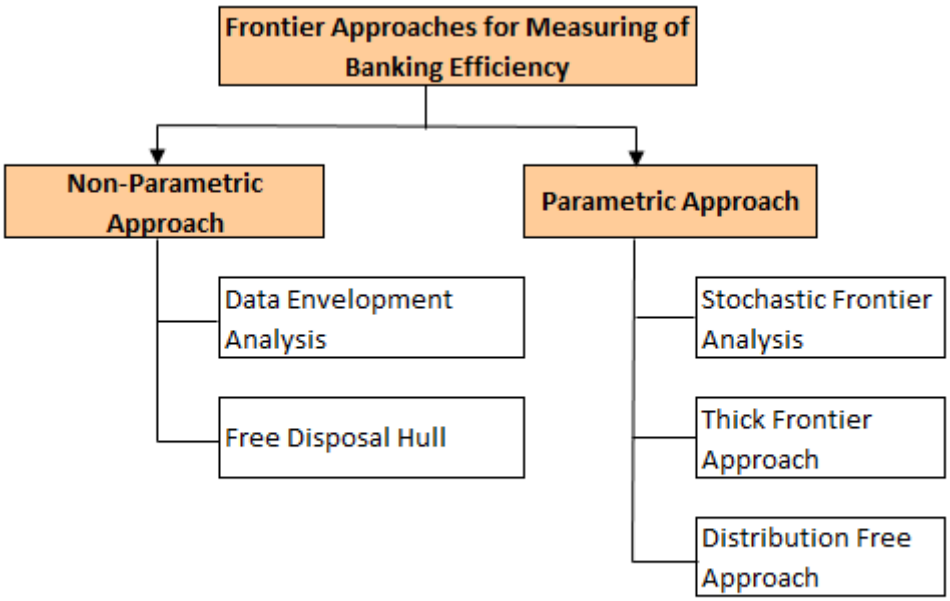
The best known and most widely used non-parametric method is **Data Envelopment Analysis** (DEA) introduced by Charnes, Cooper and Rhodes (1978). From all efficiency measures displayed in Figure 4.1, DEA has emerged as a most powerful method for estimating bank efficiency, especially thanks to its advantageous features over the other techniques (Kumar and Gulati, 2008). Berger and Humphrey (1997) conducted extensive review of efficiency analyses and they found out that DEA was employed in 62 out of 122 studies in total. It suggests that contribution of DEA in banking efficiency research is considerable.

Compared to parametric methods, the main advantage of DEA is its simplicity of computation since no specification of functional form for production function is needed. Moreover, Data Envelopment Analysis is less data demanding and thus it works well even with small samples (Coelli et al., 2005). On the other hand, DEA doesn't include statistical noise into the frontier and its results are strongly dependent on selection of input and output variables (Berg, 2010). Due to its non-stochastic nature, researchers often cannot achieve comprehensive and credible results.

Therefore, parametric approach is often preferred by researchers since it is able to distinguish the impact of deviation in efficiency from external error (Erkoc, 2012). The most frequently used parametric method is **Stochastic Frontier Analysis** introduced simultaneously by Aigner, Lovell and Schmidt (1977) and Meeusen and Van denk Broeck (1977).

In the figure below, we can see that there are more frontier techniques such as Thick Frontier Approach (TFA), Distribution-Free Approach (DFA) or Free Disposal Hull (FDH). However, these are not relevant to this work and thus won't be discussed in detail.

Figure 4.1.: Types of Frontier Approaches



Source: Kumar and Gulati, 2008 (own graphics)

Each frontier technique comprises various models designed to derive a measure of *best practice* for a given sample of banks. Then it investigates the distance of individual banks from this standard. The *best practice* generally has a form of efficient frontier which is estimated using parametric or non-parametric technique (Kumar and Gulati, 2008). However, each frontier technique has specific strengths and weaknesses (Bauer et al., 1998 present detailed analysis for each technique) and provides different efficiency estimates. Thus, researchers should carefully consider which method to use with respect to the specific features of the sample and the questions to be investigated.

4.5. Data Envelopment Analysis

Data Envelopment Analysis, introduced by Charnes et al. (1978), is a linear programming (non-parametric) technique that allows measuring of efficiency of all Decision Making Units (DMUs) without knowing which variables are more important than others or what relationship is among them. Originally, DEA was developed by Charnes et al. (1978) for evaluating efficiency of public non-profit institutions and organizations, however, Sherman and Gold (1985) were the first researchers who applied DEA in banking sector (Bader et al., 2008). Efficiency measured using DEA

is calculated as a maximum of a ratio of weighted outputs to weighted inputs. Intuitively, it means that the more output is produced from given inputs, the more efficient the financial institution is (Sufian, 2007).

DEA as a measure of banking efficiency is very popular among researchers since it is less data demanding and thus works also within small samples. Other benefit is that we don't need to specify either a proper functional form of frontier or an inefficiency structure (Coelli et al., 2005). Sufian (2007) mentions other three useful properties of DEA; (1) all decision making units are assigned by individual efficiency scores which allows simple ranking of the DMUs in the sample, (2) DEA underlines the areas for potentional improvements of each decision making unit. For instance, if we compare one DMU with the set of efficient DMUs (which is called reference set) with similar outputs and inputs, we are able to identify whether the DMU has used input as efficiently as possible or whether its output was under-produced. (3) DEA allows us to make an inference on the DMU's general profile.

Hence, a key advantage behind using DEA is its ability to detect potential opportunities for efficiency improvement. By comparing many efficient and inefficient banks, DEA is able to identify optimum quantities of inputs and outputs to be used for each bank. It means that when we deduct optimum quantities from the real (estimated) values, we get quantities of inputs that should be reduced to perform fully efficiently. The same holds for output variables but in reverse direction, i.e. quantities of outputs that must be expanded. Therefore, we can say that DEA provides a kind of a guidance for inefficient banks to perform as best practise banks (Mousa, 2015). Moreover, Hassan (2005) notes that DEA is very useful technique especially when examining efficiency in developing countries since there is very difficult to obtain the input prices due to unavailability or lack of data (unlike the econometric approach, input prices are not required in DEA).

Nevertheless, DEA has also several weaknesses from which the most important is that it doesn't assume any measurement errors in the data (Avkiran, 1999; Sufian, 2007). Further, Canhato and Dermine (2003) emphasized that since DEA measures efficiency in a relative way, the analysis is strongly limited by the particular sample used in the study. It implies that an efficient DMU found in the examined sample is not comparable with other units outside the sample since it would result in incorrect interpretation. The explanation is simple. Each sample set, separated by year in time series or panel data analyses for instance, represents a single frontier that is constructed under the assumption of same production technology. It means that comparison of efficiency scores of individual DMUs across time cannot be interpreted as technical progress but rather as changes in efficiency (Sufian, 2007).

It should be also stressed that DEA is a very sensitive to the number of inputs and outputs employed in the model. Inclusion of too many variables (irrespective whether inputs or outputs) can lead to the loss of discriminatory power of DEA if we have only small sample of DMU's since most of DMU's would exhibit 100% efficiency scores in this case (Hughs and Yaiswarng, 2004, Subramanyam and Reddy, 2008). Therefore, the researchers usually try to employ as few input and output variables as possible to prevent overestimation bias. In other words, in case of DEA "less is more" when selecting variables.

Using DEA we can examine how an individual decision making unit performs compared to the other banks in the sample. For that we need to produce efficiency scores. At first, linear technique generates a frontier determined by efficient banks and consequently compares it with inefficient ones to get efficiency scores. All banks in the sample are bounded in the interval of zero and one in a way that the most efficient bank has an efficiency score of one. However, score of one doesn't necessarily indicate that the best performing bank generates the maximum output from given inputs. Rather, it means that this bank produce the highest level of output in the particular sample (Yudistira, 2004).

For a construction of a frontier one needs to know total costs and input and output quantities of each bank. Based on these data, linear programming technique is able to construct a best practice cost and production frontiers and the performance of the individual banks is consequently evaluated relative to these frontiers. The advantage of this method is that is allows for a fairly simple and transparent interpretation (Hassan, 2005).

4.5.1. Methodology

In economic history many researchers attempted to solve the efficiency problem but none of the methods provided reliable results since they only compared weighted average of inputs with an output. However, in 1957 M. J. Farrell finally overcame the limitations arising from indices methods and proposed first satisfactory efficiency measure consisting of two components – *technical efficiency* that is defined as an ability of a DMU to obtain maximum possible output from a given set of inputs; and *allocative efficiency* (originally called price efficiency in Farrell, 1957) that reflects an ability of a DMU to utilize its inputs in optimal proportion given their respective prices. By combining these two measures we obtain a *total economic efficiency* as a result.

However, at the beginning of research one has to decide whether to address ef-

ficiency from input or output point of view since each method provides different results and interpretation. Under input-oriented approach the following question is addressed as proposed by Farrell (1957): *"By how much can input quantities be proportionally reduced while maintaining the same quantities of output produced?"* As the title suggests, inputs are controllable in this measure. Alternatively, one can ask: *"By how much can output quantities be expanded while maintaining the same input quantities employed?"* This reformulation corresponds to output-orientation where the output is fully controllable as opposed to input-orientation (Coelli, 1996; Kumar and Gulati, 2008). Choice of particular measure depends on the purpose of the study.

Input-oriented approach

To illustrate input-orientation graphically, Farrell (1957) presents a simple example of a firm that produces a single output y by employing two inputs (x_1 and x_2) under the assumption of constant return to scale (hereafter CRS). Further, let's suppose that production function of a fully efficient firm is known. Then the unit isoquant (SS') represents a various combinations of inputs that might be jointly used by a fully efficient firm to produce an output y. Thus, a knowledge of this isoquant allow us to measure technical efficiency.

Alternatively, a firm is considered to be technically inefficient as it operates below the frontier (Kumar and Gulati, 2008). Let's assume that a firm produces some output by using certain quantities of inputs x_1 and x_2, represented by the point P in Figure 4.2, then a technical inefficiency of this firm might be defined as a distance QP, where the point Q represents a fully efficient firm (as it lies on the isoquant SS') that employs inputs in the same proportion as the firm in point P. In other words, the distance QP corresponds to the amount of inputs that could be proportionally reduced while maintaining the same output. The same technical inefficiency, just expressed in a percentage form, is defined by the ratio QP/OP (Coelli, 1996). Intuitively, technical efficiency is then defined as a difference of perfect efficiency (PE), that is equal to 1, and technical inefficiency (TIE)[2]:

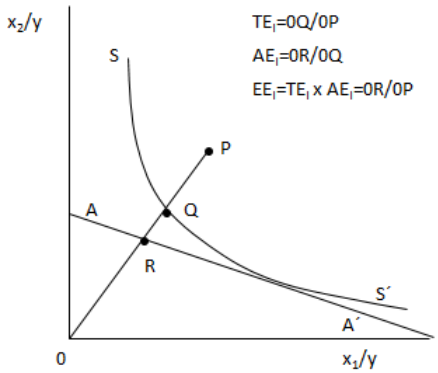
$$TE = 1 - TIE = 1 - QP/OP = OP - QP/OP = 0Q/OP$$

This efficiency ratio takes values from interval $(0;1>$, where value of 1 corresponds to the perfectly efficient firm whereas infinitely small value of ratio corre-

[2]However, some other sources (e.g. Bader et al., 2008) presents relationship between efficiency and inefficiency as $IE = (1-E)/E$ instead of $IE = 1-E$. Therefore, 89.2% efficiency corresponds to 12.1% inefficiency, not 10.8%.

sponds to the firm that employs extremely high amounts of inputs per unit of output.

Figure 4.2.: Input-oriented approach



Source: Coelli, 1996 (own graphics)

Moreover, once also input prices are known, we are able to measure to which extent a firm utilize production factors in a best production proportion, taking into consideration their prices. In other words, with input prices we can measure *allocative efficiency*. Input price ratio provides us with an information about the slope of line denoted AA' in the Figure 4.2. All points on this line represent allocative efficient firms. Mathematically, *allocative efficiency* is defined as follows:

$$AE = 0R/OQ$$

The distance RQ represents the amount of costs that would be saved if a firm's production was allocatively and simultaneously technically efficient as in point Q', instead of point Q that is technically efficient only.

The *total economic efficiency* is then defined as a product of *technical* and *allocative efficiencies*:

$$EE = TE \times AE = 0Q/OP \times 0R/OQ = 0R/0P$$

However, it should be emphasized that these efficiency measures are based on the assumption that production function of the perfectly efficient firm (i.e. a firm lying in the intersection of isoquant $SS'$and isocost AA' in the graph) is known. In reality this assumption basically fails and the efficiency isoquant must be estimated from particular sample data.

Output-oriented approach

As already mentioned, in Farrell input-oriented approach efficiency is measured in terms of output maximization while in input-oriented approach in terms of input minimization. However, since the input orientation is used in this thesis, output oriented measure will be described only very briefly.

For a simple two dimensional representation, let's assume an inefficient firm (represented by the point P in the Figure 4.3.) that produce two outputs y_1 and y_2 by employing a single input under the assumption of CRS again. The line ZZ' represents the unit production capacity curve and point B, lying on the line, technically efficient firm. Since the distance PB corresponds to technical inefficiency, i.e. by how much output quantities could be increased without demanding any extra inputs, we can measure *technical efficiency* as a ratio

$$TE = 0P/OB$$

Once also price information is available, we can measure *allocative efficiency* as follows:

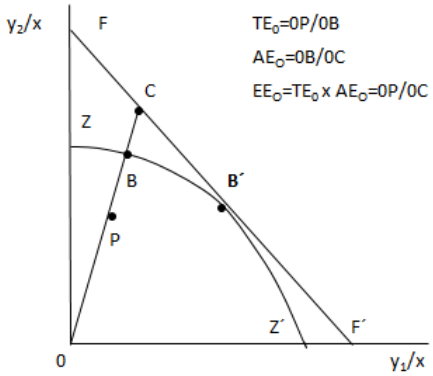
$$AE = 0B/0C$$

that is interpreted as revenue increase (compared to cost reducing in input-oriented measure). The *overall economic efficiency* is defined in a same way as in previous case, i.e. as a product of these two efficiencies:

$$EE = TE \times AE = (0P/0B) \times (0B/0C) = 0P/0C$$

Again, a fully efficient firm B' lies on the intersection of line ZZ' and iso-revenue curve FF'.

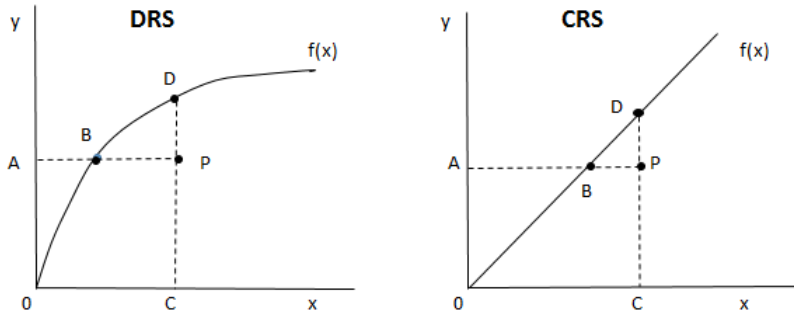
Figure 4.3.: Output-oriented approach



Source: Coelli, 1996 (own graphics)

Coelli (1996) explains the difference between these two measures on a simple example of a firm that uses single input to produce single output. Let's assume production technology $f(x)$ with decreasing return to scale (DRS) and an inefficiently operating firm represented by point P in Figure 4.4. The *technical efficiency* employing input-oriented measure is defined by the ratio AB/AP, while under output-orientation technical efficiency is equal to CP/CD. This implies that input- and output-oriented measures provide equivalent estimates of *technical efficiency* ($AB/AP = CP/CD$ for any point P) only in case of existing constant returns to scale (CRS). Otherwise, i.e. IRS or DRS, the measures will never provide the same estimates.

Figure 4.4.: Difference between input and output orientation



Source: Coelli, 1996 (own graphics)

The other difference is the position of an inefficient firm in the graph. Note that when we supposed input-orientation, an inefficient firm lay above the frontier as the curve SS´ represented lower bound of input minimization. When supposing output-orientation in contrary, an inefficient firm lies bellow the curve ZZ´ that represents the upper bound of production capacity.

Since the greatest emphasis is put on costs when dealing with banking efficiency and output quantity in basically determined by demand, input-orientation dominates in banking literature (Kumbhakar and Lozano-Vivas, 2005).

CRS and VRS Assumption

Originally, Charnes, Cooper and Rhodes (1978) proposed input-oriented model (CCR model) under the assumption of CRS. However, CRS assumption is appropriate only when all DMUs in the sample are operating in the optimal scale. Nevertheless, in reality CRS assumption is often violated due to imperfect competition, constraints on finance etc. Therefore, Banker, Charnes and Cooper (1984) relaxed the CRS assumption and proposed an extension of DEA model (BCC model) assuming variable returns to scale (VRS).

At first, CRS DEA model will be introduced. Following Coelli et al. (2005), we assume I banks, each of them employs N inputs to produce M outputs. Assuming constant return to scale (CRS), the efficiency is measured by solving mathematical problem in a following *multiplier form*:

$$Max_{u,v} = \frac{u'y_i}{v'x_i}$$

$$\text{subject to: } \frac{u'y_j}{v'x_j} \leq 1 \text{ for } j = 1,2,...,I$$

$$u, v \geq 0$$

where y is vector of outputs, x is vector of inputs, u is vector of output weights ($Mx1$) and v is vector of input weights ($Nx1$). This mathematical formulation provides us with maximized efficiency measures for each bank in the sample under the constraint of all measures to be equal to or less than one. However, one crucial problem arises from this formulation – infinitely many of solutions. Luckily, this problem can be easily treated by imposing additional constraint $v'x_i = 1$, so we get:

$$Max_{u,v}(u', y_i)$$

$$\text{subject to: } v'x_i = 1$$

$$u'y_j - v'x_j \leq 0 \text{ for } j = 1,2,..,I$$

$$u, v \geq 0$$

Alternatively, the problem above can be expressed in the dual form:

$$Min_{\theta,\lambda}\,\theta$$

$$\text{subject to: } -y_i + Y\lambda \geq 0$$

$$\theta x_i - X\lambda \geq 0$$

$$\lambda \geq 0$$

where $\lambda = Ix1$ vector of constants and θ is a scalar whose value is desired efficiency score of *i-th* bank. Value of 1 indicates point lying on the frontier and hence technically fully efficient bank, It implies that value of θ can not be higher than 1. Coelli et al. (2005) also stresses that this linear programming problem must be performed *I-times*, individually for each bank. Indeed, computer program solves the problem automatically for all banks in the sample. This *envelopment form* is generally preferred over previous *multiplier form* as it involves less constraints.

