EFFICIENCY AND PRODUCTIVITY GROWTH OF THE BANKING SECTOR IN JORDAN

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DEDICATION

I express my deep and sincere gratitude to my father, Barham Jreisat and mother, Martha Jreisat, who made every possible efforts to provide me right education. I dedicate this thesis to them.

I want to thank you for your endless support loving and infinite sacrifices that made it possible for me to reach this stage of my life; without them the road to success would have been much more difficult. My debt to you is beyond measure. I have the utmost love and respect for you and hope that this significant achievement may bring you much happiness in return for your sacrifices. I also take this opportunity to express my gratitude to my two brothers, Atef and Amer and two sisters, Randa and Rana and other family members, for their support, love and kindness.

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STATEMENT OF AUTHENTICATION

The work presented in this thesis is, to the best of my knowledge and belief, original except as acknowledged in the text. I hereby declare that I have not submitted this material, either in whole or in part, for a degree at this or any other institution. From the research conducted in this thesis, I have published several papers and presented at national and international conferences. The details of these are as follows:

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ABBREVIATIONS

AB	Arab Bank
ABC	Arab Banking Corporation
AE	Allocative Efficiency
AFM	Amman Financial Market
AJIB	Arab Jordan Investment Bank
AME	Arab Middle Eastern
ANB	Arab Nation Bank
ASE	Amman Stock Exchange
BOJ	Bank of Jordan
BSC	Bank Standard Charter
CAB	Cairo Amman Bank
CB	Citi Bank
CBJ	Central Bank of Jordan
CPB	Capital Bank
CRS	Constant Returns to Scale
DEA	Data Envelopment Analysis
DEAP	Data Envelopment Analysis Program
DFA	Distribution Free Approach
DMU	Decision Making Unit
DOS	Department of Statistics in Jordan
DRS	Decreasing Returns to Scale
Effnt	Fully Efficient
FDH	Free Disposal Hull
FTA	Free Trade Area
GCC	Gulf Co-operating Council
HBTF	The Housing Bank for Trade & Finance
HSBC	Hong Kong and Shanghai Banking Corporation
IMF	International Monetary Fund

IRS	Increasing Returns to Scale
JCB	Jordan Commercial Bank
JD	Jordanian Dinar
JIBF	Jordan Islamic Bank for Finance and Investment
JIFB	Jordan Investment and Finance Bank
JKB	Jordan Kuwait Bank
JNB	Jordan National Bank
LBR	Labour
LP	Linear Programming
MPI	Malmquist Productivity Index/Indices
MPSS	Most Productive Scale Size
NIE	Non Interest Expense
NIM	Net Interest Margin
NIN	Non Interest Income
NIRS	Non Increasing Returns to Scale
NN	Neural Networks
OBS	Off-Balance Sheet
Oinvt	Other Investment
PNN	Probabilistic Neural Network
PTE	Pure Technical Efficiency
PTEC	Pure Technical Efficiency Change
ROA	Return on Assets
ROE	Return on Equity
SD	Standard Deviation
SE	Scale Efficiency
SFA	Stochastic Frontier Approach
SGBJ	Societe Generale De Banque-Jordanie
TA	Total Assets
TC	Technological Change
Tdept	Total Deposit

TE	Technical Efficiency
TEC	Technical Efficiency Change
TFA	Thick Frontier Approach
TFP	Total Factor Productivity
TLn	Total Loan
UAE	United Arab Emirates
UBJ	Union Bank for Saving and Investment
VRS	Variable Returns to Scale

ABSTRACT

This study investigates the efficiency and productivity of the Jordanian banking sector, which consisted of 17 banks (two large, eight medium, four small and three foreign) during the period of financial deregulation, 1996–2007. It begins with the estimation of technical efficiency based on the input-oriented Data Envelopment Analysis (DEA) approach. To enable a comprehensive analysis, technical efficiency is decomposed into the product of pure technical efficiency and scale efficiency. This is followed by measuring cost efficiency, which is the product of technical and allocative efficiencies. Finally, the Malmquist Productivity Indices (MPI) are computed to examine the total factor productivity (TFP) change over the sample period. TFP change is decomposed into the products of technical efficiency change (catch-up) and technological change. The results reveal that the large banks are the most technically efficient in Jordan. The medium-sized banks have the lowest technical efficiency. There is a clear evidence of improvement (of about 0.37% per year) in the technical efficiency of banks during the sample period. The same is true of cost efficiency. Interestingly, the Jordanian banking sector as a whole shows a productivity growth of 3.5% per year, largely due to technological improvement. The productivity change among the domestic banks is much higher than that of the foreign banks during the entire deregulated period. Since the productivity growth during the regulated period of 1985–1995 was only 1.0% per annum, the higher productivity growth reported here during the deregulated period suggests that the banking sector has responded positively to the deregulation and liberalisation policies of the government.

Keywords: Technical efficiency, Cost efficiency, Data Envelopment Analysis, Jordanian banking sector, Financial reforms.

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CHAPTER 1
Introduction

1.1 Background and Objectives

There is a large body of literature dealing with the measurement of banking efficiency and productivity in the western economies, but studies on banking efficiency relating to Middle Eastern economies are few. The reasons for this can be attributed to three factors. First, the financial systems of many Middle Eastern countries are highly regulated and outdated. Second, they are dominated by the public sector and do not face any competition. Third, reliable data on banks are not available for many countries. However, during the last fifteen years, many Middle Eastern economies have moved towards liberalising their financial systems. This has encouraged researchers to undertake studies of banking efficiency and productivity in some of the countries; see, for example, Hassan et al. (2004) and Al-Muharrami (2007).

The measurement of efficiency and productivity of the banking industry is important for several reasons. First, the measures of efficiency and productivity are considered as crucial indicators of performance of individual banks and of the industry as a whole. Second, efficiency is a vital factor for the financial institutions wishing to maintaining a successful business, given the increasing competition in financial markets. Third, in a rapidly changing and more globalised financial marketplace, governments, regulators, managers and investors are concerned about how efficiently banks transform their expensive inputs into various financial products and services. Finally, it may be noted that efficiency and productivity measures are critical aspects of banking industry that enable us to distinguish banks that will survive and prosper from those that will have problems with competitiveness.

The present study examines efficiency and productivity changes in the banking sector of Jordon during the period of financial deregulation, 1996–2007. Before the 1980s the Jordanian banking sector was highly regulated, and economic policies were directed towards prevention of and protection from any foreign competition. The financial authorities put in place measures to limit foreign entry; as a result, domestic banks in Jordan operated in an oligopolistic environment, and interest rates on credits and deposits were determined in a monopolistic manner (Al-khoury et al.,2008, p.163). In August 1989, Jordan experienced a crisis in its banking system following the collapse of Petra Bank and the financial difficulties of six other financial institutions linked to it. The crisis was a result, among other factors, of inadequate banking regulations, over-exposure of the banking system to the real estate market and imprudent speculations in foreign exchange (Canakci, 1995).

The 1989 crisis led to closer cooperation between the government, the International Monetary Fund (IMF) and the World Bank to initiate a reform program for the Jordanian banking sector. The government took various steps since 1993 to enhance system efficiencies and to create competition among banks. The reform program consisted of removing restrictions on interest rates, reducing direct governmental lending, promoting deregulation and reducing the restrictions on foreign exchange transactions and the movement of capital. In addition, the government adopted trade liberalisation policies to enhance economic growth and promote exports (Maghyereh, 2004; CBJ, 2005).

This study focuses on the measurement of efficiency and productivity changes in seventeen Jordanian banks during the period of financial deregulation, 1996–2007. Our sample consists of fourteen domestic (two large, eight medium and four small) and three foreign banks for which adequate data were available. These banks cover close to 90 per cent of banking output in Jordon (Association of Banks in Jordan, Annual Report, 2007).

In an earlier study, Ahmad (2000) analysed the cost efficiency of 20 banks for the period 1990–1996. In an unpublished paper, Maghyereh (2004) examined the efficiency and productivity change in eight domestic banks during the period, 1984–2001. Our study makes a significant contribution to the Jordanian literature on banking efficiency and productivity change by covering the entire deregulated period not encompassed in earlier studies. The results of this study may help policy makers and bankers understand the ways in which regulatory changes may influence a bank’s efficiency and productivity.

In particular, this study seeks to address the following questions:

1. How efficient are Jordanian banks?

2. Which banks are most efficient in terms of technical, pure technical, scale, allocative efficiencies and in terms of economic efficiency (cost efficiency)?
3. Do all banks in Jordan exhibit the same degree of overall, technical, allocative and cost efficiencies?
4. How productive are Jordanian banks?
5. Have the levels of efficiency and productivity improved or declined during the deregulation period?

1.2 Research Methodology and Data

There are two broad approaches to measuring efficiencies and productivity change:

1. Non-parametric approach.
2. Parametric approach.

There are two non-parametric methods for measuring efficiency: Data Envelopment Analysis (DEA) and the Free Disposal Hull (FDH). The DEA, developed by Charnes et al. (1978), is more frequently used; it is a linear programming technique for constructing external piecewise frontier. The frontier is non-parametric in the sense that it is constructed through the envelopment of the decision making units (DMUs) with 'best practice' DMUs. The DEA does not impose any functional form specification on the production function. The FDH model, introduced by Deprins et al. (1984) and developed by Tulkens (1993), is a special case of the DEA model where the points on lines connecting DEA vertices are not included in the frontier: instead the FDH production possibilities set is composed only of the DEA vertices and the free disposal hull points interior to these vertices. Since the FDH frontier is either congruent with or interior to the DEA frontier, FDH will typically generate larger estimates of average efficiency than DEA (Tulkens, 1993). The DEA is the most widely used popular methodology for measuring efficiency and productivity change.

The parametric approach is useful because of its ability to allow for random error, and for the opportunity it offers for mathematical manipulation. A suitable functional form must be selected, which attempts to resemble the actual production process as closely as possible (Coelli et al, 2005). The form can be simple or complex, with varying degrees of complexity between the two extremes.

There are three parametric methods to estimate the efficiency/ inefficiency of firms: (i) The Stochastic Frontier Approach (SFA), (ii) The Distribution Free Approach (DFA) and (iii) The Thick Frontier Approach (TFA). While a discussion on each of these methods is provided in Chapter 4, it is sufficient to mention here that SFA involves the estimation of efficiencies usually by estimating either a cost function or a profit function. It allows the testing of hypotheses in regard to the efficiency and structure of production technology. It has been widely used in empirical studies of firms and the banking industry. The difficulties involved in the selection of a distribution form for the efficiency term is a disadvantage of this approach. SFA imposes a particular functional form (and associated behavioural assumptions) that presuppose the shape of the frontier. If the functional form is mis-specified, the measurement of efficiency may be confounded with specification errors. In contrast, non-parametric methods do not impose any structure on the frontier; but they do not allow for random error resulting from luck, data problems, or other measurement errors. If random error exists, measured efficiency may be confounded with these random deviations from the true efficiency frontier.

It is not possible to determine which of the two major methods dominates the other since the *true* level of efficiency is unknown. DEA has gained popular acceptance and frequent application among studies on bank efficiency and productivity. This study follows the DEA approach has been selected in this study to measure efficiency and productivity change in Jordanian banks. DEA methodology may be either input-oriented or output oriented. Since we believe that banks have better control over inputs, the input-oriented DEA approach is most suitable.

Empirical results based on DEA may depend on or are likely to be influenced by the choice and number of inputs entering the model. So far there is no agreement on the choice of bank inputs and outputs; in fact, the choice of input and output variables for the banking sector is a matter of some controversy. The literature offers three distinct approaches used for selecting inputs and outputs: the production approach, the intermediation approach, and the value-added approach. The first views financial institutions as producers who use inputs of labour and capital to generate outputs of deposits and loans. This approach is used, among others, by Sathey (2001) and Neal (2004). The intermediation approach views financial institutions as intermediaries that convert and transfer financial assets from surplus units to deficit units. Ahmad (2000) views banks as intermediaries and uses two inputs, labour and deposits, and two outputs, total loans and other investments. for measuring efficiency in Jordanian banks during 1990–1996. In another conceptualisation of the intermediate approach, Paul and Kourouche (2008) and Kourouche (2008) use interest expenses and non-interest expenses as inputs, and interest income and non-interest income as outputs. In the value-added approach, high value-creating activities such as making loans and taking deposits are classified as outputs, whereas labour, physical capital and purchased funds are classified as inputs (Wheelock and Wilson, 1995).

The intermediation approach is quite popular in empirical research, particularly that based on cross-sectional data (Colwell & Davis, 1992; Favero & Papi, 1995). The production approach, though also found in empirical studies, is less favoured when considering banking as it is known to have limitations, mainly due to the exclusion of interest expenses which are considered a vital part of banking.

There are other practical issues or reasoning governing the selection of inputs and outputs. If the aim is to estimate a unit's production efficiency, then a production approach might be appropriate; however, if the interest of the researcher is in examining intermediation efficiency, then an intermediary approach is appropriate. The choice of variables may also depend on the availability of data.

This study uses the intermediation approach, in which banks are viewed as intermediaries that employ two inputs, labour (x1) and total deposits (x2) to produce two outputs, total loans (y1) and other investments (y2). To ensure reliability, comparability and consistency, the data used in this study are taken from the annual reports of individual banks and from the Central Bank of Jordan (CBJ). In addition, different libraries in Jordan and the data bases of the Amman Stock Exchange (ASE) and the Association of Banks in Jordan were consulted to gather more information or to supply missing data.

The data were collected from 17 Jordanian banks, consisting of 14 domestic and three foreign banks. For a comprehensive analysis, the domestic banks are classified, based on their asset sizes in 2007 measured in millions of Jordanian Dinar (JD), into three categories: large, medium and small-sized banks. There are two large, eight medium, four small and three foreign banks in the sample. Details are provided in Chapter 4.

1.3 The Organisation of this Study

The study is organised into seven chapters. Chapter 2 provides an overview of how banking services have developed in Jordan. The chapter begins with a brief discussion of the Jordanian economy and its financial sector. Since the focus of this study is on analysing the performance of banks in terms of their efficiency and productivity, an overview of the development of the Jordanian banking sector provides details about the commercial, Islamic and foreign banks operating in Jordan in the period 1996–2007. Those historical developments that affected the Jordanian economy and financial institutions, and led to the financial liberalisation (deregulation) program, are highlighted.

Chapter 3 provides a review of studies of banking efficiency conducted in the Middle East and the rest of the world, but no claim is made that it covers all extant studies.

The review is selective; it does, however, reveal that the majority of studies on banking efficiency in the Middle East have used the DEA, only a few have used SFA methodology to compute efficiency estimates. The empirical studies of banking efficiency and productivity in Jordan are few, and do not cover the entire financial regulation period.

The main research contributions of this study are provided in Chapters 4 through 6.

Chapter 4 runs an input-oriented DEA model to obtain measures of technical efficiency (TE), decomposed into the product of pure technical efficiencies (PTE) and scale efficiencies (SE) for each of the 17 banks of the Jordanian banking sector during the liberalised period, 1996–2007. The chapter also investigates the nature of returns to scale and the sources of inefficiency in the inputs and outputs of each bank. The results reveal that the average technical efficiency for all banks is 79.2%. This implies that inputs can be reduced by 20.8% on average, relative to the best-practice banks during the sample period. The number of staff and the total deposits are the most common sources of inefficiency. Banks need to use deposits efficiently and reduce their staff to enhance efficiency. The Arab Bank, one of the largest banks, is found to perform at the highest level of technical efficiency (90%); small banks are found to be more efficient than the medium banks; foreign banks show the lowest technical efficiency. However, the banking sector as a whole shows improvements in technical efficiency at an average rate of 0.37% per year over the study period.

The analysis of technical efficiency conducted in Chapter 4 is based on two assumptions: first, that there are no allocative inefficiencies in the banking sector; and second, that the frontier remains the same throughout the sample period. The first assumption is guided by the international literature on the banking sector, which suggests that allocative inefficiency is negligible during a short sample period. In Chapter 5 this assumption is dropped, and the focus changes to overall (cost) efficiency, which is the product of the technical and allocative efficiencies. The assumption of the same frontier over the sample period permits a comparison of the estimates of technical efficiencies across times and banks. The results, based on DEA, provide an average estimate of cost efficiency score of 0.74, which implies that the banking sector could reduce the cost of production by 26 per cent without affecting the level of output. Again, large banks are found to be the most efficient in terms of cost efficiency (86%), allocative efficiency (92.7%) and technical efficiency (93%). The small banks rank second in terms of efficiency level. While the cost efficiency shows a decline during the early and middle phases of deregulation, shows large improvement in the latter phase of financial deregulation in Jordan.

In Chapters 4 and 5, it is assumed that the efficiency frontier does not shift over the sample period. The efficiency frontier can shift in response to technological progress (technological innovations). The latter needs to be distinguished from gains in technical efficiency represented by units moving toward the frontier (commonly referred to as the 'catching-up effect'). Chapter 6 of this study studies the changes in total factor productivity (TFP) over time, and investigate whether it is due to technological change (TC) or due to technical efficiency change (TEC), or due to a combination of both. The productivity change of banks is measured by estimating the Malmquist Productivity Index (MPI). The estimates of MPI reveal that the Jordanian banking sector as a whole has shown a productivity growth of 3.5 per year per annum, largely due to technological improvement. Productivity growth during the regulated period of 1985–1995 was only 1.0% per annum, much lower than the per annum productivity growth reported here. This shows that the banking sector has responded positively to the deregulation and liberalisation policies of the government, to achieve greater efficiency and productivity.

Chapter 7 summaries and brings together the conclusions.

CHAPTER 2

An Historical Overview of the Jordanian Banking Sector

2.1 Introduction

Since the primary objective of this study is to measure the efficiency and productivity of the Jordanian banks during the period 1996–2007, this chapter provides an overview of how banking services have developed in Jordan. To put the analysis into perspective, it begins with a brief discussion of the Jordanian economy and of the financial sector. The background and historical developments of the Jordanian banking sector are outlined in Sections 2.3 and 2.4. Section 2.5 provides an overview of the CBJ. The structure of the Jordanian banking sector is presented in Section 2.6. The developments in the banking assets, credits and deposits for the period 1996–2007 are outlined in Section 2.7. Sections 2.8 and 2.9 present developments in the interest rate structure and banking services. Islamic and foreign banks operating in Jordan are discussed in Sections 2.10 and 2.11. Section 2.12 summarises the chapter.

2.2 Introduction to the Hashemite Kingdom of Jordan

Jordan is located in the western part of Asia. Its area is about 97,740 square kilometers. At the end of 2007, the population was around 5.72 million, and its population growth rate was around 2.3% (Department of Statistics in Jordan (DOS)

2008). During the last decade, a large part of the workforce was engaged in agriculture; others worked in industry or in Arab Gulf states.

During the last 15 years, the Jordanian economy has witnessed a significant shift from the public to the private sector, which is now the main driver of growth. The CBJ maintains a monetary policy which is a vital and essential component of the economic policy, designed to enhance the economic environment and the safety of the banking system. Thus, the CBJ has secured sufficient liquidity to finance real growth while ensuring price stability and keeping inflation under control (CBJ, 2008). The banking sector is a major contributor to the national economy, playing a significant role as the main source of finance for investment in Jordan (DOS, 2008).

2.2.1 An Overview of the Jordanian Economy

Jordan is a small country with limited natural resources. The economy is characterised by various features. First, it is small in terms of the size of GDP and population compared to other countries (Seyam & Seyam, 1999). Second, due to the scarcity of natural and financial resources in Jordan, the services sector dominates the Jordanian economy; government and financial services account for 65.1% of GDP. Third, Jordan has a mixed economy wherein the government plays a significant role by employing about 50% of the workforce and by providing new services in various fields (Al-Farhan, 2001). Finally, the population growth rate is considered one of the highest compared to countries of the developed world, a result of both high migration and high natural growth (Seyam & Seyam, 1999).

The economy has been affected by several political and economic factors. For example, during the Israeli occupation of Palestine in 1948, large numbers of refugees came to Jordan. In 1950, the Jericho Conference resolved to annex the West Bank to Jordan; this meant that the Jordanian population increased suddenly. At that time, and for some time after, Jordan was mainly dependent on foreign aid. The United Kingdom supported the economy at an early stage, and later the US took over this role. Foreign grants made up an average of 30% of all government revenue, and between one fifth and one third of GDP, between 1952 and 1966 (Brynen, 1992). By the 1960s, Jordan had implemented several five-year plans, but these were disrupted by the 1967 Arab–Israeli war, which seriously affected the economy when Israeli annexation of the West Bank deprived Jordan of many economic resources: agriculture, industry, the tourist industry centred on Jerusalem and other Christian sites. Simultaneously, Jordan's population increased suddenly with a large influx of refugees (Brynen, 1992).

The economy was affected more favourably by the increment in world oil prices in the 1970s, when the GDP increased six times between 1973 and 1983. Real growth in the economy took place at about 10% per year, as Jordan's service sector developed rapidly to meet the increased demands of Gulf States markets; in addition, the expansion of the Jordanian potash industry added to the economic upturn (CBJ, Annual Report, various issues). Remittances from Palestinians and Jordanians who working in the Gulf States increased dramatically after 1973, reaching its peak at around 475 million Jordanian Dinar (JD) – approximately US$1.2 billion (Zaghloul, 1992).

In the period 1973–1980, foreign aid continued, comprising 55% of government revenue. Government expenditure during this time increased to at least 68% of GDP (Ministry of Planning, Five Year Plan, 1986–1990). At the beginning of the 1980s, because of the political situation in the region, economic growth slowed and large numbers of expatriate workers returned from the Gulf. As a result, unemployment rate began to rise. From 1981–1987 there was a decline in external grants, from more than one third of state expenditure to less than one sixth; however, governmental expenditure continued to grow at an average rate of over 6% per year; as a result the state budget began to experience a chronic, slowly growing deficit (Department of Research and Studies, CBJ, 1990).

The economic crisis of 1989[1] forced Jordan to adopt a comprehensive economic program over the period 1989–1993 under the direction of the International Monetary fund (IMF) and the World Bank (Mashaqbeh, 2005). Unfortunately, the second Gulf War stopped this program; the Jordanian government came to an agreement with the IMF mission for a second program from 1992–1998. The goal was to increase economic growth, investment and structural reform, boost productivity, stimulate the private sector, tackle unemployment, protect the poor, and

[1] The 1989 crisis is discussed in Section 2.4.

reform specific economic sectors: manufacturing, agriculture, trade, energy and water. The program continued to the middle of 2004 (Mashaqbeh, 2005). Recent decades have witnessed growing governmental interest in improving economic conditions, liberalising the economy, and increasing economic growth rates; to these ends, Jordan has signed several international trade and regional agreements, including

1. Convention on the Euro–Mediterranean Partnership of Jordan (2002);
2. Convention on the Jordanian–American free trade (2001);
3. Convention on the accession to the World Trade Organisation (2000);
4. Convention on the Greater Arab Free Trade (1998);
5. Agreements and arrangements for the establishment of Qualified Industrial Zones (1996).

2.2.2 An Overview of the Jordanian Financial Market[2]

The task of financial market intermediation was divided into four major institutions: commercial banks, insurance companies, brokers and investment banks (Akel, 1996). In the past two decades, Jordan witnessed many developments in the financial market; until 1964 it included 9 commercial banks. In 1978, the Amman Financial Market (AFM) was established, and subsequently many other investment banks and financial companies were created. AFM was established to supervise and organise the trading and issue of financial papers such as stocks and bonds (Akel, 1996). By 2007, the Jordanian financial market included the CBJ, thirteen commercial banks,

[2] For more details, see http://www.muflehakel.com/part%20one/Jordanian_Capital_Market.htm

two Islamic banks and five specialised credit institutions, 74 money exchange companies, a credit and savings company, eight representative offices of foreign banks, a loan guarantee company, a mortgage refinance company, 27 insurance companies and the Amman stock exchange (CBJ, 2007).[3]

2.3 Background to the Jordanian Banking Sector

The Jordanian banking sector consists mainly of the central bank, commercial banks, investment banks, development banks and Islamic banks. Banks engage in financial activities including providing traditional deposit and lending services, financing foreign trade activities and maintaining capital market transactions, as well as investment banking activities.

Banks in Jordan were in operation as early as 1925, when a British Bank called the Ottoman Bank became the first commercial bank to operate in Jordan.[4] Due to the absence of a central bank, the Ottoman Bank was considered the government bank with a registered office in London. The bank was registered with the Ministry of Justice on 30 August 1927. It became known as the National and Grindlays Bank in 1969, changed to ANZ Grindlays in 1989, and changed again to Standard Chartered Grindlays in 2000; in October 2003 this changed to Standard Chartered Bank. The Ottoman Bank operated alone until 1935, when the Arab Bank Limited, a Palestinian

[3] For more details see http://dsbb.imf.org/Pages/SDDS/DQAFBase.aspx?ctycode=JOR&catcode=AAB00

[4] http://www.muflehakel.com/not%20clasified/Banking.htm.

shareholding company, opened its first branch in Amman at the end of 1934 (Mouhsein, 1994). By 1948, given the political situation in Palestine, the Arab Bank moved its headquarters to Amman. On 14 April 1949, two banks were established; the British Bank for the Middle East, and the Arab Nation Bank (ANB). ANB was a Palestinian share holding company which opened its first branch in Jordan; however, it did not practise any banking activities, and finally the bank was liquidated (Mouhsein, 1994).

Later, Barclays Bank opened its first branch in Jordan, with its activities in the West Bank of Jordan. The bank was in operation up to 1955. On 25 December 1951, the Arab Real Estate Company was established with its first office registered in Cairo; later it expanded its activities to cover Jordan. The company then became a commercial bank called Arab Real Estate Bank in 1957, operating typical banking activities and providing special services related to real estate finance (Mouhsein, 1994). In 1955 two more banks were established, including one domestic, the Jordan National Bank, and the second Egyptian, the Cairo Amman Bank. In 1957, three more banks were established in Jordan: the Rafidain, Riyadh, and Intra Banks. Rafidain Bank, an Iraqi bank, still operates, but the Saudi Riyadh Bank never practised any banking activities and its registration was subsequently cancelled. Intra Bank, a Lebanese bank, suspended activity due to bankruptcy in 1970, but was re-established in 1977 under a new name: Al-Mashreq Bank. In 1989, Al-Mashreq Bank was liquidated and merged with Jordan Bank. In the second half of the 1950s, HSBC Bank established a branch in Jordan, operating as a foreign bank. By the

1960s, another domestic bank was established, the Jordan Bank. In 1961, a domestic bank was registered under the name of Holy Land Bank, but its registration was terminated in 1965. In addition, three specialised credit institutions owned by the government were established in the 1960s (Agriculture Credit Corporation, Housing and Urban Development Corporation, and Cities and Village Development Corporation) as was one joint ownership institution, the Industrial Development Bank (CBJ, 2007).

In the 1970s, five banks were established: four domestic banks (Housing Bank for Trade and Finance, Jordan Kuwaiti Bank, Jordan Gulf Bank, known now as Jordan Commercial Bank, and Arab Jordan Investment Bank) and one Islamic bank (Jordan Islamic Bank for Finance and Investment) (Mouhsein, 1994). In the 1980s, two more domestic banks (Arab Banking Corporation and Jordan Investment and Finance Bank) were established. Four banks were established in the 1990s, three domestic (Union Bank for saving and Investment, Société Générale De Banque-Jordanie, and Export and Finance Bank) and one Islamic (Islamic International Arab Bank Plc). By the turn of the century, four foreign banks had been established (Standard Chartered Bank, National Bank of Kuwait, Audi Bank and BLOM Bank).[5] All banking operations in Jordan were supervised by the CBJ.

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[5] See CBJ, Annual Report, various issues.

By 2007, domestic banks comprised thirteen commercial banks, two Islamic banks and four specialised credit institutions, and eight foreign banks (CBJ, Annual Report, 2007). Over the period 1927–2007, some merging and changing in the banking sector occurred, such as the establishment in 1927 of the Ottoman Bank which became the Standard Chartered Bank in 2003, or the Business Bank merging with the Jordan National Bank (JNB) on January 1997, as did the Philadelphia Investment Bank in July 2005. In 2004, the Jordan Gulf Bank changed its name to the Jordan Commercial Bank, Export and Finance Bank change to Capital Bank in 2005.

2.4 Developments of Jordanian Banking Sector: Banking Crisis, Financial Liberalisation Program, and Deregulation

The Jordan banking sector has undergone a number of developments since its creation in the second decade of the twentieth century. The monetary authority in Jordan was represented by the Jordanian Monetary Council up to 1959, when the Central Bank of Jordan (CBJ) was established. In 1959, the Law of the CBJ was enacted, and the bank started operational procedures on the first day of October 1964.

Before the 1980s, the Jordan banking sector was highly regulated and economic policies were directed towards prevention of and protection from foreign competition. The financial authorities put in place a set of measures to limit foreign entry, and as a result commercial banks in Jordan operated in an oligopolistic environment and interest rates on both credits and deposits were determined in a monopolistic manner (Al-khoury et al., 2008, pp.163). After the devaluation of Jordanian dinar, over the period 1988–1991, interest rates were increased rather than decreased to encourage Jordanian citizens to deposit their savings (Harrigan et al., 2006).

In August 1989, the banking system of Jordan suffered a crisis as a result of the collapse of Petra Bank, as well as financial difficulties faced by six other financial institutions linked to it. The crisis was the outcome of three main factors. First, inadequate banking regulations led to the failure of monetary bodies to detect widespread fraudulence in surveillance and management. The surveillance role was limited to ensuring that banks were complying with operating ratios, and to making sure of credit limits without forcing banks to include proper risk credit analysis in their loan allocations. Second, there was overexposure of the banking system to the real estate market, which led to non-performing loans. Third, the bank engaged in imprudent speculation in foreign exchange, leading to excessive exposure (Canakci, 1995).

To remedy the 1989 crisis, closer cooperation between Jordanian government, the International Monetary Fund (IMF) and the World Bank occured, and a reform program was followed. At the same time the CBJ implemented indirect management of monetary policy for the purpose of realising monetary stability, depending on open market operations and using various tools such as issuing certificates of deposit, reserve requirement and interest rates on monetary policy instruments. The CBJ also used other monetary instruments, such as changing the rediscount rate and the reserve requirement ratio, implementing direct management control to determine size, cost, and direction of credit facilities and restructuring the financial portfolio of banks (Harrigan et al., 2006). The Jordanian government also took steps to enhance banking system efficiency and to create competition among Jordanian banks. For example, the government began the process of liberalising the banking system in 1993 and again in 1997 by establishing a western-type free market economy and competition. The main measures for the liberalisation program were[6]

1. removing restrictions on interest rates;
2. reducing government direct lending; and
3. expanding product deregulation and reducing restrictions on foreign exchange transactions.

In addition, the government adopted policies aimed at export promotion, and structural reforms including the deregulation and liberalisation of financial markets (Maghyereh, 2004). Such reforms included the elimination of interest rate ceilings, reductions in both the reserve and liquidity requirements, and reductions in taxes. These measures were taken to allow foreign banks to operate in Jordan and to reduce foreign exchange trading and capital movements (CBJ, 2005).

The CBJ also took steps to enhance the soundness and increase the trust in the overall banking industry. For example, in 1989 all licensed banks and financial

[6] See Canakci (1995) for discussions.

companies were instructed to deposit 35% of their total deposits as a required reserve with the CBJ. In the following year, the CBJ liberalised the interest rates charged by banks and financial companies, based on different types of bank facilities (CBJ, Annual Report, 1991). In the second half of 1992, it instructed all commercial banks to restrict the maximum credit in local currency extended to non-residents to 5% of their total credit facilities (CBJ, Annual Report, 1993). Later, in 1995, it increased the minimum paid-up capital for all domestic banks to JD 20 million, and foreign banks were asked to raise their capital to JD 10 million by the beginning of 1997. During the period 1998–2001, the CBJ adopted a number of measures and legislative reforms; banking law was introduced in 2000, as will be discussed later in this chapter (CBJ, Annual Report, 1993–2001).

A milestone in the financial liberalisation process occurred when Jordan took two vital steps in 2000. First, Jordan came to an agreement with the WTO, which brought extensive legislative and regulatory reforms regarding customs and tariffs, patents, copyright and trademark legislation (Mahdi, 2001). Second, Jordan signed a Free Trade Area (FTA) agreement with the US, to eliminate trade barriers between the two countries in the following ten years – only the fourth such agreement with the US, after Israel, Mexico and Canada (see Kanaan, 2001; Ihsan et al., 2004, p.11).

Towards the end of 2007 CBJ implemented a flexible monetary policy intended to maintain monetary stability and ensure the invulnerability and soundness of the banking system. This policy contributed to the achievement of acceptable rates of economic growth accounting, at 6.0%, and of containing inflation pressure despite unfavourable conditions such as the unprecedented rise in oil prices and the resultant rise in the price of basic commodities in the international market in 2007 (CBJ, Annual Report 2007, Summary of Economic Development).

2.5 An Overview of the CBJ[7]

The CBJ is one of the most active players in Jordan's economy. It undertakes and supervises the most important features of the Jordanian economy such as monetary policy, fiscal policy and the balance of payments. Management is by a board of directors appointed by the ministry council. With respect to other important activities, the CBJ supports Jordan's budget deficit by financing a portion of any deficit via monetary expansion. The bank's capital is totally owned by the government, and increased gradually from JD1.00 million to JD18.00 million in 2007.[8] Despite its ownership, the CBJ is an independent and autonomous corporate body.

2.5.1 Objectives and Functions of the CBJ

According to legislation, 'the objectives of the central bank shall be to maintain monetary stability in the Kingdom, to ensure the convertibility of the Jordanian Dinar, and to promote the sustained growth of the Kingdom's economy in accordance with the general economic policy of the government' (CBJ, Objective

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[7] CBJ, available from http://www.cbj.gov.jo/

[8] CBJ, Annual Report (2007).

and Functions of the CBJ, 2007). To achieve these objectives, the CBJ's functions have evolved to include

1. issuing and regulating bank notes and coins,
2. maintaining and managing the Kingdom's reserves of gold and foreign exchange,
3. acting as a banker and fiscal agent to the government and public institutions,
4. acting as a banker to banks and specialised credit institutions
5. maintaining the safety of the banking system,
6. advising the government on the formulation and implementation of fiscal and economic policies,
7. managing monetary problems and participating in containing local economic problems,
8. regulating credit,
9. other roles, such as participating in the establishment of a number of financial institutions and corporations, such as Amman Stock Exchange, Jordan Mortgage Refinance Company.

2.6 The Structure of the Banking Sector in Jordan

The Jordanian banking sector consists of the CBJ, the domestic Jordanian banks (commercial and Islamic), specialised lending institutions, money-changing companies and representative offices of foreign banks. According to the annual report for the CBJ of 2007, the domestic banking sector consists of 13 commercial banks (Table 2.1), two Islamic banks (Table 2.2) and eight foreign banks in Jordan (Table 2.3).

Table 2.1: Commercial Banks operating in Jordan, 2007

Bank Number	Bank Name	Established in
1	Arab Bank	1930
2	Jordan National Bank	1956
3	Cairo Amman Bank	1960
4	Bank of Jordan	1960
5	The Housing Bank for Trade & Finance	1974
6	Jordan Kuwaiti Bank	1977
7	Arab Jordan Investment Bank	1978
8	Jordan Commercial Bank	1978
9	Jordan Investment & Finance Bank	1989
10	Arab Banking Corp./ Jordan	1989
11	Union Bank	1991
12	Societe General - Jordan	1993
13	Capital Bank	1996

Source: CBJ, Annual Report, 2007 and Association of Banks in Jordan, 29th Annual Reports, 2007, Amman, Jordan.

Table 2.2: Islamic Banks operating in Jordan, 2007

Bank Number	Bank Name	Established in
1	Jordan Islamic Bank	1978
2	International Islamic Arab Bank	1997

Source: CBJ, Annual Report, 2007 and Association of Banks in Jordan, 29th Annual Report, 2007, Amman, Jordan.

Table 2.3: Foreign Banks operating in Jordan, 2007

Bank Number	Bank Name	Established in
1	HSBC	1949
2	Egyptian Arab Land Bank	1951
3	Rafidain Bank	1957
4	Citi Bank	1974
5	Standard Chartered	2002
6	Bank Audi	2004
7	National Bank of Kuwait	2004
8	BLOM Bank	2004

Source: CBJ, Annual Report, 2007 and Association of Banks in Jordan, 29th Annual Report, 2007, Amman, Jordan.

2.6.1 Growth in Licensed Banks

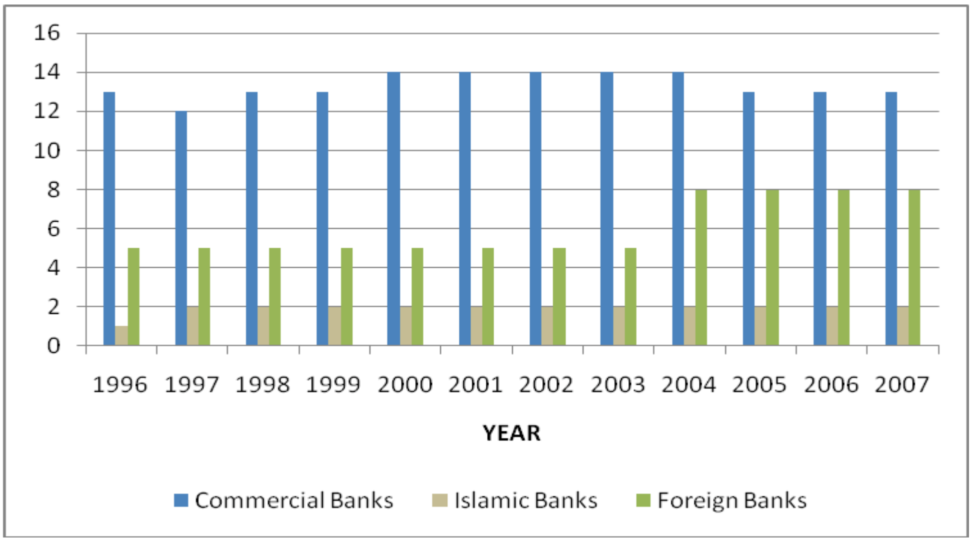
Licensed banks in Jordan increased from 19 in 1996 to 23 in 2007 (Table 2.4), due to the increase in the number of foreign banks from five in 1996 to eight in 2007. The foreign banks established in 2004 were Blom, Audi and the National Bank of Kuwait. The number of domestic banks decreased from 16 to 15 after the merger of Philadelphia Bank and Jordan National Bank in 2005; the, number of licensed banks operating in Jordan in 2007 were 23, of which 15 were Jordanian and eight were foreign (five of them Arabian).