To introduce VRS model, we just simply modify the CRS mode by adding the convexity constraint $I1'\lambda = 1$ to previous equation:

$$Min_{\theta,\lambda}\,\theta$$

$$\text{subject to: } -y_i + Y\lambda \geq 0$$

$$\theta x_i - X\lambda \geq 0$$

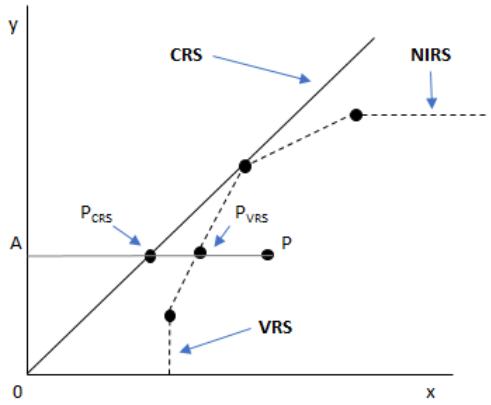
$$I1'\lambda = 1,\ \lambda \geq 0$$

where $I1$ is an Ix1 vector of ones. This method forms a convex hull in which data points are enveloped more tightly than in CRS case and hence level of technical efficiency is generally higher compared to CRS. This constraint is very useful to ensure that the inefficient bank will be compared with banks of similar banks, while in CRS DEA it may happen that a bank is benchmarked against banks that are considerably larger.

The estimating of CCR model when some of DMUs are not operating in an optimal scale, the measured TE will be skewed by *scale efficiency* (SE) as a result. The

conducting DEA under VRS specification eliminates these scale effects in the model and therefore provides more accurate results (Coelli, 1996).

Figure 4.5.: Scale efficiency measurement in DEA



Source: Coelli et al., 2005 (own graphics)

But how to identify in practice which assumption is appropriate for particular data? The standard way of measuring scale effects in DEA is to run both CRS and VRS models upon the same data and consequently compare them with each other. If these two models provide different estimates of TE for particular DMU, it indicates that the DMU exhibit some *scale inefficiency*.

The *scale efficiency* is then calculated by dividing efficiency estimate obtained from the CRS model by the efficiency estimate obtained from VRS model. Under the VRS model the data are enveloped more tightly than under CRS model, that implies that the VRS efficiency scores will be higher (denominator) and therefore scale efficiency will take value from interval 0 to 1 (Sufian, 2007).

4.5.2. Various Approaches

The proper choice of input and output variables in the banking function is a persisting issue among researchers. Financial institutions are generally multi-input and multi-output units and defining what constitutes to inputs and outputs is quite difficult since most of financial services are jointly provided and prices are usually assigned to a package of services. Therefore, the choice should be based on the particular banking technology (especially when considering specifics of Islamic banks) to get most precise efficiency estimates (Sufian, 2007). Regarding inputs and output, the literature on banking activities distinguishes three main approaches competing with each other: the production, revenue and the intermediation approach.

In **the production approach**, a bank is defined as a provider of information and financial services for account holders, i.e. all transactions regarding bank loans and deposits (Kablan and Yousfi, 2011). Hence, bank output is measured by the number of accounts or their related transactions, while inputs are measured by the number of employees and physical capital (Sufian, 2007).

The revenue approach was proposed recently by Drake et al. (2006) and it defines three banking outputs: balance sheet, deposits and loans (Ftiti et al., 2013).

Under **the intermediation approach** (sometimes called asset approach as well), bank is supposed to satisfy both "takers and suppliers" of bank funds (Subramanyam and Reddy, 2008). On the one hand, bank provides at the same time safe and liquid deposits to its customers and on the other hand, offers riskier loans that represent less liquid asset (Kablan and Yousfi, 2011). Hence, financial institution is viewed as an intermediary between borrowers and depositors and assumes deposits, physical capital and labour as inputs, while total loans with securities as output (Sufian, 2007).

Therefore, the main difference between these approaches is that in the intermediation approach deposits are considered as input, whereas in the production approach they are treated as output (Subramanyam and Reddy, 2008).

The intermediation approach is highly preferred in banking literature and is adopted also in this work from many reasons. First, it assesses efficiency as a whole. Second, this approach is more appropriate for financial institutions whose activities include mainly turning of large deposits and funds purchased from other banks into financial investments and loans (Favero and Papi, 1995). Third, this approach doesn't exclude interest expenses that represent significant portion of banks´ total costs and this exclusion could distort efficiency scores (Bader et al., 2008; Ftiti et al., 2013). Last but not least, the basic rule of Islamic banks is to participate in the companies that are using their funds on Profit-and-Loss principle. Thus, the intermediation approach underlines intermediary function executed by Islamic banks (Kablan and Yousfi, 2011).

Although intermediation approach is followed in this thesis, choice of input and output variables slightly differs from general literature on banking efficiency since the inclusion of Islamic banks and their accounting specifics must be taken into consideration in the model. Therefore, following Hassan (2005), Bader et al. (2008) and Ftiti et al. (2013), choice of variables was slightly adjusted to reflect these differences.

4.5.3. Estimation of Technical and Cost Efficiency in DEA

Data Envelopment Analysis was conducted in computer program DEAP Version 2.1 that was developed by Tim Coelli (1996) specifically for construction of DEA frontiers. Generally, DEAP offers three principal options:

- Calculation of technical and scale efficiencies under standard CRS and VRS assumptions
- Extension of previous models including calculation of cost and allocative efficiencies
- Malmquist DEA methods applied to panel data for calculation indices of total factor productivity (TFP).

All these methods are avaliable as input- or output-oriented measures. However, regarding panel data in DEA it must be stressed that DEA is not able to deal with panel data in a same way as parametric techniques and hence it lacks information about time effects. Roughly sepaking, DEA allows import of panel data but they are treated as cross-sectional data, it means that for each year separate frontier is estimated. Malmquist index is applied to measure productivity change that can be further decomposed to efficiency change and technical change (Grifell-Tatjé and Lovell, 1997) but it requires balanced data, i.e. all banks must be observed in all time periods (Coelli, 1996). This assumption is not met in this thesis as we have unbalanced data, therefore Malmquist DEA was not executed but this technique is discussed in detail in Fare et al.(1994).

Computations in DEAP are made through three separate files: data file, instruction file, in which the user specifies the model to be estimated, and output file in which estimation results are exported. Besides efficiency estimates DEA output file includes summary of input and output slacks, peers and TFP. Moreover, DEAP estimate input and output targets, it means that for each bank in the sample the program calculates optimal input (minimized) and output (maximized) quantities that must be reached to become fully efficient.

As already mentioned, DEA is very sensitive to the number of variables, therefore only reasonable quantity of variables should be employed to prevent model misspecification. In this thesis three input and three output variables were employed to estimate technical efficiency and two inputs and three outputs to estimate cost efficiency in DEA. This set of variables seems to be appropriate for comparison of commercial and Islamic banks.

Technical Efficiency

At first technical efficiency under CRS and VRS assumptions was estimated in DEA to find out whether the banks in the sample exhibit some scale inefficiency. This information is crucial especially for estimating cost efficiency in the next step where correct assumption (CRS or VRS) must be specified. As already mentioned, only possible way is to execute both models and if the efficiency estimates will differ, scale ineffciency will be proven and hence VRS assumption is more appropriate.

Table 4.3.: List of variables used for technical efficiency estimation in DEA

	Variable	Description
INPUTS:		
x_1	Labour	Personal expenses
x_2	Physical capital	Total fixed assets
x_3	Total funds	Sum of customer deposits and ST+LT funding
OTPUTS:		
y_1	Loans	Total of loans provided (ST and LT)
y_2	Other earning assets	Investment securities and inter-bank funds sold
y_3	Off-balance sheet itms	Sum of off-balance sheet activities (their nominal value)

Following intermediation approach, all banks in this thesis are modelled as multi-product units employing three inputs to produce three outputs[3] as summarized in Table 4.3. The first model is relatively simple as the estimation of technical and scale efficiency doesn't require information either about input or output prices. Therefore, only three input variables commonly used in production functions were employed in the model: ***labour*** x_1, represented by personal expenses[4] , ***physical capital*** x_2 expressed by fixed assets and ***total funds*** x_3 computed as a sum of customer deposits and other ST and LT funding. Further, three output variable were used in estimation: ***loans*** y_1 expressed by sum of all ST and LT loans provided by a bank, ***other earning assets*** y_2 standing for investment securities, inter-bank funds provided and direct lending, and ***off-balance sheet items*** y_3. The third output variable y_3 is not commonly used variable and it was included in order to reflect revenues from interest-free products of Islamic banks that shifted traditional financial intermediation from balance sheet to off-balance sheet (interest icome vs. fees and commisions based business

[3] Various combinations of inputs and outputs were tested in DEA but current choice of variables was found to be most appropriate for given data.

[4] Alternatively, labour can be expressed by number of employees as it was done in several studies (e.g. Das and Ghosh, 2006, Karemzadeh, 2012), however, personal expenses are preferred in this thesis as they provide more precise information, are directly related to costs and allow easier calculation of price of labour that is needed for further estimation. In addition, information about number of employees was missing for most bank in our sample.

(Ftiti et al., 2013). Yudistira (2004) and Bader et al. (2008) note that ignoring of these revenues and focusing only on interest-bearing transactions could significantly discriminate Islamic banks as it insufficiently captures the overall output of these banks.

Table 4.4.: Descriptive statistics on inputs and outputs in DEA (in mil. USD)

	Islamic				**Conventional**			
	Mean	St. Dev.	Min	Max	Mean	St. Dev.	Min	Max
INPPUTS:								
Personal expenses	95.628	167.959	0.514	1 213.263	115.757	206.366	0.282	1 569.865
Fixed assets	238.816	524.268	0.100	3 084.396	126.429	188.418	0.163	1 071.569
Deposits	7 117.065	11 763.140	8.674	87 855.430	10 505.650	15 823.860	4.131	109 353.300
OUTPUTS:								
Loans	5 264.753	8 632.054	0.136	57 288.240	7 435.138	12 587.390	0.306	92 892.860
Other earning assets	2 262.848	3 263.553	3.222	19 901.300	4 087.563	5 755.873	0.005	46 685.710
Off-balance sheet activities	1 826.588	3 262.846	2.300	21 732.340	4 238.156	7 532.174	0.301	68 429.570
n	389				1211			

Source: Author's collection, data obtained from Bankscope

The scale efficiency and technical efficiency scores under the CRS and VRS assumptions obtained from DEAP Version 2.1 are summarized in Table 4.5.

Table 4.5.: Technical efficiency under CRS and VRS assumption and Scale efficiency

		Conventional			Islamic			Total		
		CRS	**VRS**	**SCALE**	**CRS**	**VRS**	**SCALE**	**CRS**	**VRS**	**SCALE**
2014	Mean	0.827	0.900	0.920	0.781	0.846	0.925	0.813	0.883	0.922
	Max	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Min	0.59	0.641	0.693	0.343	0.345	0.462	0.343	0.345	0.462
	n		**80**			**36**			**116**	
2013	Mean	0.630	0.762	0.842	0.631	0.708	0.897	0.630	0.746	0.858
	Max	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Min	0.285	0.362	0.366	0.144	0.231	0.154	0.144	0.231	0.154
	n		**114**			**49**			**163**	
2012	Mean	0.631	0.740	0.863	0.616	0.706	0.881	0.626	0.730	0.868
	Max	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Min	0.184	0.349	0.224	0.152	0.276	0.152	0.152	0.276	0.152
	n		**117**			**52**			**169**	
2011	Mean	0.527	0.705	0.760	0.472	0.671	0.703	0.510	0.695	0.743
	Max	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Min	0.192	0.288	0.304	0.119	0.25	0.148	0.119	0.25	0.148
	n		**112**			**49**			**161**	
2010	Mean	0.531	0.745	0.725	0.495	0.745	0.666	0.520	0.745	0.708
	Max	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Min	0.231	0.313	0.361	0.134	0.283	0.263	0.134	0.283	0.263
	n		**108**			**46**			**154**	
2009	Mean	0.515	0.739	0.717	0.452	0.717	0.632	0.499	0.733	0.695
	Max	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Min	0.235	0.294	0.341	0.099	0.286	0.202	0.099	0.286	0.202
	n		**103**			**45**			**148**	
2008	Mean	0.653	0.769	0.861	0.595	0.725	0.824	0.639	0.758	0.852
	Max	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Min	0.25	0.367	0.486	0.048	0.292	0.1	0.048	0.292	0.100
	n		**102**			**33**			**135**	
2007	Mean	0.500	0.681	0.766	0.451	0.693	0.654	0.488	0.684	0.738
	Max	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Min	0.17	0.194	0.233	0.119	0.32	0.191	0.119	0.194	0.191
	n		**91**			**30**			**121**	
2006	Mean	0.554	0.747	0.753	0.538	0.732	0.730	0.550	0.743	0.747
	Max	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Min	0.222	0.305	0.271	0.205	0.294	0.308	0.205	0.294	0.271
	n		**84**			**28**			**112**	
2005	Mean	0.632	0.769	0.836	0.643	0.741	0.880	0.634	0.762	0.846
	Max	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Min	0.308	0.4	0.441	0.343	0.36	0.578	0.308	0.36	0.441
	n		**77**			**24**			**101**	
2004	Mean	0.685	0.773	0.894	0.752	0.853	0.882	0.697	0.787	0.892
	Max	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Min	0.27	0.287	0.533	0.398	0.448	0.573	0.27	0.287	0.533
	n		**74**			**18**			**92**	
2003	Mean	0.728	0.794	0.921	0.830	0.868	0.952	0.743	0.805	0.925
	Max	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Min	0.293	0.418	0.558	0.463	0.477	0.704	0.293	0.418	0.558
	n		**78**			**15**			**93**	
2002	Mean	0.861	0.909	0.947	0.866	0.921	0.941	0.862	0.911	0.946
	Max	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Min	0.601	0.64	0.77	0.601	0.649	0.636	0.601	0.64	0.636
	n		**67**			**10**			**77**	
Total	**Mean**	0.636	0.772	0.831	0.625	0.764	0.813	0.632	0.768	0.826
	Max	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Min	0.170	0.194	0.224	0.048	0.231	0.100	0.048	0.194	0.100
	n		**1207**			**435**			**1642**	

Source: Author's estimation, data obtained from Bankscope

The results show that estimates of technical efficiency under CRS and VRS are not equal, hence we can compute scale efficiency by dividing CRS estimates by VRS estimates. As efficiency scores under VRS (denominator) are allways higher than those under CRS, scale efficiency takes values in interval $(0,1)$. We can see that technical efficiency of conventional banks is higher than efficiency of Islamic banks except years 2002, 2003, 2004 and 2010, however, the differences are not substantial. Considering the whole examined period, conventional banks exhibited average technicial efficiency 77.2% while Islamic banks 76.4%.

The results also indicate that VRS assumption is more appropriate than CRS what is in line with our expectations as banks in reality generally fails to operate under the optimal scale. Now when we know which assumption fits the data better, we can continue with the estimation of cost efficiency.

Cost Efficiency

Before starting to estimate cost efficiency in DEA, we have to extend our former set of variables by input prices. This information is necessary for computation of banks' costs that are obtained by multiplying of inputs quantities and input prices. This is in contrast to SFA that deals with actual amounts of operating costs obtained from banks' income statements.

Table 4.6.: List of variables used for cost efficiency estimation in DEA

	Variable	Description
INPUTS:		
x_1	Labour	Personal expenses
x_3	Total funds	Sum of customer deposits and ST+LT funding
OTPUTS:		
y_1	Loans	Total of loans provided (ST and LT)
y_2	Other earning assets	Investment securities and inter-bank funds sold
y_3	Off-balance sheet itms	Sum of off-balance sheet activities (their nominal value)
INPUT PRICES:		
w_1	Price of labour	Personal expenses divided by total funds, i. e. x_1/x_3
w_3	Price of funds	Sum of interest expenses and other operating expense divided by total funds.

Source: Author's collection

Hence, we introduce new variables: ***price of labour*** w_1 obtained as personal expenses divided by total funds (x_1/x_3) and ***price of funds*** w_3 that was calculated as a sum of interest expenses and other operating expenses divided by total funds. Lastly, ***price of physical capital*** w_2 expressed by depreciation divided by the total fixed assets should be included, however, data on depreciation were not available for most of

the banks in the sample (particularly for Islamic banks). As the final data set would be too small if we included this variable, we had to remove one input variable - ***physical capital*** x_2- from the model. Hence, three outputs and two inputs with their respective prices were used for estimation of cost efficiency. Changes in variable set compared to technical efficiency are summarized in Table 4.6.

When executing cost efficiency estimation, DEAP in its output file provides also technical efficiency and allocative efficiency estimates. As discussed in previous chapter, cost efficiency is obtained by multiplying technical efficiency and allocative efficiency. The complete estimation results are displayed in Table 4.7.

Table 4.7.: Cost efficiency estimates from DEA

		Conventional			Islamic			Total		
		TE	**AE**	**CE**	**TE**	**AE**	**CE**	**TE**	**AE**	**CE**
2014	Mean	0.888	0.966	0.859	0.836	0.949	0.804	0.872	0.961	0.842
	Max	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Min	0.365	0.237	0.237	0.332	0.631	0.266	0.332	0.237	0.237
	n	80			35			115		
2013	Mean	0.731	0.794	0.597	0.668	0.797	0.536	0.713	0.795	0.579
	Max	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Min	0.281	0.338	0.166	0.199	0.196	0.109	0.199	0.196	0.109
	n	113			47			160		
2012	Mean	0.726	0.807	0.599	0.675	0.815	0.548	0.711	0.809	0.584
	Max	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Min	0.311	0.354	0.182	0.258	0.405	0.147	0.258	0.354	0.147
	n	117			50			167		
2011	Mean	0.680	0.721	0.517	0.646	0.748	0.503	0.670	0.729	0.513
	Max	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Min	0.289	0.207	0.128	0.233	0.207	0.118	0.233	0.207	0.118
	n	112			45			157		
2010	Mean	0.706	0.881	0.632	0.699	0.887	0.626	0.704	0.882	0.631
	Max	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Min	0.277	0.43	0.202	0.219	0.560	0.202	0.219	0.43	0.202
	n	108			39			147		
2009	Mean	0.730	0.761	0.563	0.691	0.813	0.578	0.720	0.775	0.567
	Max	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Min	0.314	0.108	0.108	0.275	0.241	0.129	0.275	0.108	0.108
	n	103			45			148		
2008	Mean	0.666	0.642	0.457	0.654	0.639	0.451	0.664	0.642	0.455
	Max	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Min	0.253	0.246	0.119	0.362	0.206	0.115	0.253	0.206	0.115
	n	101			28			129		
2007	Mean	0.676	0.642	0.461	0.712	0.703	0.534	0.684	0.656	0.478
	Max	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Min	0.301	0.216	0.092	0.32	0.237	0.117	0.301	0.216	0.092
	n	90			27			117		
2006	Mean	0.715	0.727	0.536	0.729	0.766	0.577	0.719	0.737	0.546
	Max	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Min	0.3	0.313	0.192	0.294	0.388	0.131	0.294	0.313	0.131
	n	84			26			110		
2005	Mean	0.738	0.805	0.608	0.704	0.780	0.561	0.731	0.800	0.599
	Max	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Min	0.4	0.397	0.204	0.24	0.393	0.175	0.24	0.393	0.175
	n	77			19			96		
2004	Mean	0.730	0.657	0.505	0.785	0.575	0.484	0.740	0.642	0.502
	Max	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Min	0.287	0.128	0.082	0.426	0.156	0.112	0.287	0.128	0.082
	n	74			16			90		
2003	Mean	0.758	0.704	0.553	0.834	0.654	0.579	0.769	0.697	0.557
	Max	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Min	0.352	0.182	0.126	0.477	0.204	0.149	0.352	0.182	0.126
	n	78			13			91		
2002	Mean	0.907	0.940	0.853	0.931	0.997	0.928	0.910	0.946	0.860
	Max	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Min	0.559	0.449	0.449	0.696	0.984	0.695	0.559	0.449	0.449
	n	67			7			74		
Total	**Mean**	0.742	0.773	0.596	0.736	0.779	0.593	0.739	0.775	0.595
	Max	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Min	0.253	0.108	0.082	0.199	0.156	0.109	0.199	0.108	0.082
	n	**1204**			**397**			**1601**		

Note: TE = technical efficiency, AE = alocative efficiency, CE = cost efficiency

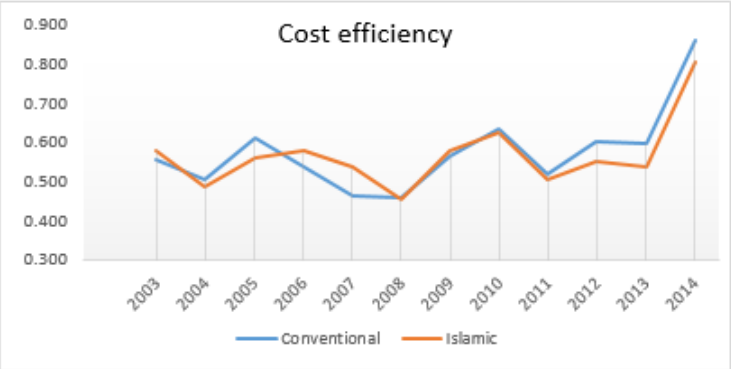
Source: Author's estimation, data obtained from Bankscope

As the cost efficiency was estimated under VRS assumption, we can evaluate how the model employing three inputs (second column in Table 4.5) differs from that employing only two inputs (first column in Table 4.7) in terms of technical efficiency. The results suggest that overall level of technical efficiency is slightly higher in the model with three inputs (0.768) compared to model with two inputs (0.739). Surprisingly, technical efficiency of both types of banks was affected by removing of one variable almost identically, average level of technical efficiency with three inputs is higher by 0.029 for conevntional banks and by 0.028 for Islamic banks. However, the differences are negligible, therefore we can conclude that removing of one input variable due to unavailability of data on input prices didn't distort the model to a large extent.

Maximum level of efficiency in all subsamples is equl to 1 as DEA constructs frontier for individual subsamples (years in this case) and assignes the most efficient banks in the sample by score 1 indicating fully efficient bank. The results also indicates that the range of estimated efficiency scores is pretty wide, cost efficiency estimates take values in interval 0.082 - 1.000 what indicates that DEA is quite strict to inefficient banks. This is another contrast to SFA where distribution of estimates is generally tighter.

Looking at the results, it is evident that cost efficiency is volatile in time. Figure 4.6 displays the evolution of banks efficiencies over the period 2003-2014.

Figure 4.6.: Development of cost efficiency over the period 2003-2014



Source: Author's estimation

Our results suggest that cost efficiency of Islamic banks was lower before 2006 but two years before global financial crisis it was even higher than that of conventional banks. In 2008, when the global financial crisis hit the world economy, the efficiency scores are lowest for both types of banks. In the post-crisis period efficiency was slightly improving and at the almost same level for both banking systems. Since the

downturn in 2011, efficiency of Islamic banks is lower than conventional banks again.

These findings support the hypotheses that Islamic banks are less efficient in general but these differences are narrowing in times of financial instability when conventional banks are hit harder.

4.6. Stochastic Frontier Analysis

4.6.1. Methodology

The researchers' effort to eliminate the shortcomings of DEA has led to the development of Stochastic Frontier Analysis (SFA), the parametric (econometric) alternative measure of efficiency. Unlike DEA, SFA, introduced independently by Aigner, Lovell and Schmidt (1977) and Meeusen and Van denk Broeck (1977), allows for specifying production function, identifies causes of deviation from given technology, takes into consideration the external factors affecting efficiency, and doesn't ignore statistical noise (Hassan, 2005). Thus, SFA is less likely that measurement error, specification error or temporal differences in costs will be misidentified (Bauer et al., 1998).

On the other hand, parametric models such as Stochastic Frontier Analysis require a large sample size for obtaining reliable and credible results (Coelli et al., 2005). The major challenge when employing parametric approach is to find the best way how to separate random error from inefficiency error since none of them is observed (Bauer et al., 1998). To solve this problem, SFA assumes that inefficiencies follow an asymmetric distribution (mostly half-normal), while random errors follow a symmetric distribution (generally standard normal) (Aigner et al., 1997).

Parametric production frontier has following form:

$$y_i = f(x_i, \beta).TE_i$$

Where $i = (1, 2, .., k)$ denotes the individual producers, y represents level of output, X stands for a vector of n inputs, $f(X_i, \beta)$ is the production frontier determined by inputs and technology parameters and β are unknown coefficients of technology parameters to be estimated. Finally, TE_i represents technical efficiency of the i^{th} bank computed as a ratio of observed output to maximum feasible output (Erkoc, 2012):

$$TE_i = \frac{y_i}{f(X_i, \beta)}$$

To take into account random shocks not directly related to the producer or the production process, we have to add a stochastic component $exp(v_i)$ describing these shocks into basic form of parametric frontier stated above. In efficiency literature, this component v_i is usually called statistical noise. Thus, the stochastic frontier has a new form:

$$y_i = f(x_i, \beta).TE_i.exp(v_i)$$

Including also inefficiency effects (u), we can replace technical efficiency TE_i by $exp(-u_i)$ as demonstrated by Coelli et al. (2005):

$$TE_i = \frac{y_i}{exp(X_i^{'}, \beta + v_i)} = \frac{exp(X_i^{'}, \beta + v_i - u_i)}{exp(X_i^{'}, \beta + v_i)} = exp(-u_i)$$

Thus, after proper substitution we get following frontier function:

$$y_i = f(x_i, \beta).TE_i.exp(v_i).exp(-u_i)$$

Now, following Aigner et al. (1977) and Coelli et al. (2005), we can transform stochastic frontier function into

Cobb-Douglas form:

$$lny_i = \beta_0 + \sum_{n=1}^{N} \beta_n ln x_{ni} + v_i - u_i$$

Translog form:

$$lny_i = \beta_0 + \sum_{n=1}^{N} \beta_n ln x_{ni} + \frac{1}{2} \sum_{n=1}^{N} \sum_{m=1}^{N} \beta_{mn} ln x_n ln x_m + v_i - u_i$$

4.6.2. Stochastic Cost Frontier

Once input prices are available, we can estimate cost efficiency by employing a stochastic cost frontier. Assuming all banks minimizing costs and employing N inputs to produce M outputs, we define cost frontier for cross-sectional data in the general logarithmic form:

$$lnTC_i \geq c(w_{1i,} w_{2i}, .., w_{Ni}, y_{1i,} y_{2i}, ...y_{Mi}) + \varepsilon_i$$

where c_i stands for costs of $i-th$ bank, w_{Ni} is a vector of N-input prices, y_{Mi} is a vector of M-outputs and $c(.)$ is a cost function. Random error ε_i is composed of *inefficiency term* (non-negative) u_i that is supposed to be *iid* assuming $u_i \sim N|\left(0, \sigma_u^2\right)|$ and *random error* v_i that is supposed to be *iid* as well with $v_i \sim N\left(0, \sigma_v^2\right)$. In addition, v_i is assumed to be independent of the explanatory variables and u_i independent of v_i (Fiorentino et al. 2006; Coelli et al., 2005).

Moreover, when estimating cost efficiency, functional form for $c(.)$ must be specified. Following Fiorentino et al. (2006) we specify multi-output translog cost functional form (aletrnatively Cobb-Douglas functional form could be used) in this thesis provided by Kumbhakar and Lovell (2000):

$$lnTC_i = \beta_0 + \sum_{m=1}^{M} \beta_m^y ln\, y_{mi} + \sum_{n=1}^{N} \beta_n^w ln\, w_{ni} + \frac{1}{2} \sum_{n=1}^{N} \sum_{k=1}^{K} \beta_{nk} ln\, w_{ni} ln\, w_{ki} +$$

$$+ \frac{1}{2} \sum_{n=1}^{N} \sum_{l=1}^{L} \beta_{nl} ln\, y_{ni} ln\, y_{li} + \sum_{m=1}^{M} \sum_{n=1}^{N} \beta_i ln\, y_m ln\, y_n + v_i - su_i$$

where TC are total costs of $i-th$ bank and $s=-1$ for cost function ($s=1$ for production function[5]). Using this translog function we estimate efficiency scores for all banks in the sample, choice of particular input and output variables follows intermediation approach and is consistent with DEA.

4.6.3. Estimation of Cost Efficiency in SFA

As already mentioned, DEA is not able to treat with panel data. Therefore, as we want to compare DEA and SFA estimates, cross-sectional data were employed in SFA to stay consistent in methodology and to prevent missleading results. The Maximum likelihood estimates (MLE) were obtained from statistical software Stata 12, however, there are alternative computer programs available from which FRONTIER Version 4.1 developed by Coelli (1996) specifically for SFA is the most popular. Stata is conveniant for modelling cost and production functions and is adapted to cross-sectional (half-normal, exponential and truncated distribution models) and panel data (time-varying and time invariant models) estimations.

For comparison with DEA estimates, consistency in variables is required as well.

[5] It follows from the original model $y_i = x_i\beta + v_i - su_i$ that the frontier fits, where $s = 1$for production function and $s=-1$ for cost function (StataCorp, 2012).

Table 4.8.: List of variables used for cost efficiency estimation in SFA

	Variable	Description
Dependent variable:		
TC	Total costs	Sum of operational costs
OUTPUTS:		
y_1	Loans	Total of loans provided (ST and LT)
y_2	Other earning assets	Investment securities and inter-bank funds sold
y_3	Off-balance sheet itms	Sum of off-balance sheet activities (their nominal value)
INPUT PRICES:		
w_1	Price of labour	Personal expenses divided by total funds
w_3	Price of funds	Sum of interest expenses and other operating expense divided by total funds.

Source: Author's compilation

Hence, we employ same inputs (***labour*** x_1 and ***total funds*** x_3), input prices (***price of labour*** $w_1$and ***price of funds*** w_3) and outputs (***loans*** y_1, ***other earning assets*** $y_2$and ***off-balance sheet items*** y_3) as in previous chapter. However, one crucial variable is added to SFA in contrast to DEA - ***Total cost*** TC expressed by the sum of all operational costs. While in DEA total costs were calculated as a product of input quantities and input prices, SFA employes standard accounting data obtained from banks' income statements (Bankscope).

Other difference compared to DEA is that SFA in the estimation doesn't employ input quantities, only total costs, outputs and input prices are required. A distinctive feature of SFA is that all variables must be tranformed to logarithmic form (required by Stata as well as by FRONTIER Version 4.1).

Table 4.9.: Descriptive statistics on variables used in SFA, in mil.USD

	Islamic				**Conventional**			
	Mean	St. Dev.	Min	Max	Mean	St. Dev.	Min	Max
Total costs	432.844	855.860	1.369	7 322.365	429.869	639.046	1.158	4 383.046
OUTPUTS:								
Loans	5 264.753	8 632.054	0.136	57 288.240	7 435.138	12 587.390	0.306	92 892.860
Other earning assets	2 262.848	3 263.553	3.222	19 901.300	4 087.563	5 755.873	0.005	46 685.710
Off-balance sheet activities	1 826.588	3 262.846	2.300	21 732.340	4 238.156	7 532.174	0.301	68 429.570
INPUT PRICES:								
Price of labour	0.029	0.105	0.003	1.758	0.013	0.012	0.002	0.264
Price of funds	0.062	0.074	0.005	0.786	0.040	0.030	0.001	0.652
n	389				1211			

Source: Author's compilation

Before starting estimations, it is necessary to check whether general model assumptions are met. The null hypotheses of *normality* was not supposrted by Shapiro-

Wilk test, however, graphically residuals seem to be normally distributed, only kutosis is slightly higher than usual. Moreover, Breusch-Pagan test revealed strong *heteroskedasticity* in the data. Heteroskedasticity is often present in frontier models but, luckilly, it can be easily treated by inclusion of robust standard errors. *Multicollinearity* is not present, the highest correlation between explanatory variables (0.82) is acceptable. Moreover, Kruskal-Wallis equality-of-population rank test was conducted to test hypothesis whether several samples come from the same population. Three groups (*Country, Year* and *Islamic*) represented by set of dummy variables were tested one by one on all three dependent variables. The test showed that there are statsitically sifnificant differences between subgroups in group Country ($\chi^2(13) = 534.179$, $p = 0.0001$) and group Year ($\chi^2(12) = 64.730$, $p = 0.0001$), while for group *Islamic* we fail to reject null hypothesis ($\chi^2(1) = 0.564$, $p = 0.4525$). However, it was probably caused by the high imbalance in number of observations in subgroups *Islamic* and *Commercial*. Finally, some *outliers* were detected and removed, therefore, final data set is slightly smaller than the original one.

The standard procedure of estimating cost efficiency is to estimate respective coefficients and error term ($\varepsilon_i = u_{it} - v_{it}$) and consequently calculate the efficiency score for each bank in the sample (Tahir and Haron, 2010). This section presents three basic models for estimation of cost efficiency in SFA varying in specification of the inefficiency term u_i: normal/halfnormal, normal/truncated and normal/exponential distribution. (StataCorp, 2012):

- ***Normal/half-normal***: assumes inefficiency term u_i to be independently halfnormaly $N^+(0, \sigma_u^2)$ distributed.
- ***Normal/exponential***: assumes u_i to be independently exponentially distributed with variance σ_u^2.
- ***Normal/truncated***: assumes u_i to be independently $N^+(\mu, \sigma_u^2)$ distributed with truncation point at 0.

Stata enables estimation of all three models, however, there is no general rule that would tell us which model is most suitable for given data. Hence, the only possible way is to estimate all models and then execute statistical test that will identify model that fits the data best.

At first, cost efficiency (CE_1) assuming **normal/half-normal distribution** was estimated. The log-likelihood function of normal/half-normal model is stated as follows:

$$lnL = \sum_{i=1}^{N} \left\{ \frac{1}{2} ln\left(\frac{2}{\pi}\right) - ln\sigma_S + ln\Phi\left(\frac{\lambda s\varepsilon_i}{\sigma_S}\right) - \frac{\varepsilon_i^2}{2\sigma_S^2} \right\}$$

where $\lambda = \sigma_u/\sigma_v$, $\sigma_S = \left(\sigma_u^2 + \sigma_v^2\right)^{\frac{1}{2}}$, $\varepsilon_i = y_i - x_i\beta$ and $\Phi()$ refers to the cumulative distribution function of standard normal distribution. Then cost efficiency (CE_2) assuming **normal/exponential distribution** with log-likelihood function defined as:

$$lnL = \sum_{i=1}^{N} \left\{ -ln\sigma_u + \frac{\sigma_v^2}{2\sigma_u^2} + ln\Phi\left(\frac{-\frac{\sigma_v^2}{\sigma_u} - s\varepsilon_i}{\sigma_v}\right) + \frac{s\varepsilon_i}{\sigma_u} \right\}$$

And finally, cost efficiency CE_3 assuming **normal/truncated distribution** with log-likelihood function:

$$lnL = \sum_{i=1}^{N} \left\{ -\frac{1}{2} ln(2\pi) - ln\sigma_S - ln\Phi\left(\frac{\mu}{\sigma_S\sqrt{\gamma}}\right) + ln\Phi\left[\frac{\mu(1-\gamma) - s\gamma\varepsilon_i}{\left\{\sigma_S^2\gamma(1-\gamma)\right\}^{\frac{1}{2}}}\right] - \frac{1}{2}\left(\frac{s\mu + \varepsilon_i}{\sigma_S}\right)^2 \right\}$$

where $\gamma = \sigma_u^2/\sigma_v^2$ (StataCorp, 2012) was attempted, however, Stata was not able to finish the estimation as truncation point couldn't be found in given data. Therefore, only $CE_1$and CE_2 will be further discussed. Estimation results are provided in Table 4.10.