Table 2.4: Number of Domestic and Foreign Banks operating in Jordan, 1996–2007

Year	Number of Domestic Banks		Number of Foreign Banks	Total
	Commercial Banks	Islamic Banks		
1996	13	1	5	19
1997	12	2	5	19
1998	13	2	5	20
1999	13	2	5	20
2000	14	2	5	21
2001	14	2	5	21
2002	14	2	5	21
2003	14	2	5	21
2004	14	2	8	24
2005	13	2	8	23
2006	13	2	8	23
2007	13	2	8	23

Source: Association of Banks in Jordan, 29th Annual Report, 2007, Amman, Jordan and CBJ, various issues.

Figure 2.1: Number of Domestic and Foreign Banks operating in Jordan, 1996–2007



2.6.2 Growth in Bank Branches

By the end of 2007 the number of branches of the Jordanian banking sector had increased to 559, as compared to 428 branches in 1996. The banking density index was 10,250 persons per branch at the end of 2007. There are 137 branches of Jordanian banks outside Jordan in 2007. Table 2.5 shows the details of number of branches.

Table 2.5: Number of Branches, 1996 –2007

Year	Number of banks	Number of branches	Population	Population /bank	Population /Branch	Staff	Staff/ bank	Staff / branch
1996	19	428	4441.2	233.75	10.35	13430	671	29.8
1997	19	451	4520.0	237.89	10	13491	710	29.9
1998	20	457	4623. 0	231.15	10.11	13403	670.1	29.3
1999	20	463	4738.0	236.9	10.23	13195	659.7	28.5
2000	21	446	4857.0	242.85	10.36	13062	622	29.2
2001	21	464	4978.0	248.9	10.57	12950	616.6	27.9
2002	21	442	5098.0	254.9	10.82	12915	615	29.2
2003	21	444	5230.0	261.5	11.65	12782	608.6	28.7
2004	24	448	5350.0	232.60	11.97	13321	555.1	29.7
2005	23	506	5473.0	237.95	10.66	13182	573.1	26.1

2006	23	516	5600.0	243.47	10.87	14165	615.8	27.4
2007	23	559	5723.0	248.82	10.26	15065	655	26.9

Sources: Association of Banks in Jordan, 29th Annual Report, 2007 and CBJ, Annual Report, 2007.

2.7 Development of Jordanian Banks' Assets, Credit Facilities and Deposits

2.7.1 Growth of Assets

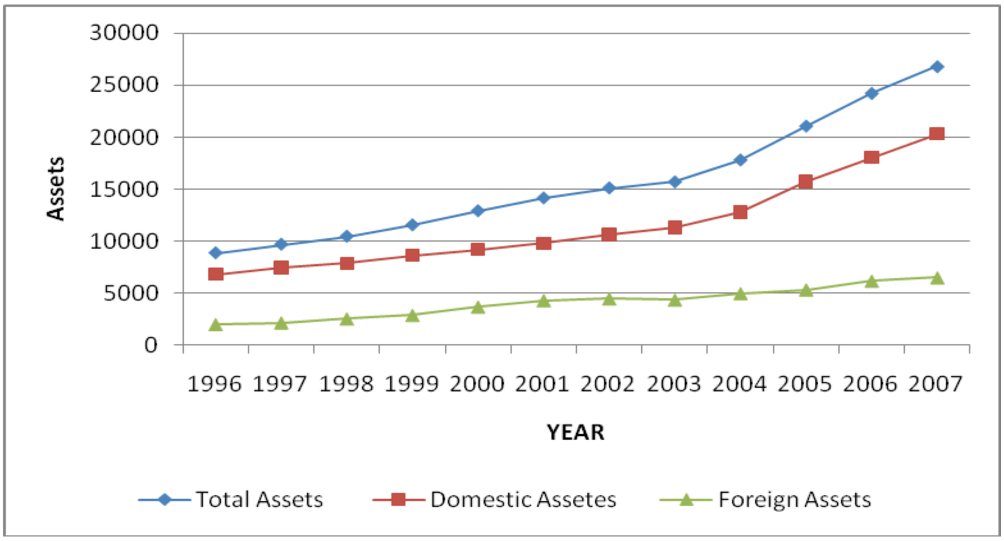
The Jordanian banking sector witnessed an impressive growth in assets over the period 1996–2007. Table 2.6 provides information about the total assets of the domestic and foreign banks in Jordan. For example, the total assets of banks operating in Jordan jumped from JD 8857.7 million in 1996 to JD 26815.6 million at the end of 2007, with an annual growth of 10.64% in 2007. The banks' assets as a percentage of the gross domestic product at current market prices increased from 180.3% in 1996 to 228.77% in 2007. The total assets of foreign banks operating in Jordan during this time were a quarter of the total assets of the Jordanian sector. The total assets held by foreign banks increased over the period 1996–2001, from 22.8% in 1996 to 30.60% in 2001, then decreased to 24.30% in 2007.

Table 2.6: Assets of Banks Operating in Jordan in millions of Dinar and its Ratio to GDP, 1996 – 2007

Year	Total Assets	Domestic Assets		Foreign Assets	percentage change of total assets		Total Assets/GDP %
	JD Million	JD Million	Total Assets (%)	JD Million	Total Assets (%)	% Annual Growth	
1996	8857.7	6840.6	77.2	2017.1	22.8	5.1	180.3
1997	9679.2	7497.3	77.5	2181.9	22.5	9.3	188.4
1998	10460.3	7902.7	75.5	2557.5	24.4	8.1	186.5
1999	11551.2	8643.3	74.8	2907.9	25.2	10.4	199.9
2000	12913.5	9201.8	71.30	3711.7	28.70	11.80	215.30
2001	14153.6	9825.6	69.40	4328	30.60	9.60	222.40
2002	15119.3	10626.6	70.30	4492.7	29.70	6.80	222.50
2003	15701.5	11319.7	72.10	4381.8	27.90	3.90	217.20
2004	17821.1	12819	71.90	5002.1	28.10	13.50	220.50
2005	21086.5	15724.7	74.60	5361.8	25.40	18.30	234.00
2006	24237.6	18034.2	74.40	6203.4	25.60	14.90	239.80
2007	26815.6	20299.1	75.70	6516.5	24.30	10.64	228.77

Source: CBJ, Monthly Bulletin, 2007.

Figure 2.2: Assets of Banks operating in Jordan in millions of JD and its Ratio to GDP, 1996–2007



2.7.2 Growth in Credit Facilities

2.7.2.1 Growth of Credit Facilities in Jordanian Dinar and Foreign Currencies

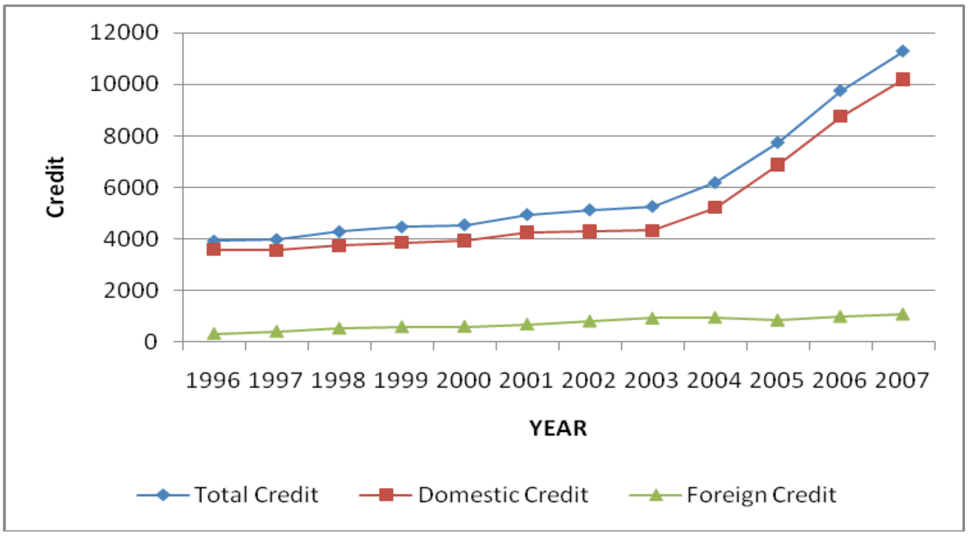
Table 2.7 shows that the balance of credits increased from JD 3920.3 million in 1996 to JD 11295.6 million at the end of 2007. In contrast, there was a decrease in the percentage of credits in domestic currencies to total credit facilities from 91.58% in 1996 to 90.30% as of the end of 2007.

Table 2.7: Total Credit Facilities Extended by Banks operating in Jordan and its Ratio to GDP, 1996–2007

Year	Total Credit Facilities in (JD) Million	Domestic Credit Facilities		Foreign Credit Facilities		Percentage change of Total Credit Facilities	Percentage of Total Credit Facilities to GDP
		JD Million	Percent of Total Credit Facilities	JD Million	Percent of Total Credit Facilities		
1996	3920.3	3590.4	91.58	329.9	8.42	**	79.8
1997	3979.7	3562.7	89.52	417.0	10.48	1.5	77.5
1998	4285.3	3746.1	87.42	539.2	12.58	7.7	76.4
1999	4466.0	3871.7	86.69	594.3	13.31	4.2	77.3
2000	4546.5	3,936.8	86.59	609.7	13.41	1.80	75.8
2001	4948.9	4,251.9	85.92	697.0	14.08	8.90	77.8
2002	5130.0	4,311.9	84.05	818.1	15.95	3.70	75.5
2003	5262.4	4,333.0	82.34	929.4	17.66	2.60	72.8
2004	6189.2	5,227.9	84.47	961.3	15.53	17.60	76.6
2005	7744.3	6,887.4	88.94	856.9	11.06	25.10	85.9
2006	9761.9	8,761.8	89.76	1000.1	10.24	26.10	96.6
2007	11295.6	10,199.7	90.30	1095.9	9.70	15.71	97.3

Source: CBJ, Monthly Bulletin, 2007.

Figure 2.3: Total Credit Facilities Extended by Banks operating in Jordan and its Ratio to GDP, 1996–2007



Source: CBJ, Monthly Bulletin, 2007.

2.7.2.2 Growth in Type of Credit Facilities

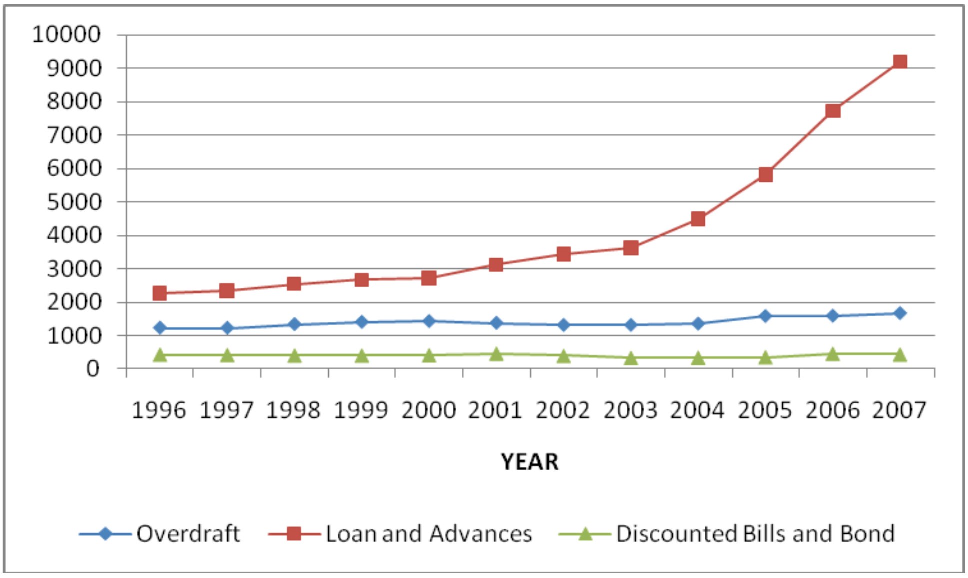
Credit facilities within the Jordanian banking sector increased over the period 1996–2007, with increases in loans to total facilities from 57.8% in 1996 to 81.5% in 2007. The overdrafts and advances under current accounts, as well as promissory notes, declined from 31.2% and 11% in 1996 to 14.7% and 3.9%, respectively in 2007 (Table 2.8).

Table 2.8: Development of Types of Credit Facilities Extended by Licensed Banks, 2000–2007

Year	Overdraft		Loans and Advances		Discounted Bills and Bond		Total
	JD Million	%	JD Million	%	JD Million	%	
1996	1223.0	31.2	2265.7	57.8	431.6	11.0	3920.3
1997	1216.6	30.6	2340.6	58.8	422.5	10.6	3979.7
1998	1329.1	31.0	2547.1	59.4	409.1	9.5	4285.3
1999	1394.9	31.2	2668.5	59.8	402.6	9.0	4466.0
2000	1419.8	31.20	2711.4	59.60	415.3	9.10	4546.5
2001	1368.2	27.60	3115.1	62.90	465.3	9.40	4948.6
2002	1304.2	25.40	3428.6	66.80	397.2	7.70	5130.0
2003	1304.7	24.80	3620.5	68.80	337.2	6.40	5262.4
2004	1343.4	21.70	4499.6	72.70	346.2	5.60	6189.2
2005	1572.9	20.30	5813.9	75.10	357.5	4.60	7744.3
2006	1580.5	16.20	7722.1	79.10	459.3	4.70	9761.9
2007	1658.6	14.68	9199.8	81.45	437.2	3.87	11295.6

Source: CBJ, Research and Studies Department, 2007.

Figure 2.4: Development of Types of Credit Facilities Extended by Licensed Banks, 2000–2007



Source: CBJ, Research and Studies Department, 2007.

2.7.3 Growth in Deposits

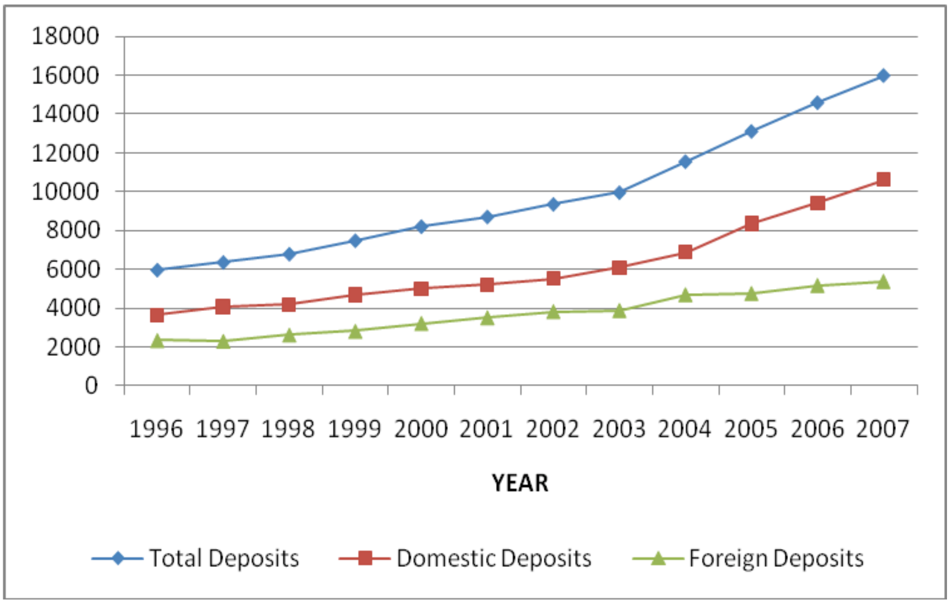
Total deposits in both Jordanian dinars and foreign currencies increased during the period 1996–2007. As shown in Table 2.9, total deposits increased slightly from 1996–2003 (JD5488.8 to JD9969.4). The Jordanian banking sector witnessed the highest growth rate in deposits in 2004, at 16%. This increase may have been due to Gulf deposits following the 2003 US-led invasion of Iraq (also see Figure 2.5).

Table 2.9: Total Deposits at Banks operating in Jordan, 1996–2007

Year	Total Deposits	Domestic Deposits		Foreign Deposits		Percentage change of Total Deposits %	Percentage of Total Deposits to GDP %
	JD Million	JD Million	In percent of Total Deposits (%)	JD Million	Total Deposits (%)		
1996	5988.8	3636.3	60.72	2352.5	39.28	**	121.9
1997	6387.9	4076.7	63.82	2311.2	36.18	6.7	124.3
1998	6811.4	4178.5	61.35	2632.9	38.65	6.6	121.4
1999	7502.4	4681.4	62.40	2821.0	37.60	10.1	129.8
2000	8224.5	5000.2	60.80	3224.3	39.20	9.60	137.1
2001	8721.3	5203.7	59.67	3517.6	40.33	6.00	137
2002	9367.7	5532.6	59.06	3835.1	40.94	7.40	137.9
2003	9969.4	6082.9	61.02	3886.5	38.98	6.40	137.9
2004	11564.1	6878.7	59.48	4685.4	40.52	16.00	143.1
2005	13119.3	8364.5	63.76	4754.8	36.24	13.40	145.6
2006	14591.9	9427.1	64.61	5164.8	35.39	11.20	144.4
2007	15988.1	10618.0	66.41	5370.1	33.59	9.57	143.2

Source: CBJ, Monthly Bulletin, 2007.

Figure 2.5: Total Deposits of Banks operating in Jordan, 1996–2007



Source: CBJ, Monthly Bulletin, 2007.

2.7.3.1 Changing Structure of Deposits

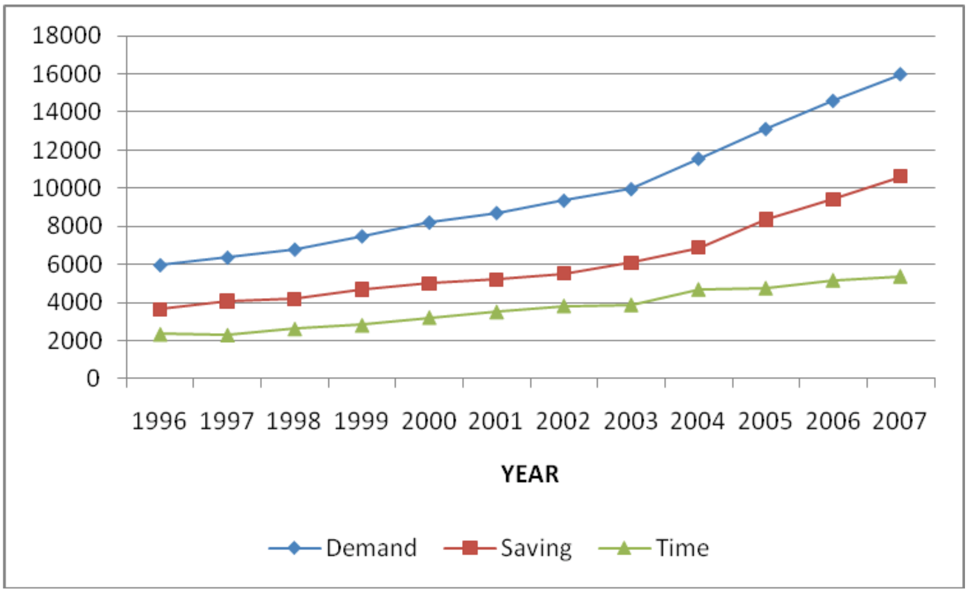
It is worth mentioning that the structure of deposits has changed during the past decade in favour of demand deposits at the expense of term deposits. Demand deposits increased from JD 925.6 in 1996 to JD 4001.9 at the end of 2007 whereas saving deposits increased from JD 782.2 in 1996 to JD2002.9 in 2007, while time deposits increased from JD 4581 in 1996 to JD 9983.3 at the end of 2007 (Table 2.10).

Table 2.10: Development of Types of Deposits of Banks operating in Jordan, 1996–2007

year	Demand		Saving		Time		Total
	JD Million	%	JD Million	%	JD Million	%	
1996	925.6	15.5	782.2	13.1.	4281.0	71.5	5988.8
1997	1038.0	16.2	787.0	12.3	4562.9	71.4	6387.9
1998	1072.5	15.7	793.6	11.7	4945.3	72.6	6811.4
1999	1108.8	14.8	843.7	11.2	5549.9	74.0	7502.4
2000	1313.7	16.00	970.8	11.80	5940.0	72.20	8224.5
2001	1529.3	17.50	1067.2	12.20	6124.8	70.20	8721.3
2002	1920.4	20.50	1233.8	13.20	6213.5	66.30	9367.7
2003	2338.8	23.50	1510.6	15.20	6120.0	61.40	9969.4
2004	3244.1	28.10	1828.6	15.80	6491.4	56.10	11564.1
2005	3674.4	28.00	1956.6	14.90	7488.3	57.10	13119.3
2006	3835.4	26.30	1997.1	13.70	8759.4	60.00	14591.9
2007	4001.9	25.03	2002.9	12.53	9983.3	62.44	15988.1

Source: CBJ, Monthly Bulletin, 2007.

Figure 2.6: Development of Types of Deposits at Banks operating in Jordan, 1996–2007



Source: CBJ, Monthly Bulletin, 2007.

2.8 Developments in the Interest Rate Structure in the Jordanian Banking Market

2.8.1 Interest Rates on Deposits

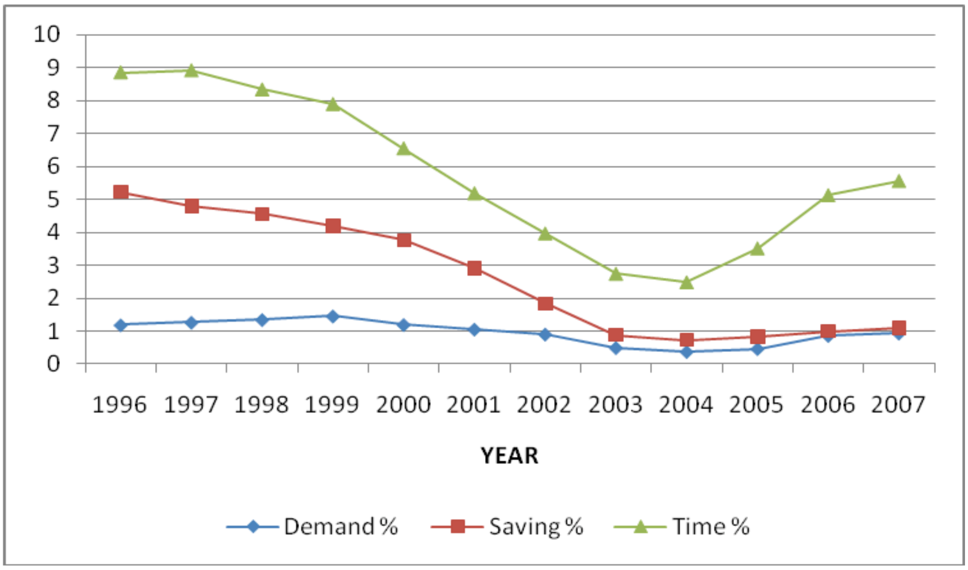
Table 2.11 below shows the weighted average of interest rates on deposits. The interest rates on deposits declined over the period 2000–2004, then increased gradually until the end of year 2007. The highest increase in the weighted average of interest rates was in time deposits in 2006. Despite the increase in interest rates on all forms of deposits, it did not reach the level registered in 2000.

Table 2.11: The Weighted Average of Interest Rates on Deposits at Banks, 1996–2007

Year	Demand %	Saving %	Time %
1996	1.19	5.22	8.85
1997	1.27	4.79	8.91
1998	1.35	4.560	8.33
1999	1.46	4.19	7.89
2000	1.200	3.760	6.550
2001	1.060	2.910	5.190
2002	0.910	1.840	3.970
2003	0.500	0.880	2.750
2004	0.380	0.730	2.490
2005	0.470	0.830	3.520
2006	0.870	0.990	5.130
2007	0.940	1.100	5.560

Source: CBJ, Monthly Bulletin, 2007.

Figure 2.7: The Weighted Average of Interest Rates on Deposits at Banks, 1996–2007



Source: CBJ, Monthly Bulletin, 2007.

2.8.2 Interest Rates on Credit Facilities

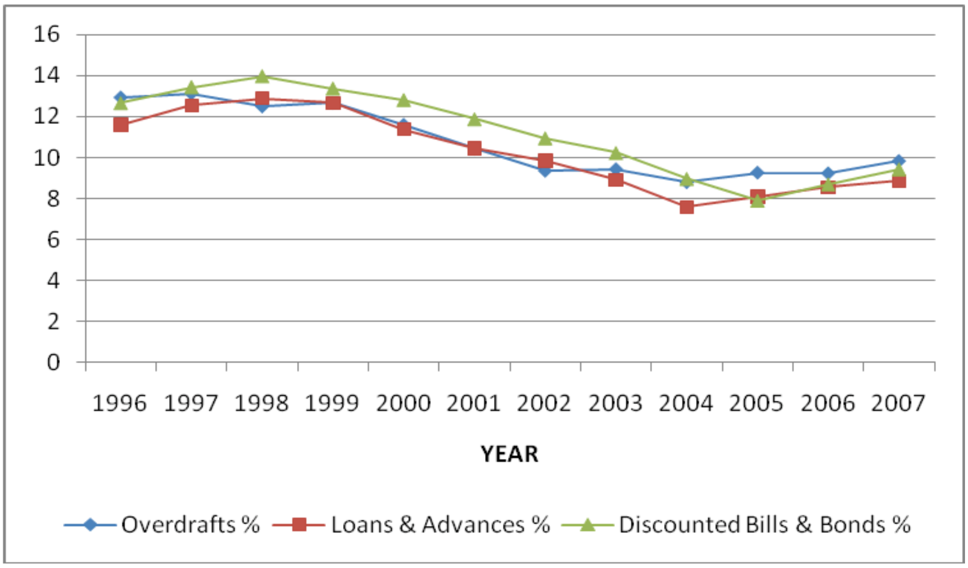
The weighted average of interest rates on all kinds of credit facilities declined over the period 1996– 2004, then increased gradually until 2007 (see Table 2.12).

Table 2.12: The Weighted Average of Interest Rates on Credit Facilities Extended by Banks, 1996–2007

Year	Overdrafts %	Loans & Advances %	Discounted Bills & Bonds %
1996	12.93	11.60	12.66
1997	13.12	12.55	13.44
1998	12.49	12.89	13.97
1999	12.66	12.67	13.37
2000	11.600	11.380	12.810
2001	10.420	10.450	11.880
2002	9.350	9.850	10.950
2003	9.430	8.920	10.240
2004	8.790	7.590	8.980
2005	9.260	8.100	7.920
2006	9.230	8.560	8.720
2007	9.830	8.860	9.450

Source: CBJ, Monthly Bulletin, 2007.

Figure 2.8: The Weighted Average of Interest Rates on Credit Facilities Extended by Banks, 1996–2007



Source: CBJ, Monthly Bulletin, 2007.

2.9 Developments in Jordanian Banking Sector Services

The Jordanian banking sector took steps to modernise and develop their products, keeping them in line with developments in the international banking industry. Banks developed their services and diversified their products in conformity with the results and outputs of the information technology and telecommunications revolution. Until the end of 2007, the Jordanian banking sector introduced approximately 66 new services, mostly by employing technology in the service of clients. Table 2.13 details the services introduced by the end of 2007. Table 2.14 details the rapid technological growth the Jordanian banking sector underwent to modernise and develop their services and to attract more customers. For instance, banks designed websites for their customers and, from 2007, provided new electronic services.

Table 2.13: New Services Introduced by the End of 2007

Name of service	Name of service
Car financing Housing financing Opening five new branches Expanding ATM network Establishing quality assurance unit	Accepting loan applications via the bank's website Upgrading the automated phone banking services " Hala Arabi" Launching new website: www.arabbank.com.jo Online cash deposit service available at 20 ATM locations Electronic clearing
Ma'ak Visa credit card programme Al-Hal programme for personal loans Mubarak programme for car loans Financing projects of Housing and Urban Development Department Establishing 12 specialized centers for developing SMEs Finance leasing New campaign for saving accounts Accepting Social Security subscriptions	Call centre Operating the customers' management system Launching the follow-up collection unit Launching the customers' follow-unit "Let's Go Places" campaign "Know Your Customer" campaign "My Business" revolving loan National premium banking service
Microfinance Internet banking SMS banking Banking services via Jordan Post	Fuel loans Golden deposit account Medical loans Social Security subscription payment
Orange bill payment Social Security installment payments Financing travel packages Discounted certificates of deposit	Western Union transfers via internet Secure shopping via internet (VBV) Electronic clearing Camera surveillance for branches and ATMs
Prepaid cards service ABC Online "Jordan" Social Security subscription payment IN card for companies	Premier centre My Rewards Points programme Credit cover Opening new branch in Abdoun
Gold certificates	Visa cards
Assortment of credit cards	Visa card :SMS service
Visa card: SMS service Master card: SMS service	LCD loan Furniture loan

Source: Association of Banks in Jordan, 29th Annual Reports, 2007. Amman, Jordan.

Table 2.14: Electronic Banking Services in the End of 2007

Bank's Name	Website	Availability of Online services in Jordan	Retail e-banking	Corporate e-banking
Arab Bank	www.arabbank.com.jo	Yes	Yes	Yes
Jordan National Bank	www.ahli.com	Yes	Yes	Yes
Cairo Amman Bank	www.cab.jo	Yes	Yes	No
Bank of Jordan	www.bankofjordan.com	Yes	Yes	Yes
The Housing Bank for Trade & Finance	www.hbtf.com	Yes	Yes	Yes
Jordan Kuwait Bank	www.jordan-kuwait-bank.com	Yes	Yes	Yes
Arab Jordan Investment Bank	www.ajib.com	Yes	Yes	Yes
Jordan Commercial Bank	www.jgbank.com.jo	No	No	No
Jordan Islamic Bank	www.jordanislamiCBJnk.com	Yes	Yes	Yes
Jordan Investment & Finance Bank	www.jifbank.com	Yes	Yes	No
Arab Banking Corp.	www.arabbanking.com.jo	Yes	Yes	Yes
Union Bank	www.unionbankjo.com	Yes	Yes	Yes
Societe General Bank-Jordan	www.sgbj.com.jo	Yes	Yes	Yes
Capital Bank	www.capitalbank.jo	Yes	Yes	Yes
International Islamic Arab Bank	www.iiabank.com.jo	No	No	No
HSBC	www.jordan.hsbc.com	Yes	Yes	Yes
Egyptian Arab Land Bank	www.arakari.com.jo	No	No	No
Rafidain Bank	www.rafidain-bank.org	No	No	No
Citi Bank	www.citibank.com/jordan	NA	NA	NA
Standard Chartered	www.standardchartered.com	Yes	Yes	No
Bank Audi	www.audi.com.lb	Yes	Yes	Yes
National Bank of Kuwait	www.nbk.com	No	No	No
BLOM Bank	www.blom.com.lb	Yes	Yes	Yes

Source: Association of Banks in Jordan, 29th Annual Reports, 2007. Amman, Jordan.

2.10 The Development of Islamic Banks

After the independence of Arab and Muslim countries several experiments were undertaken in an effort to establish Islamic financial institutions. The first idea for Islamic banks emerged in Pakistan in the nineteen forties. In the sixties the first attempt to establish Islamic banks occurred in Egypt. Ahmad Elnajar introduced savings banks based on profit-sharing in the Egyptian town of Mit Ghamr in 1963. In 1971 the bank was closed because of political circumstances. In 1972, the Mit Ghamr savings project became part of the Naser Social Bank (Al Qeri, 1996). In the late sixties, several Islamic countries endorsed the notion of Islamic banks. The Islamic Summit conference in Rabat/ Morocco in 1969 decided to refer the matter to the Arab Foreign Ministers' meeting, held on 25–28 December 1970, where it was proposed to establish an international Islamic bank. In 1974 the first Islamic bank, under the name of the Islamic Development Bank, was established in Jeddah/ Kingdom of Saudi Arabia with the participation of governments of the Islamic states (Al-Qeri, 1996). In 1975, after the establishment of the Dubai Islamic Bank in United Arab Emirates, Islamic countries have established more Islamic banks, basing them on the statute of Dubai Islamic Bank. In 1976, the Islamic Development Bank commenced its activities in Jeddah/ Kingdom of Saudi Arabia after approval from the finance ministers of 36 Islamic states; it is deemed the first international Islamic bank.

Later, the idea of Islamic banks spread over the world: an important indication of international acceptance of the idea of Islamic banking. The seventies witnessed the emergence of many Islamic banks in various Arab countries, such as the Faisal Islamic Bank of Sudan in (1978), the Jordan Islamic Bank for Finance and Investment in (1978) and the Bahrain Islamic Bank in (1979) (Sowan, 2000).

2.10.1 Historical Developments of the Islamic Banks Operating in Jordan

At the end of the 1970s the Islamic banking system was introduced to Jordan. The Jordan Islamic Bank for Finance and Investment was the first, established in 1978 as a member of the Saudi Arabia-based Al Baraka network of Islamic banks (Zeitun & Saleh, 2006), although 90% of its capital is owned by Jordanian citizens. Later, a number of Islamic financial institutions such as the Finance House and the Islamic Investment House were established; these later became the National Islamic Bank (Zeitun & Saleh, 2006). By 1986 the Jordan Islamic Bank for Finance and Investment was the sixth largest of Jordan's banks in assets, and had financed numerous projects. In 1997 a second Islamic bank was established by the Arab Bank, the Islamic International Arab Bank. Jordan was one of the first countries to organise the work of the Islamic banks, with the issuance of the banking law of Jordan in 2000. Since then, Jordan has witnessed the emergence of a new generation of Islamic financial institutions. With regard to the size of the domestic market, Jordan has taken serious steps to integrate her with other regional markets, whether stock markets the banking sector or the financial sector. In 2007 the Industrial Development Bank completed all necessary formalities to become an Islamic bank.

The Jordan Islamic Bank for Finance and Investment and the Islamic International Arab Bank provide a full range of comprehensive and complementary banking services for individuals and corporations, in accordance with Islamic Sharia law. The volume of the two banks combined in 2007 was JD208 million (293 million USD) in terms of shareholders, with total assets of JD2.2 billion (3.1 billion USD). Jordan's Islamic banks have grown almost 10% in their customer base (as defined by change and deposits) compared with 12% of all banks (CBJ, Annual Report, 2008).

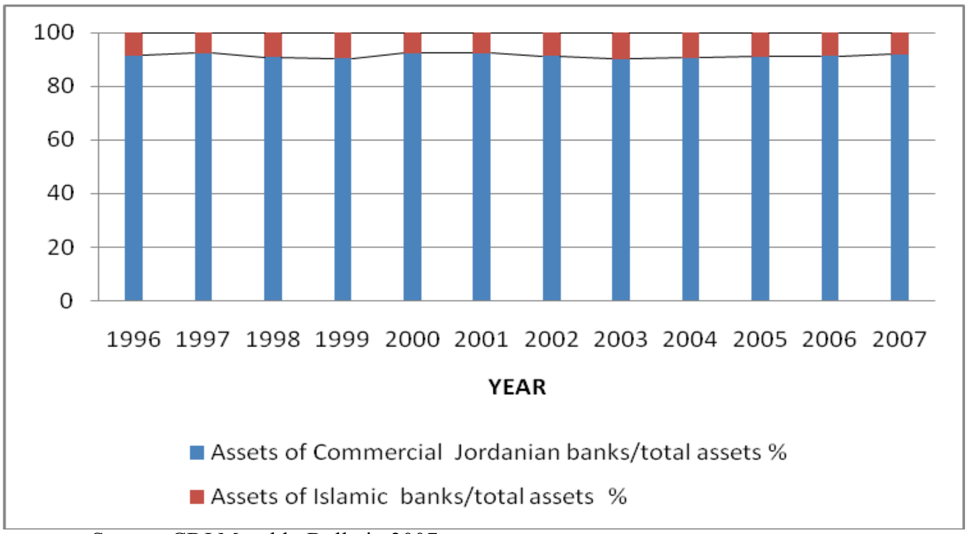
Table 2.15 indicates that at the end of 2007, Islamic banks controlled 8% of the total assets of the Jordanian banking sector. The distribution of assets fluctuated between Jordanian and foreign banks during the period (also see Figure 2.9).

Table 2.15: Distribution of the Assets of the Banking Sector between Commercial Jordanian Banks and Islamic Banks, 1996–2007

Year	Assets of Commercial Jordanian banks/total assets %	Assets of Islamic banks/total assets %
1996	91.53	8.47
1997	92.38	7.62
1998	90.88	9.12
1999	90.50	9.50
2000	92.41	7.59
2001	92.28	7.72
2002	91.35	8.65
2003	90.14	9.86
2004	90.53	9.47
2005	91.13	8.87
2006	91.18	8.82
2007	92.00	8.00

Source: CBJ Monthly Bulletin, 2007.

Figure 2.9: Distribution of the Assets of the Banking Sector between Commercial Jordanian Banks and Islamic Banks, 1996–2007



Source: CBJ Monthly Bulletin 2007.

Table 2.16 shows that at the end of 2007, Islamic banks controlled less than 11% of the total deposits in the Jordanian banking sector. This distribution fluctuated between Commercial banks and Islamic banks; high fluctuation occured in both. Islamic banks' share of deposits decreased from 8.58% in 1996 to 6.00% in 2007, while the deposits in commercial banks increased.