Table 4.10.: Smmary of cost efficiency estimates in SFA

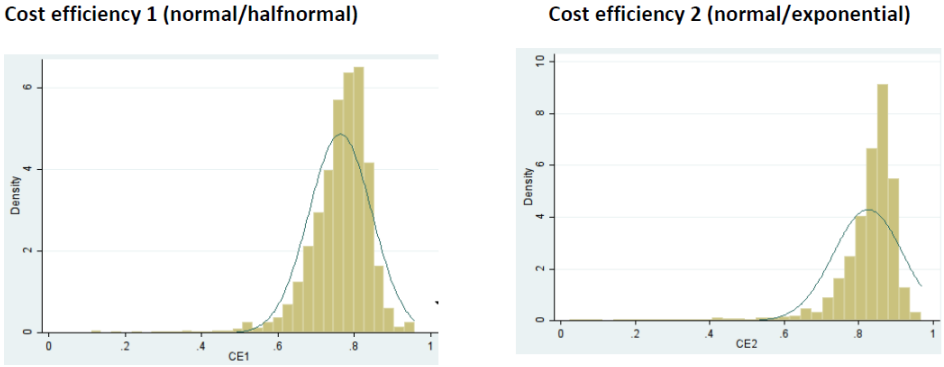
		Conventional		Islamic		Total	
		CE 1	**CE 2**	**CE 1**	**CE 2**	**CE 1**	**CE 2**
2014	Mean	0.764	0.833	0.745	0.797	0.758	0.822
	Min	0.602	0.655	0.436	0.364	0.436	0.364
	Max	0.853	0.904	0.958	0.968	0.958	0.968
	n	80		36		116	
2013	Mean	0.745	0.807	0.740	0.793	0.743	0.803
	Min	0.136	0.033	0.472	0.445	0.136	0.033
	Max	0.889	0.921	0.931	0.950	0.931	0.950
	n	114		47		161	
2012	Mean	0.747	0.810	0.747	0.807	0.747	0.809
	Min	0.111	0.023	0.515	0.407	0.111	0.023
	Max	0.887	0.920	0.946	0.960	0.946	0.960
	n	117		50		167	
2011	Mean	0.762	0.827	0.735	0.790	0.755	0.816
	Min	0.509	0.411	0.483	0.366	0.483	0.366
	Max	0.913	0.939	0.955	0.967	0.955	0.967
	n	112		45		157	
2010	Mean	0.751	0.812	0.735	0.787	0.747	0.805
	Min	0.166	0.062	0.299	0.193	0.166	0.062
	Max	0.888	0.924	0.950	0.964	0.950	0.964
	n	108		41		149	
2009	Mean	0.763	0.829	0.748	0.805	0.759	0.823
	Min	0.411	0.329	0.330	0.230	0.330	0.230
	Max	0.870	0.912	0.941	0.959	0.941	0.959
	n	103		37		140	
2008	Mean	0.766	0.833	0.758	0.820	0.764	0.830
	Min	0.616	0.668	0.534	0.562	0.534	0.562
	Max	0.870	0.912	0.940	0.957	0.940	0.957
	n	101		28		129	
2007	Mean	0.774	0.842	0.774	0.831	0.774	0.840
	Min	0.586	0.626	0.505	0.544	0.505	0.544
	Max	0.871	0.914	0.954	0.968	0.954	0.968
	n	90		28		118	
2006	Mean	0.785	0.851	0.779	0.834	0.783	0.847
	Min	0.641	0.729	0.277	0.160	0.277	0.160
	Max	0.879	0.918	0.941	0.959	0.941	0.959
	n	84		25		109	
2005	Mean	0.782	0.844	0.780	0.834	0.781	0.843
	Min	0.354	0.240	0.550	0.551	0.354	0.240
	Max	0.888	0.923	0.910	0.941	0.910	0.941
	n	77		18		95	
2004	Mean	0.782	0.845	0.806	0.850	0.786	0.846
	Min	0.612	0.676	0.487	0.424	0.487	0.424
	Max	0.886	0.919	0.936	0.951	0.936	0.951
	n	74		15		89	
2003	Mean	0.776	0.839	0.816	0.870	0.781	0.843
	Min	0.608	0.673	0.714	0.787	0.608	0.673
	Max	0.880	0.917	0.895	0.928	0.895	0.928
	n	78		12		90	
2002	Mean	0.779	0.842	0.817	0.873	0.782	0.844
	Min	0.643	0.693	0.754	0.804	0.643	0.693
	Max	0.873	0.913	0.880	0.915	0.880	0.915
	n	73		7		80	
Total	**Mean**	0.767	0.832	0.768	0.822	0.766	0.829
	Min	0.111	0.023	0.277	0.160	0.111	0.023
	Max	0.913	0.939	0.958	0.968	0.958	0.968
	n	**1211**		**389**		**1600**	

Note: CE1 refers to cost efficiency under normal/halfnormal distribution, CE2 under normal/exponential distribution.

Source: Author s estimations, results obtained from Stata

As we can see, cost efficiency scores under normal/half-normal and normal/exponential distribution are not very different, correlation between CE1 and CE2 across years was very high (0.956-0.987), but normal/exponential model provides overall higher efficiency scores. To determine which model fits the data better, two measures of relative quality of statistical models, specifically Akaike Information Criterion (AIC)[6] and Bayesian Information Criterion (BIC), were compared. The lower AIC and BIC, the better model. Hence, given the values AIC 1067.17 and BIC 1110.19, normal/exponentail model was found consistently by both measures to fit the data better than normal/halformal model (AIC 1238.96 and BIC 1281.988).

Figure 4.7.: Histograms of CE1(normal/halfnormal) and CE2 (normal/exponetial)



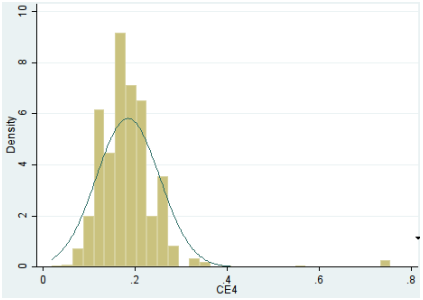
Source: Author's estimations, results obtained from Stata

Nevertheless, graphically normal/halfnormal model seems to be better as normal/exponential model exhibit high kurtosis.

Finally, panel data were applied in SFA (time-varying inefficiency model) for comparison, however, cost efficiency estimates were extremely low and not normally distributed. Hence, it seems that application of panel data in SFA is not much suitable.

[6] AIC and BIC are two popular measures that combine fit and complexity of the model and that are used for comparing maximum likelihood models. The measures are defined as follows: $AIC = -2 * ln(likelihood) + 2 * k$ and $BIC = -2 * ln(likelihood) + ln(N) * k$, where k = number of estimated parameters and N = number of observation. Generally, the smaller AIC and BIC, the better model (StataCorp, 2011).

Figure 4.8.: Histogram of cost efficiency from panel SFA



Source: Author's estimations, results obtained from Stata

4.7. Determinants of Bank Efficiency

To further investigate banks performance and main determinants of banks efficiency, two statistical methods, namely Ordinary Least Squares (OLS) and Generalized Least Squares (GLS), were conducted to examine the impact of individual determinants. The key difference between these methods is that OLS treats with cross-sectional data and hence ignores variation of coefficients in time, while GLS treats with panel data. Under GLS, Random effect (RE) model is preferred over Fixed effect (FE) model as FE doesn't allow inclusion of time-invariant variables (in our case *Islamic* dummy and all *country dummies* would be dropped from the regression). Therefore, Hausman test for comparison Fixed effects and Random effects models was not required.

As we already performed all necessary cost efficiency estimates, we can run a regression that for cross-sectional data has a following form:

$$CE_i = \beta_0 + \beta X_i + u_i$$

where CE_i is dependent variable, X is design matrix of explanatory variables, β is vector of coefficients to be estimated and u_i is an error term of $i-th$ observation $(i = 1,2,....n)$. For panel data the regression is modified by inclucion of time effect as follows:

$$CE_{it} = \beta_0 + \beta X_{it} + a_i + u_{it}$$

where t is time period, a_i is time-invariant unobserved effect and u_{it} is idiosyncratic error. Sum of these two errors $v_{it} = a_i + u_{it}$ is called composite error term (Wooldridge, 2002).

Once again we have to check that all assumptions are met and ensure consistent of

the model. Breusch-Pagan test detected strong heteroskedasticity in the data ($Prob > ch2 = 0.0041$), therefore the regression was executed with robust standard errors. Perfect collinearity or multicollinearity is not present in the data as evidenced by the correlation matrix below. Normality, heterogeneity and exogeneity of data were already checked in previous estimations.

Table 4.11.: Correlation matrix of independent variables

	ln_ta	eqr	llr_gl	roaa	roae	nim	nl_ta	crisis	Islamic
ln_ta	1.0000								
eqr	-0.2589	1.0000							
llr_gl	-0.3261	0.0948	1.0000						
roaa	0.0522	0.2773	-0.1760	1.0000					
roae	0.0715	-0.0927	0.0688	0.3534	1.0000				
nim	-0.1355	0.2882	-0.0239	0.4576	0.1308	1.0000			
nl_ta	0.4329	-0.0405	-0.4354	0.1420	0.0369	0.1092	1.0000		
crisis	0.0201	-0.0387	-0.0569	-0.0774	-0.0674	0.0011	0.0011	1.0000	
islamic	-0.0556	0.3046	-0.0520	-0.0230	-0.0926	0.0359	0.0280	0.0059	1.0000

Source: Author's estimations, results obtained from Stata

4.7.1. Variables Description

This section introduces variables employed in the regression. Set of explanatory variables consists of main bank specific characteristics that were obtained from Bankscope database. Motivation behind all explanatory variables and expecatitions about their impact (+/- signs) are discussed in the following section. The table below provides a brief description.

Table 4.12.: Description of explanatory variables

Variable	**Description**	**Expected sign**
ln_ta	logatithm of total assets (proxy for bank size)	+
eqr	equity ratio (equity/total assets)	+
lln_gl	loan loss reserves/gross loans	-
roaa	return on average assets	+
roae	return on average equity	+
nim	net interest margin	+/-
nl_ta	net loans/total assets	+/-
crisis	= 1 for years 2008 and 2009, 0 otherwise (dummy)	-
islamic	= 1 for Islamic bank, 0 otherwise (dummy)	-
islamic_crisis	= 1 when Islamic $\wedge$ crisis, 0 otherwise (interaction term)	+

Source: Author's compilation

ln_ta total assets in logrithmic form[7] is proxy for a bank's size. We suppose that bank size is positively correlated with cost efficiency (as evidenced by Hassan, 2005; Halkos and Salamouris, 2004 and others) as it should capture potential cost advantages related with economies of scale. Nevertheless, there are also some studies that reveal negative relationship of bank's size and efficiency (e.g. Sufian, 2009; Rahman and Rosman, 2013).

eqr *equity ratio* stands for bank capitalization and is expected to be positivelly correlated with efficiency as it represents cheaper funding. According to Rahemen et al.(2007), capital structure significantly affects liquidity and profitability as it allows a bank to use a various mixture of equity, debt and other financial facilities. Islamic banks are supposed to have higher equity ratio as they provide more equity-based financing, while conventional banks debt-based financing.

llr_gl *loan loss reserves/gross loans* ratio is a proxy for bank asset quality. High ratio generally indicates low quality and more problematic loans in bank's portfolio. As these reserves must be hold aside, and hence don't generate any profit, they considerably decrease bank efficiency. Therefore, negative and highly significant relationship with banks efficiency is expected. However, different lending policy of Islamic banks must be taken into consideration. Islamic banks are required to hold higher reserves than conventional banks what makes them more resilient to financial instability but also less cost efficient. Hence, if our assumptions are right, Islamic banks should be negativelly affected by *llr_gl* much deeply than their conventional counterparts.

roaa *rate of return on average assets* stands for profitability. High profit is generally related with minimized costs, therefore, we expect positive sign. In many studies (e.g. Alkassim, 2005), ROAA and ROAE are used as dependent variables when dealing with the banking performance.

roae *rate of return on average equity* is second profitability indicator. Unlike roae, higher *roae* is expected for Islamic banks due to higher share of

[7] Variables that take wide range of values (total costs, total assets etc.) are highly recommended to be transformed into natural logarithm to minimize risk of regression distortation. Logarithmic transformation generally narrows the range of values what makes estimates less sensitive to outlying observations, stabilizes the variance and normalizes skewed data distribution (Wooldridge, 2002).

equity.

nim *net interest margin*, calculated as a difference between interest received and interest paid divided by total earning assets, is the last profitability ratio. NIM was included despite the fact that Islmic banking is interest-free system. As already mentioned, Bankscope adjusts financial statements of Islamic banks to be comparable with conventional ones. Hence, for Islamic banks NIM stands for margin on PLS activities. The higher the ratio, the cheaper the funding. On the other hand, financial activities with high interest margin are usually associated with higher risk that can be costly.

nl_ta *net loans/total assests* measures the percentage of total assets that are invested in the loans. Bank' s management usually tries to avoid high *nl_ta* ratio as it can indicate liquidity issues. On the other hand, loans are source of bank' income, therefore higher ratio could indicate higher profit, and hence higher efficiency.

crisis dummy variable = 1 for years 2008 and 2009, 0 otherwise. Obvisously, negative effect of the crisis on efficiency is expected, however, as Islamic banks are considered to be more resilient to financial instability, the negative effect should be stronger for conventional banks.

islamic dummy variable = 1 for Islamic bank, 0 for conventional bank. We expect Islamic banks to be less efficient, hence negative sign.

islamic_crisis dummy variable = 1 when Islamic bank $\wedge$ crisis, 0 otherwise. Variables *islamic* and *crisis* are supposed to be negativelly correlated with efficiency but we also assume that Islamic banks withstood almost uneffected during the crisis. In other words, reverse impact of the crisis on Islamic banks is expected. Therefore, interaction term was added to the regression to verify this statement. Indeed, variables *islamic* and *islamic_crisis* were used only in the total sample.

Table 4.13.: Descriptive statistics on bank-specific explanatory variables

	Islamic				Conventional			
	Mean	St. Dev.	Min	Max	Mean	St. Dev.	Min	Max
ln_ta	14.950	1.633	10.796	18.385	15.283	1.637	10.316	18.710
eqr	19.897	15.232	3.009	91.266	12.415	7.024	-31.368	86.670
lln_gl	5.569	8.846	0.019	81.323	6.578	7.491	0.003	76.482
roaa	1.727	4.420	-26.266	35.102	1.528	1.431	-8.484	13.152
roae	9.548	16.346	-127.147	73.179	13.234	19.701	-135.994	547.381
nim	3.542	4.418	-4.480	48.197	3.119	1.366	-0.431	17.707
nl_ta	49.406	20.748	0.151	92.736	47.420	19.064	0.337	89.031
crisis			0	1			0	1
islamic_crisis			0	1			0	0
n	389				1211			

Source: Author's compilation, results obtained from Stata

Hence, for the whole sample of banks our baseline model has a following form:

$$CE_{it} = \beta_0 + \beta_1 ln\_ta_{it} + \beta_2 eqr_{it} + \beta_3 llr\_gl_{it} + \beta_4 roaa_{it} + \beta_5 roae_{it} + \beta_6 nim_{it} + \beta_7 nl\_ta_{it} + \beta_8 crisis_{it} + \beta_9 islamic_{it} + \beta_{10} islamic\_crisis_{it} + a_i + u_{it}$$

For a testing Islamic and conventional banks separately, the model was adjusted by removing variables *islamic* and *islamic_crisis* as follows:

$$CE_{it} = \beta_0 + \beta_1 ln\_ta_{it} + \beta_2 eqr_{it} + \beta_3 llr\_gl_{it} + \beta_4 roaa_{it} + \beta_5 roae_{it} + \beta_6 nim_{it} + \beta_7 nl\_ta_{it} + \beta_8 crisis_{it} + a_i + u_{it}$$

when considering panel data, in the cross-sectional models time periods t are ignored as stated above. In addition, same model but extended by country dummies was conducted. The results are not displeyd as the most of country dummies were found to be insignificant.

4.7.2. Empirical Results

First regression was conducted on the whole sample (1525 banks) with employing dummy variable *islamic* for monitoring differences in efficiency between Islamic and commercial banks. Then, both types of bank were tested separately, totalling 345 observations of Islamic banks and 1180 observations of conventional banks, to get more reliable results. Explanatory variables were regressed on all three dependent variables, i.e. cost efficiency scores obtained from SFA ($CE1$ and $CE2$) and cost efficiency scores obtained from DEA (CE_{DEA}).

Note once again that we investigate effect of bank specific characteristics on cost efficiency. Alternativelly, we could examine determinants of bank inefficicency, with dependent variable u. Intuitivelly, in this case we would get similar results but with reverse signs.

Tables 4.14, 4.15 and 4.16 present a summary of OLS and GLS results for individual dependent variable (*CE1, CE2, CE_DEA*)

Table 4.14.: Determinants of banks efficiency with dependent variable CE1 (normal/half-normal)

	Islamic		**Commercial**		**Total**	
CE1	OLS	Panel	OLS	Panel	OLS	Panel
ln_ta	-0.0134699	-.0209878	-0.0105145	-.0199947	-.0100433	-.0218279
	(-3.5)***	(-3.79)***	(-7.71)***	(-10.10)***	(-7.27)***	(-10.28)***
eqr	0.0013758	.0014163	0.0013078	.0007794	.0011921	.0009758
	(3.37)***	(2.90)***	(3.67)***	(2.26)**	(5.23) ***	(3.45)***
llr_gl	-.0046114	-.0044494	-.0001184	-.0013327	-.0016093	-.0023054
	(-6.88)***	(-6.96)***	(-0.41)	(-5.56)***	(-5.83)***	(-9.26)***
roaa	.0092883	.00308	.0097619	.0039701	.0045616	.0012502
	(3.04)***	(1.01)	(5.71)***	(3.35)***	(3.73)***	(1.41)
roae	-.0022984	-.0006886	.0000699	.0000223	.000096	.0001048
	(-3.25)***	(-1.00)	(0.73)	(0.38)	(0.88)	(1.48)
nim	-.0009503	-.0013679	-.0241376	-.0212779	-.0063081	-.003925
	(-0.60)	(-0.89)	(-14.33)***	(-12.04)***	(-5.89)***	(-4.15)***
nl_ta	.0015443	.0013478	.0013567	.0007737	.001164	.0008117
	(5.14)***	(4.06)***	(11.73)***	(4.67)***	(9.95)***	(5.19)***
crisis	-.0026309	-.004014	-.0004099	-.0017465	-.0030592	-.003017
	(-0.21)	(-0.42)	(-0.09)	(-0.63)	(-0.50)	(-0.89)
islamic					-.0322307	-.027571
					(-6.22)***	(-2.04)**
islamic*crisis					.0073222	.0038502
					(0.61)	(0.53)
intercept	.8847559	.9957046	.9061651	1.080451	.8722976	1.057286
	(15.85)***	(11.64)***	(40.52)***	(33.93)***	(40.35) ***	(31.46)***
n	345		1180		1525	
R-sq	0.2918		0.2305		0.1613	
R within		0.1854		0.1825		0.1466
R between		0.4747		0.1858		0.0706
R overall		0.2700		0.1375		0.0996
sigma_u		0.0705865		0.06357868		0.08245336
sigma_e		0.06152803		0.0330488		0.04166043
ρ		0.56824447		0.78727641		0.79662975

Note: *** significant at 1% level, ** significant at 5% level, * significant at 10% level. T-statistics in paretheses.

Source: Author's estimation, results obtained from Stata

Table 4.15.: Determinants of bank efficiency with dependent variable CE2 (normal/exponential)

	Islamic		**Commercial**		**Total**	
CE2	OLS	Panel	OLS	Panel	OLS	Panel
ln_ta	-0.0064138	-.014445	-.0053491	-.0148987	-.0042725	-.0170434
	(-1.36)	(-2.11)**	(-3.43)***	(-6.23)***	(-2.63)***	(-6.41)***
eqr	0.0013089	.0014659	.0001625	.0003643	.0005446	.0007004
	(2.62)***	(2.42)**	(0.40)	(0.88)	(1.96)**	(1.98)**
llr_gl	-.0054214	-.0057254	-.0001213	-.0013949	-.0018789	-.0027104
	(-6.60)***	(-7.01)***	(-0.37)	(-4.81)***	(-5.63)***	(-8.61)***
roaa	.0089029	.0038116	.0090621	.003597	.0031803	.0008113
	(2.38)**	(0.98)	(4.64)***	(2.52)**	(2.41)**	(0.72)
roae	-.0024398	-.0010233	.0000435	3.04e-06	.0001201	.0001201
	(-2.81)***	(-1.15)	(0.40)	(0.04)	(0.94)	(1.34)
nim	-.000398	-.000944	-.0254281	-.0248377	-.0057773	-.0036556
	(-0.20)	(-0.48)	(-13.20)***	(-11.65)***	(-4.59)***	(-3.06)***
nl_ta	.0015935	.0015344	.0010881	.000628	.0009111	.0008014
	(4.32)***	(3.62)***	(8.22)***	(3.14)***	(6.65)***	(4.07)***
crisis	-.001145	-.0061555	.0006202	-.000997	-.0016952	-.0027471
	(-0.07)	(-0.49)	(0.11)	(-0.30)	(-0.25)	(-0.64)
islamic					-.0355089	-.034835
					(-5.84)***	(-2.14)**
islamic*crisis					.0070545	.0021508
					(0.51)	(0.23)
intercept	.8366248	.9498024	.9240475	1.089733	.8699174	1.053388
	(12.22)***	(9.02)***	(36.12)***	(28.36)***	(34.25)***	(25.08)***
n	345		1180		1525	
R	0.2427		0.1657		0.1061	
R within		0.1646		0.1238		0.0935
R between		0.4774		0.2404		0.0643
R overall		0.2299		0.1045		0.0618
sigma_u		.08103137		.07660728		.09867833
sigma_e		.08173076		.04007066		.05313655
rho		.49570306		.78517712		.7752158

Note: *** significant at 1% level, ** significant at 5% level, * significant at 10% level. T-statistics in paretheses.

Source: Author's estimation, results obtained from Stata

Table 4.16.: Determinants of bank efficiency with dependent variable CE_DEA

	Islamic		**Commercial**		**Total**	
CE_DEA	OLS	Panel	OLS	Panel	OLS	Panel
ln_ta	.0668313	.0584918	0.1384816	.1144882	.1245319	.0951715
	(6.16)***	(4.10)***	(32.52)***	(18.62)***	(31.23)***	(15.37)***
eqr	.0069034	.0062493	0.012327	.0094634	.0093687	.0070924
	(6.00)***	(4.74)***	(11.08)***	(7.27)***	(13.87)***	(8.37)***
llr_gl	.0034727	.0038319	0.0037369	.0036823	.0026568	.0032913
	(1.84)*	(1.96)**	(4.16)***	(3.67)***	(3.14)***	(3.61)***
roaa	.0025393	.0037866	-.0005827	-.0009048	.0035163	.0013967
	(0.29)	(0.41)	(-0.11)	(-0.17)	(1.09)	(0.42)
roae	.000968	.0000719	.0002342	.0002305	.0001815	.0002062
	(0.48)	(0.03)	(0.79)	(0.79)	(0.58)	(0.69)
nim	-.0004188	.0006338	-.0158219	-.0150297	-.0050132	-.0019371
	(-0.09)	(0.13)	(-3.02)**	(-2.37)**	(-1.63)	(-0.56)
nl_ta	.0006418	.0015467	-.0017107	-.0010105	-.0013342	-.0001095
	(0.76)	(1.56)	(-4.74)***	(-1.93)**	(-3.96)***	(-0.22)
crisis	-.0625411	-.0544024	-.0857344	-.0802751	-.0870953	-.0782587
	(-1.73)	(-1.63)	(-5.73)***	(-5.78)***	(-5.33)***	(-5.36)***
islamic					-.0521586	-.030706
					(-3.49)***	(-1.27)
islamic*crisis					.0153437	.0201451
					(0.45)	(0.65)
intercept	-.6221676	-.5219681	-1.566876	-1.202742	-1.365243	-.9656897
	(-3.94)***	(-2.43)**	(-22.44)***	(-12.28)***	(-21.86)***	(-10.13)***
n	344		1176		1520	
R	0.2103		0.5413		0.4442	
R within		0.0333		0.0516		0.0434
R between		0.3260		0.6989		0.5185
R overall		0.2058		0.5397		0.4379
sigma_u		.1207358		.08473484		.11960027
sigma_e		.22049549		.17117634		.18316446
rho		.23066765		.1968128		.29891733

Note: *** significant at 1% level, ** significant at 5% level, * significant at 10% level. T-statistics in paretheses.

Source: Author's estimation, results obtained from Stata

4.7.3. Results and Discussion

Let start with discussing of regressions with dependent varables obtained in SFA. The results in Tables 4.14 and 4.15 indicate that there are almost no differences between normal/half-normal and normal/exponential models in terms of signs and significance. Therefore, hereafter these two models with dependent variables $CE1$ and

$CE2$ will be discussed together under the common name SFA model[8] for simplicity not to repeat the same thing twice. Nevertheless, based on $R-sq$ values and AIC and BIC measures of relative model quality, model with dependent variable $CE1$ (normal/half-normal) was found to be superior.

Now let us turn the attention back to the banks efficiency determinants, starting with those that are consistent with our expectations. Variable *eqr* denoting equity ratio was found strongly positively correlated with the efficiency for both types of banks. This result is supported by both SFA and DEA models. It implies that well balanced capital structure significantly improves banks cost efficiency. In addition, it should be noted that Islamic banks, on average, have significantly higher equity ratio (null hypothesis rejected at p-value = 0.000) than conventional banks implying better capital structure in Islamic banks. This is not surprising due to higher portion of equity-like instruments associated with PLS activities in Islamci banks.

Moreover, the variable llr_gl representing asset quality (the higher the ratio, the lower quality) also significantly affects the efficiency as expected based on SFA model. However, DEA surprisingly provides reverse results what could indicate that loan loss reserves need not be necessarily associated with worse portfolio, particularly in Islamic banks, but with higher banks precaution and hence lower potential cost related with liquidity issues.

One of the most important findings of this thesis is associated with impact of bank's specialization. Both SFA and DEA consistently revealed that Islamic banks are significantly less cost efficient than their conventional counterparts. This finding supports our main hypothesis that Islamic banking products are more cost demanding and is consistent with many previous studies (see e.g. Hassan, 2005; Mokhtar et al., 2006 and Srairi, 2010). Moreover, we peformed T-test in Stata to determine whether the mean of dependent variable (CE) is the same across two independent groups (Islamic vs. conventional). Based on *p-value* lower than 0.05 we reject the null hypothesis implying statistically significant difference in cost efficiency between Islamic and conventional banks.

[8] Note that SFA model and DEA model are meant the models with dependent variables CE obtained in Stochstic Frontier Analysis and Data Envelopment Analysis, respectively. This notation is used just for simplicity.

Table 4.17.: Summary of empirical results vs. expectations

	Islamic			**Conventional**			**Total**		
Variable	expect.	SFA	DEA	expect.	SFA	DEA	expect.	SFA	DEA
ln_ta	+	- / sig.	+/ sig.	+	- / sig.	+/ sig.	+	- / sig.	+/ sig.
eqr	+	+ / sig.	+ / sig.	+	+ / sig.	+ / sig.	+	+ / sig.	+ / sig.
lln_gl	-	- / sig	+ / sig	-	- / sig.	+/ sig.	-	- / sig.	+/ sig.
roaa	+	+ / sig.*	+/ insig.	+	+/ sig.	+/ insig.	+	+/ sig.*	+ /insig.
roae	+	- / sig.*	+ / insig.	+	+/ insig.	+/ insig.	+	+/ insig.	+ /insig.
nim	+/-	- / insig.	- / insig.	+/-	- / sig.	- / sig.	+/-	- / sig.	- / insig.
nl_ta	+/-	+ / sig.	+ / insig.	+/-	+/ sig.	-/ sig.	+/-	+/ sig.	- / sig.
crisis	**- / insig.**	**- / insig.**	**- / insig.**	**-/ sig.**	**- / insig.**	**- / sig.**	**- / sig.**	**- / insig.**	**- / sig.**
islamic							**-**	**- / sig.**	**- / sig.**
crisis_islamic							+	+/ insig.	+/ insig.

Note: * denotes variables that were found significant in OLS regression only.

Source: Author's compilation

Moreover, both SFA and DEA confirmed insignificant impact of the *crisis* on Islamic banks cost efficiency as expected, the significant negative impact of the crisis on conventional banks was revealed only in DEA. However, it should be stressed that we can not make a general conclusion about banks' stability only based on changes in their cost efficiency as the financial instability is generally accompanied by many other effects that can not be fully captured in efficiency ratio.

The last dummy variable *islamic_crisis* (interaction term), reflecting reverse or at least moderate impact of the crisis on Islamic banks, had a positive but insignificant effect on the efficiency.

The regression provides surprising findings about the impact of the bank's size. While DEA indicates significant positive relationship as expected due to potential economies of scale, SFA provides reverse results (negative sign). However, negative correlation between bank's size and efficiency is not unusual in practise and was found in many previous studies. According to findings of Rahman and Rosman (2013), most of banks, particularly in MENA region, are operating at decreasing return to scale (DRS[9]), it means that these banks are too large and hence may operate below the optimum scale.

SFA and DEA models also provide contradicting findings regarding *nl_ta*, i.e. portion of loans on total assets. As already mentioned, high *nl_ta* can result in liquidity issues that are associated with high costs, but it can also indicate that high portion of assets is efficiently invested in profitable activities. In SFA model, *nl_ta*

[9]Operating at IRS indicates that any proportionate increase in inputs results in higher than propotionate increase of outputs, while DRS implies smaller increase of outputs relative to increase in inputs (Rahman and Rosman, 2013).

was found to be significantly positively correlated with cost efficiency in both types of banks, while DEA model indicates that nl_ta has positive but insignificant impact on Islamic banks and significant negative impact on conventional banks. Here it should be emphasized that despite different form of loans provided by Islamic banks, surprisingly no significant difference in mean of nl_ta between Islamic and conventional banks was detected by T-test.

Finally, the impact of banks profitability on efficiency was investigated by including three profitability ratios (*roaa*, *roae* and *nim*). While ROAA was revealed to have significant positive impact on efficiency, ROAE had no influence on profitability in SFA model. Surprisingly, DEA model indicates that cost efficiency is not significantly affected by banks profitability. This finding is consistent with Yudistira (2004) and Ftiti et al. (2013) who emphasize that profitable banks need not necessarily be cost efficient at the same time.

In addition, both SFA and DEA results indicate that *nim* significantly decreases the efficiency of conventional banks but has no direct impact on the performance of Islamic banks. However, it must be recalled that Islamic banks have no interest, hence *nim* in Islamic banking refers to margin on Profit and Loss Sharing activities.

To sum up, main findings of this thesis indicate that banks cost efficiency is primarily influenced by bank's specialization, size, quality of portfolio and balanced capital structure but interestingly almost unaffected by the profitability. In addition, Islamic banks have proven to be more resilient to financial instability by DEA. Furthermore, our results reveal that in both types of banks there is a potential space for efficiency impovement.

Lastly, most of explanantory variables were found by T-test to be significantly different across Islamic and conventional banks suggesting different banking and credit policy. This finding is consistent with previous Financial ratio analysis.

Although there are some contradictory findings regarding impact of bank-specific characteristcs on the cost efficiency, both SFA and DEA estimates consistently support our hypothesis of lower cost efficiency of Islamic banks and negligible impact of the crisis on their performance. It is obvious that results of SFA and DEA can not be compared with each other in absolute terms due to considerable methodological differences, however they should be consistent in general conclusions. In this thesis, SFA method was revealed to provide higher quality and more reliable results but it doesn't mean that SFA is better and more appropriate method in general. In some cases, simpler non-parametric model can be more suitable despite its considerable statistical limitations. Choice of proper methodology is dependent on the quality and availability of data, characteristics of decision making units in the sample, question

being investigated and many other factors.

Chapter 5
Conclusion

The investigation of bank efficiency and stability is of growing importance, especially in the light of the recent financial crisis. It is obvious that the more efficient bank, the higher their profitability and hence the larger volume of funds intermediated. It implies lower prices of financial products, higher quality of provided services and better access to finance that altogether lead to higher level of investments and consumption in the economy. Therefore, we can say that banks efficiency significantly improves financial environment and hence indirectly influences social welfare. However, efficiency itself is not enough to ensure financial health in the economy. Other very important criterion that must be taken into consideration is banks stability and it was proved to be a weakness of conventional banks during the global financial crisis. Islamic banks, on the other hand, surprisingly withstood the crisis almost unaffected and demonstrated to be resilient to financial instability. This event has turned the world's attention towards Islamic banking that had been largely overlooked until that time.

Some researchers (e.g. Hidayat and Abduh, 2012) argue that if some principles of Islamic banking have been applied in conventional banking, the crisis would be probably avoided, or at least its impacts significantly mitigated. Nevertheless, it seems that the price of stability is relatively high as Islamic banks are generally considered to be less efficient than their conventional counterparts.

Two frontier techniques, namely parametric Stochastic Frontier Analysis (SFA) and non-parametric Data Envelopment Analysis (DEA) were performed independently in this thesis to investigate and compare efficiency of 68 Islamic and 138 conventional banks across 14 Middle East countries in the period 2002 and 2014. Furthermore, the impact of the financial crisis on both types of banks was examined with expectations of insignificant effect on Islamic banks. Unbalanced bank-level data used in this study were obtained from the Bankscope database (Bureau Van

Dijk). Finally, a cross-sectional and panel regression analyses were conducted to investigate relationship between banks efficiency and a set of bank-specific characteristics.

Both SFA and DEA consistently revealed that Islamic banks are significantly less cost efficient than traditional banks, nevertheless, the difference is smaller than expected. This finding is quite surprising when taken into consideration competitive advantages of conventional banks over Islamic banks, including wider range of financial opportunities, the pre-determined certain rate of return on transactions, inter-bank lending market and lower religious restrictiveness. Further, both frontier techniques confirmed negative and insignificant impact of the crisis on Islamic banks efficiency as expected. However, significant negative effect on conventional banks was revealed only by DEA.

The findings also suggest that banks efficiency is determined mainly by portfolio quality, bank's size, capital structure and bank's specialization but surprisingly is not affected by banks profitability, particularly for Islamic banks.

Although banking theory suggests fundamental differences in performance of Islamic and conventional banks that are based primarily on the total absence of the interest, application of *Profit and Loss principle* in investment activities and equity-like nature of Islamic banking activities, empirical evidence has shown that they are not so distant in reality.

To sum up, empirical evidience suggests that interest-free financial intermediation is more stable but simultaneously more cost demanding compared to traditional banking system.

Data Envelopment Analysis is popular method among researchers mainly due to its simplicity of estimation as no specification of functional form for production function is required. Other crucial advantage of DEA is that it works even on small samples, hence compared to other techniques, DEA is less data demanding. On the other hand, DEA doesn't take into account statistical noise in the estimation what implies a pretty high risk of omitting important variables. Further, DEA is not able to accomodate panel data and is relatively strict to inefficient banks (Coelli, 2005; Berg, 2010). As it seems that shortcomings outweigh advantages in DEA, parametric SFA is being often preferred. However, it should be stressed that there are significant methodological differences between SFA and DEA and hence it can not be determined which one is universally more suitable. In general, frontier efficiency techniques provide valuable comparative and benchmarking information compared to single-ratio analyses, however, suitability of given frontier technique is highly individual and depends on quality and availability of data, model specification, variables employed and many

other factors. Hence, despite several shortcoming of DEA, in some cases the simpler model can be more appropriate. In general, performing of both methods is the best way how to find a proper model and how to verify validity of results. It is obvious that efficiency estimates from DEA and SFA can not be compared in absolute terms as the range of efficiency scores is much wider in DEA, but it should provide similar conclusions.

Comparison of the two differently operating banking systems brings interesting outcomes regarding banks stability. The empirical results suggest that the stability of banking system is achievable, when taking the proper measures, but very costly. High reserves imply higher stability but also represent a portion of banks' funds that cannot be efficiently utilized. Hence, the unnecessarily high reserves may cause a slowdown of the economy. Futher, the results indicate that the low resilience to financial instability is a weakness of conventional banking while the low cost efficiency is a weakness of Islamic banking. Therefore, this research raises a number of new questions. Can effective banks be simultaneously stable and vice versa? What is the optimal trade-off between the level of efficiency and the level of stability? Can the spread of Islamic finance improve stability of international financial market? These questions could be a subject of further research as they have crucial policy implications for bank regulation.