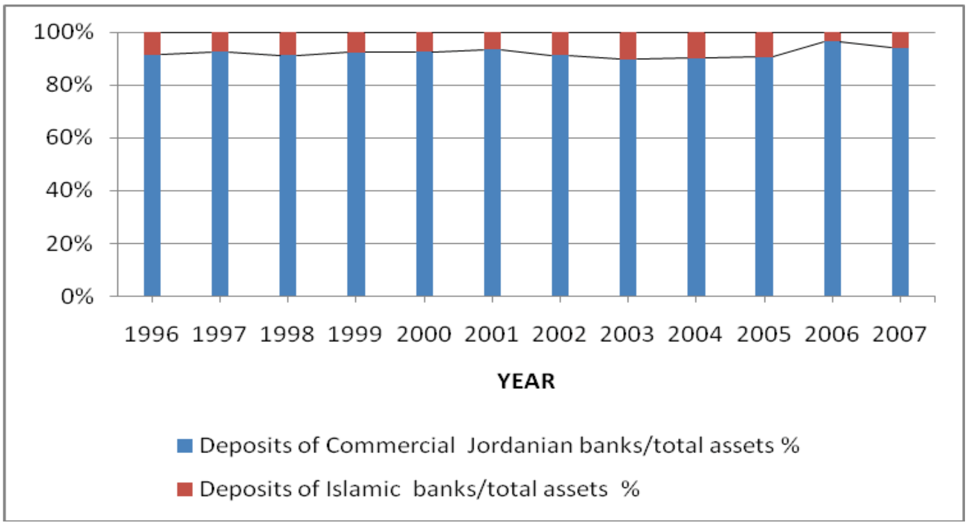
Table 2.16: Distribution of the Deposits at the Banking Sector between Commercial Jordanian Banks and Islamic Banks, 1996–2007

Year	Deposits of Commercial Jordanian banks/total assets %	Deposits of Islamic banks/total assets %
1996	91.42	8.58
1997	92.46	7.54
1998	91.28	8.72
1999	92.42	7.58
2000	92.67	7.33
2001	93.34	6.66
2002	91.31	8.69
2003	89.82	10.18
2004	90.10	9.90

Year	Deposits of Commercial Jordanian banks/total assets %	Deposits of Islamic banks/total assets %
2005	90.60	9.40
2006	96.40	3.60
2007	94.00	6.00

Source: CBJ Monthly Bulletin 2007.

Figure 2.10: Distribution of the Deposits at the Banking Sector between Commercial Jordanian Banks and Islamic Banks, 1996–2007



Source: CBJ Monthly Bulletin 2007.

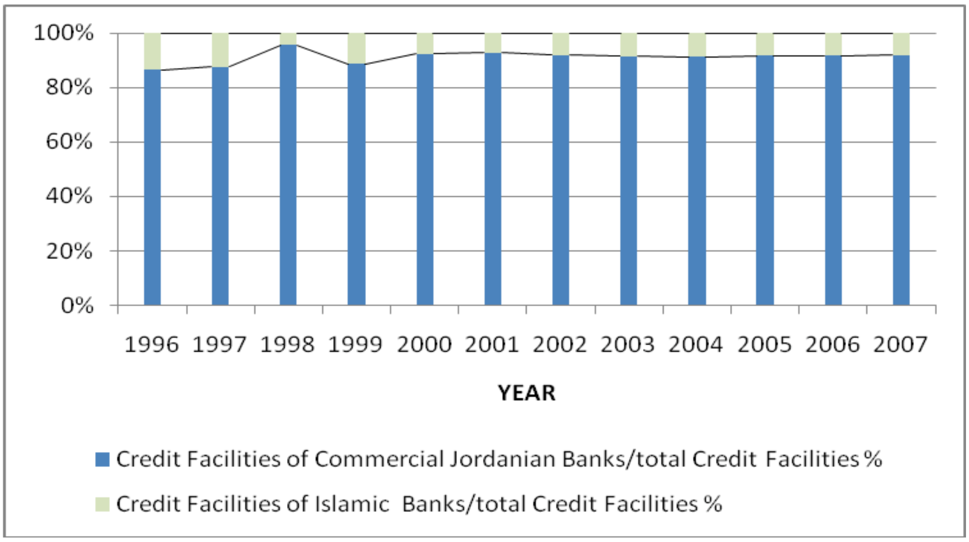
Table 2.17 indicates that at the end of 2007, Islamic banks controlled almost 8% of the total credit facilities; the rest were held by non-Islamic commercial banks. The distribution of credit facilities fluctuated between these two forms of bank during 1996–2007.

Table 2.17: Distribution of the Credit Facilities Extended by the Banking Sector between Commercial Jordanian Banks and Islamic Banks, 1996–2007

Year	Credit Facilities of Commercial Jordanian Banks/ Total Credit Facilities %	Credit Facilities of Islamic Banks/ Total Credit Facilities %
1996	86.44	13.56
1997	87.52	12.48
1998	95.50	4.50
1999	88.63	11.37
2000	92.32	7.68
2001	92.77	7.23
2002	91.83	8.17
2003	91.38	8.62
2004	91.28	8.72
2005	91.69	8.31
2006	91.67	8.33
2007	92.00	8.00

Source: CBJ Monthly Bulletin 2007.

Figure 2.11: Distribution of the Credit Facilities Extended by the Banking Sector between Commercial Jordanian Banks and Islamic Banks, 1996–2007



Source: CBJ Monthly Bulletin 2007.

2.10.2 Basic Principle of Islamic Banking

Islamic banking refers to a system of banking activity that is consistent with the principles of Sharia, which prohibits the payment of interest fees for the lending of money. Islamic banking has the same purpose as conventional banking except that it claims to follow Sharia law. The basic principle is the sharing of profit and loss and the prohibition of *riba* (interest). *Riba* is an Arabic word which, literally, denotes an increase of something to more than its original size or amount. In the Quran, the term *riba* signifies an unlawful and forced addition to the payback value of money or goods lent by one person to another.[9]

From a theoretical perspective, Islamic banking is different from conventional banking because interest (riba) is prohibited. These banks are not allowed to offer a fixed rate of return on deposits, and are not allowed to charge interest on loans. They depend on a profit-and-loss-sharing paradigm, based on modes of financing such as *mudarabah* (profit-sharing) and *musharakah* (joint venture).

There are some activities in which Islamic banks and the conventional banks are similar, but there are several differences. While Islamic banks offer banking products and services similar to those offered by conventional bank (Al-Syed, 2006), they finance lending activity on the basis of sharing achieved profit; any loss is borne by the bank (Ahmad, 2001). The most notable features of Islamic banks are:

[9] http://islamic-law.suite101.com/article.cfm/what_is_riba#ixzz0tpOL78PZ

1. Islamic banks are Islamic financial institutions.
2. Islamic banks collaborate with other institutions and individuals in the development of Islamic values and ethics in the field of transactions, to maximise the economic and social returns of the Islamic nation (Kafrawi, 1998).

While Sharia bans *riba*, this does not mean that capital in an Islamic financial system has no cost. Indeed, capital is considered one of the main factors of production, but the financial system does not allow such a factor to make a claim on productive surplus in the form of interest. Instead, the two partners, the owner of capital (*rabb-ul-mal*) and the entrepreneur share the obtained profits, since profit sharing is allowed in Islam while *riba* is not. This means, according to Islamic law, that investors are not entitled to demand a fixed rate of return. Nor is any addition to the original amount allowed to anyone who does not share in the involved risks (Racha, 2008). Islamic banks' funds are received from clients without any obligation or undertaking, directly or indirectly, to give any agreed return on their deposits, but it does undertake to return the deposits upon request. Islamic banks use such deposits in investment activities or business; they do not lend money at interest, but do finance activities on the basis of participation in achieved profit (Ahmad, 2001).

According to Ahmad (2001) the economic imperative for Islamic banks is based on the following:

1. A financial institution that deals by sharing is more able to collect cash balances for investment.

2. A banking institution that deals by sharing is more able to distribute available cash resources to make the best use of it for economic and social development.
3. A banking institution that deals with sharing contributes directly to fairness in the distribution of national income.

Assaf et al, (1993) summarises the main objectives of the Islamic bank as follows:

1. To serve and encourage individuals who do not want to deal with *riba* by collecting their savings and investing the same in a sharing transaction to benefit society on the basis of Sharia.
2. To provide needed funds for economic sectors who will not deal with conventional banks to avoid usury.
3. To introduce services that ensure social solidarity based on Islamic law, by linking economic development with social development on Islamic principles.

2.10.3 Banking Services Provided by Islamic Banks

Article (52) of Banking Law number 28 for the year 2000 states that Islamic banks may exercise the following:

1. Accept cash deposits in various accounts, whether in credit accounts, joint investment accounts or special investment accounts.
2. Issue joint common lending or special lending bonds or create investment portfolios or investment funds.
3. Undertake all business finance and investment on the basis of non-interest.

2.11 The Development of Foreign Banks Operating in Jordan

Jordan is one of the few developing countries that allows foreign banks to practise its banking activities in the domestic market by opening branches and representation offices. Foreign banks started operating in Jordan from the establishment of the Central Bank of Jordan in 1964.

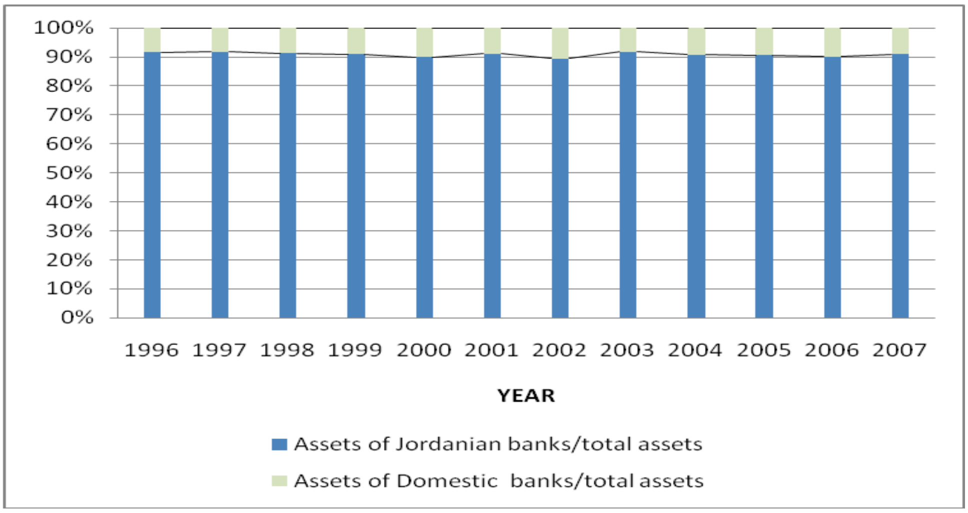
Table 2.18 indicates that at the end of 2007, foreign banks controlled 9% of the total assets of the Jordanian banking sector. The distribution of assets fluctuated between Jordanian and foreign banks during the entire period from 1996-2007.

Table 2.18: Distribution of the Assets of the Banking Sector between Jordanian Banks and Foreign Banks, 1996–2007

Year	Assets of Jordanian banks %	Assets of Foreign banks %
1996	91.6	8.4
1997	91.7	8.3
1998	91.3	8.7
1999	90.9	9.1
2000	89.96	10.04
2001	91.03	8.97
2002	89.43	10.57
2003	91.78	8.22
2004	90.71	9.29
2005	90.56	9.44
2006	90.02	9.98
2007	91.00	9.00

Source: CBJ Monthly Bulletin, 2007.

Figure 2.12: Distribution of the Assets of the Banking Sector between Jordanian Banks and Foreign Banks, 1996–2007



Source: CBJ, Monthly Bulletin, 2007.

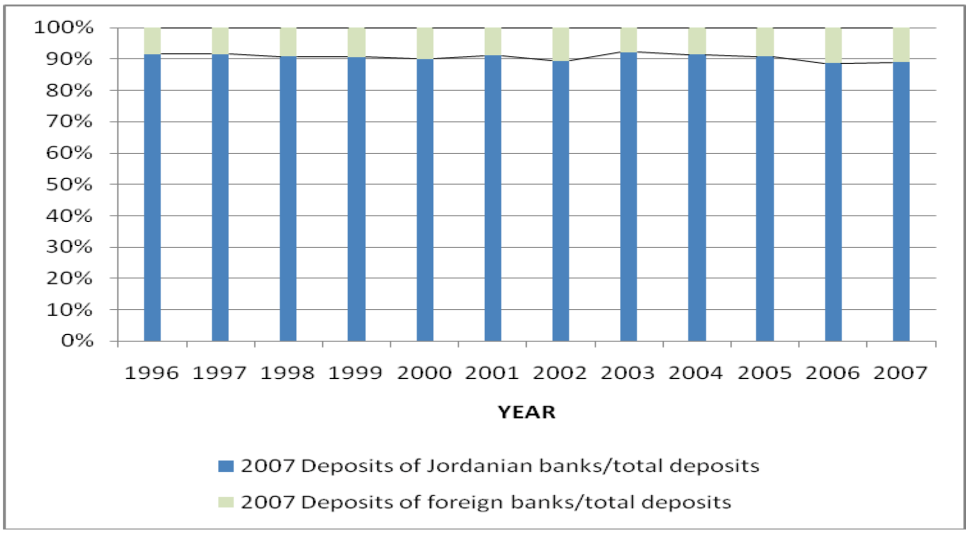
Table 2.19 shows that at the end of 2007 foreign banks controlled 11% of total deposits. The distribution of deposits in the banking sector fluctuated, some in favour of foreign banks, whose share of deposits increased from 8.5% in 1996 to 11%.

Table 2.19: Distribution of the Deposits at the Banking Sector between Jordanian Banks and Foreign Banks, 1996–2007

Year	Deposits of Jordanian banks/total deposits %	Deposits of foreign banks/total deposits %
1996	91.5	8.5
1997	91.5	8.5
1998	90.8	9.2
1999	90.6	9.4
2000	89.97	10.03
2001	91.06	8.94
2002	89.49	10.51
2003	92.12	7.88
2004	91.41	8.59
2005	90.74	9.26
2006	88.58	11.42
2007	89.00	11.00

Source: CBJ Monthly Bulletin 2007.

Figure 2.13: Distribution of the Deposits at the Banking Sector between Jordanian Banks and Foreign Banks, 1996–2007



Source: CBJ Monthly Bulletin 2007.

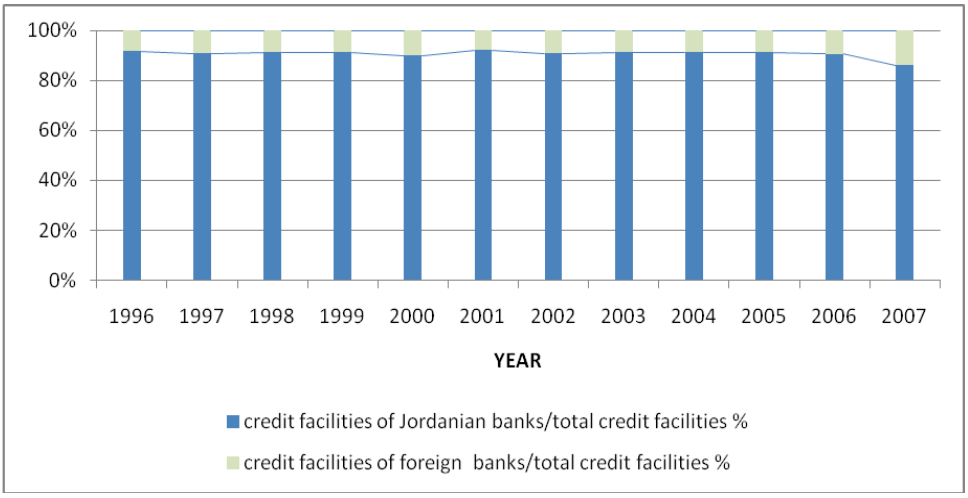
Table 2.20 shows that at the end of 2007, foreign banks controlled 14% of the total credit facilities, compared with 8.4% in 1996. The distribution of credit facilities extended fluctuated between Jordanian and foreign banks. the domestic banks share of credits declined from 91.6% in 1996 to 86% in 2007.

Table 2.20: Distribution of the Credit Facilities Extended by the Banking Sector between Jordanian Banks and Foreign Banks, 1996–2007

Year	Credit Facilities of Jordanian Banks/total Credit Facilities %	Credit Facilities of Foreign Banks/total Credit Facilities %
1996	91.6	8.4
1997	90.9	9.1
1998	91.2	8.8
1999	91.2	8.8
2000	90.00	10.00
2001	92.05	7.95
2002	90.80	9.20
2003	91.26	8.74
2004	91.22	8.78
2005	91.31	8.69
2006	90.61	9.39
2007	86.00	14.00

Source: Central Banks in Jordan, various issues.

Figure 2.14: Distribution of the Credit Facilities Extended by the Banking Sector between Jordanian Banks and Foreign Banks, 1996–2007



Source: Central Banks in Jordan, various issues.

2.11.1 Advantages and Disadvantages of Foreign Bank Entry in Jordan

There is argument regarding the positive and negative effects of foreign bank entry in developing or less developed countries, since foreign banks may affect, negatively or positively, and directly or indirectly, the domestic banking market. For example, foreign banks may have a positive impact on a national economy by

1. Improving the quality of banking and financial services, through increased banking competition and by applying more advanced technology and recruiting skilled staff.
2. Increasing competition, forcing local banks to operate more cost-effectively.
3. Modernising, developing and enhancing the banking legal environment.
4. Attracting foreign capital.

According to Melhim (2006) the negative side of foreign banks is reflected in their granting loans to large companies and institutions, leaving the less lucrative small companies and retailers to the domestic banks.

The Jordanian experience so far is that foreign bank entry into the market has enhanced banking activity in the kingdom. The following are some of the most important impacts of foreign bank entry in Jordan (Melhim, 2006):

1. Foreign banks are generally more efficient institutions, with better capabilities and greater experience in operations, and banking practices.
2. Foreign banking services are involved in personal loans, company finance, lease financing, banking insurance, portfolio management, financial management, issuing paper and providing financial consultants.
3. Foreign banks are involved in the transfer of knowledge and skill.

2.11.2 Comparison of Domestic and Foreign Banks' Performance in Terms of Financial Ratios

Based on financial ratios (ROA, ROE, NIM/TA, NIN/TA, NIE/TA),[10] we can compare the performance of foreign banks with domestic banks. Table 2.21 reveals the following:

1. Foreign banks achieved net margin interest as a percent of assets more than domestic banks.
2. Foreign banks achieved revenues other than interest (non-interest income) as a percentage of assets (NIN/TA) equal to domestic banks.
3. Domestic banks' general and administrative expenses (non-interest expenses) as a percentage of assets (NIE/TA) were less than foreign banks'.
4. Foreign banks achieved greater return on assets (ROA) than domestic banks.
5. Domestic banks achieved greater return on equity (ROE) than foreign banks.

[10] NIM: net interest margin, NIE: non-interest expense, NIN: non-interest income, ROA: return on assets, ROE: return on equity, TA: total assets.

Table 2.21: Comparison between Domestic and Foreign Banks in Jordan, 1996–2007

Year	Domestic Banks					Foreign Banks				
	ROE	ROA	NIE / TA	NIN/ TA	NIM/ TA	ROE	ROA	NIE/ TA	NIN/ TA	NIM/ TA
1996	9.1	0.5	2.1	0.6	2.9	12.9	1.1	2.2	0.4	4.1
1997	9.4	0.6	2.1	0.5	2.8	10.8	1.0	2.0	0.4	4.0
1998	9.8	0.8	2.0	0.6	2.0	6.0	0.5	1.9	0.5	3.9
1999	2.9	0.2	1.9	0.5	2.7	0.7	1.1	1.8	0.3	2.9
2000	5.6	0.4	1.7	0.3	2.6	6.9	0.1	1.8	0.2	3.5
2001	8.7	0.7	1.5	0.5	2.7	14.3	0.5	2.0	0.6	2.0
2002	5.7	0.4	1.6	0.5	2.5	14.2	1.1	1.6	0.7	2.5
2003	10.0	0.7	1.6	0.6	2.5	8.5	0.8	2.0	0.7	2.6
2004	14.2	1.1	1.6	0.8	2.4	9.8	1.2	1.8	0.7	2.8
2005	23.3	2.2	1.6	1.5	2.9	12.2	1.6	1.8	0.6	2.4
2006	22.3	2.1	1.6	1.4	2.9	12.1	1.6	1.8	0.6	2.6
2007	22.9	2.2	1.6	1.5	2.9	12.2	1.6	1.9	0.6	2.7

Source: author's calculations.
Note: NIM: net interest margin, NIE: non-interest expense, NIN: non-interest income, ROA: return on assets, ROE: return on equity, TA: total assets.

2.12 Summary

Since this study focuses on the efficiency and productivity change in Jordanian banks during the entire deregulation period 1996–2007, this chapter has provided an overview of the developments of the Jordanian banking sector with details of the commercial, Islamic and foreign banks operating in Jordan. It discussed some issues related to the financial sector and economy in Jordan and provided an overview of the CBJ. Some highlights of Jordanian financial institutions and the financial liberalisation program were also presented.

As this study covers the period of the deregulation era (1996–2007), this chapter has shown the steps taken by the Jordanian government and the Central Bank of Jordan to liberalise the financial system with a view to increasing its efficiency and creating competition in the financial system. The purpose of these steps was to establish a Western-type free market economy and create competition by removing restrictions on interest rates, reducing government direct lending and removing restrictions on foreign exchange transactions. The deregulation program provided greater autonomy to banks, promoted bank mergers and acquisitions, liberalised foreign exchange transactions and stimulated foreign investment. Other vital developments in the banking industry included the computerisation of banking operations and the introduction of Automatic Teller Machines (ATMs) and on-line communication and internet banking.

CHAPTER 3
A Review of Literature on Banking Efficiency and Productivity

3.1 Introduction

While research on the measurement of efficiency of banking sector in Western economies has expanded rapidly over the past decade, relatively little work has been done on measuring the efficiency of banks in the Middle East. One of the reasons for the lack of this research is that most Arab countries did not introduce financial and banking sector reforms until the 1990s. Until then, financial systems tended to be heavily regulated and dominated by the public sector (United Nations, 2005). However, over the past one and a half decades, the majority of Middle East countries have gradually moved towards more liberalised financial systems. This has created interest among policy makers, managers and economists in assessing the efficiency performance of banks over time in Middle Eastern countries.

In Middle Eastern economies, three types of banks operate simultaneously: conventional, Islamic and foreign banks. They vary in terms of size as measured by assets. It is a matter of great interest to policy makers and consumers to see which of banks are most efficient. This chapter reviews the literature concerning banking efficiency and productivity in two sections: international literature and studies of Middle Eastern countries including Jordan.

The efficiency of banks and other financial institutions is assessed on summary measures which are technical in nature. It is, therefore, crucial to be familiar with these measures to understand and compare the efficiency estimates of banks of different sizes and over time. The existing measures of efficiency are classified into two categories: non-parametric methods and parametric methods. Non-parametric methods include Data Envelopment Analysis (DEA) and Free Disposal Hull (FDH); parametric methods include the Stochastic Frontier Approach (SFA), Thick Frontier Approach (TFA) and Distribution Free Approach (DFA). DEA is the most widely used non-parametric technique and SFA is the favoured parametric technique for measuring efficiency.

DEA provides technical efficiency scores (divided into pure technical and scale efficiency scores) between 0 and 1, where 1 indicates full efficiency and 0 means fully inefficient; thus, DEA can reveal how efficient a decision making unit (DMU) is relative to the others. The efficiency score translates into how well a bank converts its inputs into outputs. For instance, if a bank has a technical efficiency score of 80%, then this means that it would have to reduce its inputs by 20% to become as efficient as its reference set – that is, those banks with 100% scores (for details see Chapter 4 of this study).

The parametric approach is usually based on estimating the cost or production function to obtain cost and production efficiencies using stochastic frontiers (see Coelli at al., 2005; Kourouche, 2008).

Almost all the existing studies of banking efficiency and productivity, in Middle Eastern economies and elsewhere, have been based on DEA and SFA. This chapter provides an overview of the empirical evidence from the international literature on bank efficiency and productivity in Section 3.2. The Middle Eastern studies are reviewed in Section 3.3. Section 3.4 discusses the Jordanian studies. Some concluding remarks are made in Section 3.5.

3.2 International Studies of Banking Efficiency and Productivity

Most international studies have focused on examining technical efficiency levels rather than allocative efficiency. This was due to the difficulties faced by the researchers in obtaining the required input prices for calculating allocative efficiency. Results of these empirical studies show that technical inefficiency is more prevalent than allocative inefficiency in the banking sector. Some studies also used the Malmquist Productivity Index (MPI) to identify productivity change in the banking sector.

3.2.1 International Studies of Banking Efficiency and Productivity based on the Non-Parametric Data Envelopment Analysis Approach

Emrouznejad et al. (2008) presented a survey and analysis of the first 30 years of literature in DEA, covering research developments and outcomes from the pioneering years of DEA to 2007. The survey is the most comprehensive source of references on DEA application in measuring the efficiency and productivity of

DMUs. It covers 4015 publications, serving as an important source for obtaining references.

Various studies conducted in the US, Europe and Asia have measured efficiency and productivity change in banking sector. Ferrier and Lovell (1990), Elyasiani and Mehdian (1995), Mukherjee et al. (2001), Grabowski et al. (1994), Richard et al (2002), and Seiford and Zhu (1999) have all studied efficiency and productivity of US banks in recent years. Elyasiani and Mehdian (1995) investigated productivity, concentrating on trends in technical efficiency and technological change for small and large US commercial banks for the period of 1979–1986. Mukherjee et al. (2001) studied productivity growth in 201 large US commercial banks, covering the initial post-deregulation period of 1984–1990, and found that productivity grew by 4.5% per year on average, with a significant decline in the initial years. Banks with large asset size experienced higher productivity growth overall. Ferrier and Lovell (1990) and Grabowski et al. (1994) used the DEA approach to assess the productive performance of US banks relative to the best practice frontier, and found that overall the efficiency of the US banking industry ranges from 65% to 90%. Following this, Richard et al. (2002) used the DEA model to evaluate the productive efficiency of US commercial banks from 1984–1998. Strong and consistent relationships between efficiency and independent measures of performance were found. Seiford and Zhu (1999) examined the performance of the top 55 US commercial banks using DEA.

They used a two-stage[11] production process to measure profitability and marketability, with inputs and outputs in each stage consisting of eight factors. Their results indicated that relatively large banks exhibited better performance on profitability, whereas smaller banks tended to perform better with respect to marketability.

A more recent study by Wu et al. (2006) integrated DEA and neural networks (NN), using input-oriented measures to examine the profit efficiency of 142 branches of a Canadian bank. By comparing the efficiency scores with DEA normal results, they found that the combined system identifies more efficient branches. They found that efficiency predicted using the DEA-NN model had good correlation with that calculated by DEA alone. This illustrates that the DEA-NN approach is a good proxy for the classical DEA approach in predicting efficiency.

Several studies have measured the efficiency and productivity of the banking sectors in European countries. For example, Berg et al. (1993) assessed the efficiency and productivity growth of the banking sector in Nordic countries, using DEA to measure the X-inefficiency of banks in Finland, Norway and Sweden. MPI was used to identify productivity change in banks. Their research concluded that Swedish banks

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[11] The process is divided into two stages, and the eight factors are expressed as inputs and outputs in each stage. 'The first stage measures profitability, i.e., a bank's ability to generate the revenue and profit in terms of its current labor, assets, and capital stock. The second stage measures (stock) market-ability, i.e., a bank's performance in the stock market by the revenue and profit it generates. It can be seen that revenue and profit serve as intermediate factors in the sense that they are outputs from the first stage and inputs to the second stage' (Seiford and Zhu, 1999, p.1271).

were more efficient than their counterparts. In another study, Bukh et al. (1995) used DEA to investigate inefficiencies in the banking industries of Denmark, Finland, Norway and Sweden. The study found that the largest Danish and Swedish banks tended to be the most efficient, although it was also found that one large Finnish bank and one large Norwegian bank achieved more than 90% efficiency scores.

In Spain, many studies have used DEA to investigate efficiency and productivity change in the banking sector. Perez and Quesada (1994) estimated changes in productivity in the major savings and commercial banks during 1986–1992. The study clearly revealed that the productivity of the largest banks was substantial and that 40% of commercial banks operated with high efficiency. Compared to all other Spanish banks, 20% of the commercial banks were found to be most efficient. Another study conducted by Grifell-Tatje and Lovell (1996) used similar linear programming techniques to investigate productivity change by calculating total factor productivity in savings banks between 1986 and 1991. The study reveals a productivity decline in savings banks during this period.

Havrylchyk (2006) investigated the efficiency of the Polish banking industry for 1997– 2001. DEA was applied to distinguish between cost, allocative, technical, pure technical, and scale efficiencies. The results indicated that bank efficiency had not improved over the period.

Casu and Molyneux (2003) investigated the possibility of an improvement in the technical efficiency of European banks since the creation of the EU single internal market. DEA was used to measure banks in France, Germany, Italy, Spain and the UK. The study included a sample of 530 banks from these countries, and employed two input and two output variables. The input variables consisted of total costs and short term funding, while output variables comprised total loans and other earning assets. The study concluded that relatively low levels of technical efficiency resulted from the creation of a single EU internal market for European banking. The majority of banks in the study had averages at 65% in frequency distribution of mean technical efficiency. The sampled countries showed improvements in mean technical efficiency over the study period, except for Italy, which recorded a slight decrease of 0.5%. Overall, this study demonstrated that the most technically efficient were UK banks with a score of 78.2%, followed by Germany with 71.3%. Italy was found to be the least technically efficient banking industry in the EU with a score of 53.8%.

The Casu et al. (2004) study used MPI to compare the productivity of banks from five European countries between 1994 and 2000. Three input and three output variables were used: labour, total deposits and capital as inputs; output variables included total loans, securities, and, advances and receivables off-balance sheet activity (OBS) items. The Spanish banks showed the highest productivity growth of 9.5% on average, followed by Italian (8.9%), French (1.8%), German (0.6%), and UK banks (0.1%).

Attaullah et al. (2004) examined the technical efficiency of banks in India and Pakistan during the ten years from 1988 to 1998. The study applied DEA to two models. Model A used two inputs, interest expense and operating expense; and two outputs, total loans and investments. Model B used the same inputs as model A, but outputs were different, comprising interest and non-interest income. The results showed a difference in the mean technical efficiency of banks in the two countries. For India, the mean technical efficiency scores of banks provided by Models A and B were 72.8% and 63% respectively. In contrast, the mean technical efficiency of banks in Pakistan under Models A and B were 42.4% and 54.1% respectively.

Das and Gho (2006) investigated the performance of the Indian commercial banking sector during the post reform period from 1992 to 2002 using DEA methodology. Three different approaches were used for the purpose of comparing the results of the efficiency scores with changes in inputs and outputs. These approaches were the intermediation, value-added, and operating approach. A close relationship was found between efficiency and soundness as determined by a bank's capital adequacy ratio. Moreover, the results indicated that technically efficient banks are those that have, on average, fewer non-performing loans.

The productive efficiency of 70 Indian commercial banks was examined by Bhattacharya et al. (1997) for 1986–1991. DEA was used to calculate technical efficiency scores. The result showed that publicly owned Indian banks were the most efficient, followed by foreign banks and privately owned Indian banks.

Jackson et al. (1998) measured the efficiency and productivity growth in Turkish commercial banks using the DEA-based MPI. The results, based on data for 1992–1996, showed that foreign and private banks were more efficient than banks owned by the state. Jackson and Fethi (2000) also used DEA to evaluate the technical efficiency of individual Turkish banks. This study also investigated the determinants of efficiency, using the Tobit model, for the year 1998. Larger and more profitable banks were found to be more likely to operate at higher levels of technical efficiency.

The DEA and DEA-MPI were used by Cingi and Tarim (2000) to examine efficiency and productivity changes in Turkish commercial banks between 1989 and 1996. It was found that, while the four state-owned banks were not efficient, the three private holding banks maintained high efficiency scores over the study period. Yildirim (2002) analysed the efficiency performance of the Turkish banking sector between 1988 and 1999. The technical and scale efficiencies of Turkish commercial banks were computed based on a DEA approach. Pure technical and scale efficiency measures were found to have large variations. Turkish commercial banks did not achieve sustained efficiency gains, and the Turkish commercial banking sector suffered from scale inefficiency caused by decreasing returns to scale. Moreover, some differences in the efficiency of commercial banks were related to the banks' ownership. Pure technical efficiency and scale inefficiency were positively related to bank size.

Zaim (1995) analysed the efficiency of Turkish commercial banks in order to investigate the effects of post-1980 financial liberalisation policies. It was found that financial reforms had a positive effect on both technical and allocative efficiencies, and that state-owned banks appeared more efficient than private ones. Yolalan (1996) used financial ratios to analyse the performance of Turkish commercial banks over 1988–1995. The results indicated that foreign banks were the most efficient group, followed by private banks in the Turkish commercial bank sector.

Isik and Hassan (2002) investigated efficiency in the Turkish banking industry to understand the impact of size, international variables, ownership, control and governance on profit, cost, and allocative, technical, pure technical and scale efficiency measures. The study employed both non-parametric and parametric approaches, and covered the period 1988–1996. It showed that heterogeneous characteristics of banks had a significant impact on their efficiency. The dominant source of inefficiency in Turkish banking was found to be technical inefficiency rather than allocative inefficiency.

Grigorian and Manole (2006) examined the technical efficiency of banks in 17 transition economies from 1995–1998, using a nonparametric DEA approach. They used two models which each employed three inputs and three outputs. The inputs of both models consisted of labour, fixed assets, and, interest expenses. Model A outputs consisted of revenues, net loans and liquid assets, while Model B used total deposits, net loans and liquid assets. The study results indicated that Model A's technical efficiency scores ranged between 23.7% for Belarus, and 79.9% for Czechoslovakia, while Model B's technical efficiency scores ranged between 15.5%, for Belarus and 84.3% for Slovenia. The results of Model A also indicated that five countries, Slovakia, Latvia, Romania, Moldova and the Ukraine, suffered a decline in technical efficiency. Likewise, Model B revealed that Slovakia, Kazakhstan and

Moldova suffered declines in technical efficiency levels. In spite of such results, most of the countries showed improvements in technical efficiency over time.

In the Asian region, many authors have carried out studies: Fukuyama (1995) from Japan; Yeh (1996) from Taiwan; Leightner and Lovell (1998) from Thailand; Gilbert and Wilson (1998) from Korea; Lim and Chu-Chun-Lin (1998) from Singapore; and Rezvanian and Mehdian (2002) also from Singapore. The results of these studies revealed that depository institutions had an average efficiency of around 77%.

Chen (2001) investigated the technical efficiency of Taiwan's banking sector during the deregulation period, 1988–1997, using the DEA approach. His results revealed that the implementation of banking reforms had positively affected the technical efficiency levels of banks in Taiwan. It also showed that the older banks were the least efficient, and the newly established ones were more efficient than others. The private banks were shown to have improved their performance later on.

Gilbert and Wilson (1998) employed DEA to measure the effects of deregulation on the productivity change of South Korean banks for the period 1980–1994. Their findings indicate that deregulation had led to an improvement in the productivity levels of large banks, which recorded strong productivity growth, whereas the regional banks recorded productivity regress or no change.

Chen et al (2004) examined the cost, technical and allocative efficiency of 43 Chinese banks, covering the deregulation era from 1993 to 2000, using an input-oriented DEA approach. They employed an intermediation approach for choosing three input prices (price of labour, price of deposits and price of capital) with three outputs (loans, deposits and non-interest income). The study found an improvement in the efficiency of Chinese banks after the initiation of a program of deregulation in 1995. The large state-owned banks and smaller banks were more efficient than medium sized banks.

In Malaysia, Matthews and Mahadzir (2006) examined the technical efficiency and productivity of domestic and foreign commercial banks in Malaysia during the period 1994–2000. Foreign banks were found to have higher efficiency levels than domestic banks. Technical efficiency contributed most to the observed productivity growth.

Krishnasamy et al. (2004) used DEA MPI to evaluate bank efficiency and productivity changes in Malaysia over the period from 2000 till 2001. Results from this analysis indicated a total MPI increase in all banks.

Rezvaniana et al. (2008) examined the effects of ownership on efficiency change, technological progress and productivity growth of the Indian banking industry over the period 1998–2003. A non-parametric frontier approach was used. The study revealed that foreign banks were significantly more efficient than domestic banks.

Batchelor and Gerrard (2004) used MPI to identify the extent to which technical efficiency and technological advances explained any productivity changes in the three commercial banks of Singapore over the period 1997–2001. The results showed that the banks improved their performance by 11.7% in terms of total factor productivity, while the technical efficiency of the banks remained relatively unchanged.

Randhawa and Lim (2005) used DEA to examine the X-efficiency of local banks in Hong Kong and Singapore during the period 1995–1999. The study revealed an overall efficiency score of 80.4% under the intermediation approach, and 97.2% under the production approach. Burki and Niazi (2003) showed that state-owned banks in Pakistan were the most inefficient banks compared to private banks and foreign banks, which were the least inefficient over the period 1991–2000.

Sathye (2002) analysed the change in productivity of seventeen Australian banks for the period 1995–1999. The results showed that the technical efficiency of banks declined by 3.10% and the total factor productivity (TFP) index declined by 3.5% during the sample period. Neal (2004) investigated X-efficiency and productivity changes in the Australian banking sector over the same period, revealing that regional banks were less efficient than others. It also showed that TFP in the banking sector had increased by 7.60% per annum over the sample period.

Sturm and Williams (2002) examined the efficiency and productivity performance of Australian banks based on technical efficiency and MPI for the period,1988–2001. The study utilised two models: Model A employed three inputs: labour, total deposits and capital; and two outputs: loans and, advances and receivables off-balance sheet activity (OBS). Model B employed two inputs: interest expenses and non-interest expenses; and two outputs: net interest income and non-interest income. The results indicated that technical efficiency improved over time under both models. The annual mean technical efficiency scores under Model A ranged from 73% in 1991 to 94% in1986. Under Model B, the scores ranged from 67% in 1993 to 96% in 1997. The results from the MPI analysis were mixed. Under Model A, it was found that there was an overall mean TFP growth of 10%, with technological progress dominating technical efficiency change, while under Model B, it was found that overall mean TFP declined by 3%.

Another study in Australia, conducted by Avkiran (1999), examined the effects of Australian bank mergers on efficiency levels. The sample consisted of 23 banks over the period 1986–1995 and showed that banks' efficiency increased until 1991 and then declined, due to problems associated with bad debts. More recently, Kourouche (2008) investigated the efficiency and productivity of ten Australian banks during the period 1995–2005. Technical efficiency levels of the banks were examined using DEA; and TFP change was estimated using MPI. The results revealed that the efficiency and productivity change varied across the banks and over the years. The results suggested that the banks needed to control their costs and invest in new technology and capital equipment to improve efficiency and productivity levels.

3.2.2 International Studies of Banking Efficiency and Productivity based on Parametric Stochastic Frontier Analysis Approach

Many researchers have investigated scale efficiency in the banking sector using parametric methods. For instance, Benston (1964, 1965), Bell and Murphy (1969), Powers (1969), Kalish and Gilbert (1973), and Longbrake and Haslem (1975) have measured the scale efficiency of US banks using the Cobb-Douglas production function. Other studies by Benston et al. (1982), Benston et al. (1983), Gilligan and Smirlock (1984), Gilligan et al. (1984), Lawrence and Shay (1985), Hunter and Timme (1986), Kolari and Zardhooki (1987), Berger et al. (1987) and Rangan et al. (1989) used the translog cost function developed by Christensen et al. (1973). These studies found that bank cost curves are either U-shaped or flat. Many of these studies observed that medium-sized banks are more scale-efficient than very large or very small banks (Berger et al., 1993b, p.223). The results from the studies which used data on banks with under US$1 billion in assets revealed that the average costs were usually minimised between US$75 million and US$300 million in assets., Banks with more than US$1 billion in assets showed the minimum average cost point to be between US$2 billion and US$10 billion in assets (Kourouche, 2008).

In Australia, Edgar et al. (1971) examined scale efficiency among eight banks using the parametric method. The results, based on the Cobb-Douglas production function, revealed that seven out of eight banks experienced economies of scale. Swan and Harper (1982) investigated scale economies at the branch level in two Australian banks, revealing significant economies of scale in one bank and constant returns to scale in the other.

Karim (2001) examined and compared the level of technical efficiency among banks of four countries from the Association of South-East Asian Nations (ASEAN) for the period 1989–1996. The sample consisted of 82, 31, 27 and 15 banks from Indonesia, Malaysia, the Philippines and Thailand respectively. The study specified three input and five output variables. Input variables were employee wages and salaries; expenses on land, buildings and equipment; and interest expenses. Output variables included commercial and industrial loans; other loans; time deposits; demand deposits; and securities and investments. The results revealed significant differences in mean technical efficiency scores across countries. The mean technical efficiency level of banks was highest (98.1%) in Thailand and lowest (65.8%) in Philippine.

In Europe, Kraf and Turtrong (1998) examined X-efficiency and scale-efficiencies of old and new state and private banks based on Stochastic-cost Frontier Analysis (SFA) for 1994 and 1995. They found that new state and private banks were more X-inefficient, and more scale-inefficient, than old privatised and state banks. Noulas (2001) examined the efficiency of Greek banks for the period 1993–1998 and concluded that private banks were more efficient than state controlled banks.

Bonin et al. (2005) conducted a study of eleven transition economies using SFA. The sample consisted of 225 banks for the period 1996–2000 and one input and four outputs were employed in the model. Capital was the input; outputs were total deposits, total loans, liquid assets and investments. The study recorded an overall mean technical efficiency score of 70.1%. Foreign banks were found to be more technically efficient than domestic banks.

Weill (2003) examined the differences in the efficiency levels of domestic and foreign banks in transition countries, using SFA. He took samples from two countries: 31 Polish banks and 16 Czech banks for the year 1997. The model used three inputs: personnel expenses, interest expenses and non-interest expenses; and two outputs: total loans and investment assets. The results showed that foreign banks in transition countries were more technically efficient than domestic banks. The technical efficiency of foreign banks operating in Poland and Czechoslovakia recorded an average of 70.4%, while the technical efficiency of the domestic banks recorded an average of 62.0%.

Kasman (2002) examined the productive efficiency of Turkish commercial banks in the deregulated period. The study used SFA to estimate X-inefficiency, scale economies and technological change for a panel of Turkish commercial banks. This methodology used the Fourier-flexible cost function specification form. The results showed that the Turkish banking system had a significant inefficiency problem.

Goldberg and Rai (1996) also applied SFA to measure the technical and scale efficiencies of a sample of banks from eleven European countries. They concentrated on large banks because at that time the European banking industry was being dominated by large banks. The study specified capital, labour and borrowed funds as inputs, and total loans and all other earning assets as outputs; the results showed relatively high levels of technical efficiency. The overall mean technical efficiency score for banks in the specified countries was 94.2%. Banks operating with the highest technical efficiency included Belgium at 96.7%; Denmark at 96.4%; Spain at 96.2% and Germany at 96.1%. The lowest efficiency scores were reported for Switzerland (91.9%), Sweden (91.8%), and Italy (91.8%).

More recently, Dong (2009) studied the cost efficiency of Chinese banks over the liberalisation period, 1994–2007. He employed both parametric (SFA) and non-parametric (DEA) methods. The study used a one-stage SFA model that included the input prices, the outputs and the control variables (that is, equity, non-performing loans and the time trend) in the cost frontier and the environmental variables (that is, ownership structure, size, deregulation, and market structure and market discipline) in the inefficiency term. Additionally, for the cost efficiency, a two-stage DEA model was employed. The findings from this study indicated that Chinese banking efficiency had declined since China's admission to the WTO, implying that the external environmental changes which arose from China's WTO entry may have had a negative influence on banking efficiency. The results also showed that both state-owned banks and foreign banks were more efficient than domestic private banks, and that larger banks tend to be relatively more efficient than smaller banks.

3.3 Middle East Studies of Banking Efficiency and Productivity

Almost all the existing studies of banking efficiency in Middle Eastern economies have been based on DEA and SFA. The Middle Eastern studies of banking efficiency based on non-parametric DEA approach are reviewed in Section 3.3.1, and those based on SFA are reviewed in Section 3.3.2.

3.3.1 Middle Eastern Studies of Banking Efficiency and Productivity based on DEA

Al-Faraj et al. (1993) evaluated the relative efficiency of 15 branches in Saudi Arabia Bank, one of the largest commercial banks, using a number of inputs and outputs in a DEA model. The inputs include the number of employees working in the branch, the percentage of employees with college degrees, the average years of experience of employees at a branch, an index for location, one for the rank of the highest authority, one for expenditure on decoration, one for the average monthly salaries, one for other operational expenses and one for acquired equipment. The outputs included the monthly average net profit, the monthly average balance of current accounts, the monthly average balance of savings accounts, the monthly average balance of other accounts and the monthly average of mortgages. The results revealed that 12 out of 15 branches were efficient.

Using an input-oriented DEA approach, Darrat et al. (2003) examined the performance of eight banks in Kuwait during the period 1994–1997. The data used for three inputs: labour, capital and deposits, and two outputs: loans and investment, were drawn from the balance sheets and income statements of the banks. Labour was measured by the number of all employees in the banks, capital by the book value of fixed assets and premises, and deposits by the sum of demand and savings deposits. The results showed that Kuwaiti banks failed to utilise a significant proportion of their resources optimally. The bank inefficiency appeared to be both allocative and technical in nature. The results also indicated that smaller banks in Kuwait were more efficient than larger ones, although all banks had improved their efficiency levels and experienced some gains in productivity.

Hassan et al. (2004) investigated the efficiency of the banking sector in Bahrain, based on data for a panel of 31 banks in 1998 and 2000. Their study estimated allocative and technical efficiencies, scale efficiency and overall cost efficiency. The model used three inputs: labour, capital, and loanable funds; and two outputs: short-term loans and long-term loans. The input prices were price of labour, price of capital, and interest rates on loanable funds. The results indicated that the average allocative efficiency was about 73%, whereas the average technical efficiency was about 56%. This indicated that the dominant source of inefficiency in Bahrain banks was due to technical inefficiency rather than allocative inefficiency, and this was mainly attributed to diseconomies in scale. Overall, average scale efficiency was about 79%, and average pure technical efficiency about 71%, suggesting that the major source of the total technical inefficiency for Bahrain banks was pure technical inefficiency (input related), and not scale inefficiency. Hassan et al. (2004) also investigated the conventional accounting measures of performance with four measures of cost efficiency, to investigate whether higher financial performance had an effect on bank cost efficiency. Their results showed that ROE and ROA, which measured overall profitability of the banking sector in Bahrain, gave the profitability, with average ROE and ROA being 10.36% and 1.622% in 1998, and 13.49% and 2.097% in 2000 respectively. They also measured productivity growth using MPI. Their results revealed that all banks had improved their efficiency levels and experienced some gains in productivity. Finally, regression analysis was used to investigate determinants of the overall efficiency scores. They found that larger and more profitable banks were more likely to operate at a higher level of efficiency; and that market power played an important role in cost and technical efficiencies.

The relative efficiency of the top 50 Gulf Cooperation Council (GCC) banks was investigated by Mostafa (2007a) using cross-sectional data for the year 2005. The study used a variable returns to scale DEA approach with three outputs (net profit, returns on assets, and returns on equity) and two inputs (assets and equity). The results indicated that efficiency scores ranged from 13% to 100% for all banks, with an average of 55% when using a Constant Returns to Scale (CRS) model with a standard deviation of 22.1, and from 20% to 100% when using a Varying Returns to Scale (VRS) model; the results indicted an average of 73% and standard deviation of 21.8%. Al-Muharrami (2007) investigated productivity changes in 52 GCC banks covering 1993–2002. The inputs were number of staff, total deposit, and fixed assets; the outputs were total loan, other operating income, other earning assets, and OBS activities. The results, based on Malmquist DEA, showed a decline of TFP change for GCC banks over the period due to declines in efficiency and technological regress.

Mostafa (2007b) examined the relative efficiency of the top Arab banks using cross-sectional data for the year 2005. Two methodologies were adopted in this study: the first DEA, the second a probabilistic neural network (PNN) and a traditional statistical classification method for modelling and classifying relative efficiency. The CRS model returned scores ranging from 0 to 100%, with an average of 31% and a standard deviation of 21.6, while the VRS model returned an average efficiency score of 43% with a standard deviation of 27.2; results that revealed great scope for achieving cost savings in Arab banks.

Using the data from the annual reports of individual banks published by Emirates Banks Association for 1997–2001, Al-Tamimi (2008) focused on identifying the relatively best performing banks and relatively worst performing banks in the United Arab Emirates (UAE). The study used DEA and some traditional financial ratios such as returns on assets, returns on equity, ratio of loans to deposits and ratio of loan to total assets, to investigate efficiency. The DEA model used interest expense and non-interest expense as input variables; interest revenue and non-interest revenue as output variables. The study revealed that most UAE commercial banks were inefficient. The national banks were relatively more efficient than the foreign banks. Two traditional ratios, loans to deposits and loans to total assets, indicated that the UAE commercial banks did not use available resources efficiently.

Al-Faraj et al. (2006) evaluated the technical efficiency of Saudi banks for 2002 and compared them with world mean efficiency scores. Their results indicated that the mean efficiency score of Saudi commercial banks compared very well with the world mean efficiency scores. The results suggested that Saudi banks should develop new technologies and provide new banking services to compete with other banks. In a more recent study, AlKhathlan and Malik (2010) investigated both technical and scale efficiencies of Saudi commercial banks for the period 2003–2008. Their sample covered ten of the twelve commercial banks and employed the DEA intermediation approach. The results indicated that the majority of Saudi banks operated at high levels of efficiency and managed their financial resources adequately.

3.3.2 The Middle East Studies of Banking Efficiency and Productivity Based on the Parametric Stochastic Frontier Approach

Chaffai (1997) examined the productive efficiency of banks operating in Tunisia. The study employed an econometric model to estimate input-specific technical efficiency, and revealed that the technical efficiency of both labour and capital declined over time, but labour was more inefficiently used than capital. Limam (2001) used a SFA to determine the technical efficiency of eight banks in Kuwait for the period 1994–1999. The study used earning assets as output and fixed assets, labour and financial capital as inputs; results showed that banks produced earning assets at constant returns to scale. The study also found that there was much room for improving the technical efficiency of most banks. Larger size, a higher share of equity capital in assets and greater profitability were associated with better efficiency.

Murjan and Ruze (2002) aimed to investigate the competitive nature of the Arab Middle Eastern (AME) banking sector during the 1990s. The study used data from the banking sectors of nine AME countries, and applied the Rosse-Panzar test to appraise quantitatively the dominant competitive conditions in these markets from 1993–1997. The sample consisted of 141 banks: 16 from Bahrain, 35 from Egypt, 13 from Jordan, 10 from Kuwait, 10 from Oman, 6 from Qatar, 12 from Saudi Arabia, 17 from Tunisia, and 22 from the UAE. This study concluded that banking markets had been operating in the region under conditions of monopolistic competition. Following Shaffer (1981–1982) and Nathan and Neave (1989), the study also estimated a reduced form equation to model the behaviour of the banks' revenues. An important finding revealed by this study was that in the AME region, where two distinct economic spectrums dominated the market, the banking sector in the oil-producing countries (Gulf Countries) appeared to be less competitive than its counterpart in non-oil producing countries.

Ariss (2008) investigated the evolution of bank efficiency in Lebanon subsequent to a period of deregulation/ financial liberalisation. The study attempted to answer three questions related to cost efficiency: (i) Are banks becoming more cost efficient with the passage of time? (ii) Are large banks more cost efficient than small banks? (iii) Are there cost efficiency differences between domestic and foreign banks? The results, based on a SFA model, showed that the average cost inefficiency of

Lebanese banks appeared to be small (around 12%). The results also indicated that cost efficiency had improved over the study period: that is, the consolidation in the financial sector had enhanced banking efficiency. The domestic banks were found to be as efficient as foreign banks.

3.4 Jordanian Studies of Banking Efficiency and Productivity

3.4.1 Jordanian Studies of Banking Efficiency and Productivity Based on a Non-Parametric DEA Approach

One of the earliest studies of efficiency in the Jordanian banking sector was Al-Shammari and Salimi's (1998). In this study, DEA was used and an input oriented model was applied to 16 out of 18 commercial banks operating in Jordan in the period 1991–1994. The dataset for the study was obtained from the Amman Financial Market (1995). The empirical results revealed that the majority of banks investigated were fairly inefficient over the study period. The lowest efficiency scores were 52.61%, 54.12%, 52.43%, and 49.84%, in 1991, 1992, 1993 and 1994 respectively; only three banks appeared to be fully efficient through the period.

Maghyereh (2004) investigated TFP in eight domestic Jordanian banks over 18 years from 1984 to 2001. The DEA model used three inputs (labour, capital, and deposits) and three outputs (earning assets, loans and liquid assets and investments). The results indicated that the mean of technical efficiency for all banks over the sample period was 91.8%. The main source of technical inefficiency in the Jordanian banks was scale inefficiency, with an average rate of 93.1%. Importantly, the result indicated that the larger banks in the sample had lower scale efficiency and higher pure technical efficiency than small and medium banks.

Ihsan et al. (2004) analysed managerial and scale efficiencies in the Jordanian banking sector (commercial, investment and Islamic) operating in Jordan over 1996–2001. They used two DEA Models. The first applied the production approach and specified banks as multi-product firms producing credits, investment securities and deposits services by employing labour and capital; the second model took an intermediation approach which defined banks as financial intermediaries where labour, capital and deposits served as inputs, and credits and investments securities served as outputs. The results indicated that Jordanian banks would obtain significant cost savings (as much as 40%) should they catch up with the best practice banks. The findings from the first model (production approach) estimated managerial efficiency at 71%, pure technical efficiency at 89% and scale efficiency at 79%; from the second model (intermediation approach) the managerial efficiency, pure technical efficiency and scale efficiency turned out to be 89%, 96% and 92% respectively. Most of the managerial inefficiency was found to be due to scale inefficiency rather than pure technical inefficiency. The study also found that most banks in Jordan experienced increasing returns to scale in their operations under both models, suggesting that the Jordanian banks could have expanded their operations by either internal or external growth. The Arab Bank was found to be most efficient bank.

More recently, Bdour and Al–Khouri (2008) evaluated the efficiency of 17 domestic commercial Jordanian banks during the liberalisation period, 1998–2004. The study used DEA with an intermediation approach, with three inputs (net-operating expenses, total assets and number of employees) and three outputs (net operating income, demand deposits, and net direct credits). They found that the liberalisation program had improved the efficiency of the Jordanian banks for all years except 2003 and 2004, when a decline in efficiency occurred, possibly due to the adverse effects of the Gulf War.

3.4.2 Jordanian Studies of Banking Efficiency and Productivity Based on a Parametric SFA Approach

A study by Ahmad (2000) examined the efficiency of the banking sector in Jordan for seven years (1990–1996). The study applied both DEA and SFA to a data set consisting of 20 banks, domestic and foreign. For the DEA approach the outputs used were total loan, other investments (defined as investment in bonds and securities plus deposits at foreign banks); the inputs were the number of full-time workers and total deposits. In addition, the study used prices of labour and capital. In the SFA approach, cost efficiency was estimated based on the Cobb-Doglas cost function which employed two banking outputs (loans and other investments) and prices of labour and capital, in addition to the number of branches. Total Cost was defined as interest expenses plus wages and benefits for workers. An attempt was also made to estimate profit function. The study revealed that the large banks were more profit efficient than other banks. The efficiency scores obtained using DEA were higher than those obtained from the SFA.

3.5 Concluding Remarks

This chapter has provided a review of major studies of banking efficiency conducted in the Middle East countries and the rest of the world, although no claim is made to have covered all extant studies. The majority of studies of the Middle East used DEA; only a few used SFA methodology to compute efficiency estimates. The studies revealed that banks achieved some levels of efficiency in the Middle East.

There were a few Jordanian studies of banking efficiency and productivity, but none covered the entire deregulation era, the years covered by the present study investigating the levels of efficiency and productivity growth in 17 banks operating in Jordan covering the deregulation period 1996-2007. A DEA approach is used to examine efficiency and productivity change in the next chapters.

CHAPTER 4
The Technical Efficiency of the Jordanian Banking Sector

4.1 Introduction

This chapter analyses the technical efficiency of banks in Jordan using a non-parametric Data Envelopment Analysis (DEA) approach. For a comprehensive analysis, technical efficiency is split into pure technical efficiency and scale efficiency. The empirical results are obtained by running an input-oriented DEA model using the software package DEAP Version 2.1 (Coelli, T. 1996). The study uses data for 13 domestic commercial banks, 1 domestic Islamic bank and 3 foreign banks operating in Jordan during the period 1996–2007.

The chapter is organised as follows: Section 4.2 discusses alternative approaches for estimating efficiencies, with a particular emphasis on DEA approach. Section 4.3 provides a discussion on the choice of input and output variables required for estimating the DEA model. The data sources are described in Section 4.4. Section 4.5 discusses the results of technical efficiency, divided into the product of pure technical efficiency and scale efficiency. Conclusions are presented in Section 4.6.

4.2 Approaches to Measuring Efficiencies

Efficiency in generally refers to how a firm allocates scarce resources to meet production targets. The efficiency of a production unit is defined by the relationship between the observed and optimal values of its inputs and outputs (Coelli et al., 2005). There are two broad approaches to measuring efficiency:

1. The Non-parametric Approach
2. The Parametric Approach

4.2.1 The Non-Parametric Approach

There are two non-parametric approaches for measuring efficiency: DEA and FDH. DEA is the most frequently used non-parametric technique. It was developed by Charnes *et al.* (1978) and is a linear programming technique for constructing a piecewise frontier. The constructed frontiers are non-parametric in the sense that they are constructed through the envelopment of the decision making units (DMUs) with the 'best practice' DMUs forming the non-parametric frontier. It does not impose any functional specification on the production function. The frontier is formed in such a way that no observation point lies beyond it; therefore, the frontier creates an envelopment of all data points. DEA is often used to generate relative technical efficiency scores by comparing a particular DMU to a virtual technically efficient DMU (or its target). The comparison is made with the underlying condition that compared DMUs have the same input-output configuration. The efficiency scores generated follow the technical efficiency ratio as defined by Farrell (1957).

The Free Disposal Hull (FDH) model was introduced by Deprins et al. (1984) and developed by Tulkens (1993). It is a special case of the DEA model in which the points on lines connecting DEA vertices are not included in the frontier. Instead, the

FDH production possibilities set is composed only of the DEA vertices and the free disposal hull points interior to these vertices. Since the FDH frontier is either congruent with or interior to the DEA frontier, FDH will typically generate larger estimates of average efficiency than DEA (Tulkens, 1993).

4.2.2. The Parametric Approach

The parametric approach is popular due to its flexibility in allowing for random error, and the opportunity it offers for mathematical manipulation. A suitable functional form must be selected to resemble the actual production process as closely as possible (Coelli et al, 2005). This form could be simple or very complex, with many varying degrees of complexity between these two extremes.

There are three parametric methods to estimate efficiency/ inefficiency of firms:

1. The Stochastic Frontier Approach (SFA)
2. The Distribution Free Approach (DFA)
3. The Thick Frontier Approach (TFA)

The Stochastic Frontier Approach (SFA)[12] involves the use of econometric modelling methods. This method identifies the functional form for cost, profit or production function in relation to inputs and outputs, and allows for random errors. Technical efficiency, scale efficiency, allocative efficiency and MPI can be measured

[12] Aigner, Lovell and Schmidt (1977) and Meeuse and vanden Broeck (1977) simultaneously propose the stochastic frontier model (see Kumbhakar and Lovell, 2000, p.8). For more details, see Kumbhakar and Lovell (2000) for an extensive survey of parametric methods and Coelli et al. (2005), p.241.

with SFA. SFA also allows the testing of hypotheses in regard to the inefficiency and structure of production technology. However, the difficulties involved in selecting the distribution form for the efficiency term is a disadvantage, as is the difficulty in adapting SFA to multiple outputs in the case of production function approach. Some studies such as Benston (1964, 1965), Powers (1969), Kalish and Gilbert (1973) and Longbrake and Haslem (1975) have used the Cobb-Douglas form to measure the scale efficiency of US banks using SFA, and many studies have used more flexible functional forms to represent production technology (for example, Dong, 2009; Ncube, 2009;, Kiyota, 2009,; Delis et al., 2009;, Isik & Hassan, 2002; Battes & Coelli, 199; Benston et al., 1982, 1983; Gilligan & Smirlock, 1984; Gilligan et al., 1984; Lawrence & Shay, 1985; Hunter & Timme, 1986; Kolari and Zardhooki, 1987; Berger et al., 1987 Berger & Master 1997; and Rangan et al.. 1989).

The Distribution Free Approach (DFA) is similar to SFA as it specifies a functional form for production technology, but it assumes that efficiency is stable and that random error averages out to near zero over time. Thus, DFA seeks to describe average deviations in terms of inefficiency of each DMU relative to the benchmark’s inefficiency at any point in time. DFA has been employed by Bauer et al (1993) and Berger and Humphrey (1997).

The Thick Frontier Approach (TFA) does not impose any pre-conceived functional form on technology. Instead, random errors and inefficiencies are accounted for by (a) deviations from predicted performance within the highest quartiles and (b) deviations from predicted performance between the lowest and the highest quartiles.

TFA does not provide estimates of efficiency for individual DMUs, but is intended instead to provide an estimate of the general level of overall efficiency. Studies that have applied TFA include Bauer et al. (1993), Lozano (1995) and Mahajan et al. (1996).

SFA is the most popular and widely used parametric approach.

4.2.3 Choice between Non-parametric and Parametric Measures

In essence, one can assume that parametric models impose a particular functional form (and associated behavioural assumptions) that presuppose the shape of the frontier. If the functional form is mis-specified, measured efficiency may be confounded with specification errors. This weakness has been shown to provide poor approximations for banking data that are not near the mean scale and product mix (see McAllister & McManus, 1993; Mitchell & Onvural, 1996).

In contrast, non-parametric methods do not impose any structure on the frontier; but they do not allow for random error owing to luck, data problems, or other measurement errors. If random error exists, measured efficiency may be confounded with these random deviations from the true efficiency frontier. The conflict between parametric and non-parametric models is important because they tend to have different degrees of dispersion and to rank the same DMUs differently. It is not possible to determine which of the two major methods dominates the other since the *true* level of efficiency is unknown. DEA is a close substitute for SFA; DEA reports the same measures that SFA does. In light of this, DEA has gained popular acceptance and frequent application among studies on bank efficiency and productivity: hence the decision to use DEA to measure efficiency in this study.

4.2.4 Data Envelopment Analysis (DEA) Approach to Measuring Technical Efficiency

There are two measures of DEA:

1. Input-oriented DEA Measures
2. Output-oriented DEA Measures

Input-oriented technical efficiency measures deal with questions relating to the reduction of input quantities, without changing the output quantities produced. If the question is reversed to discover how much output quantities can be proportionally expanded without altering the input quantities used, this will deal with output-oriented measures (Coelli et al., 2005). These are discussed below.

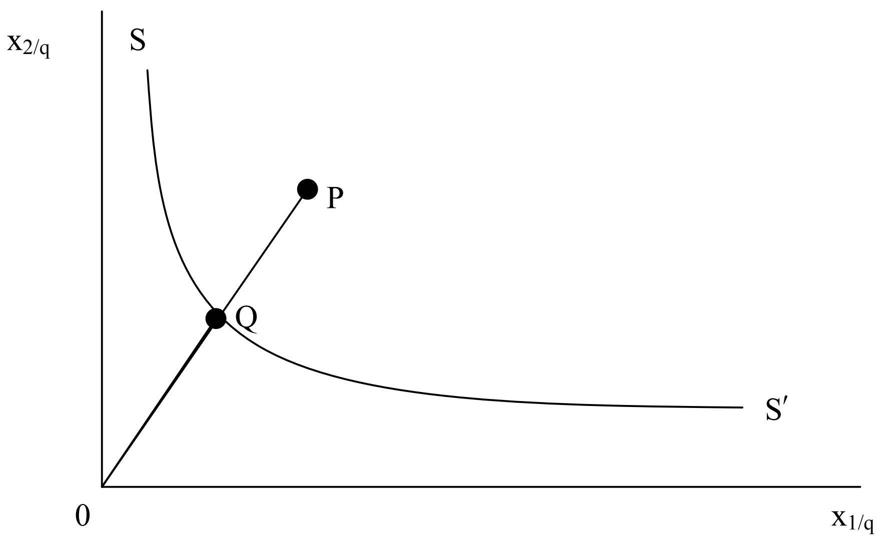
4.2.4.1 The Input-Oriented DEA Measure of Technical Efficiency

Input oriented measures are attributed to Farrell (1957), who demonstrated his ideas using a simple example of firms who use two inputs (x1 and x2) to produce one output (q) with the assumption of constant return to scale. In figure 4.1, the unit isoquant of a fully efficient firm is represented by the curve SS'. This curve can be used to measure technical efficiency; so if a given firm uses quantities of inputs, defined by the point P, for producing a unit of outputs, then the technical inefficiency of that firm can be represented by the distance QP. The distance QP refers to the amount to which all inputs could be proportionally reduced without a reduction in outputs. Percentage terms are used to express this amount through the ratio QP/0P which represents the percentage through which all inputs should be reduced in order to achieve technically efficient production. The technical efficiency (TE) of a firm is measured by the following ratio:

$$TE = 0Q/0P, \qquad (4.1)$$

This is equal to one minus QP/0P. The value ranges between zero and one. If the value is one, it indicates the firm is fully technically efficient, but if the value is zero or less than one, it indicates that the company is technically inefficient. In Figure 4.1 the point Q lies in the efficient isoquant curve; this means that this point is technically efficient.

Figure 4.1: Technical Efficiency from an Input-Orientation

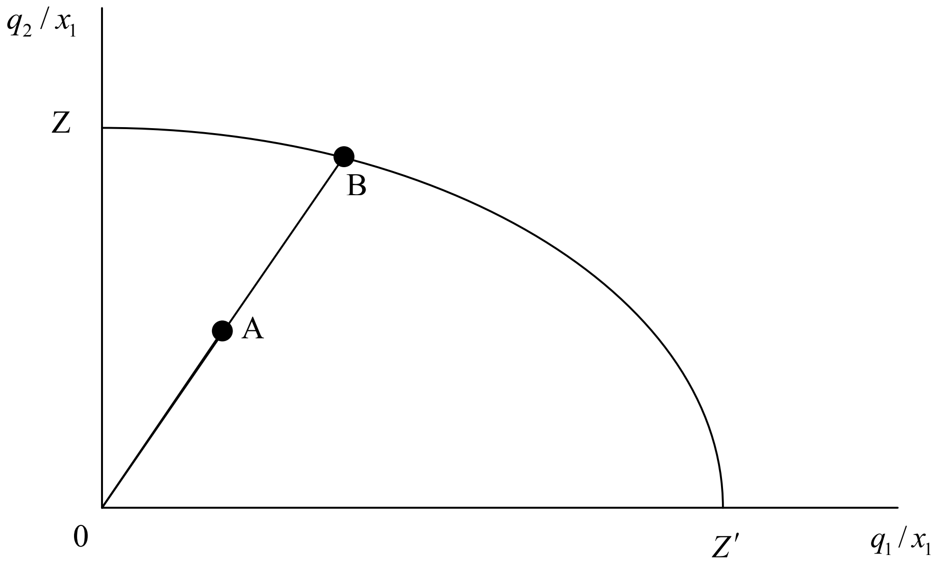


Source: Coelli et al. (2005)

4.2.4.2. The Output-oriented DEA Measure of Technical Efficiency

The Farrell output-oriented DEA measure of technical efficiency is illustrated by assuming that production involves two outputs, (q_1 and q_2), and a single input (x_1). Hence, if we assume constant returns to scale, then the technology can be represented by a unit production possibility curve ZZ' in two dimensions (see Figure 4.2). The point A refers to an inefficient firm; this is because A lies *below* the curve, ZZ' which represents the upper limit of the production possibilities.

Figure 4.2: Technical Efficiency from an Output Orientation



Source: Coelli et al. (2005)

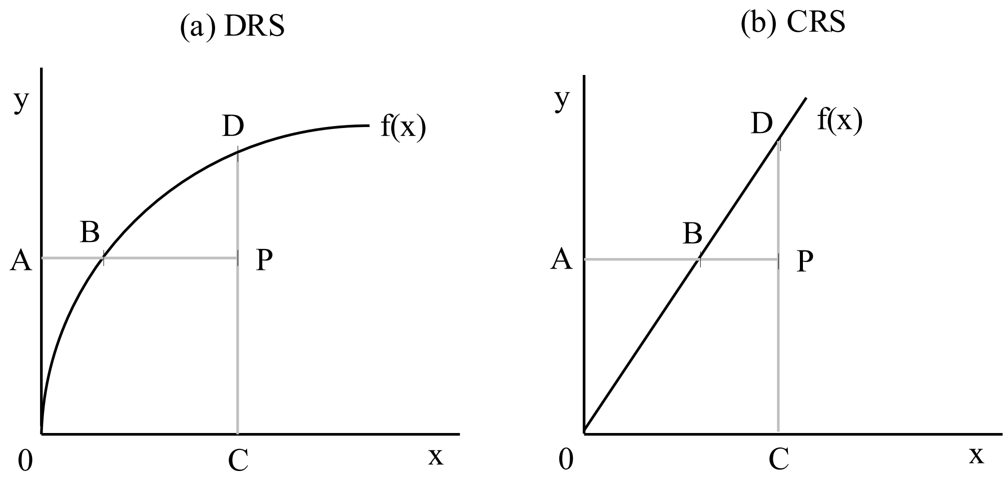
The distance AB refers to the technical inefficiency that is the amount by which outputs could be increased without requiring extra input. The measure of output-oriented technical efficiency is expressed by the ratio

$$\text{TE} = \text{OA} / \text{OB} \tag{4.2}$$

4.2.4.3 Difference between the Two Orientations Measures of Technical Efficiency – an Illustration

The difference between input- and output-oriented measures can be illustrated by a simple one-input (*x)* and one-output (*y*) example, as provided by Coelli et al. (2005). In Figure 4.3(a) a decreasing returns to scale (DRS) technology is represented by *f*(*x*), and an inefficient DMU operating at the point *P*. The Farrell (1957) input-oriented measure of technical efficiency would be equal to the ratio AB / AP, while the output-oriented measure of technical efficiency would be equal to the ratio CP / CD. Note that AB / AP is not equal to CP / CD. The constant returns to scale case is illustrated in Figure 4.3(b) where we observe that $AB / AP = CP / CD$, for the inefficient firm operating at point *P*. The input- and output-oriented measures provide equivalent measures of technical efficiency only when constant returns to scale exist – they will be unequal if increasing or decreasing returns to scale are present.

Figure 4.3: Technical Efficiency Measures and Returns to Scale



Source: Coelli et al. (1998). Note: DRS denote Decreasing Returns to Scale and CRS Constant Returns to Scale.

4.2.4.4 Choice of DEA Orientation

The input-orientated DEA model maximises the proportional reduction in inputs as much as possible, without changing the level of outputs. Conversely, the output-oriented model maximises the proportional expansion in outputs for the same level of inputs. These orientations have similar envelopment surface, or *efficiency frontier*; however, the measures of inefficient firms may differ between the two under non-constant returns to scale. The selection of a suitable orientation depends on which quantities (inputs or outputs) the managers have most control over (Dong, 2009).

Thus, if the firm manager is required to meet market demands, and he can freely adjust input usage, then it is appropriate to choose an input-oriented model. An output-oriented model will be more appropriate if the firm has a fixed quantity of inputs and is asked to produce as much output as possible. However, some researchers have pointed out that the choice of orientation has only a minor effect on the scores obtained, and therefore may not be a vital issue (see Coelli & Perelman, 1999). Here, the input-oriented model for measuring technical efficiency is chosen, as banks are believed to have better control over inputs.

4.2.4.5 Data Envelopment Analysis Program (DEAP Version 2.1)

Coelli's (1996) Data Envelopment Analysis Program (DEAP Version 2.1) for calculating efficiencies in production implement methods based upon the work of Fare, Grosskopf and Lovell (1994a) and their associates. DEA involves the use of linear programming methods to construct a non-parametric piecewise surface or frontier over the data. In DEAP, three options are available:

1. The standard CRS and VRS DEA models;[13]
2. The extension of these models to account for cost and allocative efficiencies; and
3. The application of Malmquist DEA methods to calculate Total Factor Productivity (TFP) change.[14]

Option 1 is used in this Chapter, Option 2 in Chapter 5 and Option 3 in Chapter 6. The relevant mathematics underlying these methods is available in Coelli et al (2005).

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[13] These methods are outlined in Fare, Grosskopf and Lovell (1994a).

[14] For more details, see Fare, Grosskopf, Norris and Zhang (1994b).

4.3 Choice of Variables for DEA Model

Empirical results based on DEA may depend on, or are likely to be influenced by, the choice and number of inputs entering the model. There is no agreement on the choice of bank inputs and outputs; in fact, the choice of input and output variables for the banking sector remains controversial. The literature provides three distinct approaches used for selecting inputs and outputs: the production approach, the intermediation approach, and the value-added approach. The first views financial institutions as producers who use inputs of labour and capital to generate outputs of deposits and loans. This approach is used by, among others, Sathey (2001) and Neal (2004). The intermediation approach views financial institutions as intermediaries that convert and transfer financial assets from surplus units to deficit units. Ahmad (2000) views banks as intermediaries and uses two inputs, labour and deposits; and two outputs, total loans and other investments, for measuring efficiency in Jordanian banks during 1990–1996. In another conceptualisation of the intermediation approach, Paul and Kourouche (2008) and Kourouche (2008) use interest expenses and non-interest expenses as inputs and interest income and non-interest income as outputs. In the value-added approach, high-value-creating activities such as making loans and taking deposits are classified as outputs, whereas labour, physical capital and purchased funds are classified as inputs (Wheelock & Wilson, 1995).

The intermediation approach is quite popular in empirical research, particularly that based on cross-sectional data (Colwell & Davis, 1992; Favero & Papi, 1995). The production approach, also used in empirical studies, is known to have a limitation as it excludes interest expenses, which are considered a vital part of banking.

There are other practical issues or reasoning governing the selection of inputs and outputs. If one's aim is to estimate a unit's production efficiency, then the production approach might be appropriate. However, if the interest of the researcher is in examining intermediation efficiency, then the intermediary approach is more appropriate. The choice of variables may also depend on the availability of required data.

In the DEA approach, the number of inputs and outputs is always determined by the number of DMUs (banks, in the present context) in the sample. The ability of DEA to distinguish between efficient inefficient DMUs depends on the number of inputs and outputs incorporated in the model. As a rule of thumb, the product of the number of inputs and outputs should not exceed the number of DMUs in the sample (Cooper et al., 2000). Dyson et al. (2001) suggest that the product of the total number of inputs and outputs should not exceed fifty percent of the unit's number under investigation, for the purpose of obtaining a reasonable level of differentiation. On the other hand, Cinca et al. (2004) suggest that DMUs' efficiency may be estimated using alternative specification methods, and should rely on the average estimated efficiency. In examining banking efficiency based on DEA, the rule of thumb, mentioned above, is the most popular strategy for selecting the number of inputs and outputs.

This study uses the intermediation approach originally suggested by Sealey and Lindley (1977), in which banks are viewed as intermediaries that employ two inputs, labour (x1) and total deposit (x2) to produce two outputs, total loans (y1) and other investments (y2). The variables are listed in Table 4.1.