Bibliography

Abdul- Majid, M., Saal, D. and Battisti, G. (2010): *Efficiency in Islamic and conventional banking: an international comparison*, Journal of Productivity Analysis, Volume 34, pp. 25–43

Aigner, D., Lovell C.A.K., and Schmidt P. (1977): *Formulation and estimation of stochastic frontier production function models*, Journal of Econometrics 6: 21-37

Akhtar, M. F., Ali, K. and Sadaqat, S.(2011): *Liquidity Risk Management: A comparative study between Conventional and Islamic Banks of Pakistan*, Interdisciplinary Journal of Research in Business, Vol. 1, Issue. 1, pp.35-44

Alkassim, F. A. (2005): *The Profitability of Islamic and Conventional Banking in the GCC Countries: A Comparative Study*; Bangor, UK: University of Wales

Amba, M. S. and Almukharreq, F. (2013): *Impact of the Financial Crisis on Profitability of the Islamic Banks vs Conventional Banks- Evidence from GCC*, International Journal of Financial Research, Vol. 4, No. 3, ISSN 1923-4023

Archer, S. and Rifaat, A.A.K. (2009): *Profit-sharing investment accounts in Islamic banks: Regulatory problems and possible solutions*, Journal of Banking Regulation, Vol. 10/Iss.4, pp. 300-306

Ariff, M. (1988): *Islamic Banking, Asian-Pacific Economic Literature*, September: pp 46- 62

Ariff, M. and Iqbal, M. (2011): *The Foundations of Islamic Banking: Theory, Practice and Education*, Cheltenham, UK: Edward Elgar Publishing Ltd., ISBN 978-1-84980-792-0

Avkiran, N. K. (1999): *The Evidence on Efficiency Gains: The Role of Mergers and the Benefits to the Public*, Journal of Banking and Finance 23 (7), 991-1013.

Bader et al. (2008): *Cost, Revenue and Profit Efficiency of Islamic versus Conventional Banks: International Evidence Using Data Envelopment Analysis*, Islamic Economic Studies Vol. 15, No. 2

Bashir, A. M. (2001): *Assessing the Performance of Islamic Banks: Some Evidence from the Middle East*, American Economic Association Annual Meeting, New Orleans, Louisiana

Bauer, P. W., Berger, A. N., Ferrier, G. D., and Humphrey, D. B. (1998): *Consistency Conditions for Regulatory Analysis of Financial Institutions: A Comparison of Frontier Efficiency Methods*, Journal of Economics and Business 50(2): 85-114.

Beck at. al. (2010): *Islamic vs. Convetional Banking: Business Model, Efficiency and Stability*, Policy Research Working Paper 5446, World Bank

Berg, S. (2010): *Water Utility Benchmarking: Measurement, Methodology, and Performance Incentives*, London, UK: IWA Publishing, pp.172, ISBN: 9781843392729

Berger, A. N., Hunter, W.C. and Timme, S. G. (1993): *The Efficiency of Financial Institutions: A Review and Preview of Research Past, Present and Future*, Journal of Banking and Finance, 17, 221-249

Berger, A. N and Humphrey, D. B. (1997): *Efficiency of Financial Institutions: International Survey and Directions for Future Research*, European Journal of Operational Research 98(2): 175- 212.

Berger, A. N. and Mester, L.J. (1997): *Inside the black box: What explains differences in the efficiencies of financial institutions*, Journal of Banking and Finance 21, 895-947

Canhoto, A. and Dermine, J. (2003): *A Note on Banking Efficiency in Portugal: New Vs. Old. Banks*, Journal of Banking and Finance 27 (11), 2087-2098.

Coelli, T. J. (1996): *A Guide to DEAP Version 2.1: A Data Envelopment Analysis (Computer) Program*, CEPA Working Paper, No 8/96, ISBN 1 86389 4969

Coelli, T. J. (1996): *A Guide to FRONTIER Version 4.1: A Computer Program for Stochastic Frontier Production and Cost Function Estimation*, Centre for Efficiency and Productivity Analysis (CEPA) Working paper, 96/07, ISBN: 1 86389 4950

Coelli, T. J.; Rao, D.S.P., O'Donnell, C.J. and Battese, G.E. (2005): *An Introduction to Efficiency and ProductivityAnalysis*, 2nd Edition, Springer, New York, 350 pp.

Das A. and Ghosh S. (2006): *Financial deregulation and efficiency: An empirical analysis of Indian banks during the post reform period*, Review of Financial Economics. 15(3). 197-199

Derbel, H. (2011): *Can Islamic Finance Constitute A Solution to Crisis?*, International Journal of Economics and Finance, Vol. 3, No. 3

El-Galfy, A., Khiyar, K. A. (2012): *Islamic Banking And Economic Growth: A Review*, The Journal of Applied Business Research – September/October 2012; Volume 28, Number 5

El-Gamal, M. A. (2003): *"Interest" and the Paradox of Contemporary Islamic Law and Finance*, Fordham International Law Journal, Vol. 27, Iss. 1, p. 108-149

El-Hawary, D., Grais, W. and Iqbal, Z. (2007): *Diversity in the regulation of Islamic Financial Institutions*, The Quarterly Review of Economics and Finance 46 (2007) 778–800

Erkoc, T. E. (2012): *Estimation Methodlogy of Economic Efficiency: Stochastic Frontier Analysis vs Data Envelopment Analysis*, International Journal of Academic Research in Economics and Management Sciences, Vol. 1, No. 1

Erol C. and El-Bdour, R. (1989) :*Attitudes, Behaviour, and Patronage Factors of Bank Customers towards Islamic Banks*, International Journal of Bank Marketing, Vol. 7 Iss: 6, p.31 – 37

Fare, R., Grosskopf, S., Norris, M. and Zhang, Z. (1994): *Productivity growth, Technical Progress and Efficiency Changes in Industrialized Countries*, American Economic Review, 84, pp 66-83

Farrell, M. J. (1957): *The Measurement of Productive Efficiency*, Journal of the Royal Statistical Society, Series A, 120 (3): 253-290

Farooq, M. and Zaheer, S. (2015): *Are Islamic Banks More Resilient during Financial Panics?,* IMF Working Paper, Research Department and Strategy, Policy, and Review Department, WP/15/41

Favero, C. and Papi, L. (1995): *Technical efficiency and scale efficiency in the Italian banking sector: A nonparametric approach*, Applied Economics, 27, p. 385–395.

Fiorentino, E., Karmann, A. and Koetter, M. (2006): *The cost efficiency of German banks: a comparison of SFA and DEA*, Deutsche Bundesbank, Discussion Paper Series 2: Banking and Financial Studies No 10/2006

Ftiti, Z., Nafti, O. and Sreiri, S.(2013): *Efficiency Of Islamic Banks During Subprime Crisis: Evidence Of GCC Countries*, The Journal of Applied Business Research, Volume 29, Number 1

Free World Map [online]: available at http://www.freeworldmaps.net/

Gafoor, A. L. M. A. (1995): *Islamic banking&Finance: Another approach*; Revised version of a paper presented at the Islamic Hinterland Conference on Critical Debates Among Canadian Muslims

Gerrard, P. and Cunningham, J.B. (1997): *Islamic Banking: A Study in Singapore*, International Journal of Bank Marketing, Vol. 15, Iss. 6, p. 204-216

Grifell-Tatjé, E. and Lovell, C. A. K. (1997): *A DEA-based analysis of productivity change and intertemporal managerial performance*, Annals of Operations Research, Volume 73, pp177-189

Halkos, G. E. and Salamouris, D. S. (2004): *Efficiency measurement of the Greek commercial banks with the use of financial ratios: a DEA*, Management Accounting Research, Vol. 15, No.2, pp. 201-224

Hamdi, F.M. and Zarai, M.A. (2013): *Earnings Management and Investment Accounts Holders Interests In Islamic Banking Institutions*, International Journal of Business and Management Invention, Volume 2 Iss. 12, ISSN (Online): 2319 – 8028, p. 22-35

Hanif, M. (2014): *Differences and Similarities in Islamic and Conventional Banking*, International Journal of Business and Social Sciences, Volume 2, No 2

Hasan, M. and Dridi, J. (2010): *The Effects of the Global Crisis on Islamic and Conventional Banks: A Comparative Study*, IMF Working Paper 10/201

Hassan, M .K. (2003): *Cost, Profit and X-Efficiency of Islamic Banks in Pakistan, Iran and Sudan*, Paper presented at the International Conference on Islamic Banking: Risk Management, Regulation and Supervision, organized by Bank of Indonesia, Indonesia Ministry of Finance and Islamic Development Bank

Hassan, M. K. (2005): *The Cost, Profit and X-Efficiency of Islamic Banks*, 12th ERF Conference Paper

Hassan, M. K. and and Lewis , M.K. (2007): *Handbook of Islamic Banking*, ISBN 978 1 84542 083 3

Hidayat, S. E. and Abduh, M: (2012): *Does Financial Crisis Give Impacts on Bahrain Islamic BankingPerformance? A Panel Regression Analysis*, International Journal of Economics and Finance, Vol. 4, No. 7, pp. 79-87

Hughes, A. and Yaisawarng, S. (2004): *Sensitivity and dimensionality tests of DEA efficiency scores*, Eur. J. Oper. Res. 2004, 154

Chapra, U. (2008): *The Global Financial Crisis: Can Islamic Finance Help Minimize the Severity and Frequency of Such a Crisis in the Future?* paper presented on Conference on Forum on the Global Financial Crisis (Jeddah, 2008: Islamic Development Bank)

Charnes, A., Cooper, W. W. and Rhodes, E. (1978): *Measuring the Efficiency of Decision Making Units*, European Journal of Operational Research 2 (6), 429-44

International Monatery Fund (2011): *Global financial stability report, Durable Financial Stability: Getting There from Here*, Chapter 2: How to adress systemic part of liquidity risk, p.77

Investment&Finance: the financial encyclopedia [online], Investment&Finance, © 2005 Investment and Finance, available at http://investment-and-finance.net/

Islamic Financial Services Board (2015): *Islamic Financial Services Industry Stability Report 2015*, ISBN 978-967-5687-42-6

Iqbal, M. and Molyneux, P. (2005): *Thirty Years of Islamic Banking: History, Performance and Prospects,* Palgrave Macmillan: Basingstoke, Hampshire (UK)

Jedidia, K. B. and Hamza, H. (2014): *Profits and Losses Sharing paradigm in Islamic banks: Constraints or solutions for liquidity management?* Journal of Islamic Economics, Banking and Finance, Vol. 10 No. 3

Johnes, J., Izzeldin, M. and Pappas, V. (2009): *Efficiency in Islamic and conventional banks: A comparison based on financial ratios and data envelopment analysis*, Working papers (2009/ 023), Management School, Lancaster University, UK

Jouaber, K. and Mehri, M. (2011): *A Theory of Sharing Ratio under Adverse Selection: The Case of Islamic Venture Capital*, International Sustainable Finance Paris-Dauphine University Workshop

Kablan, S. and Yousfi, O. (2011): *Efficiency of Islamic and Conventional Banks in Countries with Islamic Banking*, MPRA Paper No. 32951

Kamso, N. (2013): *Investing in Islamic Funds: A Practitioner's Perspective*, Wiley: Singapore

Karemzadeh, M. (2012): *Efficiency Analysis by using Data Envelop Analysis Model: Evidence from Indian Banks*, International Journal of Latest Trends in Finance & Economic Sciences, Vol-2 No. 3, pp. 228-237

Kepel, R. (2006): *Jihad-The Trail of Political Islam*, I.B.Tauris

Khalaf, R. (2008): *Grappling with problems of success*, Islamic Finance, Financial Times Special Report, 19 June

KPMG (2006): *Making the Transition from Niche to Mainstream*, Islamic Banking and Finance: A Snapshot of the Industry and its Challenges Today, London: KPMG Financial Advisory Services

Kumar, S. and Gulati, R. (2008): *An Examination of Technical, Pure Technical, and Scale Efficiencies in Indian Public Sector Banks using Data Envelopment Analysis*, Eurasian Journal of Business and Economics 2008, 1 (2), 33-69

Kumar, S. and Gulati, R. (2013): *Deregulation and Efficiency of Indian Banks*, Springer, ISBN 978-81-322-1544-8

Kumbirai, M and Webb, R (2010): *A financial Ratio Analysis of Commercial Bank Performance in South Africa*, African Review of Economics and Finance, Vol. 2, No. 1, pp. 30-53.

Kumbhakar, S. C. and Lozano-Vivas, A. (2000): *Stochastic Frontier Analysis*, Cambridge: Cambridge University Press

Kumbhakar, S.C. and Lozano-Vivas, A. (2005): *Deregulation and Productivity: The Case of Spanish Banks*, Journal of Regulatory Economics 27 (3), 331-351

Leibenstein, H. (1966): *Allocative Efficiency Vs. X-Efficiency*, American Economic Review, Vol. 56, June, pp. 392-415

Majía, A. L., Aljabrin, S, Awad, R, Norat M. and Song, I. (2014): *Regulation and Supervision of Islamic Banks*, IMF Working Paper, Monetary and Capital Markets Department, WP/14/219

Maudos, J. and Pastor, J.M. (1999): *Cost and profit efficiency in banking: an international comparison of Europe*, Japan and USA, Economics Letters, p. 39-44

Maudos, J. and Pastor, J.M., Perez, F. and Quesada, J (2002): *Cost and Profit Efficiency in European Banks*, Journal of International Financial Markets Institutions and Money, 12, 33–58

Marcinkowski, Ch. (2009): *The Islamic World and the West: Managing Religious and Cultural Identities in the Age of Globalization*, ISBN 978-3-643-80001-5

Mohammad, S. (2013): *Liquidity Risk Management in Islamic Banks: A Survey; Afro Eurasian Studies*, Vol. 1, Issues 2, 215-230

Mokhtar, H. S. A., Abdulah, N. and Al-Habshi, S. M. (2006): Efficiency of Islamic banking in Malaysia: A Stochastic Frontier Approach, Journal of Economic Cooperation 27, 37-70

Mousa, G. A. (2015): *Financial Ratios versus Data Envelopment Analysis: The Efficiency Assessment of Banking Sector in Bahrain Bourse*, International Journal of Business and Statistical Analysis ISSN (2384-4663) Int. J. Bus. Stat. Ana. 2, No. 2

Meeusen, W. and Van den Broeck, J. (1977): *Efficiency estimation from Cobb-Douglas production functions with composed error*, International Economic Review 18, pp. 435-444

Newaz, F., Raman, R. and Fam, K. S. (2015): *Understanding the Nature and Market for Islamic Financial Products*, Asian Journal of Business Research, Special Issue, ISSN 1178-8933

Okumus, S. H. and Kibritci Artar, O. (2012): *Islamic Banks And Financial Stability In The GCC: An Empirical Analysis,* Istanbul Ticaret Universitesi Sosyal Bilimler Dergisi Yıl, pp. 147-164

Rahman, A. R. and Rosman, R. (2013): *Efficiency of Islamic Banks: A Comparative Analysis of MENA and Asian Countries*, Journal of Economic Cooperation and Development, 34, 1 (2013), pp.63-92

Raheman, A., Zulfiqar, B., and Mustafa, M. (2007): *Capital Structure and Profitability: Case of Islamabad Stock Exchange*, International Review of Business Research Papers, 3(5), 347-361

Rozzani, N. and Rahman, R. A. (2013): *Determinants of Bank Efficiency: Conventional versus Islamic*, International Journal of Business and Management, Vol. 8, No. 14 ISSN: 1833-3850

Salah, I. (2010): *The Effect of the Financial Crisis on the Middle East*, Global Business Law Review, pp. 99-108

Samad, A. and Hassan, M. K. (1999): *The Performance of Malaysian Islamic Bank During 1984-1997: An Exploratory Study*, International Journal of Islamic Financial Services, 1(3), p. 1-14.

Sarker, M. A. A. (1999): *Islamic Banking in Bangladesh: Performance, Problems,and Prospects*, International Journal of Islamic Financial Services, 1(3), p. 15-36

Sherman, D. and Gold, F. (1985): *Branch Operating Efficiency: Evaluation with Data Envelopment Analysis*, Journal of Banking and Finance, 9, 297-315

Srairi, S. (2010): *Cost and profit efficiency of conventional and Islamic banks in GCC countries*, Journal of Productivity Analysis, 34, pp. 45-62

StataCorp. (2011): Stata 12 Base Reference Manual. College Station, TX: Stata Press

Subramanyam, T. and Reddy, C.S. (2008): *Measuring the Risk Efficiency in Indian Commercial Banking: A DEA Approach*, Journal of Economics and Business Vol. XI, No 1 & No 2

Sundararajan, V. and Errico, L. (2002): *Islamic financial institutions and products in the global financial system: key issues in risk management and challenges ahead,* IMF Working paper, WP/02/192

Sufian, F. (2007): *The Efficiency of Islamic Banking Industry: A Non-parametric Analysis with Non-discretionary Input*, Islamic Economic Studies, Vol. 14, No. 1 & 2

Tahir, I. M. and Haron, S. (2010): *Cost and profit efficiency of Islamic banks: international evidence using the stochastic frontier approach,* Banks and Bank System, Volume 5, Issue 4

The World bank: Data [online]: © 2016 The World Bank Group, available at http://data.worldbank.org/

Visser, H. (2009): *Islamic Finance: Principles and Practice*, Published by Edward Elgar Publishing Limited, ISBN 978 1 84542 525 8

Weill, L. (2013): *The economic impact of Islamic finance and the European Union*, chapter in the book Islamic Finance in Europe: Towards a Plural Financial System edited by Cattelan, V. E-ISBN 978 1 78100 250 6, pp. 96-108

Wooldridge, J. (2002): *Introductory Econometrics: A Modern Approach*, 2nd Revised edition, ISBN 978-0324113648

Yudistira, D. (2004): *Efficiency in Islamic Banking: An Empirical Analysis of Eighteen banks*, Islamic Economic Studies, Vol. 12, No. 1

Appendix A
List of Banks

Figure A.1.: Middle East political map

Source: Free World Maps, available online at http://www.freeworldmaps.net/

Table A.1.: List of banks

No.	Bank name	Specialisation	Country	City
1.	Qatar National Bank	Commercial	Qatar	DOHA
2.	National Commercial Bank	Commercial	Saudi Arabia	JEDDAH
3.	Bank Hapoalim BM	Commercial	Israel	TEL-AVIV
4.	National Bank of Abu Dhabi	Commercial	United Arab Emirates	ABU DHABI
5.	Bank Leumi Le Israel BM	Commercial	Israel	TEL-AVIV
6.	Emirates NBD PJSC	Commercial	United Arab Emirates	DUBAI CITY
7.	National Bank of Kuwait S.A.K.	Commercial	Kuwait	SAFAT
8.	Samba Financial Group	Commercial	Saudi Arabia	RIYADH
9.	First Gulf Bank	Commercial	United Arab Emirates	ABU DHABI
10.	Riyad Bank	Commercial	Saudi Arabia	RIYADH
11.	Abu Dhabi Commercial Bank	Commercial	United Arab Emirates	ABU DHABI
12.	Israel Discount Bank LTD	Commercial	Israel	TEL-AVIV
13.	Mizrahi Tefahot Bank Ltd.	Commercial	Israel	RAMAT GAN
14.	Banque Saudi Fransi JSC	Commercial	Saudi Arabia	RIYADH
15.	Saudi British Bank JSC	Commercial	Saudi Arabia	RIYADH
16.	Arab Bank Group (Combined)	Commercial	Jordan	
17.	Arab National Bank Public Joint Stock Company	Commercial	Saudi Arabia	RIYADH
18.	Bank Audi SAL	Commercial	Lebanon	BEIRUT
19.	Arab Bank Plc	Commercial	Jordan	AMMAN
20.	Ahli United Bank BSC	Commercial	Bahrain	MANAMA
21.	Commercial Bank of Qatar	Commercial	Qatar	DOHA
22.	FIBI Bank	Commercial	Israel	TEL-AVIV
23.	Arab Banking Corporation BSC	Commercial	Bahrain	MANAMA
24.	Mashreqbank PSC	Commercial	United Arab Emirates	DUBAI
25.	BLOM Bank s.a.l.	Commercial	Lebanon	RIAD EL SOLH, BEIRUT
26.	Burgan Bank SAK	Commercial	Kuwait	SAFAT
27.	Saudi Hollandi Bank	Commercial	Saudi Arabia	RIYADH
28.	Union National Bank	Commercial	United Arab Emirates	ABU DHABI
29.	Bank Muscat SAOG	Commercial	Oman	RUWI
30.	Saudi Investment Bank	Commercial	Saudi Arabia	RIYADH
31.	Gulf International Bank BSC	Commercial	Bahrain	MANAMA
32.	Doha Bank	Commercial	Qatar	DOHA
33.	Byblos Bank S.A.L.	Commercial	Lebanon	ASHRAFIEH, BEIRUT
34.	Gulf Bank KSC	Commercial	Kuwait	SAFAT
35.	Fransabank sal	Commercial	Lebanon	BEIRUT
36.	Bank of Beirut S.A.L.	Commercial	Lebanon	BEIRUT
37.	Commercial Bank of Kuwait SAK	Commercial	Kuwait	SAFAT
38.	Al Khalij Commercial Bank	Commercial	Qatar	DOHA
39.	Bankmed, sal	Commercial	Lebanon	BEIRUT
40.	Société Générale de Banque au Liban - SGBL	Commercial	Lebanon	BEIRUT
41.	Commercial Bank of Dubai P.S.C.	Commercial	United Arab Emirates	DUBAI
42.	Al Ahli Bank of Kuwait (KSC)	Commercial	Kuwait	SAFAT

Table A.2.: List of banks cont.

No.	Bank name	Specialisation	Country	City
43.	Banque Libano-Francaise	Commercial	Lebanon	HAMRA, BEIRUT
44.	Housing Bank for Trade & Finance	Commercial	Jordan	AMMAN
45.	Union Bank of Israel Ltd	Commercial	Israel	TEL-AVIV
46.	National Bank of Ras Al-Khaimah-RAKBANK	Commercial	United Arab Emirates	RAS AL-KHAIMAH
47.	BBK B.S.C.	Commercial	Bahrain	MANAMA
48.	Crédit Libanais S.A.L.	Commercial	Lebanon	BEIRUT
49.	Ahli Bank QSC	Commercial	Qatar	DOHA
50.	International Bank of Qatar Q.S.C.	Commercial	Qatar	DOHA
51.	Bank Dhofar SAOG	Commercial	Oman	RUWI
52.	Mercantile Discount Bank Ltd.	Commercial	Israel	TEL-AVIV
53.	National Bank of Oman (SAOG)	Commercial	Oman	RUWI, MUSCAT
54.	National Bank of Bahrain	Commercial	Bahrain	MANAMA
55.	United Arab Bank PJSC	Commercial	United Arab Emirates	SHARJAH
56.	Bank of Sharjah	Commercial	United Arab Emirates	SHARJAH
57.	National Bank of Fujairah PJSC	Commercial	United Arab Emirates	FUJAIRAH
58.	HSBC Bank Oman	Commercial	Oman	RUWI
59.	Bank Sohar SAOG	Commercial	Oman	MUSCAT
60.	Commercial Bank International P.S.C.	Commercial	United Arab Emirates	RAS-AL-KHAIMAH
61.	B.L.C. Bank S.A.L	Commercial	Lebanon	BEIRUT
62.	BBAC sal	Commercial	Lebanon	RIAD EL SOLH, BEIRUT
63.	IBL Bank sal	Commercial	Lebanon	BEIRUT
64.	Oman Arab Bank SAOC	Commercial	Oman	RUWI
65.	Bank Otsar Hahayal Ltd	Commercial	Israel	TEL-AVIV
66.	Arab Bank for Investment & Foreign Trade	Commercial	United Arab Emirates	ABU DHABI
67.	Bank of Jerusalem	Commercial	Israel	JERUSALEM
68.	Invest Bank P.S.C.	Commercial	United Arab Emirates	SHARJAH
69.	Jordan Kuwait Bank	Commercial	Jordan	AMMAN
70.	National Bank of Umm Al-Qaiwain PSC	Commercial	United Arab Emirates	UMM AL-QAIWAIN
71.	First National Bank SAL	Commercial	Lebanon	BEIRUT
72.	Cairo Amman Bank	Commercial	Jordan	AMMAN
73.	Jordan Ahli Bank Plc	Commercial	Jordan	AMMAN
74.	Lebanon & Gulf Bank S.A.L.	Commercial	Lebanon	BEIRUT
75.	Bank of Jordan Plc	Commercial	Jordan	AMMAN
76.	Capital Bank of Jordan	Commercial	Jordan	AMMAN
77.	UBank Ltd	Commercial	Israel	TEL-AVIV
78.	CreditBank SAL	Commercial	Lebanon	BEIRUT
79.	Bank of Palestine Plc	Commercial	Palestina	OMAR MOKHTAR
80.	BMI Bank BSC	Commercial	Bahrain	MANAMA
81.	Al-Mawarid Bank S.A.L	Commercial	Lebanon	BEIRUT
82.	MEAB SAL	Commercial	Lebanon	BEIRUT
83.	Jordan Commercial Bank	Commercial	Jordan	AMMAN
84.	International Bank of Yemen YSC	Commercial	Yemen	SANA'A

Table A.3.: List of banks cont.

No.	Bank name	Specialisation	Country	City
85.	Future Bank B.S.C.	Commercial	Bahrain	MANAMA
86.	Arab Banking Corporation (Jordan)	Commercial	Jordan	AMMAN
87.	Fenicia Bank SAL	Commercial	Lebanon	BEIRUT
88.	Lebanese Swiss Bank SAL (The)	Commercial	Lebanon	BEIRUT
89.	Banque BEMO Sal	Commercial	Lebanon	BEIRUT
90.	Bank Audi Private Bank	Commercial	Lebanon	BEIRUT
91.	Emirates Lebanon Bank SAL	Commercial	Lebanon	BEIRUT
92.	Bank Melli Iran	Commercial	United Arab Emirates	ABU DHABI
93.	Banque Misr Liban	Commercial	Lebanon	BEIRUT
94.	Banque Bemo Saudi Fransi SA	Commercial	Syria	DAMASCUS
95.	Société générale de Banque-Jordanie	Commercial	Jordan	AMMAN
96.	Alubaf Arab International Bank	Commercial	Bahrain	MANAMA
97.	Bank of China Middle East (Dubai) Limited	Commercial	United Arab Emirates	DUBAI
98.	Bank of Syria and Overseas SA	Commercial	Syria	DAMASCUS
99.	BSL Bank SAL	Commercial	Lebanon	BEIRUT
100.	HSBC Bank Middle East	Commercial	Lebanon	BEIRUT
101.	Al Baraka Bank Syria SA	Commercial	Syria	DAMASCUS
102.	North Africa Commercial Bank SAL	Commercial	Lebanon	BEIRUT
103.	United Credit Bank SAL	Commercial	Lebanon	BEIRUT
104.	Federal Bank of Lebanon SAL	Commercial	Lebanon	BEIRUT
105.	International Bank for Trade and Finance SA	Commercial	Syria	DAMASCUS
106.	Ahli International Bank SAL	Commercial	Lebanon	BEIRUT
107.	Banque de l'Industrie et du Travail SAL	Commercial	Lebanon	BEIRUT
108.	Bahrain Commercial Facilities Company BSc	Commercial	Bahrain	MANAMA
109.	Jammal Trust Bank SAL	Commercial	Lebanon	BEIRUT
110.	National Bank of Yemen	Commercial	Yemen	ADEN
111.	Bank Audi Syria	Commercial	Syria	DAMASCUS
112.	Saudi Lebanese Bank SAL	Commercial	Lebanon	SANAYEH, BEIRUT
113.	Yemen Commercial Bank	Commercial	Yemen	SANA'A
114.	Byblos Bank Syria SA	Commercial	Syria	DAMAS
115.	Arab Bank Syria SA	Commercial	Syria	DAMASCUS
116.	Investment Bank of Iraq SA Co	Commercial	Iraq	BAGHDAD
117.	Al khaliji France SA	Commercial	United Arab Emirates	
118.	Union Bank of Iraq	Commercial	Iraq	BAGHDAD
119.	Near East Commercial Bank SAL	Commercial	Lebanon	ASHRAFIEH, BEIRUT
120.	Syria Gulf Bank SA	Commercial	Syria	DAMASCUS
121.	RT Bank	Commercial	Iraq	ERBIL
122.	National Bank of Kuwait (Lebanon) SAL	Commercial	Lebanon	BEIRUT
123.	Yemen Kuwait Bank for Trade and Investment	Commercial	Yemen	SANA'A
124.	Banque Pharaon & Chiha SAL	Commercial	Lebanon	BEIRUT
125.	Babylon Bank	Commercial	Iraq	BAGHDAD
126.	Palestine Commercial Bank	Commercial	Palestina	RAMALLAH

Table A.4.: List of banks cont.

No.	Bank name	Specialisation	Country	City
127.	CSCBank SAL	Commercial	Lebanon	BEIRUT
128.	Banque de Crédit National	Commercial	Lebanon	BEIRUT
129.	Bank of Jordan-Syria	Commercial	Syria	DAMASCUS
130.	Blom Development Bank SAL	Commercial	Lebanon	BEIRUT
131.	Bank Saderat Iran	Commercial	Lebanon	BEIRUT
132.	Standard Chartered Bank SAL	Commercial	Lebanon	ANTELIAS, BEIRUT
133.	Eurotrade Ltd	Commercial	Israel	TEL-AVIV
134.	Yemen Gulf Bank	Commercial	Yemen	SANA'A
135.	Bank Mellat	Islamic	Iran	TEHRAN
136.	Al Rajhi Bank Public Joint Stock Company	Islamic	Saudi Arabia	RIYADH
137.	Bank Saderat Iran	Islamic	Iran	TEHRAN
138.	Kuwait Finance House	Islamic	Kuwait	SAFAT
139.	Bank Melli Iran	Islamic	Iran	TEHRAN
140.	Bank Tejarat	Islamic	Iran	TEHRAN
141.	Dubai Islamic Bank PJSC	Islamic	United Arab Emirates	DUBAI
142.	Abu Dhabi Islamic Bank - Public Joint Stock Co.	Islamic	United Arab Emirates	ABU DHABI
143.	Parsian Bank	Islamic	Iran	TEHRAN
144.	Qatar Islamic Bank SAQ	Islamic	Qatar	DOHA
145.	Bank Pasargad	Islamic	Iran	TEHRAN
146.	Albaraka Banking Group B.S.C.	Islamic	Bahrain	MANAMA
147.	Masraf Al Rayan (Q.S.C.)	Islamic	Qatar	DOHA
148.	Alinma Bank Public joint stock company	Islamic	Saudi Arabia	RIYADH
149.	Islamic Development Bank	Islamic	Saudi Arabia	JEDDHA
150.	Bank Sepah	Islamic	Iran	TEHRAN
151.	Bank AlJazira JSC	Islamic	Saudi Arabia	JEDDAH
152.	Ahli United Bank KSC	Islamic	Kuwait	SAFAT
153.	Bank AlBilad	Islamic	Saudi Arabia	RIYADH
154.	Emirates Islamic Bank PJSC	Islamic	United Arab Emirates	DUBAI
155.	Eghtesad Novin Bank PJSC-EN Bank	Islamic	Iran	TEHRAN
156.	Qatar International Islamic Bank	Islamic	Qatar	DOHA
157.	Al Hilal Bank PJSC	Islamic	United Arab Emirates	ABU DHABI
158.	Barwa Bank	Islamic	Qatar	DOHA
159.	Boubyan Bank KSCP	Islamic	Kuwait	SAFAT
160.	Bank of Industry and Mine	Islamic	Iran	TEHRAN
161.	Saman Bank	Islamic	Iran	TEHRAN
162.	Noor Bank	Islamic	United Arab Emirates	DUBAI
163.	Ithmaar Bank B.S.C.	Islamic	Bahrain	MANAMA
164.	Sharjah Islamic Bank	Islamic	United Arab Emirates	SHARJAH
165.	Kuwait International Bank	Islamic	Kuwait	SAFAT
166.	Al-Salam Bank-Bahrain B.S.C.	Islamic	Bahrain	MANAMA
167.	Jordan Islamic Bank	Islamic	Jordan	AMMAN
168.	Karafarin Bank	Islamic	Iran	TEHRAN

Table A.5.: List of banks cont.

No.	Bank name	Specialisation	Country	City
169.	Kuwait Finance House	Islamic	Bahrain	MANAMA
170.	Bank Sarmayeh	Islamic	Iran	TEHRAN
171.	Arcapita Bank B.S.C.	Islamic	Bahrain	MANAMA
172.	Amlak Finance PJSC	Islamic	United Arab Emirates	DUBAI
173.	Investment Dar Co	Islamic	Kuwait	SAFAT
174.	Ajman Bank	Islamic	United Arab Emirates	AJMAN
175.	Tadhamon International Islamic Bank	Islamic	Yemen	SANA'A
176.	Bahrain Islamic Bank B.S.C.	Islamic	Bahrain	MANAMA
177.	Aref Investment Group	Islamic	Kuwait	SAFAT
178.	Tamweel PJSC	Islamic	United Arab Emirates	DUBAI
179.	Islamic International Arab Bank	Islamic	Jordan	AMMAN
180.	Warba Bank	Islamic	Kuwait	KUWAIT CITY
181.	Albaraka Islamic Bank BSC	Islamic	Bahrain	MANAMA
182.	Khaleeji Commercial Bank	Islamic	Bahrain	MANAMA
183.	A'Ayan Leasing & Investment Company	Islamic	Kuwait	SAFAT
184.	ABC Islamic Bank (E.C.)	Islamic	Bahrain	MANAMA
185.	Gulf Finance House BSC	Islamic	Bahrain	MANAMA
186.	Saba Islamic Bank	Islamic	Yemen	SANA'A
187.	Syria International Islamic Bank	Islamic	Syria	DAMASCUS
188.	Jordan Dubai Islamic Bank	Islamic	Jordan	AMMAN
189.	Kurdistan International Bank for Investment and Development	Islamic	Iraq	ERBIL
190.	Bank Nizwa SAOG	Islamic	Oman	MUSCAT
191.	Cham Islamic Bank SA	Islamic	Syria	DAMASCUS
192.	Palestine Islamic Bank	Islamic	Palestina	RAMALLAH
193.	Bank Alkhair BSC	Islamic	Bahrain	AL-SEEF DISTRICT
194.	Arab Islamic Bank	Islamic	Palestina	AL-BIREH, WEST BANK
195.	First Investment Company K.S.C.C.	Islamic	Kuwait	SAFAT
196.	Iraqi Islamic Bank for Investment & Development PJSC	Islamic	Iraq	BAGHDAD
197.	International Investor Company, K.S.C.	Islamic	Kuwait	SAFAT
198.	Ibdar Bank BSC	Islamic	Bahrain	MANAMA
199.	Alizz Islamic Bank S.A.O.G	Islamic	Oman	RUWI
200.	Elaf Islamic Bank	Islamic	Iraq	BAGHDAD
201.	Venture Capital Bank BSC (c)-VCBank	Islamic	Bahrain	MANAMA
202.	Shamil Bank of Yemen & Bahrain	Islamic	Yemen	SANA'A
203.	Al Baraka Bank SAL	Islamic	Lebanon	BEIRUT
204.	Arab Finance House Holding SAL	Islamic	Lebanon	BEIRUT
205.	Rasameel Structured Finance Company K.S.C (closed)	Islamic	Kuwait	SAFAT
206.	Islamic Bank of Yemen for Finance & Investment	Islamic	Yemen	SANA'A

Source: Bankscope database (Bureau Van Dijk)