Table 4.1: List of Inputs and Outputs

Inputs	
	Labour (x1) Total deposits (x2)
Outputs	
	Total loans (y1) Other investments (y2)

The definitions of the variables used in DEA models are as follows: *labour* is measured in terms of full time workers; *total deposits* are the total amount of customers' deposits. *Total loans* are the total credit facilities as they appear in the balance sheets of the banks. *Other investments* consist of investments in bonds and securities, shares, treasury bills, and investment in affiliate and subsidiary companies. All the monetary variables are expressed in 2000 Jordanian Dinar (JD) using a GDP deflator. Ideally an investment price deflator should be used to express other investments at constant prices. Since information on investment deflators is not available, we use a GDP deflator to express investment at constant price. This adjustment does not apply to labour, as this is measured by the number of employees (workers).

4.4. Data Sources

The non-availability of data at the micro level is one of the main reasons for the lack of adequate numbers of empirical analyses on banking efficiency in emerging economies in general and Jordan in particular. The *Bankscope* databases provide limited information on Jordanian banks. They do not cover all the banks operating in the country, particularly in the earlier years of data compilation. In addition, the data reported in *Bankscope* are aggregate, and so lack details; this inhibits a comprehensive analysis of the institutions under study. As well, samples compiled by *Bankscope* suffer from an implicit selectivity bias in favour of large banks, which may not be a good representation of the banking industry and thus may yield biased and inaccurate results (Ehrmann et al., 2001).

Bhattacharya (2003) and Ehrmann et al. (2001) recommend the use of databases maintained by central banks, because such databases have more complete data and therefore produce more consistent, robust and stable results. To ensure reliability, comparability and consistency, the data used in this study cover the period 1996–2007 and are taken from auditing annual reports of individual banks and from the CBJ. In addition, different libraries in Jordan and the databases of the Amman Stock Exchange (ASE) and the Association of Banks in Jordan were consulted to gather further information and supply missing data.

The data were collected from 17 Jordanian banks, consisting of thirteen domestic banks, one domestic Islamic bank (two large, eight medium, four small) and three foreign banks (see Table 4.2). A total of 204 Annual Reports were consulted. The data collection process from the Annual reports was time-consuming. There are existing studies of banking efficiency in Jordan covering the period 1990–1996 and analysing 19 banks; however, closure and merger over the years and the non-availability of data restricted the present study to 17 banks. The deregulated period 1996–2007 was selected because it had not been compassed in earlier studies.

The 14 domestic Jordanian banks selected for this study are those listed on the Amman Stock Exchange (ASE; these banks contribute about 90 percent of banking output in Jordan (Association of Banks in Jordan, Annual Report, 2007). ASE does not list foreign banks, of which currently there are eight; the data for three for the whole period was collected from libraries and the Association of Banks in Jordan. Of the remaining five foreign banks, two refused to provide the required data, and the other three came into existence only in 2004.

For a comprehensive analysis, the domestic banks are classified into three categories, based on their assets size in 2007, measured in Jordanian Dinar (JD) millions; see Table 4.2. The three categories are:

1. Large domestic banks: (Assets size ≥ JD 4000 million)
2. Medium domestic banks: (700 ≤ Assets size < JD 4000 million)
3. Small domestic banks: (Assets size < JD 700 million).

The banks' assets have changed over the years but none have changed their categories, facilitating their comparison over the sample period.

Table 4.2: Assets of Domestic and Foreign Banks, 2007

(Measured in JD Millions)

Bank Category	Serial number	Bank Name	short Name	Total Assets
Large	1	Arab Bank	AB	6093
	2	The Housing Bank for Trade and Finance	HBTF	4132.6
Medium	3	Jordan Kuwait Bank	JKB	1752
	4	Jordan Islamic Bank For Finance and Investment	JIBF	1596.83
	5	Jordan National Bank	JNB	1548.58
	6	Bank of Jordan	BOJ	1276
	7	Cairo Amman Bank	CAB	1085.36
	8	Union Bank for Saving and Investment	UBJ	1056.3
	9	Capital Bank	CPB	896.82
	10	Jordan Investment and Finance Bank	JIFB	707.37
Small	11	Arab Banking Corporation	ABC	574
	12	Jordan Commercial Bank	JCB	533.92
	13	Arab Jordan Investment Bank	AJIB	516
	14	Societe Generale De Banque-Jordanie	SGBJ	222.58
		Foreign Banks		
	15	HSBC BANK	HSBC	587.07
	16	Bank Standard Charter	BSC	483.89
	17	Citi Bank	CB	241.8

Source: The Association of Banks in Jordan, Annual Report 2007.

4.5 An Analysis of Technical Efficiency of Banks in Jordan

Before turning to the empirical results, the summary statistics for inputs and outputs, which might be useful in understanding the broad structure of banking sector in Jordan, are presented below.

4.5.1 Summary Statistics for Inputs and Outputs

The statistics presented in Table 4.3 reveal the heterogeneity of Jordanian banks, as seen by the considerable variety in mean size across the four variables within

Jordanian banking groups. For instance, the number of employees in large banks is almost three times the number in medium sized banks, six times the number in small banks and twelve times the number in foreign banks. The number of employees, recognised as input, within the domestic banks as a whole is five times that of the number within foreign banks.

Another interesting observation is that deposits in the large Jordanian banks are almost 11 times those held by medium banks, and 32 times those of small banks. This difference could be a product of variation in operational efficiency within the respective banking sectors, or a results of services in Jordan's large banks, which are more efficient and attractive for customers than other banks'. The fact that larger banks are taking the lead in regard to deposits implies that a major source of funding in Jordanian banks is collection. This is a typical characteristic of a traditional banking system. When considering the output variables, a similar trend is evident, as the large banks have a total loan amount eleven times that of the medium banks, and 30 times that of the small banks. Other investments of large banks are nearly 17 times those of the medium banks, and 47 times those of the small banks. In addition, it appears that the total loans of large Jordanian banks are half of their total deposits. In light of this, it can be inferred that Jordanian banks are facing a risky business environment and may be reluctant to engage heavily in loan markets, as business credits are more costly to originate, maintain and monitor, and thus more likely to default than investment securities. As a result, the Jordanian banking environment – loan activities/ markets – is markedly skewed towards liquid loans.

The total loan provided by domestic banks to their customers in Jordan is seven times larger than the total loan provided by foreign banks. Other investments of domestic banks are 26 times larger than those of foreign banks; and domestic banks have six times the total deposit of the foreign banks operating in Jordan.

The contribution of individual banks, or of a category of banks, to total banking outputs has not remained stable or unchanged over the sample period. The share of large banks in total banking output has declined from 72% in 1996 to 66% in 2007, while the shares of medium and small banks in total banking output have shown significant increase over the years from 1996-2007. The output share of foreign banks shows a marginal decline over the sample period (see Table 4.4). The Islamic bank (JIBF) has the largest shares in the group of medium banks, indicating that the Islamic banks in Jordan make a significant contribution to the banking industry; however, their share has declined slightly over the sample period.

Table 4.3: Summary Statistics of Variable for Jordanian Banks, 1996–2007

(Values in Jordanian Dinar at constant 2000 prices using GDP Deflator)

Variable	Number of Banks	Mean	SD	Minimum	Maximum
All Banks					
Total Loans	17	551.14	1280.97	11.39	7867.51
Other Investments	17	219.28	631.06	0.20	4019.06
Labour	17	759	700	41	2894
Total Deposits	17	1181.13	2790.17	14.20	13845.15
Large Banks					
Total Loans	2	3163.35	2491.00	556.61	7867.51
Other Investments	2	1444.36	1310.84	129.18	4019.06
Labour	2	2079	380	1639	2894
Total Deposits	2	6871.50	5439.22	976.81	13845.15
Medium Banks					
Total Loans	8	292.18	173.88	11.39	898.26
Other Investments	8	86.13	51.58	3.19	205.16
Labour	8	861	573	41	1611
Total Deposits	8	597.96	354.63	14.20	1381.49
Small Banks					
Total Loans	4	106.97	59.42	21.03	234.98
Other Investments	4	29.95	32.10	0.31	113.54
Labour	4	338	128	177	699
Total Deposits	4	210.62	106.56	36.36	387.01
ALL Domestic Banks					
Total Loans	14	646.48	1388.85	11.39	7867.51
Other Investments	14	262.60	685.70	0.31	4019.06
Labour	14	882	708	41	2894
Total Deposits	14	1377.71	3029.62	14.20	13845.15
Foreign Banks					
Total Loans	3	92.46	52.29	14.17	203.04
Other Investments	3	10.08	6.47	0.20	30.95
Labour	3	168	93	54	393
Total Deposits	3	236.66	97.32	93.34	442.33

Source: data collected by author from individual bank Annual Report.
Note: SD: standard deviation. All value variables divided by 1 Million (JD), excluding Labour (number of employees).

Table 4.4: Contribution of Individual Banks to Total Banking Output, 1996–2007

Banks	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Large Banks												
AB	62.1%	62.7%	61.6%	61.4%	66.3%	65.2%	66.3%	65.8%	63.9%	56.4%	53.3%	54.7%
HBTF	9.7%	9.0%	8.9%	8.4%	7.1%	7.9%	7.7%	7.9%	9.3%	11.0%	11.9%	11.7%
Medium Banks												
JKB	1.9%	2.0%	1.8%	1.9%	2.2%	2.3%	2.5%	2.9%	3.3%	4.5%	5.6%	5.4%
JIBF	5.9%	5.2%	4.9%	4.9%	2.9%	2.9%	2.7%	2.9%	2.7%	3.4%	3.3%	3.3%
JNB	3.6%	5.1%	5.6%	5.5%	5.4%	5.3%	4.6%	4.3%	3.7%	4.2%	4.1%	3.9%
BOJ	3.1%	2.7%	3.2%	3.2%	2.8%	3.0%	3.2%	3.6%	3.3%	3.6%	3.8%	3.7%
CAB	3.8%	3.8%	3.8%	3.7%	3.2%	2.5%	3.0%	2.6%	2.8%	3.6%	3.3%	3.0%
UBJ	1.1%	1.0%	0.9%	1.0%	1.1%	1.3%	1.6%	1.8%	2.1%	2.6%	2.9%	2.6%
CPB	0.2%	0.4%	0.6%	0.9%	1.2%	1.3%	1.5%	1.8%	1.8%	2.6%	2.7%	2.6%
JIFB	1.4%	1.4%	1.5%	1.7%	1.3%	2.2%	1.5%	1.3%	1.3%	1.7%	2.0%	1.8%
Small Banks												
ABC	1.2%	1.2%	1.2%	1.2%	1.1%	1.2%	1.2%	1.2%	1.2%	1.3%	1.5%	1.5%
JCB	1.4%	1.2%	1.4%	1.5%	1.8%	1.9%	1.0%	0.6%	0.7%	1.3%	1.5%	1.4%
AJIB	1.0%	0.9%	1.0%	1.1%	1.2%	1.1%	1.2%	1.1%	1.3%	1.3%	1.5%	1.5%
SGBJ	0.5%	0.4%	0.4%	0.3%	0.2%	0.2%	0.2%	0.2%	0.4%	0.5%	0.5%	0.6%
Foreign Banks												
HSBC	1.5%	1.6%	1.4%	1.2%	1.0%	0.8%	1.0%	1.0%	1.0%	1.0%	1.0%	1.1%

Banks	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
BSC	1.2%	1.3%	1.5%	1.6%	0.9%	0.5%	0.5%	0.6%	0.8%	0.8%	0.9%	1.1%
CB	0.4%	0.4%	0.4%	0.5%	0.3%	0.3%	0.4%	0.4%	0.3%	0.1%	0.2%	0.2%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Source: Author’s calculations.

4.5.2 Results of Technical Efficiency

The results determining the technical efficiency levels of banks are obtained by running the DEA model using the DEAP program to construct a grand frontier that envelops all input-output observations of all banks. As mentioned earlier, the sample comprises thirteen domestic commercial banks, one domestic Islamic bank, and three foreign banks for which data were available, and the study covers the entire financial liberalisation period.

The input-oriented DEA approach is applied to the panel data (204 observations) of all 17 banks to construct the grand efficient frontier against which the technical efficiency scores of all banking units are computed. The efficiency scores compare across banks and over years, because the efficient frontier is made of best-practice observations from the whole data set. The approach provides the simplest and most direct way to compare and track down the efficiency level of a bank. The approach assumes that technology is constant over the sample period.

The technical efficiency scores lie between 0 and 1, where 1 indicates full efficiency and 0 indicates full inefficiency. The DEA reveals how efficient a decision making unit (DMU) is relative to the others. The efficiency score translates into how well a bank converts its inputs into outputs. For instance, if a bank has a technical efficiency score of 75%, this means that it would have to reduce its inputs by 25% to become as efficient as its reference set: those banks with 100% scores.

Technical efficiency can be split into the product of 'pure technical' and 'scale' efficiencies. This requires the estimation of two DEA models: one with constant returns to scale (CRS), and, the other with variable returns to scale (VRS). If there is a difference in the two technical efficiency scores for a particular bank, then this indicates that the bank has scale inefficiency. This process is illustrated in Figure 4.4 for a case with one input (x) and one output (y). The constant returns and variable returns to scale DEA frontiers are represented by CRS and VRS respectively. Under CRS, the input-oriented technical inefficiency of point P is the distance PP_c, while under VRS the technical inefficiency would be PP_v. The difference between these two, P_cP_v, is put down to scale inefficiency. This can all be expressed in ratio efficiency measures:

$$TE_{CRS} = AP_C/AP \qquad \text{(Technical Efficiency)} \qquad (4.3)$$

$$TE_{VRS} = AP_V/AP \qquad \text{(Pure Technical Efficiency)} \qquad (4.4)$$

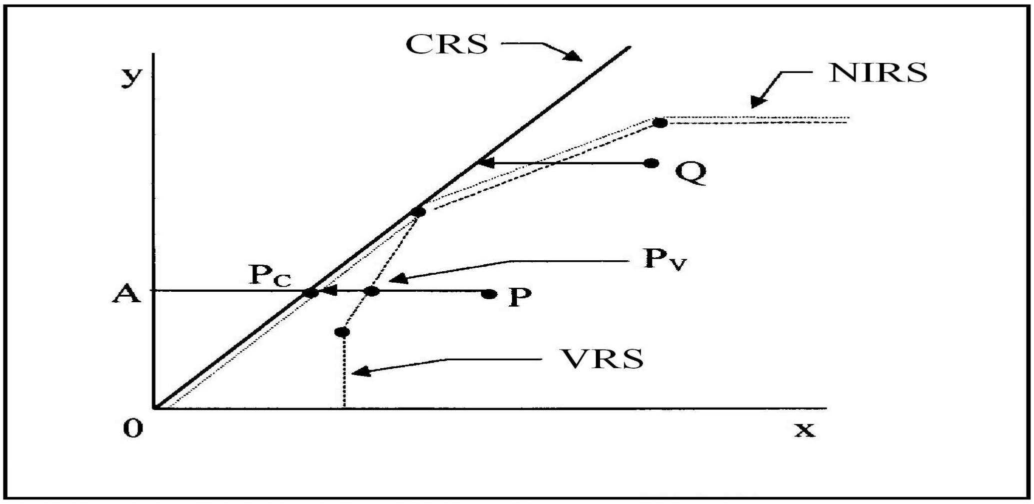
$$SE = AP_C/AP_V \qquad \text{(Scale Efficiency)} \qquad (4.5)$$

All of these efficiency measures are bounded by zero and one. It may be noted that

$$TE_{CRS} = TE_{VRS} \times SE. \qquad (4.6)$$

That is, the CRS technical efficiency measure is the product of pure technical efficiency and scale efficiency. The scale efficiency measure does not indicate whether a bank is operating at increasing returns to scale (IRS) or decreasing returns to scale (DRS). This may be determined by imposing non-increasing returns to scale (NIRS) to the DEA problem. The NIRS DEA frontier is plotted in Figure 4.4. The nature of the scale inefficiencies, due to increasing or decreasing returns to scale, for a particular bank can be determined by noting whether the NIRS technical efficiency score is equal to the VRS technical efficiency score. If they are unequal, as is the case at P (Figure 4.4), then IRS exists for that bank. If they are equal, as is the case at Q (Figure 4.6), then DRS applies for that bank (Coelli 1996, p. 18).

Figure 4.4: Calculation of Scale Economies in DEA



Source: Coelli (1996)

The results for DEA technical efficiency (TE), pure technical efficiency (PTE) and scale efficiency (SE) for individual banks are presented in Table 4.5. Following Paul and Kourouche (2008), an aggregated estimate of technical efficiency for the entire banking sector is obtained as the weighted geometric mean of an individual bank's scores, using the share of each bank in total output as weight. The same procedure is used to calculate the efficiency scores of each group of banks. The aggregate efficiency scores, calculated in this way, are more accurate than the simple arithmetic or geometric average of the banks specific scores. This is so because each bank differs in terms of its contribution to the aggregate output of the banking sector.

The average estimates of technical efficiency for the whole banking sector as well as for different bank categories are presented in Table 4.5. The table reveals that the technical efficiency score for the banking sector as a whole is 0.79, which reveals that 21% of inputs can be reduced to achieve full level of efficiency (without affecting their output). This value is similar to those found in developing countries but lower than what is found in some developed countries. For example, Bhattacharya et al., (1997), Taylor et al. (1997), Chaffai (1997), Darrat et al. (2002) and Yildirim (2002) report the technical efficiency levels of Indian, Mexican, Tunisian, Kuwaiti and Turkish banks respectively at 79%, 75%, 72%, 86% and 89%. However, in developing countries, studies by Fukuyama (1993), Altunbas et al. (1994), Favero and Papi (1995), Miller and Noulas (1996), and Kourouche (2008) report technical efficiency levels of Japanese, Germany, Italian, US, and Australian banks respectively at 94%, 92%, 90%, 95%, and 92.7%. We may note that these efficiency scores are not strictly comparable across countries because banks in these countries face different DEA frontiers.

The group of large-sized banks has the highest technical efficiency, at 90.5% on average during the study period. The medium banks have the lowest technical efficiency, at 57.5% on average. The efficiency performance of small banks is somewhat better than that of medium-sized banks, with a technical efficiency score of 60.5% on average. Foreign banks show the worst performance in terms of technical, pure technical and scale efficiencies.

Table 4.5: Mean DEA Estimates of Technical, Pure Technical and Scale Efficiency by Category, 1996–2007

Bank Type	TE	PTE	SE
Large	0.905	0.93	0.973
Medium	0.575	0.584	0.984
Small	0.605	0.616	0.982
Foreign Banks	0.44	0.508	0.866
All Domestic Banks	0.804	0.823	0.976
All Banks	0.792	0.814	0.974

Source: author's calculations.

Some interesting points emerge from the broad bank category-specific yearly estimates of technical efficiency presented in Table 4.6 and displayed in Figures 4.5 through 4.10. First, the technical and pure technical efficiency levels in the category of large banks are much higher than in small and medium-sized banks throughout the sample period. Second, the small banks have outperformed medium banks in terms of technical and pure technical efficiency since 2000. Third, the scale efficiency of large banks seems to be declining, particularly after 2000, implying that the efficiency of these banks might be improved by enhancing the scale of their operations.

There are differences in the efficiency levels of banks in each category, and each bank shows yearly fluctuations in their efficiency (Table 4.8). The Arab Bank, which is the largest bank, is found to be the most technically efficient with an average score of 94%. It was fully technically efficient in 2004 and 2007, when it was also operating at the most productive scale size (MPSS) or optimal scale (See Table 4.7). The efficiency level of the second largest bank, the Housing Bank for Trade and Finance (HBTF), is relatively quite low. This bank has also shown relatively strong deterioration in scale efficiency (i.e. operating at decreasing returns to scale) over the years. At DRS, increase in inputs is accompanied with a less than proportionate rise in outputs. The banks such as HBTF operating at DRS could increase efficiency levels by downsizing their scale of operations.

In the category of medium-sized banks, the Capital Bank (CPB) is found to be the most efficient at 92.6%. This bank is the second most efficient bank in Jordan. It is also the most scale-efficient bank, along with the Arab Bank, with an average score of 95.5%, as it consistently performed at the optimal scale during 1998, 2001, 2002, 2003, 2005, 2006 and 2007. However, it has experienced increasing returns to scale (IRS) in other years. At IRS, an increase in inputs leads to a more than proportionate rise in outputs. Banks operating at IRS could increase efficiency by enlarging their scale of operations.

The CPB dominated in pure technical efficiency, with a mean value of 97%, by being fully pure technically efficient in 8 out of 12 years (see Table 4.8). There is evidence of a decrease in efficiency for few medium-sized banks over time.

Among the group of small-sized banks, the Jordan Commercial Bank (JCB) showed the highest efficiency score at 67.4%, and operated at IRS over the sample period (see Tables 4.7 and 4.8). The Arab Jordan Investment Bank (AJIB) had the lowest mean efficiency of 53%. All three foreign banks had low efficiency scores compared to domestic banks. Their efficiency scores were less than half those of the large banks.

A complete picture on the nature of the returns to scale experienced by the banking sector is provided in Table 4.7 and Figure 4.11. On average each year, only one bank was operating at MPSS exceptions. During 1997, 2001, 2002, 2004, 2006 and 2007, two banks operated at MPSS, but in 2000 no bank operated at MPSS. The number of banks operating at IRS has declined from 15 banks in 1996 to six in 2007.

Not all banks have shown an improvement in efficiency over the sample period. The Arab Bank (AB) and the Capital Bank (CPB) and some small banks show a substantial improvement in technical efficiency, which can be attributed to improvement in both PTE and SE. Among the medium-sized banks, Jordan National Bank (JNB) shows deterioration in TE and PTE; all other banks show improvement in all efficiency scales. Among the foreign banks, all three show fluctuations in efficiency over time. The efficiency scores of Jordanian banks increased between 1999 and 2002 and dropped again in 2003. This pattern can be attributed to the worldwide recession and the political situation in the region. The third Gulf war, also known as the American–British War on Iraq (2003), adversely affected Jordan’s economy, causing income decline, inflation, unemployment and impoverishment (see

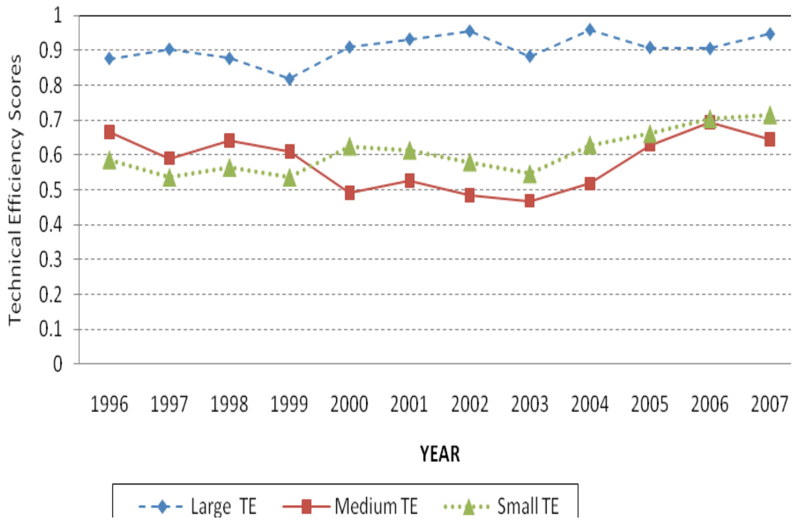
Table 4.8). In 2004, banks' efficiency scores started to increase in both domestic and foreign banks.

Table 4.6: DEA Estimates of Efficiency by Category of Banks, 1996–2007

Banks	Eff	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Mean
Domestic Banks														
Large														
	TE	0.877	0.903	0.877	0.818	0.909	0.932	0.955	0.883	0.960	0.908	0.905	0.947	0.905
	PTE	0.882	0.908	0.885	0.833	0.927	0.959	0.981	0.907	0.993	0.949	0.967	0.989	0.930
	SE	0.994	0.996	0.990	0.983	0.981	0.972	0.974	0.973	0.966	0.957	0.936	0.958	0.973
Medium														
	TE	0.665	0.590	0.641	0.610	0.491	0.526	0.484	0.468	0.518	0.628	0.693	0.645	0.575
	PTE	0.674	0.599	0.643	0.614	0.496	0.532	0.488	0.470	0.529	0.651	0.712	0.669	0.584
	SE	0.988	0.986	0.996	0.995	0.991	0.989	0.993	0.995	0.978	0.965	0.974	0.964	0.984
Small														
	TE	0.586	0.536	0.564	0.536	0.625	0.614	0.580	0.546	0.629	0.660	0.703	0.715	0.605
	PTE	0.603	0.551	0.575	0.546	0.634	0.620	0.587	0.558	0.634	0.670	0.716	0.730	0.616
	SE	0.972	0.971	0.981	0.981	0.986	0.989	0.987	0.979	0.991	0.986	0.982	0.979	0.982
Foreign Banks														
	TE	0.480	0.566	0.551	0.512	0.377	0.356	0.367	0.379	0.408	0.412	0.433	0.510	0.440
	PTE	0.527	0.612	0.599	0.557	0.440	0.487	0.454	0.468	0.480	0.477	0.484	0.550	0.508
	SE	0.910	0.926	0.919	0.919	0.855	0.731	0.810	0.809	0.849	0.864	0.896	0.926	0.866
All Domestic Banks														
	TE	0.812	0.806	0.801	0.750	0.788	0.810	0.813	0.758	0.827	0.811	0.829	0.842	0.804
	PTE	0.819	0.813	0.808	0.761	0.802	0.830	0.831	0.775	0.853	0.844	0.873	0.876	0.823
	SE	0.992	0.993	0.991	0.985	0.983	0.976	0.979	0.978	0.969	0.961	0.949	0.961	0.976
ALL Banks														
	TE	0.799	0.797	0.791	0.740	0.776	0.799	0.801	0.747	0.815	0.801	0.817	0.832	0.792
	PTE	0.807	0.805	0.800	0.753	0.791	0.822	0.822	0.767	0.843	0.835	0.863	0.867	0.814
	SE	0.989	0.990	0.989	0.983	0.980	0.971	0.975	0.974	0.967	0.959	0.948	0.960	0.974

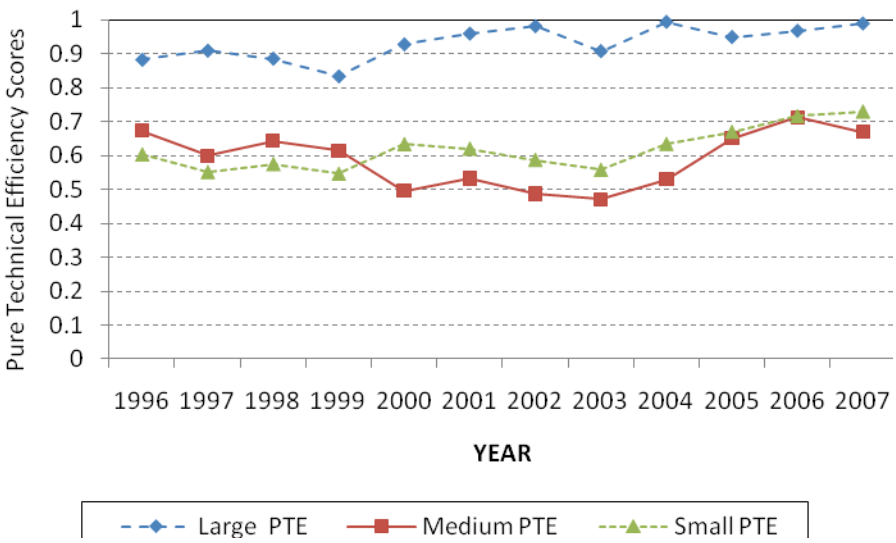
Source: author's calculations.
Note: TE: technical efficiency, PTE: pure technical efficiency SE: scale efficiency. The efficiency estimates for each bank category are the weighted geometric means of bank specific efficiencies, where the weights are their share in the aggregate output of the bank category they belong to. The weights vary from year to year.

Figure 4.5: DEA Estimates of Technical Efficiency by Bank Category, 1996–2007



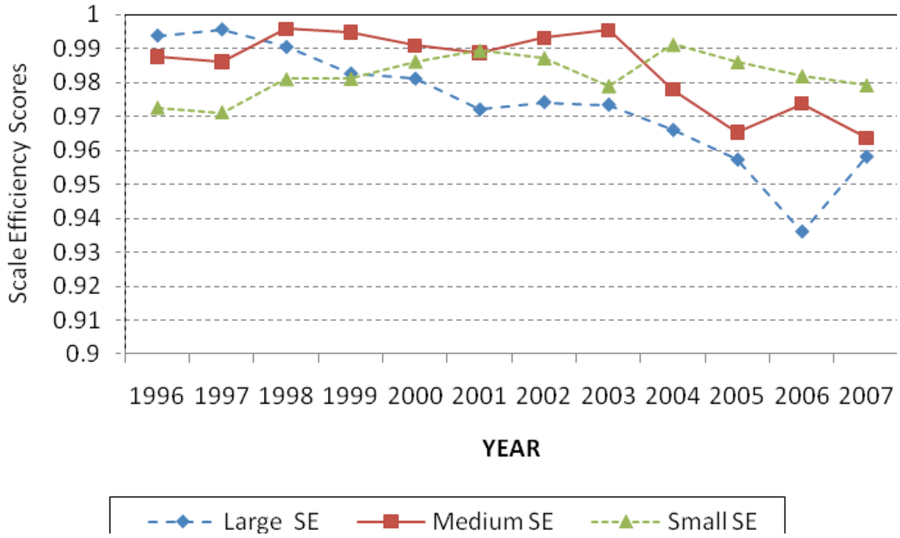
Source: Author’s calculations. Note: TE denotes Technical Efficiency.

Figure 4.6: DEA Estimates of Pure Technical Efficiency by Bank Category, 1996–2007



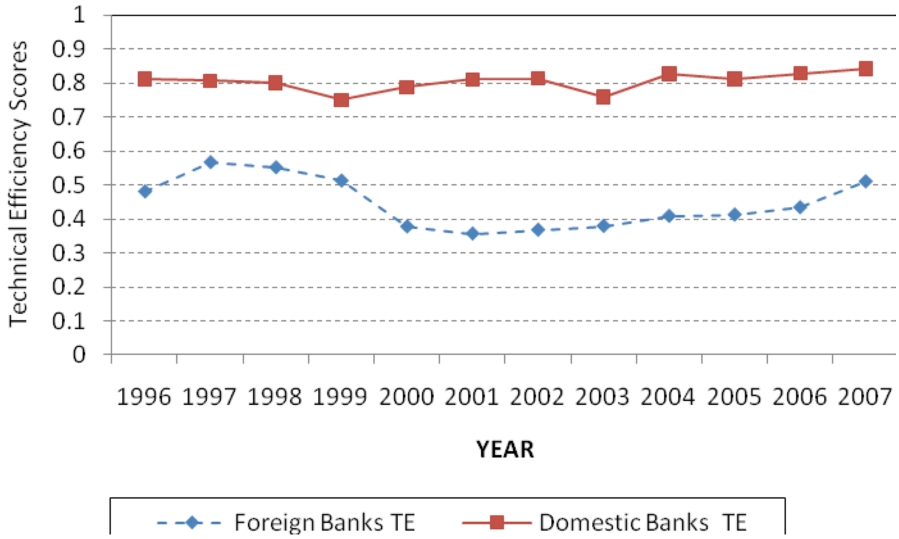
Source: Author’s calculations. Note: PTE denotes Pure Technical Efficiency

Figure 4.7: DEA Estimates of Scale Technical Efficiency by Bank Category, 1996–2007



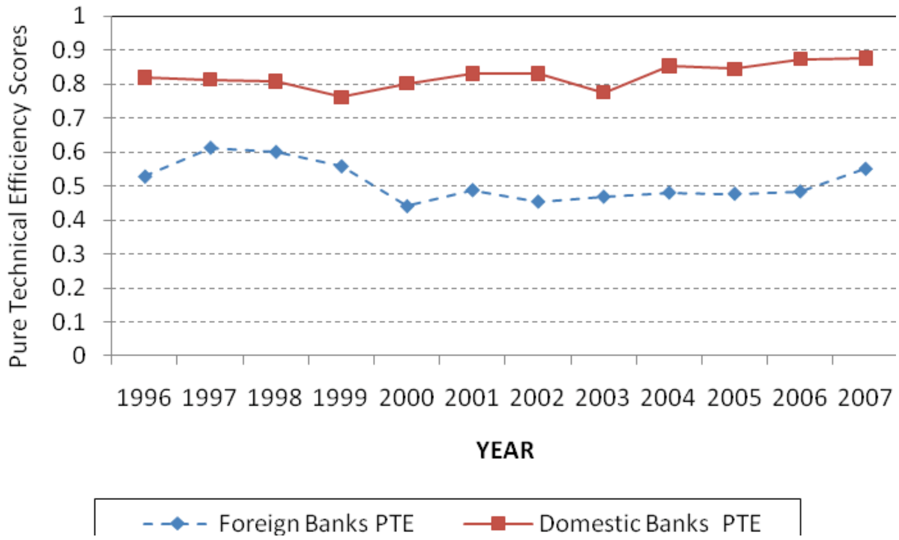
Source: Author's calculations. Note: SE denotes Scale Efficiency

Figure 4.8: DEA Estimates of Technical Efficiency by Bank Ownership, 1996–2007



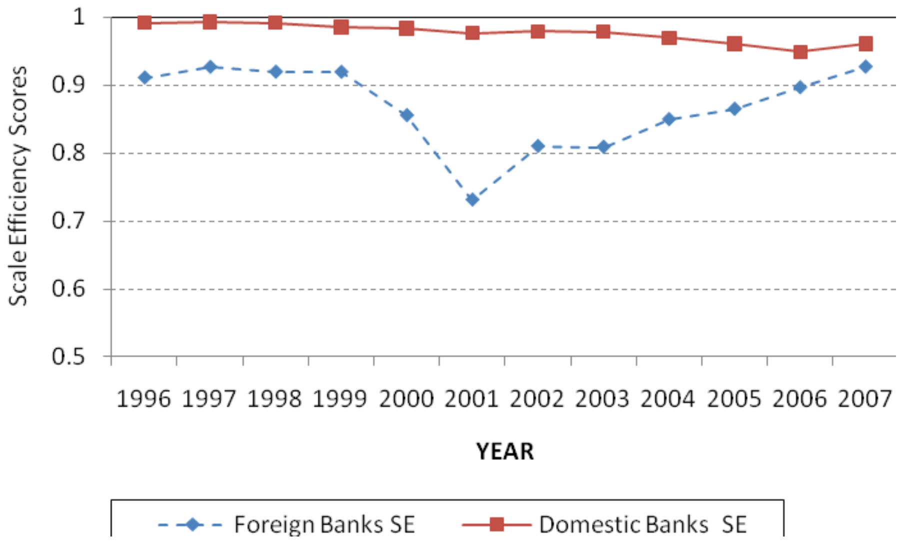
Source: Author's calculations. Note: TE denotes Technical Efficiency

Figure 4.9: DEA Estimates of Pure Technical Efficiency by Bank Ownership, 1996–2007



Source: Author's calculations. Note: PTE denotes Pure Technical Efficiency

Figure 4.10: DEA Estimates of Scale Technical Efficiency by Bank Ownership, 1996–2007



Source: Author's calculations. Note: SE denotes Scale Efficiency

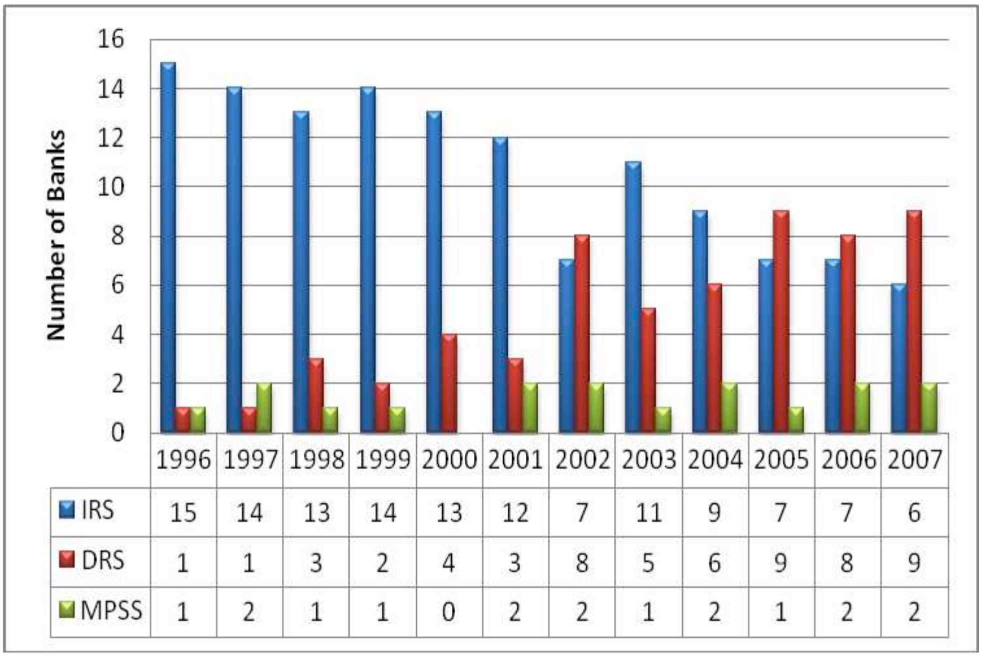
Table 4.7: Estimates of the Nature of Returns to Scale for Domestic and Foreign Banks, 1996–2007

Banks	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Domestic Banks												
Large Banks												
AB	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS	MPSS	DRS	DRS	MPSS
HBTF	MPSS	MPSS	DRS	DRS	DRS	DRS	DRS	DRS	DRS	DRS	DRS	DRS
Medium Banks												
JKB	IRS	IRS	IRS	IRS	DRS	IRS	IRS	IRS	IRS	DRS	MPSS	DRS
JIBF	IRS	IRS	IRS	IRS	DRS	DRS	DRS	IRS	IRS	DRS	IRS	IRS
JNB	IRS	MPSS	IRS	IRS	IRS	MPSS	DRS	DRS	DRS	DRS	DRS	DRS
BOJ	IRS	IRS	IRS	IRS	IRS	IRS	MPSS	DRS	DRS	IRS	IRS	DRS
CAB	IRS	IRS	IRS	IRS	DRS	IRS	DRS	IRS	DRS	DRS	DRS	DRS
UBJ	DRS	DRS	IRS	IRS	IRS	IRS	DRS	DRS	DRS	DRS	DRS	DRS
CPB	IRS	IRS	MPSS	IRS	IRS	MPSS	MPSS	MPSS	IRS	MPSS	MPSS	MPSS
JIFB	IRS	IRS	DRS	MPSS	IRS	DRS	DRS	DRS	DRS	DRS	DRS	DRS
Small Banks												
ABC	IRS	IRS	IRS	IRS	IRS	IRS	DRS	IRS	IRS	IRS	DRS	DRS
JCB	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS
AJIB	IRS	IRS	DRS	DRS	IRS	IRS	DRS	IRS	MPSS	DRS	DRS	DRS
SGBJ	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS

Banks	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
						Foreign Banks						
BSC	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS
CB	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS
HSBC	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS	IRS

Source: author's calculations.
Note: MPSS: most productive scale size; DRS: decreasing returns to scale; IRS: increasing returns to scale.

Figure 4.11: DEA Estimates of Nature of Return to Scale, 1996–2007



Source: Author's calculations.
Note: MPSS: Most Productive Scale Size; DRS: Decreasing Return to Scale; IRS: Increasing Return to Scale.

Table 4.8: DEA Estimates of Efficiency for Domestic and Foreign Banks, 1996–2007

Banks	Efficiency	1996	1997	1998	1999	2000	2001	2002
Large								
AB	TE	0.903	0.940	0.906	0.846	0.950	0.958	0.988
	PTE	0.909	0.946	0.911	0.851	0.953	0.960	0.989
	SE	0.993	0.995	0.994	0.995	0.997	0.998	0.999
HBTF	TE	0.725	0.684	0.698	0.638	0.605	0.741	0.714
	PTE	0.725	0.684	0.723	0.711	0.717	0.948	0.911
	SE	0.999	1.000	0.966	0.897	0.845	0.781	0.784
Medium								
JKB	TE	0.587	0.592	0.519	0.484	0.460	0.512	0.518
	PTE	0.595	0.600	0.526	0.491	0.463	0.516	0.522
	SE	0.986	0.987	0.986	0.987	0.996	0.993	0.994
JIBF	TE	0.859	0.837	0.734	0.726	0.504	0.474	0.324
	PTE	0.861	0.838	0.736	0.728	0.508	0.489	0.325
	SE	0.998	0.998	0.997	0.997	0.991	0.969	0.996
JNB	TE	0.743	0.632	0.782	0.689	0.485	0.450	0.400
	PTE	0.748	0.632	0.784	0.691	0.486	0.450	0.404

Banks	Efficiency	1996	1997	1998	1999	2000	2001	2002
	SE	0.993	1.000	0.998	0.998	0.999	1.000	0.990
BOJ	TE	0.612	0.475	0.567	0.562	0.480	0.506	0.489
	PTE	0.617	0.479	0.568	0.566	0.482	0.508	0.490
	SE	0.992	0.992	0.998	0.994	0.995	0.995	0.999
CAB	TE	0.518	0.413	0.501	0.436	0.415	0.395	0.435
	PTE	0.521	0.415	0.503	0.438	0.417	0.397	0.439
	SE	0.994	0.995	0.995	0.995	0.995	0.995	0.990
UBJ	TE	0.492	0.546	0.464	0.443	0.448	0.522	0.564
	PTE	0.495	0.547	0.472	0.453	0.457	0.530	0.568
	SE	0.995	0.998	0.983	0.978	0.979	0.985	0.994
CPB	TE	0.861	0.605	1.000	0.990	0.973	0.932	1.000
	PTE	1.000	0.862	1.000	1.000	1.000	0.932	1.000
	SE	0.861	0.702	1.000	0.990	0.973	1.000	1.000
JIFB	TE	0.588	0.525	0.614	0.741	0.511	0.962	0.786
	PTE	0.641	0.561	0.615	0.741	0.535	1.000	0.801
Small								
ABC	TE	0.610	0.568	0.544	0.503	0.481	0.510	0.529
	PTE	0.624	0.580	0.555	0.513	0.487	0.511	0.530
	SE	0.978	0.979	0.980	0.980	0.986	0.999	0.999
JCB	TE	0.723	0.681	0.692	0.662	0.744	0.748	0.522
	PTE	0.737	0.695	0.703	0.671	0.751	0.754	0.531
	SE	0.981	0.979	0.984	0.986	0.991	0.992	0.983
AJIB	TE	0.353	0.315	0.396	0.430	0.654	0.537	0.674
	PTE	0.365	0.325	0.397	0.433	0.657	0.542	0.679
	SE	0.969	0.967	0.998	0.994	0.995	0.991	0.992
SGBJ	TE	0.818	0.711	0.769	0.559	0.435	0.620	0.654
	PTE	0.869	0.760	0.828	0.611	0.484	0.688	0.706
	SE	0.942	0.935	0.929	0.914	0.897	0.901	0.926
Foreign								
HSBC	TE	0.510	0.641	0.557	0.462	0.407	0.367	0.364
	PTE	0.513	0.651	0.566	0.466	0.414	0.377	0.367
	SE	0.994	0.985	0.985	0.992	0.982	0.975	0.994
BSC	TE	0.464	0.545	0.590	0.568	0.375	0.352	0.322
	PTE	0.476	0.557	0.601	0.572	0.408	0.530	0.415
	SE	0.975	0.979	0.980	0.993	0.917	0.665	0.776
CB	TE	0.430	0.397	0.423	0.464	0.293	0.336	0.440
	PTE	0.771	0.641	0.719	0.818	0.705	0.808	0.818
	SE	0.557	0.619	0.588	0.567	0.416	0.415	0.537

Note: TE: technical efficiency, PTE: pure technical efficiency SE: scale efficiency

Table 4.8 (Continued): DEA Estimates of Efficiency for Domestic and Foreign Banks, 1996-2007

Banks	Efficiency	2003	2004	2005	2006	2007	Mean	Ranking based on mean TE
Large								
AB	TE	0.920	1.000	0.948	0.938	1.000	0.940	1
	PTE	0.922	1.000	0.950	0.960	1.000	0.945	
	SE	0.998	1.000	0.998	0.977	1.000	0.995	
HBTF	TE	0.627	0.723	0.728	0.772	0.734	0.697	4
	PTE	0.793	0.949	0.942	1.000	0.937	0.829	
	SE	0.791	0.762	0.773	0.772	0.784	0.842	
Medium								
JKB	TE	0.552	0.619	0.821	1.000	0.912	0.611	7
	PTE	0.555	0.621	0.833	1.000	0.967	0.619	
	SE	0.995	0.997	0.985	1.000	0.944	0.987	
JIBF	TE	0.281	0.287	0.375	0.398	0.449	0.483	13
	PTE	0.282	0.288	0.377	0.399	0.449	0.485	
	SE	0.997	0.997	0.996	0.998	0.999	0.994	
JNB	TE	0.404	0.368	0.463	0.520	0.498	0.520	12
	PTE	0.406	0.384	0.487	0.563	0.529	0.532	
	SE	0.994	0.957	0.951	0.925	0.942	0.979	
BOJ	TE	0.500	0.544	0.526	0.568	0.492	0.525	11
	PTE	0.503	0.558	0.527	0.569	0.493	0.528	
	SE	0.994	0.975	0.998	0.999	0.998	0.994	
CAB	TE	0.377	0.453	0.638	0.635	0.550	0.473	14
	PTE	0.379	0.456	0.714	0.665	0.591	0.485	
	SE	0.994	0.994	0.893	0.956	0.930	0.977	
UBJ	TE	0.555	0.732	0.860	0.784	0.745	0.581	8
	PTE	0.557	0.778	0.904	0.830	0.768	0.596	
	SE	0.997	0.941	0.951	0.944	0.969	0.976	
CPB	TE	0.907	0.942	1.000	1.000	1.000	0.926	2
	PTE	0.907	0.957	1.000	1.000	1.000	0.970	
	SE	1.000	0.984	1.000	1.000	1.000	0.955	
JIFB	TE	0.652	0.862	0.792	0.954	0.764	0.714	3
	PTE	0.656	0.884	0.832	1.000	0.816	0.742	
	SE	0.995	0.975	0.952	0.954	0.936	0.963	
Small								

Banks	Efficiency	2003	2004	2005	2006	2007	Mean	Ranking based on mean TE
ABC	TE	0.516	0.566	0.663	0.729	0.716	0.573	9
	PTE	0.525	0.571	0.670	0.732	0.723	0.580	
	SE	0.983	0.992	0.990	0.995	0.990	0.988	
JCB	TE	0.667	0.670	0.711	0.650	0.654	0.674	5
	PTE	0.690	0.675	0.719	0.655	0.658	0.684	
	SE	0.967	0.993	0.989	0.992	0.993	0.986	
AJIB	TE	0.508	0.639	0.623	0.716	0.750	0.530	10
	PTE	0.511	0.639	0.633	0.745	0.786	0.539	
	SE	0.993	0.999	0.984	0.961	0.955	0.983	
SGBJ	TE	0.619	0.724	0.621	0.770	0.786	0.665	6
	PTE	0.668	0.754	0.639	0.791	0.802	0.709	
	SE	0.926	0.960	0.972	0.973	0.980	0.938	
Foreign								
HSBC	TE	0.386	0.390	0.406	0.446	0.473	0.444	16
	PTE	0.388	0.391	0.408	0.447	0.476	0.449	
	SE	0.995	0.996	0.996	0.997	0.994	0.990	
BSC	TE	0.384	0.462	0.497	0.483	0.603	0.461	15
	PTE	0.460	0.493	0.530	0.485	0.604	0.507	
	SE	0.833	0.937	0.938	0.996	0.998	0.909	
CB	TE	0.352	0.339	0.153	0.203	0.320	0.331	17
	PTE	0.787	0.883	0.783	0.771	0.694	0.764	
	SE	0.448	0.384	0.196	0.264	0.460	0.433	

Source: Author's calculations.
Note: TE: technical efficiency, PTE: pure technical efficiency SE: scale efficiency

It is of interest to understand how changes in pure technical efficiency (PTE) and scale efficiency (SE) have contributed to the observed temporal changes in technical efficiency. To this end, we make use of the relationship PTE x SE =TE and express the growth rate of technical efficiency as the sum of the growth rate of pure technical efficiency and scale efficiency.

$$\ln\left(TE_{CRS(t)} \big/ TE_{CRS(t-1)} \right) = \ln\left(TE_{VRS(t)} \big/ TE_{VRS(t-1)} \right) + \ln\left(SE_{(t)} \big/ SE_{(t-1)} \right) \qquad (4.7)$$

Presented in Table 4.9 are the estimates of the decomposition of the growth of technical efficiency for the aggregate as well as the broad bank categories, for the sample period plus three sub-periods 1996–1999, 1999–2003, and 2003–2007, which represent the early, middle and latter phases of financial deregulation.

In the early phase of financial deregulation all bank categories except foreign banks show a decline in technical, pure technical and scale efficiencies. This may be because this was a period banks could not cope with the adverse economic situations. However, efficiency improved considerably in the middle and latter phases of financial liberalisation, in all bank categories. The observed efficiency improvements would have been much higher had there not been a decline in scale efficiencies. The banks can improve technical efficiencies by expanding the scale of their operations.

The medium-size banks are the only category that has shown a decline of technical efficiency at the rate of 0.28 % on average over the sample period. As compared to foreign banks, small banks show greater improvements in efficiency, particularly in the latter phase of financial deregulation in Jordan.

It may further be noted that the DEA approach enables us to identify the sources of inefficiencies, or areas with the opportunity to develop efficiency levels, by identifying slacks in output or input vectors for each bank of the sample. Slacks refer to the additional amount by which an output or input can be decreased or increased, respectively, to reach the point of full technical efficiency. This is under the condition that decreased inputs or outputs are in equal proportion in order to reach the production frontier.

The results in Table 4.10 suggest sources of inefficiencies in each bank. For example, the Arab Bank in 1996 would have needed to reduce labour by 10% and increase investments by 123% to reach the efficient point. Its performance improved to become fully efficient by 2007. HBTF in 1996 could have reduced total deposits by 28% and done the same with other investments. In 2007 HBTF appears to be more efficient than in 1996, after a reduction in total deposits and increased deposits in other investments.

The fact that different banks are found to be efficient or inefficient indicates that bank size does not necessarily affect the level of efficiency: that is, banks can be efficient at different sizes. It can be seen that the number of fully efficient banks has increased over the study period of financial reforms; in the year 1996 there were no fully efficient banks, but in 2007 two were fully efficient: the Arab Bank and the Capital Bank.

4.5.3 A comparison with Earlier Studies

Magayrah (2004) investigated the efficiency of eight domestic banks using DEA, covering the period up to 2001. The results show a mean technical efficiency of 91.8%. Bdour and Al–Khouri (2008) evaluated the efficiency of 17 Jordanian banks during the six-year liberalisation period, 1998–2004. Their results show an increase in the efficiency scores of most banks, except a few which showed a decline in 2003 and 2004, possibly due to the Gulf War. The estimates of efficiency are not strictly comparable to those in this study because of differences in sample size, sample period and model specifications; however, a rough comparison does reveal that deregulation and financial liberalisation worked positively and led to improvement in the technical efficiency levels of banks in Jordan.

It should also be noted that not all the studies of banking sectors conducted in other countries support the view that financial deregulation improves efficiency. While the positive effects of deregulation on banking efficiency are observed by Leightner and Lovell (1998), Gilbert and Wilson (1998), and Avkiran (1999) in Asian countries, unexpected (negative) effects were found by Grabowski, Rangan and Rezvanian (1994), and Wheelock and Wilson (1999) in the US banks.

Table 4.9: Average Annual Growth Rates of Efficiency by Sub-group, 1996–2007 (Percentage)

Banks type	Period	Growth of TE	Growth of PTE	Growth of SE
Domestic Banks				
Large Banks				
	1996–99	-2.32	-1.90	-0.38
	1999–03	1.92	2.14	-0.24
	2003–07	1.75	2.15	-0.40
	1996–2007	0.70	1.04	-0.33
Medium Banks				
	1996–99	-2.88	-2.70	0.24
	1999–03	-6.63	-6.65	0.01
	2003–07	8.02	8.83	-0.81
	1996–2007	-0.28	0.05	-0.22
Small Banks				
	1996–99	-2.99	-3.32	0.29
	1999–03	0.47	0.53	-0.05
	2003–07	6.73	6.73	0.01
	1996–2007	1.80	1.73	0.06
Foreign Banks				
	1996–99	2.14	1.85	0.30
	1999–03	-7.54	-4.36	-3.19
	2003–07	7.42	4.03	3.40
	1996–2007	0.54	0.38	0.16
ALL Domestic Banks				
	1996–99	-2.66	-2.42	-0.21
	1999–03	0.29	0.46	-0.18
	2003–07	2.61	3.07	-0.46
	1996–2007	0.33	0.62	-0.29
All Banks				
	1996–99	-2.54	-2.31	-0.20
	1999–03	0.24	0.45	-0.22
	2003–07	2.68	3.05	-0.38
	1996–2007	0.37	0.64	-0.27

Source: author's calculations.
Note: The growth rates of PTE and SE do not add up exactly to the growth rate of TE due to the rounding up errors. TE: Technical Efficiency, PTE: Pure Technical Efficiency and SE: Scale Efficiency.

Table 4.10: Sources of Inefficiency in Input and Output Variables, 1996–2007

Banks	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Large												
AB	Oinvt (123)	Oinvt (97)	Oinvt (65)	Oinvt (80)					Effnt			Effnt
	LBR (-10)											
	Tdept(-17)	LBR (-5)	LBR (-9)	LBR (-15)	LBR (-4)	LBR (-4)	LBR (-1)	LBR (-7)		LBR (-5)	LBR (-6)	
HBTF	Oinvt (31)	Oinvt (10)				TLn (0.5)						
	LBR (-73)	LBR (-71)	LBR (-66)	LBR (-54)	LBR (-57)	LBR (-70)	LBR (-67)	LBR (-64)	LBR (-57)	LBR (-27)	LBR (-23)	LBR (-26)
	Tdept (-28)	Tdept (-31)	Tdept (-30)	Tdept (-36)	Tdept (-39)	Tdept (-26)	Tdept (-28)	Tdept (-37)	Tdept (-28)	Tdept (-27)	Tdept (-23)	Tdept (-26)
Medium												
JKB	Oinvt (181)	Oinvt (6)	Oinvt (13)	Oinvt (7)		Oinvt (3)	Oinvt (9)	Oinvt (32)	Oinvt (29)	Oinvt (9)	Effnt	
	LBR (-78)	LBR (-78)	LBR (-75)	LBR (-73)	LBR (-59)	LBR (-61)	LBR (-60)	LBR (-53)	LBR (-42)	LBR (-17)		LBR (-8)
	Tdept (-41)	Tdept (-41)	Tdept (-48)	Tdept (-51)	Tdept (-54)	Tdept (-48)	Tdept (-48)	Tdept (-45)	Tdept (-38)	Tdept (-17)		Tdept (-8)
JIBF	Oinvt (377)	Oinvt (377)	Oinvt (68)	Oinvt (6)							Oinvt (11)	Oinvt (18)
	LBR (-64)	LBR (-65)	LBR (-69)	LBR (-72)	LBR (-77)	LBR (-32)	LBR (-79)	LBR (-80)	LBR (-78	LBR (-68)	LBR (-70)	LBR (-68)
	Tdept (-14)	Tdept (-16)	Tdept (-27)	Tdept (-27)	Tdept (-50)	Tdept (-53)	Tdept (-68)	Tdept (-72)	Tdept (-71)	Tdept (-62)	Tdept (-60)	Tdept (-55)
JNB	Oinvt (34)		Oinvt (27)	Oinvt (28)								
	LBR (-82)	LBR (-73)	LBR (-70)	LBR (-70)	LBR (-64)	LBR (-63)	LBR (-64)	LBR (-59)	LBR (-63)	LBR (-58)	LBR (-56)	LBR (-50)
	Tdept (-25)	Tdept (-36)	Tdept (-22)	Tdept (-31)	Tdept (-51)	Tdept (-55)	Tdept (-60)	Tdept (-59)	Tdept (-63)	Tdept (-53)	Tdept (-48)	Tdept (-50)
BOJ	Oinvt (60)	Oinvt (54)		Oinvt (15)	Oinvt (62)	Oinvt (43)				Oinvt (1)	Oinvt (25)	
	LBR (-82)	LBR (-84)	LBR (-82)	LBR (-82)	LBR (-80)	LBR (-79)	LBR (-75)	LBR (-71)	LBR (-67)	LBR (-67)	LBR (-63)	LBR (-55)
	Tdept (-38)	Tdept (-52)	Tdept (-43)	Tdept (-44)	Tdept (-52)	Tdept (-49)	Tdept (-51)	Tdept (-50)	Tdept (-45)	Tdept (-47)	Tdept (-43)	Tdept (-51)
CAB	Oinvt (50)	Oinvt (18)	Oinvt (14)	Oinvt (13)		Oinvt (568)		Oinvt (10)				
	LBR (-82)	LBR (-81)	LBR (-81)	LBR (-80)	LBR (-78)	LBR (-80)	LBR (-75)	LBR (-82)	LBR (-77)	LBR (-64)	LBR (-64)	LBR (-56)
	Tdept (-48)	Tdept (-59)	Tdept (-50)	Tdept (-56)	Tdept (-58)	Tdept (-60)	Tdept (-56)	Tdept (-62)	Tdept (-55)	Tdept (-36)	Tdept (-36)	Tdept (-45)
UBJ					Oinvt (7)							
	LBR (-73)	LBR (-69)	LBR (-75)	LBR (-72)	LBR (-68)	LBR (-59)	LBR (-44)	LBR (-44)	LBR (-34)	LBR (-14)	LBR (-21)	LBR (-25)
	Tdept (-50)	Tdept (-45)	Tdept (-54)	Tdept (-56)	Tdept (-55)	Tdept (-48)	Tdept (-44)	Tdept (-44)	Tdept (-27)	Tdept (-4)	Tdept (-21)	Tdept (-25)

Banks	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
CPB		Oinvt (95)	Effnt	Oinvt (10)			Effnt	LBR (-9)		Effnt	Effnt	Effnt
	LBR (-68)	LBR (-43)		LBR (-1)	LBR (-2)	LBR (-6)		Tdept (-9)	LBR (-5)			
	Tdept (-14)	Tdept (-39)		Tdept (-1)	Tdept (-2)	Tdept (-6)			Tdept (-5)			
JIFB				Tln (22)		TLn (53)	TLn (41)	TLn (52)	TLn (83)	TLn (27)	TLn (25)	
	LBR (-41)	LBR (-47)	LBR (-38)	LBR (-36)	LBR (-49)	LBR (-4)	LBR (-25)	LBR (-39)	LBR (-30)	LBR (-23)	LBR (-13)	LBR (-23)
	Tdept (-41)	Tdept (-47)	Tdept (-38)	Tdept (-25)	Tdept (-49)	Tdept (-4)	Tdept (-21)	Tdept (-35)	Tdept (-14)	Tdept (-20)	Tdept (-4)	Tdept (-23)
Small												
ABC	Oinvt (195)	Oinvt (140)	Oinvt (81)	Oinvt (49)				Oinvt (22)		Oinvt (34)		
	LBR (-68)	LBR (-67)	LBR (-66)	LBR (-68)	LBR (-64)	LBR (-58)	LBR (-58)	LBR (-65)	LBR (-56)	LBR (-44)	LBR (-31)	LBR (-28)
	Tdept (-39)	Tdept (-43)	Tdept (-46)	Tdept (-50)	Tdept (-52)	Tdept (-49)	Tdept (-47)	Tdept (-48)	Tdept (-43)	Tdept (-34)	Tdept (-27)	Tdept (-28)
JCB	Oinvt (178)	Oinvt (167)	Oinvt (540)	Oinvt (618)	Oinvt (799)	Oinvt (104)	Oinvt (403)	Oinvt (173)		Oinvt (6)	Oinvt (28)	Oinvt (1)
	LBR (-85)	LBR (-84)	LBR (-78)	LBR (-75)	LBR (-63)	LBR (-63)	LBR (-80)	LBR (-81)	LBR (-75)	LBR (-61)	LBR (-52)	LBR (-51)
	Tdept (-27)	Tdept (-32)	Tdept (-31)	Tdept (-34)	Tdept (-26)	Tdept (-25)	Tdept (-48)	Tdept (-33)	Tdept (-33)	Tdept (-29)	Tdept (-35)	Tdept (-35)
AJIB	Oinvt (19)	Oinvt (11)			TLn (29)	TLn (27)	TLn (82)	TLn (35)	Tln (2)	TLn (19)	TLn (8)	
	LBR (-78)	LBR (-79)	LBR (-68)	LBR (-64)	LBR (-72)	LBR (-75)	LBR (-66)	LBR (-73)	LBR (-67)	LBR (-63)	LBR (-59)	LBR (-42)
	Tdept (-65)	Tdept (-69)	Tdept (-60)	Tdept (-56)	Tdept (-35)	Tdept (-46)	Tdept (-33)	Tdept (-49)	Tdept (-36)	Tdept (-38)	Tdept (-28)	Tdept (-25)
SGBJ	Oinvt (200)	Oinvt (120)	Oinvt (55)	Oinvt (68)	Oinvt (67)	Oinvt (78)	Oinvt (528)	Oinvt (23)	Oinvt (789)	Oinvt (677)	Oinvt (3663)	Oinvt (208)
	LBR (-83)	LBR (-85)	LBR (-87)	LBR (-88)	LBR (-72)	LBR (-87)	LBR (-83)	LBR (-83)	LBR (-70)	LBR (-61)	LBR (-60)	LBR (-56)
	Tdept (-18)	Tdept (-29)	Tdept (-23)	Tdept (-44)	Tdept (-57)	Tdept (-38)	Tdept (-0.35)	Tdept (-38)	Tdept (-27)	Tdept (-38)	Tdept (-137)	Tdept (-21)
Foreign												
HSBC	Oinvt (9)	Oinvt (561)	Oinvt (420)	Oinvt (191)	Oinvt (80)	Oinvt (112)	Oinvt (122)	Oinvt (327)	Oinvt (549)	Oinvt (278)	Oinvt (235)	Oinvt (338)
	LBR (-48)	LBR (-40)	LBR (-43)	LBR (-53)	LBR (-59)	LBR (-63)	LBR (-63)	LBR (-61)	LBR (-60)	LBR (-60)	LBR (-55)	LBR (-52)
	Tdept (-49)	Tdept (-35)	Tdept (-44)	Tdept (-53)	Tdept (-59)	Tdept (-63)	Tdept (-63)	Tdept (-61)	Tdept (-61)	Tdept (-60)	Tdept (-55)	Tdept (-52)
BSC	Oinvt (70)	Oinvt (55)	Oinvt (13)				Oinvt (36)	Oinvt (138)	Oinvt (42)	Oinvt (249)	Oinvt (307)	Oinvt (140)
	LBR (-61)	LBR (-53)	LBR (-43)	LBR (-42)	LBR (-62)	LBR (-63)	LBR (-67)	LBR (-61)	LBR (-53)	LBR (-49)	LBR (-52)	LBR (-39)
	Tdept (-54)	Tdept (-45)	Tdept (-41)	Tdept (-43)	Tdept (-62)	Tdept (-64)	Tdept (-59)	Tdept (-61)	Tdept (-55)	Tdept (-50)	Tdept (-52)	Tdept (-39)
CB	Oinvt (32)	Oinvt (279)	Oinvt (51)	Oinvt (89)	Oinvt (26)		Oinvt (98)	Oinvt (105)	Oinvt (101)			Oinvt (18)
	LBR (-55)	LBR (-59)	LBR (-57)	LBR (-53)	LBR (-70)	LBR (-66)	LBR (-55)	LBR (-64)	LBR (-64)	LBR (-84)	LBR (-78)	LBR (-67)

Banks	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
	Tdept (-57)	Tdept (-60)	Tdept (-57)	Tdept (-53)	Tdept (-70)	Tdept (-66)	Tdept (-56)	Tdept (-64)	Tdept (-66)	Tdept (-84)	Tdept (-79)	Tdept (-68)

Source: author's calculations.

Note: LBR: Labour, Tdept: Total Deposit, Oinvt: Other Investment, TLn: Total Loan Effnt: Fully Efficient banks. The numbers in parentheses are percentage potential improvement: -ve for input contraction and +ve for output expansion.

4.6 Conclusions

This chapter has used DEA to examine technical efficiency in domestic and foreign banks in Jordan during the entire deregulated period of 1996 to 2007. The results were obtained by running an input-oriented DEA model to construct a grand frontier that envelops all the input-output observations for all banks. In addition, estimates of technical efficiency were divided into the product of pure technical efficiency and scale efficiency. To the best of our knowledge, this is the first study that provides estimates for both domestic and foreign banks over the entire deregulated period in Jordan.

The empirical results reveal several interesting points. The average technical efficiency for all banks is found to be 79.2%. This implies that inputs can be reduced by 20.8% on average, relative to the best-practice banks during the sample period. The Arab bank, one of the large banks, performed at the highest level of technical efficiency (90%) during the sample period. Small banks were found to be more efficient than medium sized banks, and foreign banks showed the lowest technical efficiency, indicating a large scope for cost reduction.

The study reveals that only one bank, on average, was operating at MPSS exceptions throughout the full time of the study. During 1997, 2001, 2002, 2004, 2006 and 2007, two banks operated at MPSS; in 2000 no bank did so. The number of banks operating at IRS declined from 15 in 1996 to six banks in 2007, and most of the large banks operated at DRS over the entire period. This indicates that large banks can reduce the size of their operations to achieve efficiency improvements. On the other hand, most small-sized banks operated at IRS over the sample period, indicating that they should increase the size of their operations to reach optimal scale efficiency.

The study reveals that banks can be efficient at different sizes. This result is consistent with banking studies conducted elsewhere (see, for example, Kourouche (2008); Maghyereh (2004); Berg et al. (1991) for Australian, Jordanian, and Norwegian Banks, respectively).

The banking sector as a whole has shown improvements in technical efficiency at an average rate of 0.37% per year over the study period. This seems to be due to substantial improvements in pure technical efficiency (0.64% per year). The improvement in technical efficiency would have been higher had there been no decline in scale efficiencies.

This DEA analysis also provides insights into the input-output inefficiencies experienced by Jordanian banks during the sample period. The results suggest that number of staff and total deposits are the most common sources of inefficiency. Banks need to use deposits better and reduce staff to enhance efficiency.

The analysis of technical efficiency conducted in this chapter is based on two assumptions: first that there are no allocative inefficiencies in the banking sector, and second that the frontier remains the same throughout the sample period. The first assumption was guided by the international literature, which suggested that allocative inefficiency is negligible over a short sample period. This assumption is dropped in the next chapter, which focuses on overall (cost) efficiency, which is the product of technical and allocative efficiencies. The assumption of the same frontier over the sample period enables a comparison of the estimates of technical efficiencies across times and banks.

CHAPTER 5

Cost Efficiency in the Jordanian Banking Sector

5.1. Introduction

The previous chapter investigated the technical efficiency of banks using DEA, assuming the absence of allocative efficiency. This chapter makes use of input prices, which permit an investigation of cost efficiency and its decomposition into allocative efficiency and technical efficiency. The empirical results for cost efficiency are obtained by running an input-oriented DEA model, using the software package DEAP Version 2.1 (Coelli, 1996).

A discussion of the concept of cost efficiency and its decomposition and estimation using input oriented DEA model appears in Section 5.2. Data on two inputs and two outputs for measuring technical efficiency in the previous chapter are used. Measuring cost efficiency requires additional data on input prices. Section 5.3 discusses these data and presents a detailed analysis of cost efficiency for 17 Jordanian banks for the period 1996–2007. Section 5.4 summarises and brings together the conclusions.

5.2 Cost Efficiency: Concept and Measurement

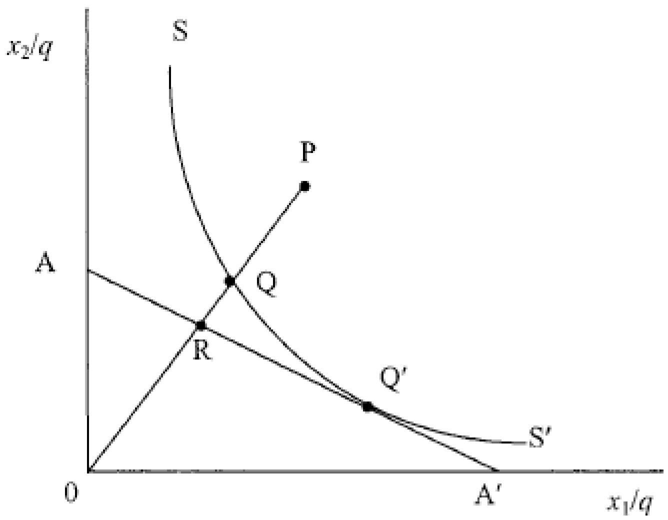
The previous chapter recorded the measurement and analysis of technical efficiency (TE) and its components, PTE and SE, for the banking sector in Jordan by running an input-oriented DEA model. The technical efficiency of a production unit is defined by the relationship between the optimal and observed levels of inputs and outputs. In the input-oriented DEA model, as shown in previous chapter, the existence of technical inefficiency means that some inputs can be reduced without affecting the level of output. It was implicitly assumed in that chapter that the bank, given input prices, allocates resources in such a way that costs of production are minimised. This assumption may not hold. If input prices are taken into account, results for the other important efficiency concept can be obtained. This concept is cost efficiency (CE), which may be reached when the banks find a combination of inputs that enables them to produce the desired outputs at minimum cost. CE is the product of technical and allocative efficiencies. Allocative efficiency (AE) refers to the selection of inputs to produce a certain level of outputs at a certain level of input prices, where the cost of production is minimum (Al-Ani & Al-Delaimi, 2006). CE is defined as the ratio of minimum (optimum) cost to the observed cost for producing a level of output by a firm. Thus, if the cost efficiency score for a firm is 0.75, the firm is using only 75% of its resources efficiently: in other words, the firm wastes 25% of its costs relative to the best-practice firm (Berger & Mester, 1997).

Figure 5.1, reproduced from Coelli et al. (2005, p.52), explains how cost efficiency can be conceptualised and measured using input-oriented measures.[15] The working of this is explained by Farrell (1957), who used a simple example of a firm requiring two inputs x_1 and x_2 for producing one output *q*, assuming constant return to scale. Let **w** refer to input price vector and **x** to the observed vector of inputs used associated with point *P;* and let $\hat{x}$ and x^* refer to the input vectors associated with the technically efficient point Q and the cost minimising input vector at Q' respectively. Thus, cost efficiency can be defined as the ratio of input costs associated with input vectors **x** and x^* associated with points P and Q':

$$CE = \frac{w'x^*}{w'x} = OR/OP. \qquad (5.1)$$

[15] Coelli et al. (2005) discussed input-oriented and output-oriented measures, for more details see pp.51-57.

Figure 5.1: Cost, Technical and Allocative Efficiencies



Source: Coelli et al. (2005)

As shown in Figure 5.1, the slope of the isocost line AA' represents the proportion of input prices. AE and TE can be calculated as follows:

$$AE = \frac{\mathrm{w}'\mathrm{x}^*}{\mathrm{w}'\hat{\mathrm{x}}} = \frac{OR}{OQ} \tag{5.2}$$

$$TE = \frac{\mathrm{w}'\hat{\mathrm{x}}}{\mathrm{w}'\mathrm{x}} = \frac{OQ}{OP} \tag{5.3}$$

Thus, if the firm sets its inputs at the point Q on the isoquant curve SS', then it can be said that this firm is technically efficient but allocatively inefficient. If the firm wishes to be technically and allocatively efficient it should reduce the production cost represented by the distance RQ, which would occur at the allocatively (and technically) efficient point Q', instead of at the technically efficient but allocatively inefficient point Q.

It follows from this that cost efficiency can be expressed as the product of technical and allocative efficiency measures:

$$TE \times AE = (OQ / OP) \times (OR / OQ) = (OR / OP) = CE. \tag{5.4}$$

DEA efficiency scores assign numerical values (between 0 and 1 or 0 and 100%) to the cost efficiency level of a DMU relative to others. Cost efficiency (CE) of one represents a fully cost efficient bank; (1-CE) represents the amount by which the bank could reduce its costs and still produce at least the same amount of output.

To measure CE, two sets of linear programs are required, one to measure technical efficiency and the other to measure cost efficiency. The cost efficiency is also often called economic efficiency. A discussion on required linear programming is provided in Coelli et al. (2005, p.184).

5.3 The Data and Estimates of DEA-based Cost Efficiency of Banks

5.3.1 The Data

The estimation of cost efficiency requires data not only on real values of inputs and outputs but also on input prices. The input and output variables used in this chapter are the same as we used in the previous chapter.

The input prices for each bank for each year are calculated as follows:

> Price of funds = total interest expenses divided by total deposits.
> Price of labour = total staff salaries and other and benefits divided by total number of workers.

The input and output variables are listed in Table 5.1.

Table 5.1: Variable Definitions Banks' Input prices and Outputs for Jordan

Variables	Description
Outputs	
Total loan: y_1	Total customers' loan.
Other investments: y_2	Investments in bonds and securities, shares, treasury bills, and investment in affiliate and subsidiary companies.
Inputs	
Labour: x_1	Number of employee.
Total Deposit: x_2	Total customers deposit.
Input Prices	
Price of labour: P_L	Wages and personal expenses and benefit of the banks staff divided by number of staff.
Price of fund: P_F	Interest expense divided by total deposits.

A summary of statistics on the input prices for different categories of banks is presented in Table 5.2. The table shows that there are large variations in labour prices across bank categories, although the variations in fund price are not large.

Table 5.2: Summary Statistics for the Variables for the Jordanian Banks 1996–2007

(Values in Jordanian Dinar at constant 2000 prices using GDP Deflator)

Variable	Number of Banks	Mean	SD	Min	Max
All Banks					
Price of Labour	17	14369	11081	4526	63685
Price of Fund	17	0.0414	0.0193	0.0053	0.0888
Large Banks					
Price of Labour	2	32557	21368	5519	63685
Price of Fund	2	0.0384	0.0152	0.0120	0.0589
Medium Banks					
Price of Labour	8	10573	4331	4849	24493
Price of Fund	8	0.0430	0.0198	0.0118	0.0860
Small Banks					
Price of Labour	4	10184	3652	4526	25304
Price of Fund	4	0.0478	0.0193	0.0165	0.0888
ALL Domestic Banks					
Price of Labour	14	13602	11729	4526	63685
Price of Fund	14	0.0437	0.0192	0.0118	0.0888
Foreign Banks					
Price of Labour	3	17945	6305	9213	39297
Price of Fund	3	0.0309	0.0164	0.0053	0.0562

Source: data collected by author from individual banks' Annual Reports.
Note: SD: standard deviation, Min: minimum and Max: maximum.

5.3.2. Empirical Results on Cost Efficiency

The estimates of cost efficiency are obtained by running an input-oriented DEA model using the software package, DEAP Version 2.1 (Coelli, 1996).

Summary statistics on efficiency scores are presented in Table 5.3. The average efficiency scores are the weighted geometric means of bank-specific scores where weights are their shares in total output. The procedure is the same that used in the previous chapter. The table reveals that the average cost efficiency scores vary from 48.7% in 2003 to 66.5% in 2007; this suggests that the average bank in the sample could have reduced its costs by approximately 33% to 51%, to achieve 'best practice' performance. Similarly, the minimal cost efficiency scores range from 23.8% in 1998 to 40.8% in 2007.