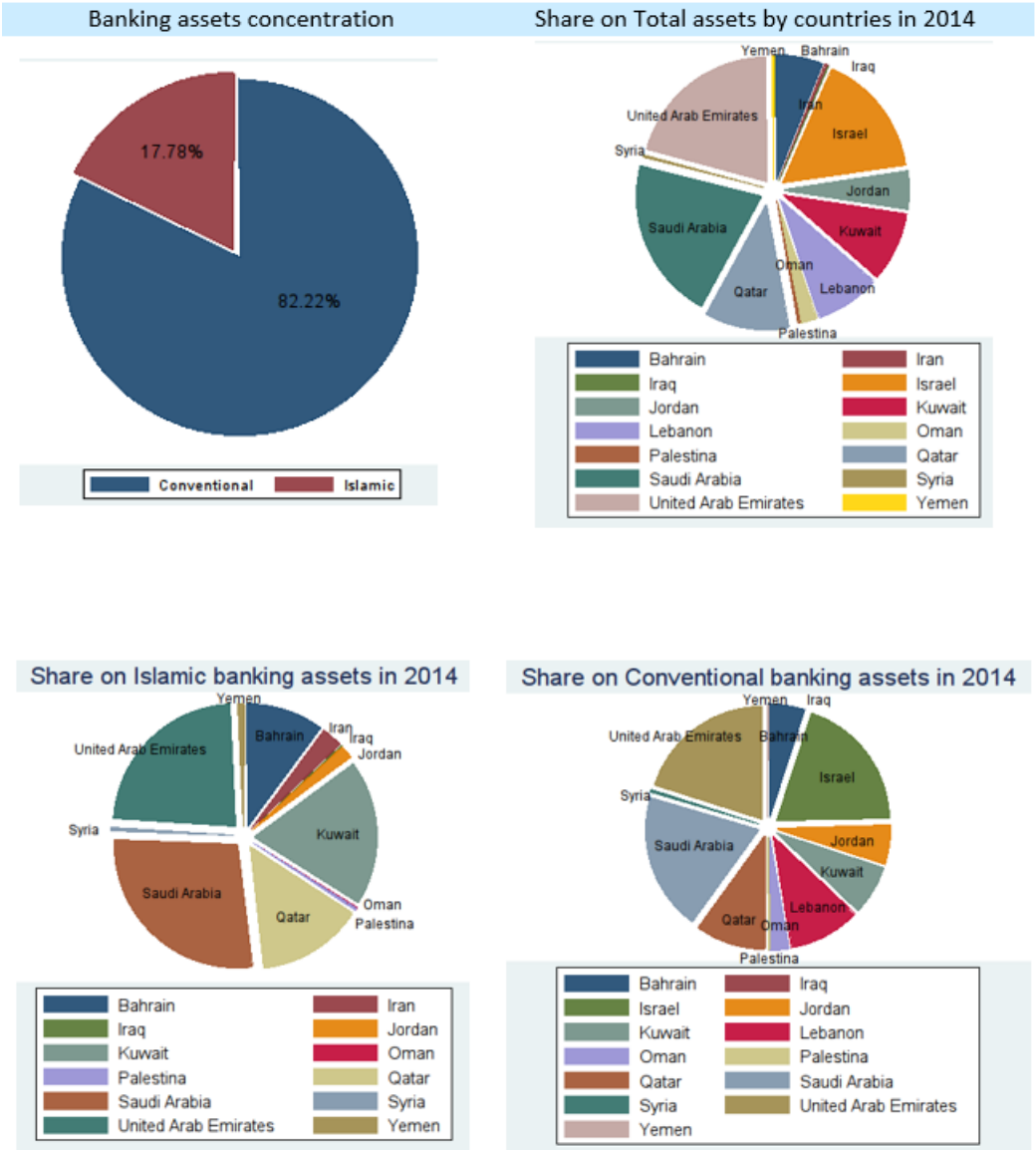
Table A.6.: Frequency of banks by countries

	Freq.	Percent	Cumulative
Bahrain	174	10.88	10.88
Iran	46	2.88	13.75
Iraq	16	1.00	14.75
Israel	123	7.69	22.44
Jordan	147	9.19	31.63
Kuwait	105	6.56	38.19
Lebanon	290	18.13	56.31
Oman	75	4.69	61.00
Palestina	36	2.25	63.25
Qatar	96	6.00	69.25
Saudi Arabia	137	8.56	77.81
Syria	64	4.00	81.81
UAE	246	15.38	97.19
Yemen	45	2.81	100
Total	**1600**	**100**	

Source: Bankscope database (Bureau Van Dijk)

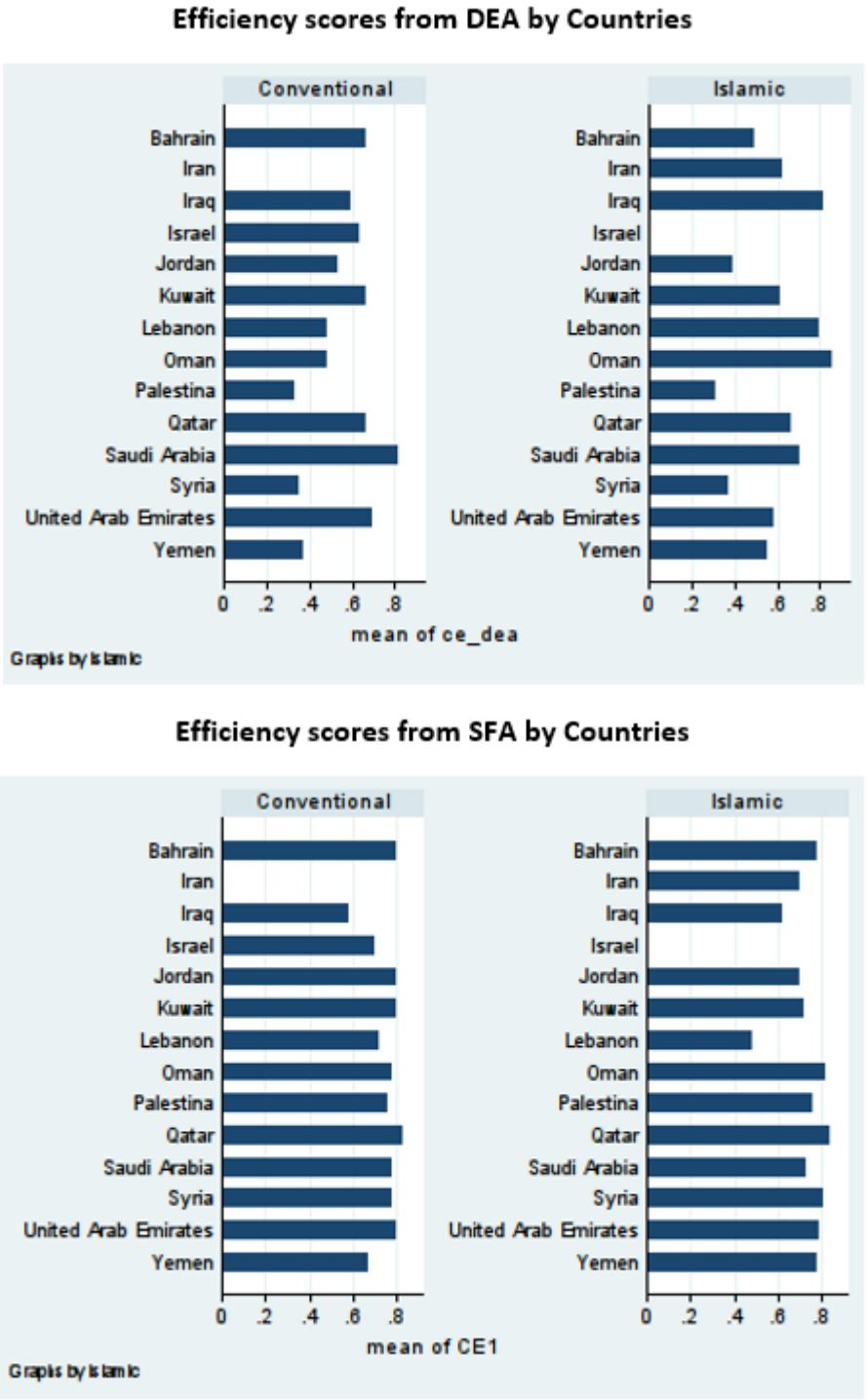
Appendix B
Supplementary Information

Figure B.1.: Middle East banking assets concentration



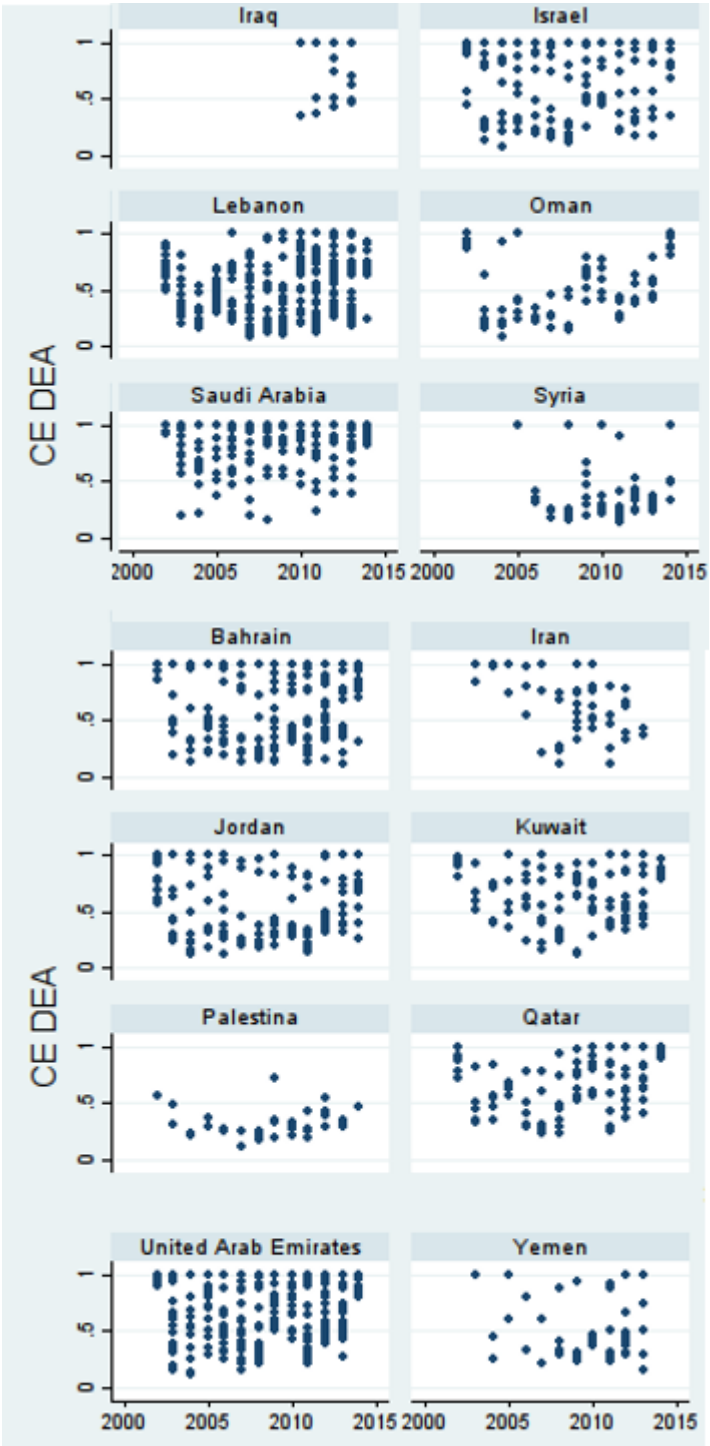
Source: Author's calculations, graphs obtained from Stata

Figure B.2.: Summary of efficiency scores by countries and specialization



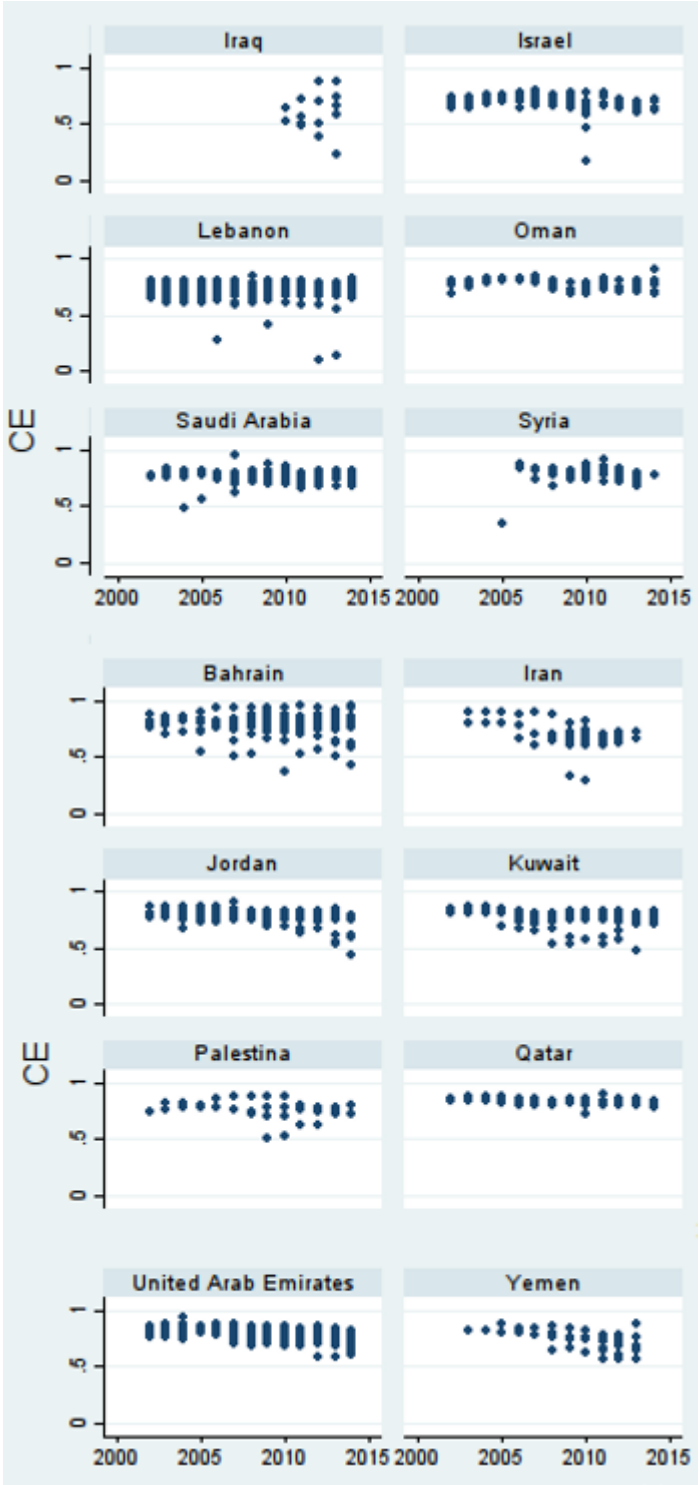
Source: Author's calculations, graphs obtained from Stata

Figure B.3.: Scatter plot of efficiency scores from DEA by countries



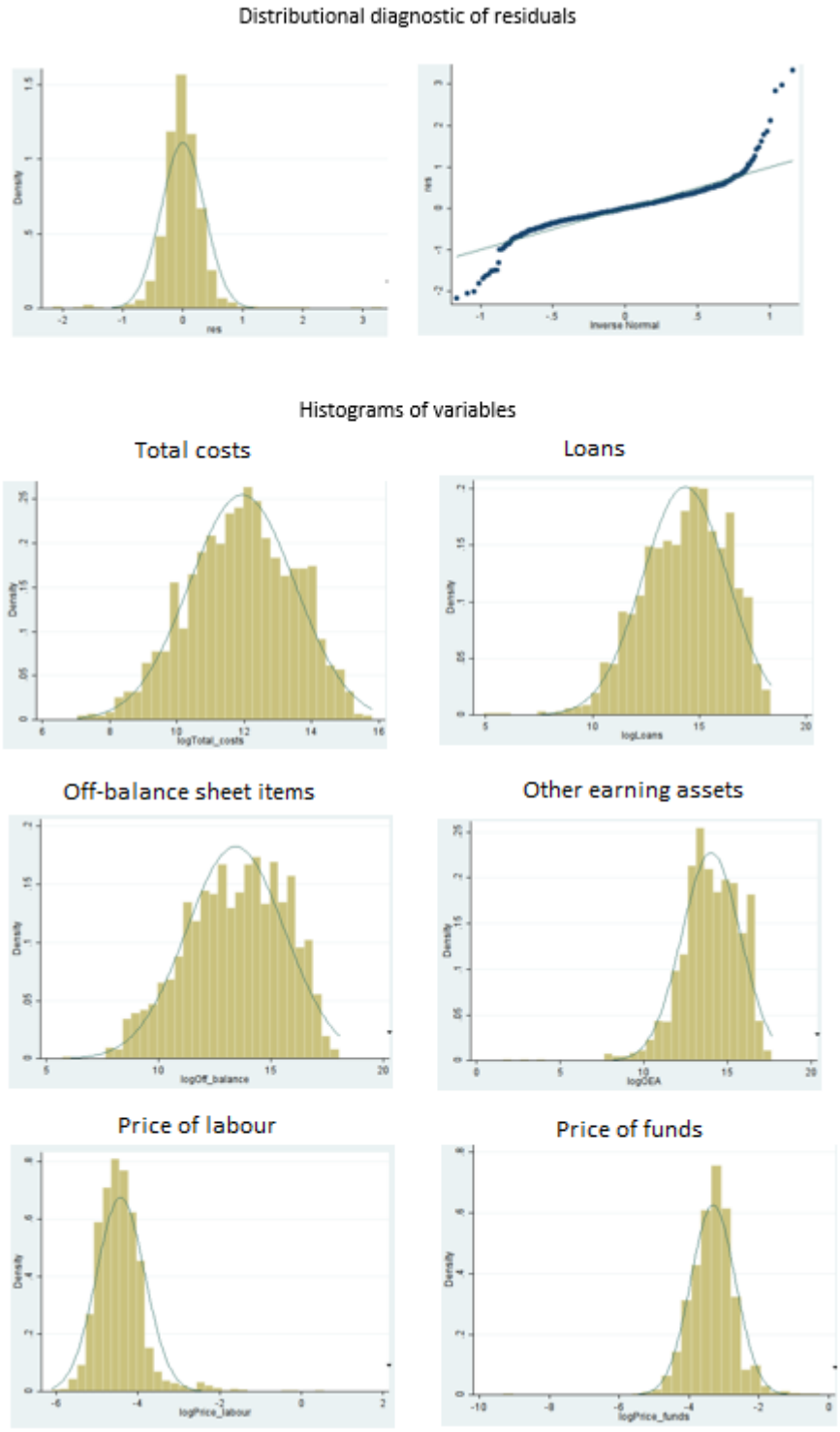
Source: Author's calculations, graphs obtained from Stata

Figure B.4.: Scatter plot of efficiency scores from SFA by countries



Source: Author's calculations, graphs obtained from Stata

Figure B.5.: Histograms



Source: Author's calculations, graphs obtained from Stata