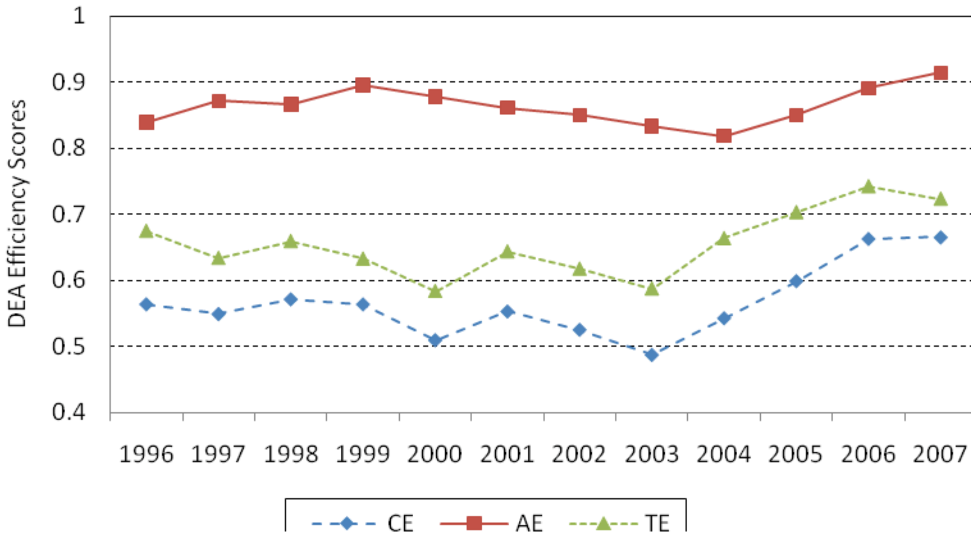
The yearly average cost efficiency scores are plotted in Figure 6.2. The average cost efficiency shows a declining trend with some fluctuations up to 2003 and an improvement thereafter. This implies that the latter phase of financial deregulation has had a positive effect on the cost efficiency of banks in Jordan.

Table 5.3: Yearly DEA Estimates of Cost, Allocative and Technical Efficiency 1996–2007

	Cost Efficiency				Allocative Efficiency				Technical Efficiency			
Year	Max	Min	Mean	SD	Max	Min	Mean	SD	Max	Min	Mean	SD
1996	1.000	0.260	0.564	0.179	1.000	0.421	0.839	0.141	1.000	0.365	0.675	0.174
1997	0.861	0.307	0.549	0.135	0.985	0.698	0.871	0.074	0.946	0.325	0.634	0.159
1998	1.000	0.238	0.572	0.176	1.000	0.419	0.866	0.144	1.000	0.397	0.659	0.162
1999	1.000	0.373	0.564	0.159	1.000	0.620	0.895	0.098	1.000	0.433	0.633	0.164
2000	0.927	0.343	0.509	0.171	0.993	0.518	0.878	0.115	1.000	0.408	0.584	0.184
2001	0.964	0.332	0.553	0.207	0.994	0.540	0.861	0.121	1.000	0.377	0.644	0.213
2002	1.000	0.249	0.525	0.215	1.000	0.571	0.850	0.122	1.000	0.325	0.617	0.219
2003	0.893	0.246	0.487	0.179	0.990	0.575	0.833	0.134	0.922	0.282	0.588	0.187
2004	1.000	0.265	0.543	0.224	1.000	0.583	0.818	0.159	1.000	0.288	0.664	0.222
2005	0.995	0.335	0.599	0.216	0.997	0.489	0.850	0.151	1.000	0.377	0.703	0.193
2006	1.000	0.369	0.663	0.225	1.000	0.519	0.891	0.131	1.000	0.399	0.742	0.205
2007	1.000	0.408	0.665	0.202	1.000	0.632	0.914	0.099	1.000	0.449	0.723	0.184

Source: author's calculations.

Figure 5.2 Average Efficiency Over Time for DEA Model (1996–2007)



Source: Author's calculations.

Table 5.4 presents the sample period mean estimates of cost, allocative and technical efficiencies for the banking sector as a whole as well as for different bank categories.

Table 5.4: Mean DEA Estimates of Cost, Allocative and Technical Efficiency by Category, 1996–2007

Bank type	CE	AE	TE
Large	0.863	0.927	0.930
Medium	0.495	0.848	0.584
Small	0.528	0.858	0.616
Foreign Banks	0.460	0.904	0.508
All Domestic Banks	0.749	0.905	0.823
All Banks	0.737	0.906	0.814

Source: author's calculations.

The average cost efficiency of banks is 0.74, which implies that the banking sector could reduce the cost of production by 26 percent without affecting the level of output. This implies that banks have wasted 26 percent of resources in producing their levels of output. The allocative efficiency is quite high (90%), consistent with the estimates of allocative efficiency reported in studies on banking in other countries.

The large banks were found to be most efficient in terms of cost efficiency (86%), allocative efficiency (92.7%) and technical efficiency (93%) during the sample period. The small banks ranked second in terms of their efficiency level. The cost efficiency of foreign banks was much lower than that of domestic banks.

The average estimates of CE, AE and TE (weighted geometric mean over the period) for individual banks are presented in Table 5.5. These estimates reveal that the medium-sized bank CPB ranked first in terms of all three efficiencies; the Arab Bank, the largest bank, ranked second and JIFB (a medium-sized bank) third. The medium-sized banks CAB and BOS were found to be the lowest performers in cost efficiency. It is worth noting that medium-sized banks showed wide variations in efficiency, while the foreign banks seemed very similar in terms of their cost/ economic efficiency performance.

The time series estimates of the cost efficiency of different bank categories are presented in Table 5.6 and displayed in Figures 5.4 through 5.9. It follows from this table and figures that in terms of CE and TE, domestic firms performed better than foreign banks in each year over the sample period. The gap in their efficiency levels has widened, especially from 2000 onwards. However, in terms of allocative efficiency, there is hardly any significant difference in the performance of banks. The group of large banks has outperformed all other bank categories in terms of cost efficiency in almost all the sample years.

Table 5.5: Mean DEA Estimates of Cost, Allocative and Technical Efficiencies, 1996–2007

Banks	CE	AE	TE
Domestic Banks			
Large			
AB	0.896	0.948	0.945
HBTF	0.664	0.802	0.829
Medium			
JKB	0.579	0.937	0.618
JIBF	0.401	0.826	0.485
JNB	0.460	0.865	0.532
BOJ	0.377	0.714	0.528
CAB	0.362	0.747	0.485
UBJ	0.567	0.952	0.596
CPB	0.942	0.971	0.970
JIFB	0.717	0.967	0.742
Small			
ABC	0.523	0.902	0.580
JCB	0.545	0.797	0.684

AJIB	0.481	0.894	0.539
SGBJ	0.561	0.791	0.709
Foreign			
HSBC	0.440	0.981	0.449
BSC	0.480	0.947	0.507
CB	0.449	0.588	0.764

Source: author's calculations.
Note: CE: cost efficiency, AE: allocative efficiency, TE: technical efficiency

Table 5.6: DEA Estimates of Cost Efficiency by Category of Banks and ownership, 1996–2007

Banks	Efficiency	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Mean
Domestic Banks														
Large														
	CE	0.798	0.824	0.811	0.778	0.828	0.864	0.918	0.830	0.938	0.900	0.920	0.965	0.863
	AE	0.906	0.907	0.918	0.934	0.894	0.901	0.936	0.915	0.944	0.949	0.951	0.976	0.927
	TE	0.882	0.908	0.885	0.833	0.927	0.959	0.981	0.907	0.993	0.949	0.967	0.989	0.930
Medium														
	CE	0.502	0.513	0.502	0.526	0.433	0.469	0.416	0.400	0.433	0.552	0.639	0.620	0.495
	AE	0.745	0.857	0.780	0.858	0.873	0.881	0.854	0.851	0.818	0.848	0.897	0.926	0.848
	TE	0.674	0.599	0.643	0.614	0.496	0.532	0.488	0.470	0.529	0.651	0.712	0.669	0.584
Small														
	CE	0.512	0.477	0.507	0.491	0.577	0.553	0.493	0.439	0.473	0.550	0.650	0.667	0.528
	AE	0.849	0.865	0.882	0.899	0.910	0.892	0.839	0.788	0.746	0.821	0.908	0.913	0.858
	TE	0.603	0.551	0.575	0.546	0.634	0.620	0.587	0.558	0.634	0.670	0.716	0.730	0.616

Banks	Efficiency	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Mean
Foreign Banks														
	CE	0.485	0.571	0.561	0.521	0.390	0.392	0.386	0.409	0.435	0.444	0.458	0.517	0.460
	AE	0.920	0.934	0.936	0.935	0.886	0.804	0.851	0.873	0.907	0.931	0.947	0.939	0.904
	TE	0.527	0.612	0.599	0.557	0.440	0.487	0.454	0.468	0.480	0.477	0.484	0.550	0.508
All Domestic Banks														
	CE	0.709	0.727	0.713	0.696	0.714	0.744	0.760	0.695	0.774	0.772	0.815	0.841	0.749
	AE	0.866	0.894	0.882	0.914	0.890	0.896	0.915	0.897	0.907	0.915	0.933	0.959	0.905
	TE	0.819	0.813	0.808	0.761	0.802	0.830	0.831	0.775	0.853	0.844	0.873	0.876	0.823
ALL Banks														
	CE	0.700	0.721	0.707	0.689	0.704	0.736	0.750	0.687	0.765	0.764	0.805	0.831	0.737
	AE	0.868	0.896	0.884	0.915	0.890	0.895	0.913	0.896	0.907	0.915	0.933	0.958	0.906
	TE	0.807	0.805	0.800	0.753	0.791	0.822	0.822	0.767	0.843	0.835	0.863	0.867	0.814

Source: author's calculations.
Notes*:* CE: cost efficiency; AE; allocative efficiency; TE: technical efficiency. The cost efficiency estimates for each bank category are the weighted average means of bank specific efficiencies, where the weights are their shares in the aggregate output of the bank category they belong to. The weights vary from year to year.

The annual estimates of cost efficiency scores and the components for each bank, presented in Table 5.7, show yearly fluctuations in cost efficiency over the deregulation era from 1996 until 2007. Despite annual fluctuations, most estimates of cost efficiency reveal an improvement after 2003, revealing that banking deregulation had a positive impact on efficiency in the latter phase of deregulation.

Table 5.7: DEA Estimates of Cost Efficiency for Domestic and Foreign Banks, 1996–2007

Bank	Cost Efficiency	1996	1997	1998	1999	2000	2001	2002
Large								
AB	CE	0.827	0.861	0.840	0.799	0.854	0.878	0.953
	AE	0.910	0.910	0.923	0.939	0.896	0.914	0.964
	TE	0.909	0.946	0.911	0.851	0.953	0.960	0.989
HBTF	CE	0.637	0.608	0.637	0.641	0.625	0.758	0.662
	AE	0.879	0.888	0.882	0.902	0.872	0.799	0.727
	TE	0.725	0.684	0.723	0.711	0.717	0.948	0.911
Medium								
JKB	CE	0.522	0.530	0.474	0.446	0.437	0.491	0.488
	AE	0.877	0.883	0.900	0.909	0.944	0.952	0.935
	TE	0.595	0.600	0.526	0.491	0.463	0.516	0.522
JIBF	CE	0.712	0.684	0.595	0.564	0.371	0.350	0.249
	AE	0.827	0.816	0.809	0.775	0.731	0.715	0.765
	TE	0.861	0.838	0.736	0.728	0.508	0.489	0.325
JNB	CE	0.563	0.558	0.681	0.602	0.458	0.428	0.359
	AE	0.753	0.883	0.868	0.871	0.943	0.952	0.889
	TE	0.748	0.632	0.784	0.691	0.486	0.450	0.404
BOJ	CE	0.260	0.392	0.238	0.461	0.394	0.399	0.385
	AE	0.421	0.819	0.419	0.816	0.818	0.785	0.786
	TE	0.617	0.479	0.568	0.566	0.482	0.508	0.490
CAB	CE	0.428	0.359	0.422	0.373	0.343	0.332	0.319
	AE	0.822	0.864	0.838	0.851	0.821	0.836	0.728
	TE	0.521	0.415	0.503	0.438	0.417	0.397	0.439

Bank	Cost Efficiency	1996	1997	1998	1999	2000	2001	2002
UBJ	CE	0.460	0.503	0.444	0.438	0.439	0.516	0.534
	AE	0.930	0.918	0.940	0.967	0.961	0.975	0.941
	TE	0.495	0.547	0.472	0.453	0.457	0.530	0.568
CPB	CE	1.000	0.697	1.000	1.000	0.927	0.927	1.000
	AE	1.000	0.809	1.000	1.000	0.927	0.994	1.000
	TE	1.000	0.862	1.000	1.000	1.000	0.932	1.000
JIFB	CE	0.532	0.513	0.613	0.735	0.517	0.964	0.800
	AE	0.830	0.913	0.997	0.991	0.965	0.964	0.999
	TE	0.641	0.561	0.615	0.741	0.535	1.000	0.801
Small								
ABC	CE	0.572	0.538	0.514	0.477	0.475	0.481	0.474
	AE	0.917	0.927	0.927	0.929	0.974	0.941	0.896
	TE	0.624	0.580	0.555	0.513	0.487	0.511	0.530
JCB	CE	0.557	0.534	0.577	0.573	0.663	0.657	0.422
	AE	0.756	0.768	0.820	0.853	0.883	0.872	0.796
	TE	0.737	0.695	0.703	0.671	0.751	0.754	0.531
AJIB	CE	0.334	0.307	0.373	0.407	0.595	0.485	0.576
	AE	0.917	0.944	0.939	0.939	0.906	0.895	0.849
	TE	0.365	0.325	0.397	0.433	0.657	0.542	0.679
SGBJ	CE	0.725	0.628	0.681	0.526	0.409	0.527	0.505
	AE	0.835	0.826	0.823	0.860	0.844	0.766	0.716
	TE	0.869	0.760	0.828	0.611	0.484	0.688	0.706
Foreign								
HSBC	CE	0.510	0.641	0.563	0.466	0.411	0.366	0.357
	AE	0.995	0.985	0.995	0.999	0.993	0.971	0.974
	TE	0.513	0.651	0.566	0.466	0.414	0.377	0.367
BSC	CE	0.453	0.536	0.588	0.571	0.378	0.407	0.381
	AE	0.952	0.961	0.978	0.998	0.924	0.769	0.918
	TE	0.476	0.557	0.601	0.572	0.408	0.530	0.415
CB	CE	0.495	0.447	0.476	0.507	0.365	0.436	0.467
	AE	0.642	0.698	0.662	0.620	0.518	0.540	0.571
	TE	0.771	0.641	0.719	0.818	0.705	0.808	0.818

Note: CE: Cost Efficiency; AE: allocative efficiency ;TE: technical efficiency

Table 5.7 (Continued): DEA Estimates of Cost Efficiency for Domestic and Foreign Banks, 1996–2007

Bank	Cost Efficiency	2003	2004	2005	2006	2007	Mean
Large							
AB	CE	0.877	1.000	0.947	0.942	1.000	0.896
	AE	0.951	1.000	0.997	0.981	1.000	0.948
	TE	0.922	1.000	0.950	0.960	1.000	0.945
HBTF	CE	0.527	0.603	0.693	0.826	0.815	0.664
	AE	0.665	0.636	0.736	0.826	0.870	0.802
	TE	0.793	0.949	0.942	1.000	0.937	0.829
Medium							
JKB	CE	0.519	0.592	0.826	1.000	0.912	0.579
	AE	0.936	0.953	0.992	1.000	0.967	0.937
	TE	0.555	0.621	0.833	1.000	0.944	0.618
JIBF	CE	0.246	0.265	0.335	0.369	0.408	0.401
	AE	0.874	0.922	0.888	0.924	0.907	0.826
	TE	0.282	0.288	0.377	0.399	0.449	0.485
JNB	CE	0.361	0.329	0.387	0.451	0.477	0.460
	AE	0.888	0.856	0.795	0.801	0.901	0.865
	TE	0.406	0.384	0.487	0.563	0.529	0.532
BOJ	CE	0.359	0.353	0.418	0.494	0.464	0.377
	AE	0.714	0.633	0.792	0.869	0.941	0.714
	TE	0.503	0.558	0.527	0.569	0.493	0.528
CAB	CE	0.261	0.266	0.422	0.454	0.438	0.362
	AE	0.689	0.583	0.590	0.683	0.741	0.747
	TE	0.379	0.456	0.714	0.665	0.591	0.485
UBJ	CE	0.526	0.710	0.859	0.828	0.765	0.567
	AE	0.945	0.913	0.950	0.998	0.995	0.952
	TE	0.557	0.778	0.904	0.830	0.768	0.596
CPB	CE	0.893	0.947	0.995	0.974	1.000	0.942
	AE	0.985	0.989	0.995	0.974	1.000	0.971
	TE	0.907	0.957	1.000	1.000	1.000	0.970
JIFB	CE	0.649	0.861	0.828	1.000	0.814	0.717
	AE	0.990	0.974	0.995	1.000	0.998	0.967
	TE	0.656	0.884	0.832	1.000	0.816	0.742

Bank	Cost Efficiency	2003	2004	2005	2006	2007	Mean
Small							
ABC	CE	0.430	0.472	0.583	0.664	0.650	0.523
	AE	0.819	0.828	0.870	0.906	0.899	0.902
	TE	0.525	0.571	0.670	0.732	0.723	0.580
JCB	CE	0.482	0.396	0.531	0.608	0.617	0.545
	AE	0.699	0.586	0.739	0.928	0.937	0.797
	TE	0.690	0.675	0.719	0.655	0.658	0.684
AJIB	CE	0.423	0.512	0.555	0.684	0.725	0.481
	AE	0.828	0.802	0.877	0.918	0.923	0.894
	TE	0.511	0.639	0.633	0.745	0.786	0.539
SGBJ	CE	0.465	0.511	0.505	0.649	0.696	0.561
	AE	0.696	0.677	0.790	0.820	0.868	0.791
	TE	0.668	0.754	0.639	0.791	0.802	0.709
Foreign							
HSBC	CE	0.384	0.369	0.398	0.446	0.458	0.440
	AE	0.988	0.943	0.976	0.997	0.961	0.981
	TE	0.388	0.391	0.408	0.447	0.476	0.449
BSC	CE	0.426	0.487	0.520	0.485	0.602	0.480
	AE	0.925	0.989	0.982	1.000	0.996	0.947
	TE	0.460	0.493	0.530	0.485	0.604	0.507
CB	CE	0.453	0.556	0.383	0.400	0.439	0.449
	AE	0.575	0.630	0.489	0.519	0.632	0.588
	TE	0.787	0.883	0.783	0.771	0.694	0.764

Source*:* author's calculations.
Note: TE: technical efficiency; PTE: pure technical efficiency; SE: scale efficiency.

To understand how efficiency has changed over the sub-periods of financial reforms and how changes in allocative and technical efficiencies have contributed to it, we decompose the growth of cost efficiency as the sum of the growth of allocative and technical efficiencies using the relationship AE ×TE = CE (see Equation 5.5). The decomposition estimates for broad categories of banks for the full period under study as well as three sub-periods 1996–99, 1999–03 and 2003–07, are presented in Table 5.8. These sub-periods constitute the early, medium and latter phases of financial deregulation/ reform in Jordanian economy.

$$\ln\left(CE_{CRS(t)} \big/ CE_{CRS(t-1)} \right) = \ln\left(AE_{VRS(t)} \big/ AE_{VRS(t-1)} \right) + \ln\left(TE_{(t)} \big/ TE_{(t-1)} \right) \qquad (5.5)$$

As Table 5.8 shows, the banking sector as a whole experienced a decline in cost efficiency at the rate of 0.54 and 0.06 % per annum respectively in the early and middle phases of financial deregulation. In the latter phase, cost efficiency increased at the rate of 4.73 % per annum, two thirds of this improvement from an improvement in technical efficiency. Over the entire sample period, cost efficiency increased at the rate of 1.55% per annum; the improvement in allocative efficiency contributed about 60% of this figure.

In the early phase of deregulation, all bank categories except foreign banks showed deterioration in cost efficiency. However, in the latter phase, 2003–2007, small, medium and foreign banks showed large improvements in cost, allocative and technical efficiencies.

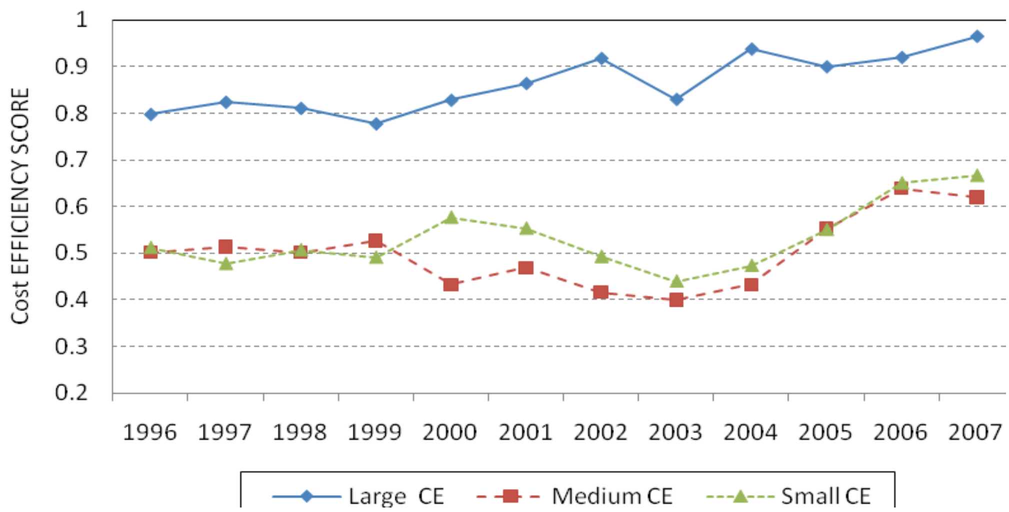
Table 5.8: Average Annual Growth Rates of Cost Efficiency by Sub-group, 1996–2007 (Percentage)

Bank type	Period	Growth of CE	Growth of AE	Growth of TE
Domestic Banks				
Large Banks				
	1996–99	-0.861	1.040	-1.901
	1999–03	1.621	-0.521	2.142
	2003–07	3.752	1.603	2.149
	1996–2007	1.719	0.677	1.042
Medium Banks				
	1996–99	1.591	4.708	-3.117
	1999–03	-6.858	-0.203	-6.655
	2003–07	10.947	2.121	8.826
	1996–2007	1.920	1.981	-0.061
Small Banks				
	1996–99	-1.416	1.899	-3.315
	1999–03	-2.758	-3.283	0.525
	2003–07	10.416	3.688	6.728
	1996–2007	2.398	0.665	1.733
Foreign Banks				
	1996–99	2.370	0.520	1.850
	1999–03	-6.071	-1.712	-4.359
	2003–07	5.856	1.828	4.028
	1996–2007	0.568	0.184	0.384
ALL Domestic Banks				
	1996–99	-0.614	1.811	-2.425
	1999–03	-0.031	-0.487	0.456
	2003–07	4.748	1.679	3.069
	1996–2007	1.548	0.928	0.620
All Banks				
	1996–99	-0.541	1.773	-2.314
	1999–03	-0.066	-0.519	0.453
	2003–07	4.735	1.681	3.054
	1996–2007	1.550	0.906	0.644

Source: author's calculations.

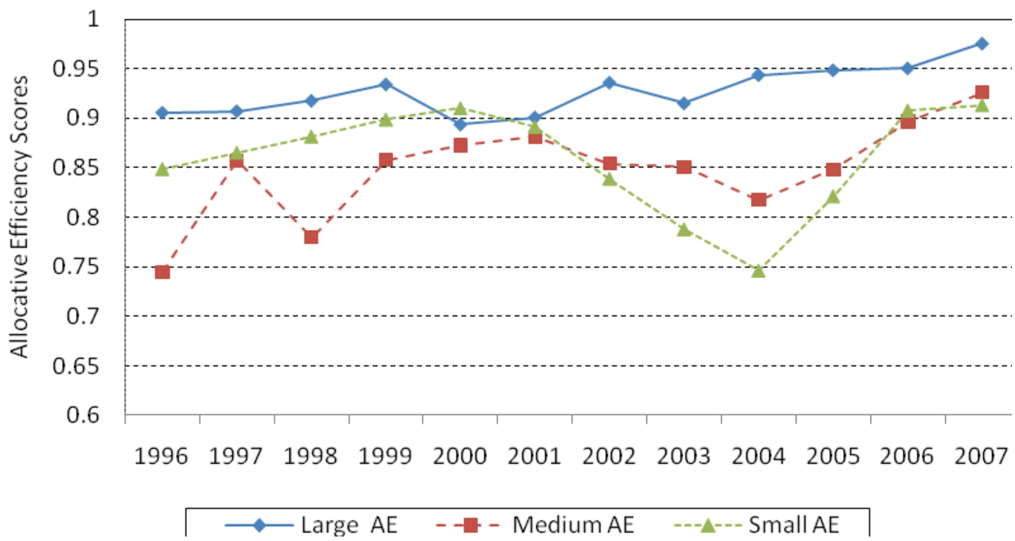
Note: CE: cost efficiency; AE: allocative efficiency; TE: technical efficiency.

Figure 5.3: DEA Estimates of Cost Efficiency by Bank Category, 1996–2007



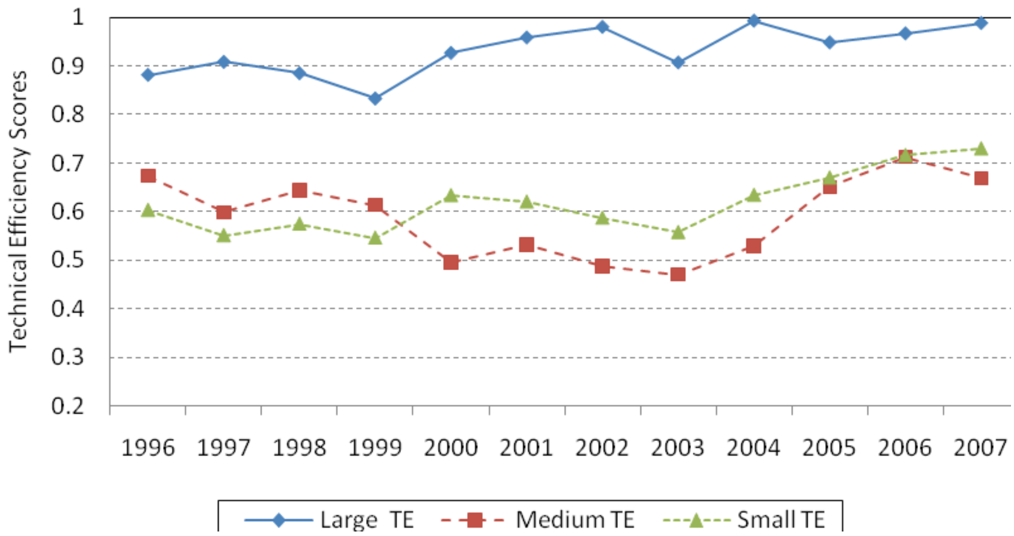
Source: author's calculations.
Note: CE: Cost Efficiency

Figure 5.4: DEA Estimates of Allocative Efficiency by Bank Category, 1996–2007



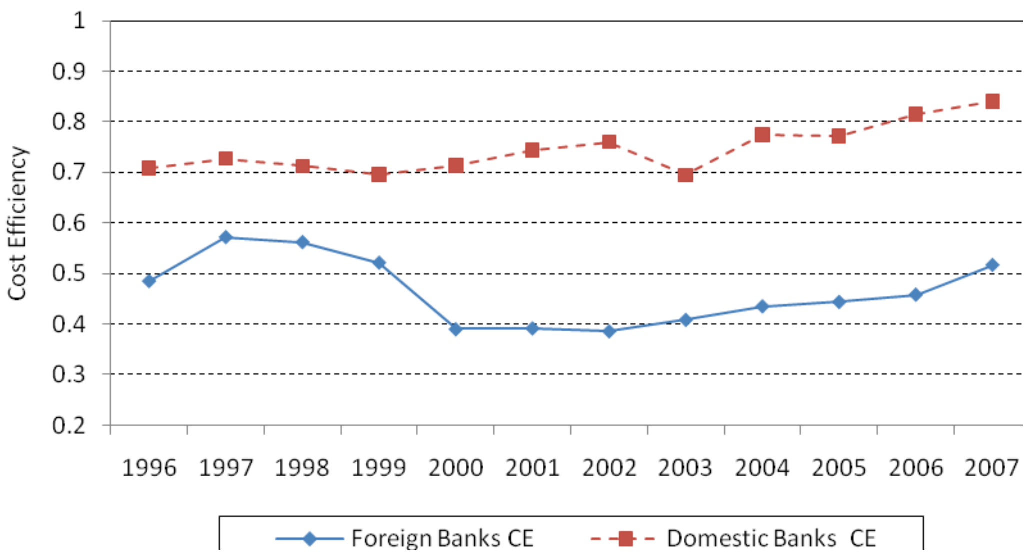
Source: author's calculations.
Note: AE: Allocative Efficiency

Figure 5.5: DEA Estimates of Technical Efficiency by Bank Category, 1996–2007



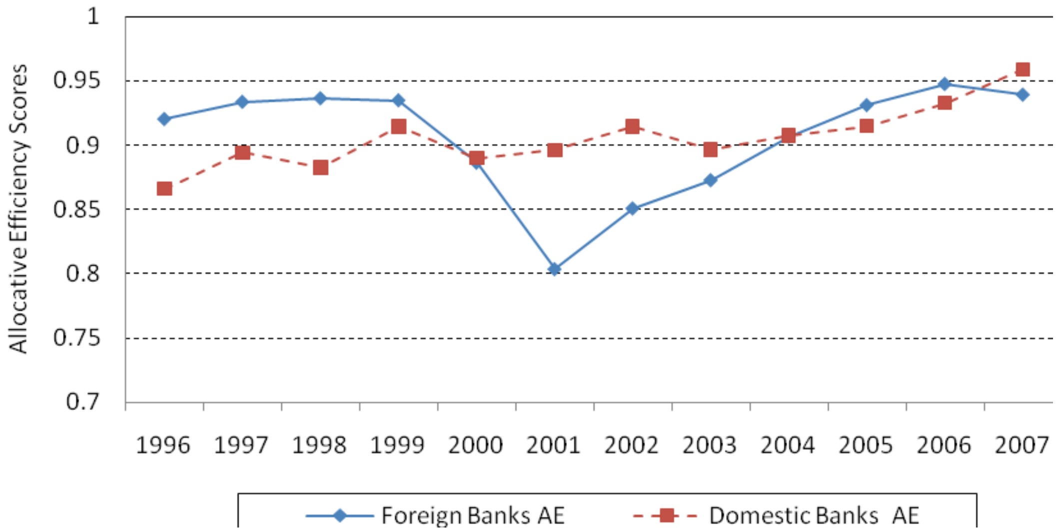
Source: author's calculations.
Note: TE: Technical Efficiency

Figure 5.6: DEA Estimates of Cost Efficiency by Bank Ownership, 1996–2007



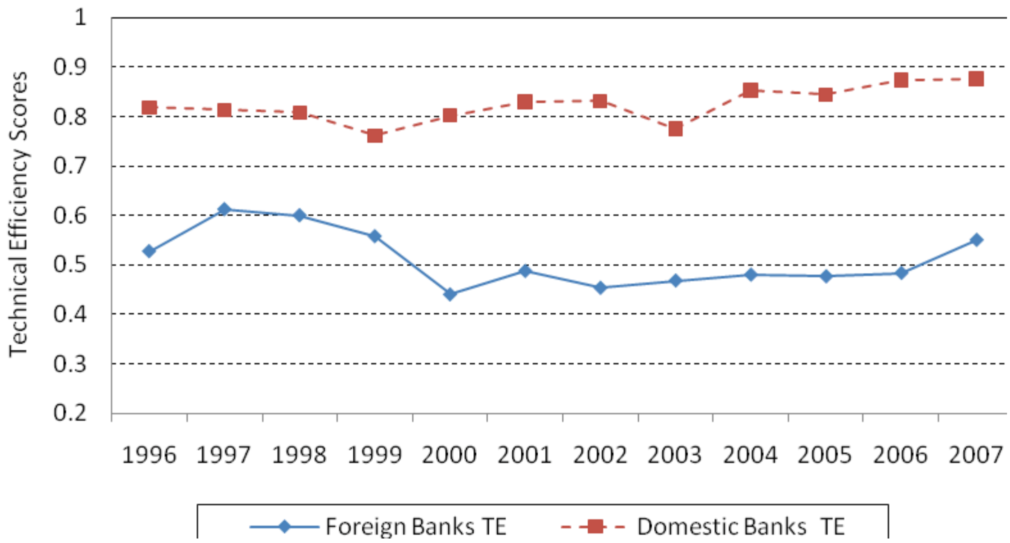
Source: author's calculations.
Note: CE: Cost Efficiency

Figure 5.7: DEA Estimates of Allocative Efficiency by Bank Ownership, 1996–2007



Source: author's calculations.
Note: AE: denotes Allocative Efficiency

Figure 5.8: DEA Estimates of Technical Efficiency by Bank Ownership, 1996–2007



Source: author's calculations.
Note: TE: Technical Efficiency

5.4. Conclusions

This chapter has investigated the level of cost efficiency in Jordanian banks. The cost efficiency scores for each bank are obtained using the input-oriented DEA model. The cost efficiency is decomposed into allocative and technical efficiency levels. Consistent with the existing literature, we find that the allocative efficiency is quite high in the Jordanian banking sector. The average cost efficiency score of banks is 0.74, which implies that they could reduce the cost of production by 26 percent without affecting the level of output.

The large banks are found most efficient in terms of cost efficiency (86%), allocative efficiency (92.7%) and technical efficiency (93%) during the sample period. The small banks rank second in terms of efficiency level. The cost efficiency of foreign banks is much lower than that of the domestic banks.

Over the entire sample period, cost efficiency has increased at the rate of 1.55% per annum; the improvement in allocative efficiency has contributed about 60% of this. While cost efficiency shows a decline during the early and middle phase of deregulation, it shows large improvements in the final phase of financial deregulation in Jordan.

CHAPTER 6
Productivity Change in the Jordanian Banking Sector

6.1 Introduction

The previous chapter investigated changes in efficiency levels of banks over the study period. DEA methodology was used on the assumption that the efficiency frontier did not shift over the sample period. The efficiency frontier can shift due to technological progress (technological innovations). Technological progress should be distinguished from gains in technical efficiency represented by units moving toward the frontier (the 'catching-up effect'). This chapter investigates changes in total factor productivity (TFP) over time, whether due to technological change (TC) or technical efficiency change (TEC) or a combination of both. The productivity change of banks is estimated using the Malmquist Productivity Index (MPI). The MPI provides a measure of total factor productivity (TFP) change, which is decomposed into the product of technical efficiency change (TEC) and technological change (TC). Technical efficiency change is further decomposed into the product of pure technical efficiency change (PTEC) and scale efficiency change (SEC). This decomposition is useful in that it provides information on the sources of productivity change in banks.

The concept of TFP change and its decomposition is discussed, and details on the estimation of the MPI methodology using DEA-like methods provided, in Section 6.2. The data and variables employed in the present chapter to estimate the MPI are those used in the investigation of efficiency in the previous chapters. Section 6.3 presents the results of TFP change and its decomposition into technical efficiency change and technological change for all 17 Jordanian banks for the period 1996–2007. Section 6.4 summarises the main findings.

6.2 The Malmquist Productivity Index (MPI): Decomposition and Measurement

The Malmquist TFP index was first introduced in two very influential papers by Caves, Christensen and Diewert (1982a, 1982b). These authors define the TFP index using Malmquist distance functions; the resulting index is therefore known as the Malmquist TFP index (MPI).

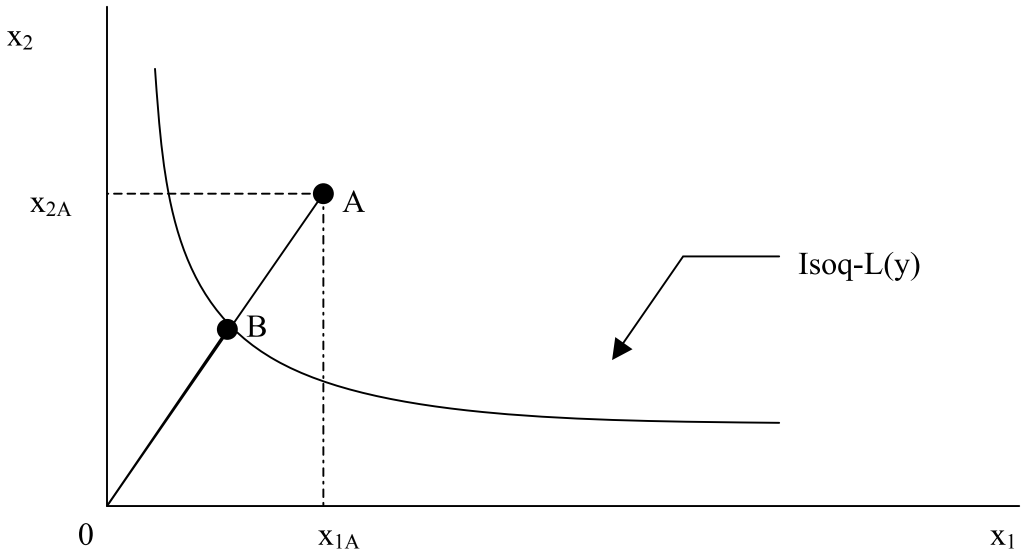
One of the important features of distance functions is that they allow description of a multi-input, multi-output production technology without the need to specify a behavioural objective such as cost minimisation or profit maximisation. Distance functions are of two types: input distance functions and output distance functions. Input distance functions look for a minimal proportional contraction of an input vector, given an output vector; and output distance functions consider the maximum proportional expansion of output with a given set of inputs. Since banks have better control over inputs than outputs, an input-orientated approach for computing TFP is adopted in this study.

Let $y_t \in R_+^M$ denotes an (Mx1) output vector, $x_t \in R_+^N$ an (Nx1) input vector, and L(y) denote the input set representing the set of all input vectors, x, which can produce the output vector, y. Then the input distance function, which involves the scaling of input vector, is defined on input set, L(y), as

$$d_i^t(y_t, x_t) = \max\{\rho_t : (x_t / \rho_t) \in L(y)\} \quad (6.1)$$

where the subscript 'i' indicates 'input oriented' measure. The notation $d_i^t(y_t, x_t)$ stands for the distance from the period t observation to the period t technology. In other words, this distance function represents the largest factor, ρ_t, by which an input vector (x_t) is deflated to produce the output vector under period t technology. Similarly, $d_i^s(y_t, x_t)$ indicates distance from period t observation to period s technology. An input distance function can be illustrated using an example where two inputs, x_1 and x_2, are used to produce a given output vector, y. For a given output vector, the production technology is represented by the isoquant, L(y), in Figure 6.1. The value of the distance function for the point, A, which defines the production point where the firm uses x_1 of input 1 and x_2 of input 2, to produce the output vector y, is equal to the ratio ρ = OA/OB.

Figure 6.1: Input Distance Function and Input Requirement Set



Source: Coelli et. al (2005)

Once input distance functions are defined, the Malmquist TFP index can be constructed to measure productivity change between periods s and t, based on period t technology:

$$m_i^t\left(y_{s,}x_s, y_{t,}x_t\right) = \frac{d_i^t\left(y_t, x_t\right)}{d_i^t\left(y_{s,}x_s\right)}. \qquad (6.2)$$

A similar output-oriented Malmquist index can be obtained based on period s technology as follows:

$$m_i^s\left(y_s, x_s, y_t, x_t\right) = \frac{d_i^s\left(y_t, x_t\right)}{d_i^s\left(y_s, x_s\right)}. \tag{6.3}$$

Clearly, Equations (6.2) and (6.3) imply that the estimation of TFP change between the two periods depends on the choice of technology. In order to avoid the effect of any arbitrarily chosen technology, Färe et al. (1994) suggest estimating the output-oriented TFP as the geometric mean of the indices based on periods t and s technologies, as given by Equations (6.2) and (6.3) respectively. Hence we have

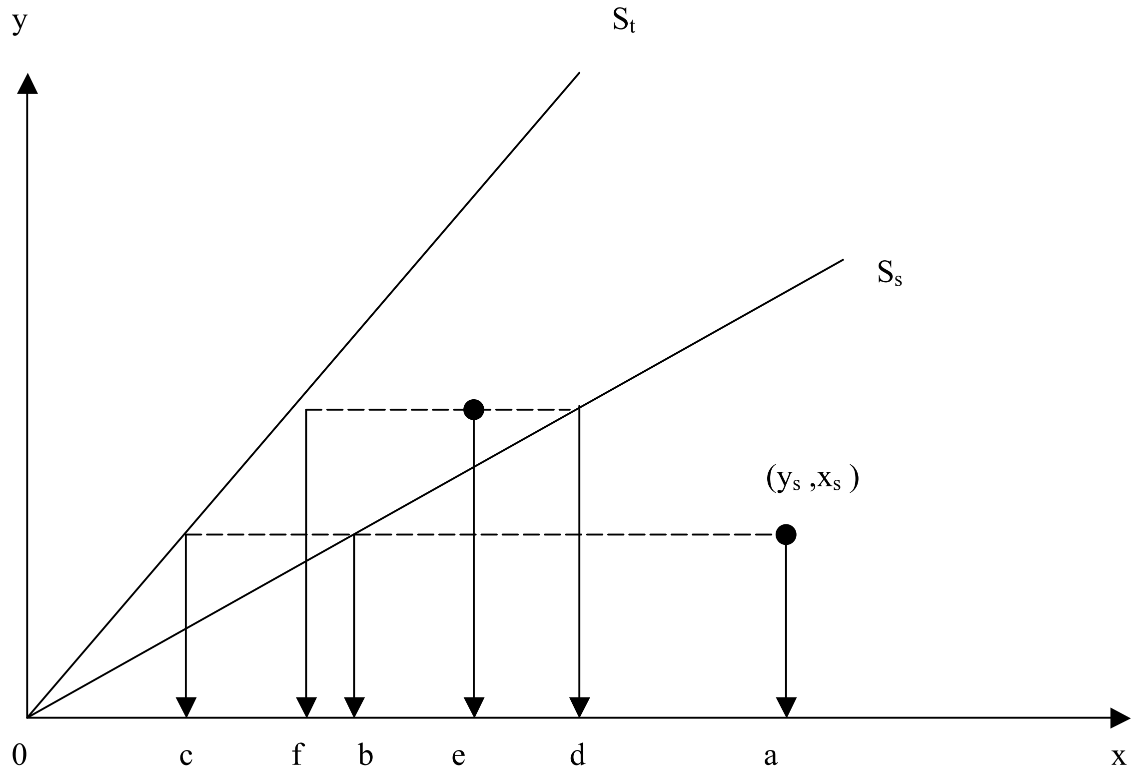
$$m_i\left(y_s, x_s, y_t, x_t\right) = \left[\left\{\frac{d_i^s\left(y_t, x_t\right)}{d_i^s\left(y_s, x_s\right)}\right\}\left\{\frac{d_i^t\left(y_t, x_t\right)}{d_i^t\left(y_s, x_s\right)}\right\}\right]^{\frac{1}{2}}. \tag{6.4}$$

When the value of m_i exceeds unity, this indicates a positive TFP growth from period s to period t, and a value of the index less than one indicates a decline in TFP growth. Equation (6.4) can be re-written as

$$m_i\left(y_s, x_s, y_t, x_t\right) = \frac{d_i^t\left(y_t, x_t\right)}{d_i^s\left(y_s, x_s\right)}\left[\left\{\frac{d_i^s\left(y_t, x_t\right)}{d_i^t\left(y_t, x_t\right)}\right\}\left\{\frac{d_i^s\left(y_s, x_s\right)}{d_i^t\left(y_s, x_s\right)}\right\}\right]^{\frac{1}{2}}. \tag{6.5}$$

The ratio outside the square brackets measures the change in the input-oriented measure of technical efficiency between periods s and t. This efficiency change is equivalent to the ratio of the Farell technical efficiency in period t to the Farell technical efficiency in period s. The remaining part of the index indicates the shift in technology between the two periods. Thus, the Malmquist TFP index given by Equation (6.5) shows that productivity change is the product of technical efficiency change (catch-up) and technological change (shift in frontier). Figure 6.2 below illustrates the decomposition.

Figure 6.2: Decomposition of Malmquist Productivity Index



Source: Fare et al (1990)

The technologies for period t and period s (t >s) are represented by S_t and S_s, showing technological progress from period s to t. Both observations (y_t, x_t) and (y_s, x_s) are inefficient with respect to their own frontier, and (y_t, x_t) does not belong to (y_s, x_s). Our formula (6.5) of the Malmquist index can be expressed in terms of distances along the x-axis thus :

$$m_i\left(y_s, x_s, y_t, x_t\right) = \frac{oe/of}{oa/ob}\left[\left\{\frac{of}{od}\right\}\left\{\frac{oc}{ob}\right\}\right]^{\frac{1}{2}} \quad (6.6)$$

To measure Malmquist TFP change between any two periods as defined in equation (6.5), four distance functions have to be calculated. The decomposition of technical efficiency change into changes in scale efficiency and pure technical efficiency components requires the calculation of the distance functions with VRS technology. The values obtained with CRS and VRS technology can be used to calculate the scale efficiency change residually. The mathematics underlying the estimation procedure is outlined in Fare and Grosskopf (1990) and Coelli et al. (2005).

6.3 Empirical Results

The data envelope approach described above is used to compute the input-oriented Malmquist indices of productivity change based on the panel data for all 17 banks (two large, eight medium, four small and three foreign) for the period 1996–2007. The output and input variables are the same as in the previous chapters. The computer software DEAP (Coelli, 1996) is used to calculate these indices. As mentioned earlier, by definition DEA efficiency scores assign numerical values (between 0 and 1 or 0 and 100%) to the efficiency level of a DMU relative to others; but in the case of MPI, a value of the index greater than one indicates positive productivity growth or productivity progress, while a value less than one indicates productivity decline or productivity regress. Percentage change in productivity is given by (Productivity Change – 1) x 100. Where mean aggregate indices are reported for the different groups of banks, these are weighted geometric means, in this case using the shares of individual banks in the group output as weights. The broad bank categories are the same as in previous chapters. The indices aggregated over the period are also weighted geometric means, where shares of yearly outputs in the total output for the period are used as weights.

The sample period mean results for TFP change and its components of technical efficiency change, pure technical efficiency change, scale efficiency change and technological change indices for each bank are presented in Table 6.1. The results reveal that both the large banks, five medium-sized banks, two small and one foreign bank have shown productivity improvements and the seven other banks showed productivity regress over the years. The highest mean TFP growth per annum was that of the Jordan Kuwait Bank (5.7%) and the lowest that of the Housing Bank for Trade and Finance (HBTF). The observed improvement in mean TFP is largely attributable to technological progress. About half of the banks showed a decline in their technical efficiency. All the domestic banks showed either marginal improvement (less than 1% per year) in their scale efficiency or remained at the constant returns to scale during the entire period. The scale efficiency of foreign banks declined in their scale inefficiency; the highest decline (-7.6% per annum) was observed for the Citi Bank.

Table 6.1: Mean MPI Estimates of Productivity Change and its Components, 1996–2007

Banks	TFPC	TC	TEC	PTEC	SEC
			Domestic Banks		
Large					
AB	1.044	1.044	1.000	1.000	1.000
HBTF	1.018	1.014	1.004	1.000	1.004
Medium					
JKB	1.057	1.028	1.028	1.030	0.999
JIBF	0.968	1.025	0.945	0.946	0.998
JNB	0.967	1.010	0.957	0.955	1.002
BOJ	0.971	0.995	0.976	0.971	1.005
CAB	1.022	1.019	1.003	0.995	1.008
UBJ	1.038	1.047	0.992	0.984	1.007
CPB	1.032	1.032	1.000	1.000	1.000
JIFB	1.073	1.073	1.000	1.000	1.000
Small					
ABC	1.033	1.032	1.002	1.009	0.992
JCB	0.984	0.996	0.988	0.989	0.999
AJIB	1.073	1.017	1.054	1.048	1.006
SGBJ	0.999	1.006	0.994	1.003	0.990
Foreign					
HSBC	0.993	1.031	0.964	0.969	0.994
BSC	1.032	1.043	0.989	1.001	0.988
CB	0.977	1.041	0.938	1.015	0.924

Source: author's calculations.
Note: TFP: total factor productivity; TEC: technical efficiency change; PTEC: pure technical efficiency change; SE: scale efficiency change; TC: technological change.

Table 6.2 records the mean MPI estimates for the broad groups of banks and the banking sector as a whole. Over the sample period of the entire deregulation era, the Jordanian banking sector as a whole showed a productivity growth of 3.5% per year, largely due to technological improvement. The productivity change among domestic banks was much higher than in foreign banks. Amongst the domestic banks, large banks showed the highest productivity improvement.

It is worthwhile to compare these estimates of TFP growth with those for the regulated period. Magayrah (2004) investigated the estimates of TFP for eight domestic banks in the years prior to banking and financial liberalisation in Jordan. Calculations of the geometric means of the TFP and its components, using his estimates for the period 1985–1995, are presented in Table 6.3. While the estimates presented in this table are not strictly comparable to the ones in this study, largely because of the difference in the sample size, the comparison does provide a broad and interesting picture. Productivity growth during the regulated period of 1985–1995 was only 1.0% per annum, whereas the deregulated period showed (as noted earlier) a growth of 3.5% per annum. The unregulated period showed a 3.8% increase in technological progress, against no technological change during the regulated and controlled regime. This comparison does reveal that deregulation or, say, financial liberalisation, has led to technological improvement (and hence enhanced TFP) in the Jordanian banking sector.

Table 6.2: Mean MPI Estimates of Productivity Change Broad Groupby Category, 1996–2007

Banks	TFPC	TC	TEC	PTEC	SEC
Large	1.0423	1.0420	1.0003	1.0000	1.0003
Medium	1.0041	1.0206	0.9838	0.9834	1.0005
Small	1.0266	1.0110	1.0155	1.0167	0.9988
Foreign Banks	1.0134	1.0380	0.9763	0.9871	0.9890
All Domestic Banks	1.0353	1.0381	0.9974	0.9969	1.0005
ALL Banks	1.0350	1.0384	0.9967	0.9966	1.0001

Source: author's calculations.

Table 6.3: MPI Estimates for Eight Jordanian Banks, 1985-1995

MPI	Mean
TFPC	1.010
TC	0.998
TEC	1.012
PTEC	1.009
SEC	1.003

Source: Magayrah (2004)

The annual estimates of productivity change and its components for each bank, presented in Table 6.4, show yearly fluctuations in efficiency and technological levels. Both large banks show TFP improvements during two thirds of the sample years, whereas in all other domestic banks TFP improvement is revealed in about half of the sample years (see also Table 6.5). To check how productivity has changed over the sub-periods of financial reforms, Table 6.6 presents the estimates of TFP for the broad categories of banks for the three sub-periods that represent the early, middle and late phases of financial liberalisation. In the early phase of deregulation, TFP growth in none of the domestic bank subgroups was different from that of the pre-deregulation period. All the bank categories except small and foreign banks showed accelerated TFP growth in the second phase of deregulation. The large banks showed the highest TFP growth (10.5%) per annum, largely due to technological improvement. The medium-sized and foreign bank groups each showed TFP regress of about 6.5% per annum and a decline in both technical and technological efficiencies. The TFP growth across all bank categories except the large banks improved in the latter phase of deregulation, implying that the banking sector responded positively to the financial liberalisation policies initiated by the Jordanian government.

Table 6.4: MPI Estimates of Productivity Change and its Components, 1996–2007

Banks	Prod	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Mean
large														
Arab Bank	TFPC	1.000	1.105	1.046	0.914	1.540	1.023	1.061	0.913	1.134	0.917	0.919	1.094	1.044
	TC	1.000	1.105	1.046	0.914	1.540	1.023	1.061	0.913	1.134	0.917	0.919	1.094	1.044
	TEC	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	PTEC	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	SEC	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
HBTF	TFPC	1.000	1.001	1.040	0.889	1.019	1.345	0.968	0.882	1.168	0.983	1.059	0.945	1.018
	TC	1.000	0.891	1.260	0.901	1.049	1.242	1.145	0.713	1.070	1.064	1.124	0.862	1.014
	TEC	1.000	1.123	0.825	0.986	0.972	1.083	0.846	1.238	1.091	0.925	0.942	1.096	1.004
	PTEC	1.000	1.000	1.000	1.000	0.975	1.026	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	SEC	1.000	1.123	0.825	0.986	0.997	1.055	0.846	1.238	1.091	0.925	0.942	1.096	1.004
medium														
JKB	TFPC	1.000	1.154	0.878	0.948	0.957	1.222	1.013	1.067	1.121	1.266	1.276	0.887	1.057
	TC	1.000	0.893	1.185	1.167	0.872	0.987	0.867	1.248	1.095	1.061	1.131	0.925	1.028
	TEC	1.000	1.293	0.740	0.812	1.098	1.238	1.169	0.855	1.023	1.193	1.128	0.959	1.028
	PTEC	1.000	1.303	0.747	0.936	1.106	1.155	1.220	1.000	1.000	1.000	1.000	1.000	1.030
	SEC	1.000	0.992	0.991	0.868	0.993	1.072	0.958	0.855	1.023	1.193	1.128	0.959	0.999
JIBF	TFPC	1.000	0.973	0.930	1.021	0.693	0.909	0.791	0.940	1.025	1.318	1.031	1.128	0.968
	TC	1.000	0.973	1.000	1.183	0.902	1.029	0.895	1.239	1.037	1.071	1.151	0.888	1.025

Banks	Prod	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Mean
	TEC	1.000	1.000	0.930	0.863	0.768	0.883	0.883	0.758	0.989	1.231	0.896	1.270	0.945
	PTEC	1.000	1.000	0.974	1.027	0.803	0.837	0.869	0.843	0.874	1.102	0.857	1.270	0.946
	SEC	1.000	1.000	0.955	0.841	0.957	1.055	1.017	0.899	1.131	1.117	1.046	1.000	0.998
JNB	TFPC	1.000	0.949	1.185	0.881	0.743	0.922	0.824	1.011	0.894	1.262	1.129	0.923	0.967
	TC	1.000	0.849	1.185	1.222	0.784	0.985	0.871	1.251	0.903	1.108	1.120	0.974	1.010
	TEC	1.000	1.118	1.001	0.721	0.947	0.936	0.946	0.808	0.990	1.140	1.008	0.948	0.957
	PTEC	1.000	1.000	1.000	1.000	0.958	0.918	0.896	0.924	0.711	1.166	0.931	1.020	0.955
	SEC	1.000	1.118	1.001	0.721	0.988	1.020	1.056	0.874	1.392	0.978	1.082	0.930	1.002
BOJ	TFPC	1.000	0.780	1.270	0.956	0.840	1.058	0.967	0.942	1.065	0.946	1.056	0.860	0.971
	TC	1.000	0.876	1.165	1.132	0.759	0.997	0.874	1.226	0.893	1.081	1.155	0.903	0.995
	TEC	1.000	0.891	1.090	0.845	1.107	1.061	1.107	0.768	1.193	0.874	0.915	0.951	0.976
	PTEC	1.000	0.818	1.177	0.980	1.056	1.050	1.179	0.865	0.902	0.885	0.847	0.968	0.971
	SEC	1.000	1.089	0.926	0.862	1.048	1.011	0.939	0.888	1.322	0.988	1.080	0.983	1.005
CAB	TFPC	1.000	0.880	1.206	0.872	0.978	0.983	0.965	1.019	1.179	1.436	0.977	0.898	1.022
	TC	1.000	0.894	1.151	1.188	0.848	0.997	0.868	1.215	0.998	1.106	1.107	0.944	1.019
	TEC	1.000	0.984	1.048	0.735	1.153	0.986	1.112	0.839	1.182	1.298	0.883	0.951	1.003
	PTEC	1.000	0.881	1.070	0.942	1.135	0.920	1.155	0.884	0.960	1.275	0.849	0.961	0.995
	SEC	1.000	1.117	0.980	0.780	1.016	1.072	0.963	0.949	1.231	1.018	1.040	0.989	1.008
UBJ	TFPC	1.000	1.223	0.855	0.964	0.990	1.173	0.878	1.059	1.457	1.118	0.962	0.915	1.038
	TC	1.000	1.112	1.537	1.052	0.808	0.986	0.878	1.178	0.986	1.102	1.068	1.005	1.047
	TEC	1.000	1.100	0.556	0.916	1.225	1.189	1.000	0.899	1.477	1.015	0.901	0.911	0.992
	PTEC	1.000	1.000	0.558	0.938	1.224	1.166	1.064	0.841	1.486	1.007	0.910	0.909	0.984

Banks	Prod	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Mean
	SEC	1.000	1.100	0.997	0.977	1.000	1.021	0.940	1.069	0.994	1.007	0.990	1.001	1.007
CPB	TFPC	1.000	0.816	1.622	1.033	1.026	0.978	1.041	0.898	1.020	1.057	1.002	1.053	1.032
	TC	1.000	0.857	1.545	1.033	1.026	0.978	1.041	0.898	1.020	1.057	1.002	1.053	1.032
	TEC	1.000	0.953	1.050	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	PTEC	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	SEC	1.000	0.953	1.050	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
JIFB	TFPC	1.000	1.196	1.497	1.262	0.740	1.730	0.839	0.826	1.278	0.961	1.175	0.807	1.073
	TC	1.000	1.196	1.497	1.262	0.978	1.309	1.066	0.650	1.278	0.961	1.175	0.807	1.073
	TEC	1.000	1.000	1.000	1.000	0.756	1.322	0.786	1.272	1.000	1.000	1.000	1.000	1.000
	PTEC	1.000	1.000	1.000	1.000	0.823	1.216	0.864	1.157	1.000	1.000	1.000	1.000	1.000
	SEC	1.000	1.000	1.000	1.000	0.919	1.088	0.910	1.099	1.000	1.000	1.000	1.000	1.000
small														
ABC	TFPC	1.000	0.984	0.985	0.925	1.010	1.014	1.006	1.080	1.112	1.114	1.146	1.043	1.033
	TC	1.000	0.984	1.132	1.222	0.796	0.992	0.874	1.241	1.054	1.064	1.134	0.979	1.032
	TEC	1.000	1.000	0.870	0.757	1.269	1.022	1.152	0.870	1.056	1.047	1.011	1.066	1.002
	PTEC	1.000	1.004	0.949	0.786	1.125	1.014	1.166	0.867	1.109	1.100	1.044	1.015	1.009
	SEC	1.000	0.996	0.916	0.963	1.128	1.008	0.988	1.004	0.952	0.951	0.968	1.050	0.992
JCB	TFPC	1.000	0.943	0.994	0.956	1.123	1.005	0.694	1.265	1.000	1.027	0.901	1.006	0.984
	TC	1.000	0.938	0.965	1.222	0.772	1.005	0.841	1.192	1.019	1.069	1.146	0.888	0.996
	TEC	1.000	1.006	1.029	0.782	1.456	1.000	0.825	1.061	0.981	0.961	0.787	1.133	0.988
	PTEC	1.000	1.016	1.007	0.934	1.212	1.000	0.888	1.062	1.060	0.965	0.743	1.060	0.989
	SEC	1.000	0.990	1.022	0.838	1.201	1.000	0.929	0.999	0.926	0.996	1.058	1.069	0.999

Banks	Prod	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Mean
AJIB	TFPC	1.000	0.928	1.220	1.094	1.658	0.823	1.241	0.754	1.306	0.946	1.171	1.015	1.073
	TC	1.000	0.945	1.505	0.809	0.976	1.322	1.108	0.681	1.138	1.024	1.188	0.793	1.017
	TEC	1.000	0.981	0.810	1.352	1.698	0.622	1.120	1.107	1.148	0.924	0.986	1.281	1.054
	PTEC	1.000	0.950	0.888	1.191	1.746	0.644	1.092	1.068	1.158	1.005	0.957	1.196	1.048
	SEC	1.000	1.033	0.912	1.135	0.973	0.967	1.025	1.036	0.992	0.919	1.031	1.071	1.006
SGBJ	TFPC	1.000	0.888	1.113	0.727	0.777	1.423	1.036	0.948	1.170	0.857	1.240	1.021	0.999
	TC	1.000	0.931	1.043	1.222	0.755	0.998	0.882	1.167	1.095	1.061	1.131	0.888	1.006
	TEC	1.000	0.954	1.068	0.595	1.029	1.426	1.175	0.813	1.068	0.808	1.097	1.150	0.994
	PTEC	1.000	1.038	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.003
	SEC	1.000	0.919	1.068	0.595	1.029	1.426	1.175	0.813	1.068	0.808	1.097	1.150	0.990
foreign														
HSBC	TFPC	1.000	1.232	0.893	0.828	0.885	0.906	0.978	1.024	1.001	1.054	1.090	1.096	0.993
	TC	1.000	1.020	1.152	1.356	0.737	0.964	0.885	1.260	1.095	1.061	1.065	0.920	1.031
	TEC	1.000	1.208	0.776	0.610	1.201	0.940	1.105	0.812	0.914	0.994	1.023	1.191	0.964
	PTEC	1.000	1.188	0.896	0.691	0.933	0.948	1.088	0.936	0.903	1.136	1.028	0.984	0.969
	SEC	1.000	1.017	0.866	0.883	1.287	0.992	1.016	0.868	1.012	0.875	0.995	1.210	0.994
BSC	TFPC	1.000	1.198	1.163	0.983	0.668	0.917	0.958	1.153	1.193	1.076	0.978	1.256	1.032
	TC	1.000	0.994	1.278	1.288	0.882	0.862	0.981	1.111	1.192	1.064	1.024	0.944	1.043
	TEC	1.000	1.205	0.910	0.763	0.757	1.063	0.977	1.038	1.001	1.011	0.955	1.331	0.989
	PTEC	1.000	1.211	1.039	0.882	0.584	1.624	0.881	1.139	0.933	1.083	0.856	1.112	1.001
	SEC	1.000	0.996	0.876	0.865	1.295	0.654	1.109	0.911	1.073	0.934	1.115	1.197	0.988
CB	TFPC	1.000	0.925	1.073	1.114	0.632	1.036	1.553	0.802	0.975	0.450	1.263	1.517	0.977

Banks	Prod	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Mean
	TC	1.000	1.024	1.106	1.279	0.922	0.959	1.020	1.036	1.103	1.027	1.019	1.041	1.041
	TEC	1.000	0.903	0.970	0.871	0.686	1.080	1.523	0.775	0.884	0.438	1.240	1.456	0.938
	PTEC	1.000	0.902	1.229	1.082	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.015
	SEC	1.000	1.001	0.789	0.805	0.686	1.080	1.523	0.775	0.884	0.438	1.240	1.456	0.924

Source: authors' calculations

Table 6.5: MPI Productivity Change by Bank Category, 1996–2007

Banks	Prod	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Mean
Domestic Banks														
Large														
	TFPC	1.000	1.091	1.045	0.911	1.479	1.054	1.051	0.910	1.138	0.927	0.943	1.066	1.0423
	TC	1.000	1.076	1.071	0.912	1.484	1.045	1.069	0.889	1.126	0.940	0.953	1.049	1.0420
	TEC	1.000	1.015	0.976	0.998	0.997	1.009	0.983	1.023	1.011	0.987	0.989	1.016	1.0003
	PTEC	1.000	1.000	1.000	1.000	0.998	1.003	1.000	1.000	1.000	1.000	1.000	1.000	1.0000
	SEC	1.000	1.015	0.976	0.998	1.000	1.006	0.983	1.023	1.011	0.987	0.989	1.016	1.0003
Medium														
	TFPC	1.000	0.959	1.123	0.959	0.831	1.061	0.902	0.979	1.091	1.185	1.087	0.930	1.0041
	TC	1.000	0.924	1.171	1.178	0.842	1.024	0.899	1.152	0.998	1.075	1.115	0.937	1.0206
	TEC	1.000	1.037	0.959	0.814	0.987	1.037	1.003	0.850	1.093	1.102	0.975	0.992	0.9838
	PTEC	1.000	0.977	0.982	0.985	0.993	0.996	1.022	0.919	0.942	1.056	0.922	1.015	0.9834
	SEC	1.000	1.061	0.976	0.826	0.993	1.041	0.982	0.925	1.161	1.044	1.057	0.977	1.0005
Small														
	TFPC	1.000	0.946	1.054	0.963	1.201	0.975	0.976	0.970	1.159	1.008	1.079	1.021	1.0266
	TC	1.000	0.954	1.141	1.092	0.831	1.070	0.936	0.992	1.081	1.054	1.153	0.884	1.0110
	TEC	1.000	0.992	0.923	0.882	1.445	0.911	1.042	0.978	1.073	0.957	0.936	1.156	1.0155
	PTEC	1.000	0.998	0.957	0.952	1.309	0.902	1.047	0.980	1.104	1.020	0.913	1.078	1.0167
	SEC	1.000	0.994	0.964	0.926	1.104	1.010	0.995	0.998	0.973	0.938	1.025	1.073	0.9988
Foreign Banks														

Banks	Prod	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Mean
	TFPC	1.000	1.175	1.027	0.939	0.752	0.934	1.078	1.014	1.067	1.000	1.053	1.203	1.0134
	TC	1.000	1.010	1.199	1.311	0.819	0.930	0.940	1.167	1.132	1.060	1.044	0.942	1.0380
	TEC	1.000	1.163	0.857	0.716	0.918	1.004	1.147	0.868	0.942	0.944	1.009	1.277	0.9763
	PTEC	1.000	1.155	0.996	0.829	0.770	1.134	1.007	1.007	0.928	1.103	0.948	1.042	0.9871
	SEC	1.000	1.006	0.860	0.863	1.192	0.886	1.138	0.862	1.015	0.855	1.064	1.225	0.9890
All Domestic Banks														
	TFPC	1.000	1.055	1.063	0.924	1.302	1.052	1.015	0.926	1.129	0.994	0.988	1.025	1.0353
	TC	1.000	1.035	1.096	0.976	1.287	1.041	1.026	0.943	1.095	0.979	1.006	1.009	1.0381
	TEC	1.000	1.019	0.970	0.946	1.012	1.010	0.989	0.982	1.031	1.015	0.982	1.016	0.9974
	PTEC	1.000	0.995	0.994	0.994	1.009	0.997	1.006	0.981	0.991	1.016	0.973	1.008	0.9969
	SEC	1.000	1.024	0.976	0.952	1.003	1.013	0.983	1.000	1.040	1.000	1.010	1.008	1.0005
ALL Banks														
	TFPC	1.000	1.059	1.062	0.925	1.287	1.049	1.016	0.928	1.127	0.994	0.990	1.029	1.0350
	TC	1.000	1.035	1.099	0.986	1.275	1.039	1.025	0.948	1.096	0.981	1.007	1.007	1.0384
	TEC	1.000	1.023	0.966	0.938	1.009	1.010	0.992	0.979	1.029	1.014	0.983	1.022	0.9967
	PTEC	1.000	1.000	0.994	0.988	1.003	0.999	1.006	0.982	0.989	1.017	0.972	1.009	0.9966
	SEC	1.000	1.023	0.972	0.949	1.007	1.011	0.986	0.997	1.040	0.997	1.011	1.013	1.0001

Source: authors' calculation.

Table 6.6: Mean MPI Estimates of Productivity Change by Sub-group, 1996– 2007

Banks	Prod	1996–99	1999–03	2003–07	1996–2007
Domestic Banks					
Large					
	TFPC	1.0097	1.1048	1.0150	1.0423
	TC	1.0125	1.1018	1.0141	1.0420
	TEC	0.9972	1.0028	1.0009	1.0003
	PTEC	1.0000	1.0001	1.0000	1.0000
	SEC	0.9972	1.0028	1.0009	1.0003
Medium					
	TFPC	1.0079	0.9394	1.0692	1.0041
	TC	1.0627	0.9720	1.0292	1.0206
	TEC	0.9486	0.9664	1.0389	0.9838
	PTEC	0.9861	0.9818	0.9822	0.9834
	SEC	0.9619	0.9843	1.0577	1.0005
Small					
	TFPC	0.9900	1.0260	1.0653	1.0266
	TC	1.0443	0.9535	1.0378	1.0110
	TEC	0.9480	1.0760	1.0265	1.0155
	PTEC	0.9767	1.0491	1.0257	1.0167
	SEC	0.9705	1.0258	1.0010	0.9988
Foreign Banks					
	TFPC	1.0316	0.9358	1.0780	1.0134
	TC	1.1227	0.9560	1.0421	1.0380
	TEC	0.9190	0.9789	1.0345	0.9763
	PTEC	0.9885	0.9702	1.0030	0.9871
	SEC	0.9297	1.0089	1.0314	0.9890
All Domestic Banks					
	TFPC	1.0089	1.0652	1.0327	1.0353
	TC	1.0260	1.0674	1.0215	1.0381
	TEC	0.9834	0.9980	1.0110	0.9974
	PTEC	0.9958	0.9982	0.9966	0.9969
	SEC	0.9875	0.9998	1.0144	1.0005
ALL Banks					
	TFPC	1.0097	1.0622	1.0337	1.0350
	TC	1.0290	1.0649	1.0218	1.0384
	TEC	0.9812	0.9975	1.0117	0.9967
	PTEC	0.9956	0.9974	0.9967	0.9966
	SEC	0.9855	1.0001	1.0150	1.0001

Source: authors' calculations.

6.4 Concluding Remarks

This chapter has used the DEA approach to estimate input-oriented Malmquist indices to examine TFP changes in the Jordanian banking sector during the entire deregulated period, 1996–2007. The TFP changes were decomposed into the product of technological change and technical efficiency change (catch-up). The technical efficiency change was further decomposed into the product of pure technical efficiency change and the product of scale efficiency change. This is the first known attempt to investigate TFP change in both domestic and foreign banks in Jordon over the entire deregulated period.

The research reveals that over the sample period which covers the entire deregulation era, the Jordanian banking sector as a whole showed a productivity growth of 3.5 per year, largely due to technological improvement. The productivity change among domestic banks was much higher than among foreign banks. Amongst the domestic banks, large banks showed the highest productivity improvement.

The productivity growth during the regulated period of 1985–1995 was only 1.0% per annum, which is much lower than the per annum productivity growth reported here. This shows that the banking sector has responded positively to the deregulation and liberalisation policies of the government, to achieve greater efficiency and productivity.

CHAPTER 7
Summary and Conclusions

7.1 Summary and Conclusions

This study was undertaken to investigate efficiency and productivity changes in the Jordanian banking sector during the financial deregulated period 1996–2007. In an earlier study, Ahmad (2000) analysed the cost efficiency of 20 banks for 1990–1996. In an unpublished paper, Maghyereh (2004) examines the efficiency and productivity change in eight domestic banks over the period 1984–2001. This present study makes a significant contribution to the literature on Jordanian banking efficiency and productivity change by covering almost the entire sector and all of the deregulated period, which has not been fully compassed in earlier studies. The results of this study should help policy makers and bankers in understanding the ways regulatory changes influence banks' efficiency and productivity.

The study used an input-oriented DEA approach to analyse the levels of efficiency and productivity change in seventeen banks, consisting of two large, eight medium, four small and three foreign banks. Chapter 2 provided an overview of the development of banking services in Jordan, beginning with a brief discussion of the Jordanian economy and its financial sector. Since the study focused on the performance of banks in terms of their efficiency and productivity, an overview of the developments of the Jordanian banking sector was provided, with details about the commercial, Islamic and foreign banks operating in Jordan during 1996–2007. The historical developments that affected the Jordanian economy and financial institutions and led to the financial liberalisation (deregulation) program were highlighted.

Chapter 3 provided a selective review of previous studies of banking efficiency conducted in the Middle East and the rest of the world. It reveals that the majority of studies on banking efficiency in the Middle East have used a DEA approach; only a few have used SFA methodology to compute efficiency estimates. These did not compass the entire financial regulation period; the present study fills a gap in the literature on the Jordanian banking sector by covering the entire deregulated period.

The main results of this research are provided in Chapters 4 through 6. An input-oriented DEA model is used to obtain and analyse the estimates of technical efficiency of 17 banks during 1996–2007, for which comparable data were available from reliable sources. The efficiency scores for different categories of banks – small, medium, large and foreign – were obtained as the weighted geometric means of the bank-specific scores, with their output shares serving as weights. The same procedure was adopted to obtain average scores over the entire period as well as three sub-periods, 1996–1999, 1999–2003 and 2003–2007, representing the early, middle and latter phases of financial deregulation in Jordan.

The results obtained in Chapter 4 reveal several interesting points. First, the average technical efficiency for all banks is found to be 79.2%. This implies that inputs can be reduced by 20.8% on average, relative to the best-practice banks during the sample period.

Second, the Arab Bank, one of the two large banks involved in this study, performed at the highest level of technical efficiency (90%) during the sample period. Small banks were found to be more efficient than medium sized banks. Foreign banks showed the lowest technical efficiency, indicating scope for cost reduction.

Third, the large banks operated at decreasing returns to scale (DRS) over the entire period. This indicates that large banks must reduce the size of their operations to achieve efficiency improvements. On the other hand, most of the small-sized banks operated at increasing returns to scale (IRS) over the sample period. This indicates that they must increase the size of their operations to reach optimal scale efficiency. However, the results also reveal that banks can be efficient at different sizes. This is consistent with studies conducted elsewhere.

Fourth, the banking sector as a whole has shown improvements in technical efficiency at the average rate of 0.37% per year over the study period. This seems to be due to substantial improvement in pure technical efficiency (0.64% per year). The improvement in technical efficiency would have been higher had there been no decline in scale efficiencies.

Finally the scores of technical efficiency provided insights into the input-output inefficiencies experienced by Jordanian banks, suggesting that staff numbers and total deposits are the most common sources of inefficiency. Banks need to use their deposits more efficiently and reduce their staff to enhance efficiency.

The results described above were obtained by assuming that there are no allocative inefficiencies in the banking sector, and that the frontier remains the same throughout the sample period. The first assumption was guided by the international literature, which suggests that allocative inefficiency is negligible during a short sample period. This assumption was dropped in Chapter 5, which focused on overall (cost) efficiency, the product of technical and allocative efficiencies. Assuming the frontier remained unchanged over the sample period enabled a comparison of the estimates of technical efficiencies across times and banks.

The results presented in Chapter 5 provide an average cost efficiency score of 0.74, implying that the banking sector could reduce the costs of production by 26 per cent without affecting the level of output. Again, large banks were found to be the most efficient in terms of cost efficiency (86%), allocative efficiency (92.7%) and technical efficiency (93%). Small banks ranked second in terms of efficiency levels.

While cost efficiency showed a decline during the early and middle phases of deregulation, it made great improvement in the final phase of financial deregulation in Jordan.

In Chapters 4 and 5, it was assumed that the efficiency frontier had not shifted over the sample period. The efficiency frontier can shift due to technological progress (technological innovations). The technological progress should be distinguished from gains in technical efficiency represented by units moving toward the frontier (commonly referred to as the 'catching-up effect'). Chapter 6 investigated over-time changes in total factor productivity (TFP) of banks, changes which could be due either to technological change (TC) or technical efficiency change (TEC), or a combination of both. The productivity changes of banks were measured by estimating the Malmquist Productivity Indices. The results revealed that the Jordanian banking sector as a whole showed a productivity growth of 3.5 per cent per annum, largely due to technological improvement. Productivity growth during the regulated period of 1985–1995, at 1.0% per annum, was less than the per annum productivity growth reported here. This shows that the banking sector has responded positively to the deregulation and liberalisation policies of the government to achieve greater efficiency and productivity.

7.2 Limitations and Suggestions for Future Research

Like any other research, the current study is not free from limitations and there is scope for refining and extending the results. The results presented in this study are based on a DEA approach. The parametric approach, particularly the stochastic frontier approach (SFA), provides additional avenues for efficiency analysis; for example, SFA allows the application of statistical tools to test the significance of cost or profit efficiencies. Further research based on flexible stochastic cost and profit functions will add to our understanding of efficiency and productivity changes in the Jordanian banking sector.

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